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Developing Disaster Health Preparedness in Australia

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A thesis by portfolio of publications submitted in partial fulfillment of the requirements of the degree of Doctor of Public Health within the College of Public Health, Medical and Veterinary Sciences, Division of Tropical Health and Medicine, James Cook University, Townsville, Australia.

October 2015

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Declaration on Ethics

The research presented and reported in this thesis was conducted within the guidelines for research ethics outlined in the *National Statement on Ethics Conduct in Research Involving Human (*1999*)*, the *Joint NHMRC/AVCC Statement and Guidelines on Research Practice* (1997)*,* the *James Cook University Policy on Experimentation Ethics*. *Standard Practices and Guidelines* (2001), and the *James Cook University Statement and Guidelines on Research Practice* (2001).

The research methodology received clearance from the:

- James Cook University Human Research Ethics Committee
    - Approval number H3456
        - Papers 4.2 to 4.4 (QSS Pandemic Survey).
    - Approval number H2464
        - Papers 5.1 to 5.6 (DMAT Survey).
- Central Queensland University Human Research Ethics Committee
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We all have goals in life. One of mine was to complete my doctorate in four years. I have not met this somewhat ambitious timeframe, but have learned far more during this period, both about disaster health and myself than I ever thought possible, and made friends for life I would have never met otherwise.

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I offer you the thesis.

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The scope of these research programs extends far beyond disaster health. For this reason not all papers from these research programs have been included but only those directly relevant to the thesis.

Abstract

Disasters have always occured and no civilization in history is immune from their effects. This thesis examines the major elements of health system preparedness for disaster response in Australia and the issues that impact on this. The thesis aim is to identify factors that can be targeted to improve preparedness for response.

A conceptual model is presented as the framework for the thesis, which incorporates the major variables involved. These are the type of disaster, which influences the nature of response; the scale of the disaster, which influences the size of the response; and the components of surge management – space, supplies, staff and system, which enable the response.

The thesis is presented in three parts, consistent with the conceptual model. The literature review (Chapter 2) outlines existing work and the current state of knowledge. Separate chapters (Chapter 3-5) for local, national and international response are mapped against examples of the main disaster types (natural; man-made; mixed). Chapter 6 then collates the findings to form conclusions and identify future directions. In all, 26 publications are submitted as the core of the thesis, comprised of two editorials, three monographs, one textbook chapter and 20 peer reviewed research papers. Novel sources of data are used, including the first published survey of the disaster preparedness of Australian Emergency Departments (ED), the first study looking at the impact of Pandemic H1N1 2009 on Australian EDs and the first survey of Australian health team members deployed internationally.

A number of recommendations are presented and mapped against models such as the surge management paradigm, the comprehensive approach to disaster management, Haddon's matrix and the Input, Thrioughput, Output model for ED care. Three of these are combined to form a novel integrated model that can be used as a tool to help understand, prepare for, and respond to disasters.

The thesis has multiple direct links to policy and practice, with a number of findings already translated into practice or used to inform system development. This has occurred across local, state, national and international preparedness. It is hoped that the findings of this thesis, and its associated outputs, will continue to help inform future emergency preparedness and contribute to further improvements in the care provided to the victims of disasters.

List of Abbreviations

ACEM	Australasian College for Emergency Medicine
ACEN	Australian College for Emergency Nursing
ACOEM	American College of Occupational and Environmental Medicine
ACT	Australian Capital Territory
ADF	Australian Defence Force
AEMI	Australian Emergency Management Institute
AHMPPI	Australian Health Management Plan for Pandemic Influenza
AHPC	Australian Health Protection Committee
AHPPC	Australian Health Protection Principal Committee
AIDS	Acquired Immuno Deficiency Syndrome
AIHW	Australian Institute of Health and Welfare
APIC	Association for Professionals in Infection Control and Epidemiology
ARC	Australian Research Council
ATLS	Advanced Trauma Life Support
AUSMAT	Australian Medical Assistance Team
CATI	Computer Assisted Telephone Interview
CBH	Cairns Base Hospital
CBR	Chemical, Biological, Radiological
CDC	Centres for Disease Control and Prevention
CENA	College of Emergency Nursing Australia
CI	Confidence Interval
COAG	Council of Australian Government
CONFIDE	CONsensus Guidelines on Reports of Field Interventions in Disasters and Emergencies
CQU	Central Queensland University
CRED	Centre for Research on the Epidemiology of Disasters
DMAT	Disaster Medical Assistance Team
DMSIG	Disaster Medicine Special Interest Group
DoHA	Department of Health and Ageing
DrPH	Doctorate of Public Health
ECMO	Extra Corporeal Membrane Oxygenation
ED	Emergency Department
EHA	Emergency Hospital Admissions
EHS	Emergency Health Services
EHSQ	Emergency Health Services Queensland

EMA	Emergency Management Australia
EM-DAT	Emergency Events Database
EOC	Emergency Operations Centre
FFH	Foreign Field Hospitals
G20	Group of 20
GDP	Gross Domestic Product
GP	General Practitioner
HC	Health Commander
HEOC	Health Emergency Operations Centre
HIC	Health Incident Controller
HIV	Human Immunodeficiency Virus
ICS	Incident Command System
ICU	Intensive Care Unit
IDFC	International Development Fund Committee
IDSA	Infectious Diseases Society of America
IFEM	International Federation for Emergency Medicine
IFRC	International Federation of Red Cross and Red Crescent Societies
ILI	Influenza Like Illness
ISDM	International Society of Disaster Medicine
IT	Information Technology
JCU	James Cook University
Km	Kilometre
MIMMS	Major Incident Management and Support
MPERT	Mobile Paediatric Emergency Response Team
NCCTRC	National Critical Care and Trauma Response Centre
NDMS	National Disaster Medicine System
NHEMS	National Health Emergency Management Standing Committee
NHMRC	National Health and Medical Research Council
NSW	New South Wales
NT	Northern Territory
OHS	Overcrowding Hazard Scale
OR	Odds Ratio
PAHO	Pan American Health Organisation
PDA	Personal Digital Assistants
PHERP	Public Health Education and Research Program
POCT	Point of Care Testing
PPE	Personal Protective Equipment

PPRR	Prevention, Preparedness, Response, Recovery
PTSD	Post Traumatic Stress Disorder
QAS	Queensland Ambulance Service
QCTC	Queensland Counter Terrorism Committee
QEMRF	Queensland Emergency Medicine Research Foundation
Qld	Queensland
QSS	Queensland Social Survey
QUT	Queensland University of Technology
RSQ	Retrieval Services Queensland
SA	South Australia
SARS	Severe Acute Respiratory Syndrome
SHEA	Society for Healthcare Epidemiology of America
Tas	Tasmania
TEC	Tsunami Evaluation Coalition
TTH	The Townsville Hospital
UK	United Kingdom
UN	United Nations
UNDAC	United Nations Disaster Assessment and Coordination
USA	United States of America
USD	United States Dollar
Vic	Victoria
WA	Western Australia
WADEM	World Association for Disaster and Emergency Medicine
WDR	World Disaster Report
WHO	World Health Organization

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Chapter 1 : Introduction

1.1 Background

Disasters will always occur (McEntire 1998), and no civilization in history has been immune from their effects (Dara et al. 2005). Examples of major disasters from world history, including their location, number killed and broader impact are described in Table 1.1. The Black Death killed an estimated 100 million people in the 14th century, almost half of Europe's population (Ziegler 2013). While only six official deaths were recorded in the Great Fire of London (the poor and homeless were not included in records), 80% of buildings were destroyed (Hanson 2002). Change the context to the London of today to imagine the impact on not just London, but the world – socially, psychologically and economically.

Table 1.1: Selected Major Disasters in World History (prior to 2000)

Year	Location	Disaster	Dead	Broader Impact
79	Pompeii	Volcano (Vesuvius)	30,000	First recorded description of a disaster
1300's	Europe	Black Death Plague	1,000,000	1/3 -1/2 Europe's population die
1666	London	Great Fire	6 officially	80% buildings in London destroyed
1883	Indonesia	Volcano (Krakatoa)	40,000	Global temperatures affected
1912	North Atlantic	Titanic	1517	Shipping safety improvements (lifeboats)
1918-19	World	Spanish Flu pandemic	20-40,000,000	3% world population dead 27% world population infected
1931	China	Floods	1-2,000,000	Most deaths of any natural disaster
1970	Bangladesh	Cyclone Bhola	300,000	Most cyclone deaths
1976	China	Tangshan Earthquake	>300,000	International aid refused
1989	England	Hillsborough	91	Stadium safety

(Source: Developed from AEMI 2011, IFRC 2001, EM-DAT (Guha-Sapir, Below & Hoyois 2011))

Early civilisations regarded a disaster as something that was beyond their control and a punishment from the gods. The derivation of the word disaster reflects this coming from the Latin “dis” for bad and “astro” for stars, meaning the stars were not in alignment (Oxford Dictionary 2015). As our understanding of disasters has improved so has awareness that while we may not be able to prevent disasters, we can be prepared and make efforts to reduce their effects, improve our response to them and hasten our recovery.

1.2 Rationale for the Thesis

1.2.1 Definition of a disaster

There are many definitions of a disaster (Al-Mahari 2007). While these tend to focus on the role of the organisation and include for example finance, transport or health respectively, there are a number of common elements:

(1) An extraordinary event
(2) Damage to existing infrastructure
(3) A state of disaster / emergency declared
(4) A need for external assistance

Definitions from the World Association of Disaster and Emergency Medicine [WADEM] (Sundnes & Birnbaum 2002) and Emergency Management Australia [EMA] (EMA 1998) are shown in Figure 1.1 and highlight these commonalities.

WADEM Disaster Definition	**EMA Disaster Definition**
“A serious disruption of the functioning of society, causing widespread human, material and environmental losses which exceed the ability of the affected society to cope using only its own resources; the result of a vast ecological breakdown in the relations between man and his environment, a serious and sudden event (or slow as in drought) on such a scale that the stricken community needs extraordinary efforts to	*“A serious disruption to community life which threatens or causes death or injury in that community, and damage to property which is beyond the day-to-day capacity of the prescribed statutory authorities and which requires special mobilisation and organisation of resources other than those normally available to those authorities.”* (EMA 1998, pp. 32-33)

cope with it, often with outside help or international aid." (Sundnes & Birnbaum 2002, p.149)	

Figure 1.1: Examples of Disaster Definitions

WADEM has tried to standardise the language of disasters through development of their Utstein Template (Sundnes & Birnbaum 2002). While the primary purpose was to promote research consistency it also assists consistency of response.

1.2.2 Types of disaster

Disasters may be described by hazard and separated into natural disasters, man-made disasters and mixed disasters, where both nature and man contribute such as flooding due to altered waterways or landslides due to removal of trees (Sundnes & Birnbaum 2002). An abbreviated version is provided in Table 1.2.

Table 1.2: Classification of Disasters by Hazard

Natural	**Seismic**	Earthquake Volcano Tsunami Celestial collision
	Climatic	High winds – gale, cyclone, hurricane, tornado Precipitation – rain, snow, ice Lightening Temperature extremes – heat, cold Erosion Drought Floods Avalanches
Man Made	**Technological**	Chemical, biological, radiological Transport Structural failure Explosions and fire Environmental interference
	Conflict	Armed conflict – war, complex emergencies, terrorism Unarmed conflict: sanctions, embargo
Mixed		Desertification Floods Erosion

		Landslides / mudslides Health related – epidemics, genetic, other

(Source: Adapted from Sundnes & Birnbaum 2002)

1.2.3 Frequency of disaster

The World Health Organisation (WHO) sponsored Centre for Research on the Epidemiology of Disasters (CRED) maintains an Emergency Events Database [EM-DAT] (Guha-Sapir, Below & Hoyois 2011). Events are included if at least one of the criteria is fulfilled:

- 10 people are reported killed.
- 100 people are reported affected.
- An appeal for international assistance is issued.
- A state of emergency is declared.

Of note, war is specifically excluded and complex emergencies have only recently been added as a separate category (Guha-Sapir, Below & Hoyois 2011).

The frequency of disasters globally is shown in Figure 1.2 using data from EM-DAT (Guha-Sapir, Below & Hoyois 2011). There have been more than 10,000 reported disasters from 1951 to 2000 with almost 2 billion people affected by disasters in just the last 10 years of the 20th Century (Guha-Sapir, Below & Hoyois 2011). Data from the International Federation of Red Cross and Red Crescent Societies (IFRC) also show an increase in frequency of recorded disasters over the same period (IFRC 2001). While some of this is due to improved reporting, the increase is associated with multiple other factors including increased industrial technology (especially in developing countries with immature safety systems), global warming, civil war and potential for population displacement, and the rise of terrorism (Drabek 1986; Dynes 1998; Kizer 2000; Noji 2000; Quarentelli 1985). Both Karl Western (Leus 2000) and Kizer (2000) note that population growth and urbanisation may result in increased mortality and morbidity from both natural and man made disasters simply because of greater population density.

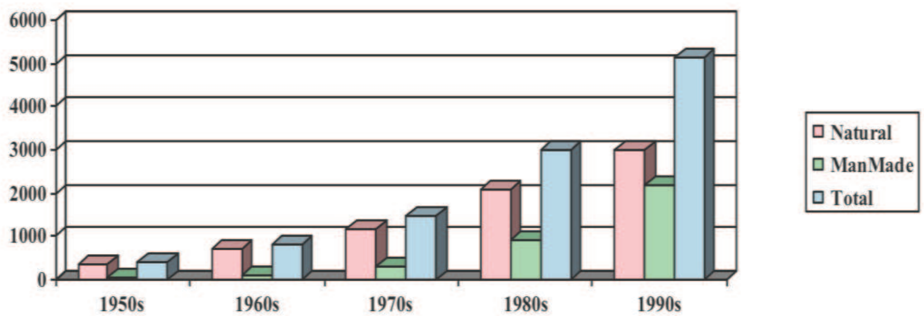

Figure 1.2: Frequency of Disasters (Numbers vs Decade: 1951 – 2000)
(Source: Developed using data from EM-DAT (Guha-Sapir, Below & Hoyois 2011))

1.2.4 Location of disasters

Disasters occur on every continent. The frequency of different disaster types by continent shows the most common across all continents are transport disasters, floods, and windstorms (including cyclones and hurricanes)(Table 1.3) (IFRC 2001). This holds true for all continents except Africa where flood is replaced by drought.

Table 1.3: Frequency of Disaster Types by Continent 1992-2001

Disaster Type	Asia	Americas	Africa	Europe	Oceania	Total
Transport	668	233	437	186	11	1535
Floods	362	216	207	153	25	963
Windstorms	322	283	49	71	58	783
Industrial	225	55	37	67	2	386
Misc. accidents	178	45	57	53	5	338
Droughts / Famine	77	39	113	13	11	253
Earthquakes	112	48	10	37	8	215
Avalanche / Landslide	101	40	12	25	5	183
Forest fires	18	55	11	39	9	132

Extreme temperatures	35	30	6	51	4	126
Volcanic eruptions	16	23	3	2	6	50

Source: IFRC 2001

Economic status is related to disaster vulnerability (McEntire 1998) with approximately 90% of disaster related injuries and deaths occurring in countries with per capita income levels below US$760 per year (Haddow & Bullock 2003). These countries not only have more disasters but less capacity to cope, less capacity to plan and prepare (Keim & Rhyne 2001; Lennquist 2004; Leus 2000), and less recovery time (Campbell 2005). In such circumstances, disaster management programs may be viewed as superfluous (Haddow & Bullock 2003) and pre-existing vulnerabilities compound the impact of the disaster (Telford, Cosgrove & Houghton 2006).

1.2.5 Damage caused by disasters

The EM-DAT database was used to illustrate the impact of disaster on a global scale by considering the impact of natural (see Table 1.4) and man made disasters (see Table 1.5) (Guha-Sapir, Below & Hoyois 2011). Between 1951 and 2000 disasters have been estimated to be responsible for the loss of more than 12 million lives, affected more than 12 billion people and cost more than 12 trillion US Dollars.

These figures are also likely to be underestimations given the inherent problems with reporting associated with disasters as reflected by the low availability of cost data. The CRED annual review of 2011 (Guha-Sapir et al 2012), found that while Asia was the continent most often hit by natural disasters in 2011 (44.0%), it also accounted for 86.3% of global victims, and suffered the most damage (75.4% of global disaster damages).

Table 1.4: Impact of Natural Disasters

	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - 2000	TOTAL
NUMBER	367	717	1,162	2,081	2,985	7,312
Persons Affected	11 million	234 million	768 million	1.5 billion	2.1 billion	4.6 billion
Persons Killed	4.2 million	2.1 million	1.4 million	0.8 million	0.75 million	9.3 million
Costs (mill USD)	7,000	18,500	80,000	189,000	667,000	962,000
Cost Data Avail (%)	12%	41%	31%	32%	31%	31%

Source: Reproduced using EM-DAT data (Guha-Sapir, Below & Hoyois 2011).

Table 1.5: Impact of Man Made Disasters (Human Conflict Not Included)

	1951 - 1960	1961 - 1970	1971 - 1980	1981 - 1990	1991 - 2000	TOTAL
NUMBER	52	94	289	922	2,167	3,524
Persons Affected	0.4 million	0.1 million	1.9 million	2.3 million	0.7 million	5.3 million
Persons Killed	8,400	5,500	90,000	66,000	87,000	257,000
Costs (mill USD)	218	238	89	6,951	21,029	27,525
Cost Data Avail (%)	4%	40%	15%	9%	5%	7%

Source: Reproduced using EM-DAT data (Guha-Sapir, Below & Hoyois 2011).

The decade since 2000 has seen not just a further increase in disasters, but also a series of large-scale disasters of international significance. A selection of major disasters that have occurred post 2000 including terrorist events such as the Bali bombings (1 and 2) and the World Trade Centre attacks (“9/11”) are displayed in Table 1.6 These disasters have resulted in not just loss of life and multiple injuries but changed the fabric of society. There is no better example of the impact of terrorism than the increased security during air travel and other aspects of 'homeland protection' that have affected us all (Stevens et al 2011).

While responsible for many deaths and societal changes, the loss of life from terrorist disasters again pales in comparison with that from natural disasters. The devastation caused by the South East Asian Tsunami in 2004 and the recent disaster in Haiti, have seen efforts at a concerted international response. Other large-scale disasters have either not received the same level of attention, or, as with the China earthquake and Japanese tsunami and nuclear incident, been managed predominantly by the affected country with limited acceptance of multiple offers of international assistance.

Table 1.6: Examples of Major Disasters since 2001

Year	**Location**	**Disaster**	**Dead**	**Broader Impact** (Cost in US Dollars (USD))
2001	New York	World Trade Centre terrorist attack - 9/11	> 3,000	Broad societal change
2002	Bali	Bali bombing 1	202	Air evacuation injured Security impact
2004	South Asia	Tsunami	>230,000	1.6 million homeless
2004	Spain	Madrid train bombing	191	Change of government
2005	London	Subway bombings	52	Societal impact
2007	New Orleans	Hurricane Katrina	> 1,800	> $80 billion USD
2008	Myanmar	Cyclone Nargis	>140,000	Politics of aid
2008	China	Earthquake	> 65,000	> $140 billion USD
2009	Haiti	Earthquake	>80,000	1.5 million homeless
2010	Pakistan	Floods	>1000	20 million homeless

2011	New Zealand	Earthquake	181	>$20 billion USD
2011	Japan	Earthquake + Tsunami	> 15,000	> $300 billion USD

Source: Reproduced using EM-DAT data (Guha-Sapir, Below & Hoyois 2011).

1.2.6 Injury patterns and disasters

An understanding of the injury patterns caused by disasters is necessary to help estimate likely numbers, needs and timelines of future response (Campbell 2005; Griekspoor & Sondorp 2001; Milsten 2000; Noji 2000). This holds not just for natural disasters but also complex health emergencies, as knowledge of their epidemiological consequences and effect on public health infrastructure can assist in planning medical personnel requirements (VanRooyen & Eliades 2001). The mortality and morbidity patterns for different natural disasters are summarized in Table 1.7 (adapted from PAHO 2000), while note is made that these are also influenced by the level of development in the affected community and the services available.

Table 1.7: Mortality and Morbidity Patterns for Disasters

Short-term effects of major natural disasters						
Effect	**Type of Disaster**					
	Earth quakes	**High winds (without floods)**	**Tidal waves flash floods**	**Slow-onset floods**	**Land slides**	**Volcano**
Deaths – *Potential lethal impact in absence of preventive measures*	Many	Few	Many	Few	Many	Many
Severe injuries requiring extensive treatment	Many	Moderate	Few	Few	Few	Few
Increased risk of communicable diseases	Potential risk following all major disasters - (Probability rising with overcrowding and deteriorating sanitation)					

Damage to health facilities	Severe (structure and equipment)	Severe	Severe but localized	Severe (equipment only)	Severe but localized	Severe (structure and equipment)
Damage to water systems	Severe	Light	Severe	Light	Severe but localized	Severe
Food shortage	Rare (may occur due to economic and logistic factors)		Common	Common	Rare	Rare
Major population movements	Rare (may occur in heavily damaged urban areas)		Common (generally limited)			

Source: Adapted from PAHO 2000.

The timing of injuries and illness is important with a trimodal distribution of medical issues seen after a sudden onset disaster (Kongsaengdao, Bunnag & Siriwiwattnakul 2005; Maegele et al. 2005; Taylor, Emonson & Schlimmer 1998):

- Phase 1 is characterised by high mortality from injuries so severe that they are incompatible with life.
- In phase 2, minutes to hours afterwards, medical care is focussed on early trauma management. There is a 'golden 24-hour' period during which most casualties are recovered and when most fatalities occur (Noji et al. 2001). The main problems encountered are adequate first aid and evacuation, which have to be performed immediately by the local people and the capacity of the local medical and surgical system to cope with a large number of casualties (Russbach 1990).
- In phase 3, occurring days to weeks after the disaster, major efforts are needed to prevent and treat complications such as sepsis, multiple organ failure and psychological problems, as well as the large number of displaced persons and lack of essential resources (Russbach 1990).

During the post-disaster phase, trauma issues are usually related to recovery and clean-up operations or delayed medical attention due to inaccessibility. More commonly, long-term health issues, daily urgent medical needs, mental health and stress, environmental and infectious disease concerns, public health issues and special needs populations will form the bulk of health and medical issues (Wallace 2002). Primary care will need to be addressed as soon as 24 to 48 hours after the disaster (Wallace 2002). After a natural disaster, a hospital ED can expect to see three to five times the normal number of patients. During a hurricane, for example, patient numbers can be expected to rise between 6 and 65% with a return to normal patient volumes within a few days to two weeks (Henderson et al. 1994; Milsten 2000).

Different disaster types may also be associated with specific injury patterns and not always what is expected.

- A problem specific to earthquakes is crush syndrome and renal failure with 10.6% of patients hospitalized patients following the Bam earthquake suffering acute renal failure with most requiring dialysis (Bidari et al. 2005).
- Governments have expressed surprise over the deaths of people in complex emergencies from childbirth, malaria and diarrhoea (Leus, Wallace & Loretti 2001). During the war in the Democratic Republic of the Congo, an estimated 10.7 million deaths occurred over a 22-month period with only 11% due to trauma. The majority was attributable to preventable infections such as measles, acute respiratory infections, malaria, diarrhoea, and malnutrition. Most trauma deaths also occurred in insecure sites where relief agencies had poor access (Brennan & Nandy 2001).

1.2.7 Broader Societal Impact of Disasters

The effects of a disaster are far reaching and may affect all aspects of a society. These include not only medical care, but also sanitation and water, food, clothing and shelter, energy supplies and education. These have been described as “Basic Societal Functions’ by WADEM and are described in Table 1.8 (Sundnes & Birnbaum 2002). This may also impact on the health effort by limiting the ability of staff to report to work, while power and water failures may lead to secondary health hazards that need to be planned for and addressed. The effects of Hurricane Mitch on Honduras in 1997 illustrate this - while approximately 9000 people were killed, more than 3 million were displaced with 75% of the Honduran population affected. The damage bill of 8.5 billion US dollars was more than the GDP of Honduras and was estimated to set development back by more than 20 years (Lichtenstein 2001).

Table 1.8: Basic Societal Functions as Defined by WADEM

(1) Medical
(2) Public Health
(3) Sanitation / Water
(4) Shelter / Clothing
(5) Food
(6) Energy Supplies
(7) Search & Rescue
(8) Public Works & Engineering
(9) Environment
(10) Logistics / Transport
(11) Security
(12) Communication
(13) Economy
(14) Education

Source: Adapted from Sundnes & Birnbaum 2002.

1.2.8 Defining disaster health

Disaster Health thus combines elements of Clinical Medicine and Public Health as well as aspects of many non-medical disciplines. The prerequisite multi disciplinary skillmix, multi agency response and inherent disruption to the health 'system' all contribute to defining this unique field and reinforcing the need for specific preparedness crossing traditional professional boundaries. Bradt et al. (2003) describe the interface between public health, clinical medicine and emergency management as the core focus of disaster medicine.

1.2.9 Disasters in Australia

The pattern of higher mortality with natural than man-made disasters also holds true for Australia as depicted in Table 1.9, showing the highest mortality from disaster since federation in 1901. There were a number of shipwrecks with high death counts in the late 1800's, but the highest death tolls have been associated with natural disasters and dominated by heatwaves and cyclones (AEMI 2012).

Table 1.9: Highest Mortality from Australian Disasters since 1901

Disaster	Year	Deaths
Heatwave – Southern states	1939	438
Heatwave – Victoria / South Australia	2009	404

Cyclone – Port Hedland	1912	173
Bushfire – Victoria (Black Saturday)	2009	173
Heatwave - widespread	1912	147
Heatwave - widespread	1911	143
Cyclone - Broome	1935	141
Heatwave - widespread	1926	130
Cyclone – North Queensland	1911	122
Heatwave - widespread	1913	122

Source: Produced using data from Australian Emergency Management Knowledge Hub – Disaster Information (AEMI 2012).

In Australia, natural disasters caused over 500 deaths and 6,000 injuries over the last 30 years of the 20th century (Abrahams 2001). In contrast, disasters in the Western Pacific region in just the last 10 years of the 20th century constituted 23% of natural disasters worldwide, resulting in 41,530 dead, 434,706 injured and 6,151,609 homeless. The most common disasters were typhoons/cyclones, floods and earthquakes, with the most disaster prone countries being the Philippines, China and Vietnam (Asahi, Pesigan & Reyes 1999). In Oceania, between 1992 and 1996, disasters affected an average of 4.5 million people annually, with an average annual damage bill of US$1 billion (Keim and Rhyne 2001). The number of natural disasters per country between 1976 and 2005 using data from the EM-DAT database (Guha-Sapir, Below & Hoyois 2011) highlight the importance of natural disasters to Australia as well as out regional neighbours in Asia (Figure 1.3).

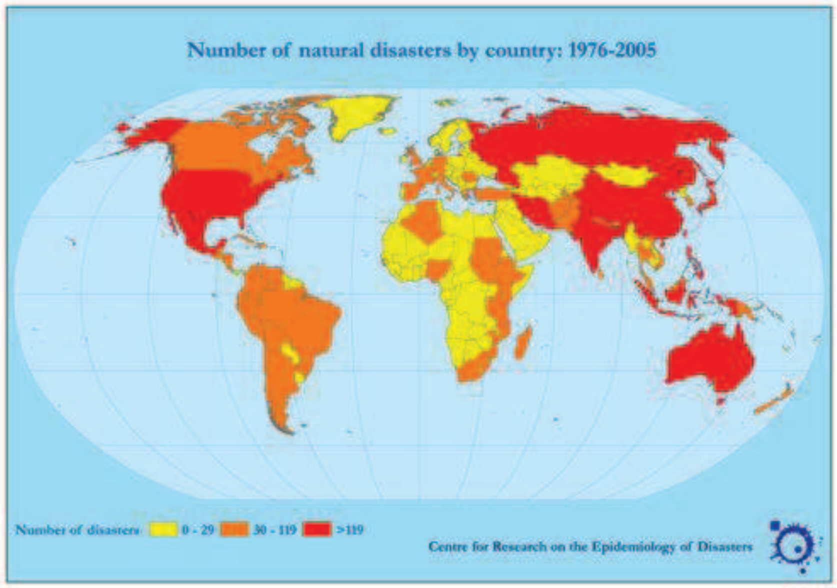

Figure 1.3: Number of disasters by country 1976-2005

Source: EM-DAT (Guha-Sapir, Below & Hoyois 2011).

1.2.10 Disaster management

Disaster Management is "the aggregate of all measures taken to reduce the likelihood of damage that will occur related to a hazard(s), and to minimise the damage once an event is occurring or has occurred and to direct recovery from the damage" (Sundnes & Birnbaum 2002 p149). The damage caused by disasters can be minimised at a number of stages including pre, during and post disaster. This involves preparation and planning with adequate risk assessment, efficient, timely and cost effective response coupled with a coordinated recovery process. This understanding is enhanced by some of the core concepts of emergency management and disaster health. These are described as they provide important contextual information for the work of this thesis and a valuable reference framework.

1.2.11 Disaster Concepts

1.2.11.1 Comprehensive Approach

The Comprehensive Approach consists of Prevention / Mitigation; Preparation, Response and Recovery (PPRR) (AEMI 2011). It is important to recognise that these are *not* sequential phases, but simply different areas of emphasis. Recovery, for example, should start early in the response phase rather than after the response has finished and for maximum effect should also address mitigation issues.

1.2.11.1.1 Prevention and Mitigation

Prevention refers to activities undertaken to stop a disaster happening. This is obviously impossible for many disasters. Mitigation is the usual alternative and refers to activities undertaken to lessen the effects of a disaster. Examples include building codes and town planning with inclusion of flood zones. A definition is the 'regulatory and physical measures to ensure that emergencies are prevented, or their effects mitigated' (EMA 1998, p.89).

1.2.11.1.2 Preparedness

Preparedness refers to those activities undertaken beforehand to lessen the impact of the disaster. This consists primarily of planning but examples also include the education, training and exercising of staff and the development of warning systems fro communities. A definition is the 'arrangements to ensure that, should a disaster occur, all those resources and services which may be needed to cope with the effects can be rapidly mobilised and deployed' (EMA 2004, p.32).

1.2.11.1.3 Response

Response refers to the actions taken directly following a disaster. Examples include deployment of teams and emergency services, rescue services and acute health care. A definition is the 'actions taken in anticipation of, during and immediately after impact to ensure that its effects are minimised and that people are given immediate relief and support' (EMA 1998, p.94).

1.2.11.1.4 Recovery

Recovery refers to the process of restoring the affected community to normal. This includes psychosocial issues, the economy and reconstruction. A definition is 'the coordinated process of supporting disaster affected communities in reconstructing their physical infrastructure and restoration of emotional, social, economic and physical well being' (EMA 1998, p.92).

1.2.11.2 All Agencies

The All Agencies approach emphasises the multiple agencies that come together in disaster management. Nobody responds alone and preparations should ensure the ability to work together establishing in advance a common language, relationships and interoperability of systems (AEMI 2011).

1.2.11.3 All Hazards

The All Hazards principle promotes the concept of planning for a consistent response across disaster types. Many elements of a plan are common across disaster types such as activation arrangements, staff recall, triage, surge arrangements and documentation (AEMI 2011).

1.2.11.4 Prepared Community

The prepared community recognises that the initial response will be from those in the affected community including rescue and initial care. People by nature will turn to local agencies and present to local facilities, whether they be health or government. Increasing the ability of the local community to respond increases the ability of the community to manage the disaster. "A prepared community is one which has developed effective emergency and disaster management arrangements at the local level, resulting in:

- Alert, informed, active community, which supports its voluntary organisations.
- Active and involved local government.
- Agreed and coordinated arrangement for PPRR" (EMA 1998, p. 88).

1.2.11.5 Risk Management

The principles of risk management can be described as identification, analysis and management of the risk. Risk can be defined as 'the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, evaluating, treating and monitoring risk' (EMA 1998, p.96).

1.2.11.6 Resilience

There has been a recent focus on the importance of resilience (Castleden 2011). The United Nations Office for Disaster Risk Reduction (2009) defines resilience as:

> The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions'. Or put simply it 'means the ability to "resile from" or "spring back from" a shock. (UNISDR 2009, p.24).

Factors contributing to community resilience include past experiences, preparedness, and degrees of dependence or independence.

1.2.12 Improving disaster management

Improvements in disaster management can occur at all stages in the life cycle of a disaster. Using the comprehensive approach (PPRR) as the underlying paradigm the obvious approach is to prevent disasters from happening. While theoretically attractive it is usually not feasible. We are unable to prevent natural events such as cyclones and earthquakes. Even preventing man-made disasters is virtually impossible. We can reduce the likelihood of these occurring but no system is foolproof and human error may occur. Mitigation rather than prevention is thus the preferred strategy to support preparedness, response and recovery measures.

If we return to the definition of a disaster one of the main elements is a situation where demand exceeds supply. Figure 1.4 is an original diagram, which illustrates this, using differences in size between two circles representing demand and supply.

- The purpose of prevention/mitigation is to try and address this imbalance by decreasing demand. This involves strategies that reduce the likelihood of the disaster occurring or damage caused. In Figure 1.4 the size of the circle representing demand is reduced in size.
- The purpose of response/recovery measures is to address this imbalance by increasing supply. This involves use of strategies that increase the quantity/ quality of the response and recovery arrangements. In Figure 1.4 the size of the circle representing demand stays the same but the circle representing supply is larger.
- The ideal situation is where both prevention/mitigation and response/recovery are addressed and there is no imbalance between supply and demand. In Figure 1.4 the circles representing demand and supply are the same size.

From a clinical perspective the focus is often on response. This is not to lessen the importance of other areas but simply recognises the roles that clinicians usually play. Quarantelli (1988) highlights there are both qualitative and quantitative differences between disaster management and responding to individual patients. The system being under severe stress means it is much more difficult than simply an increase in patient numbers (Quarantelli 1988). This requires a different approach, which does not occur without appropriate preparation.

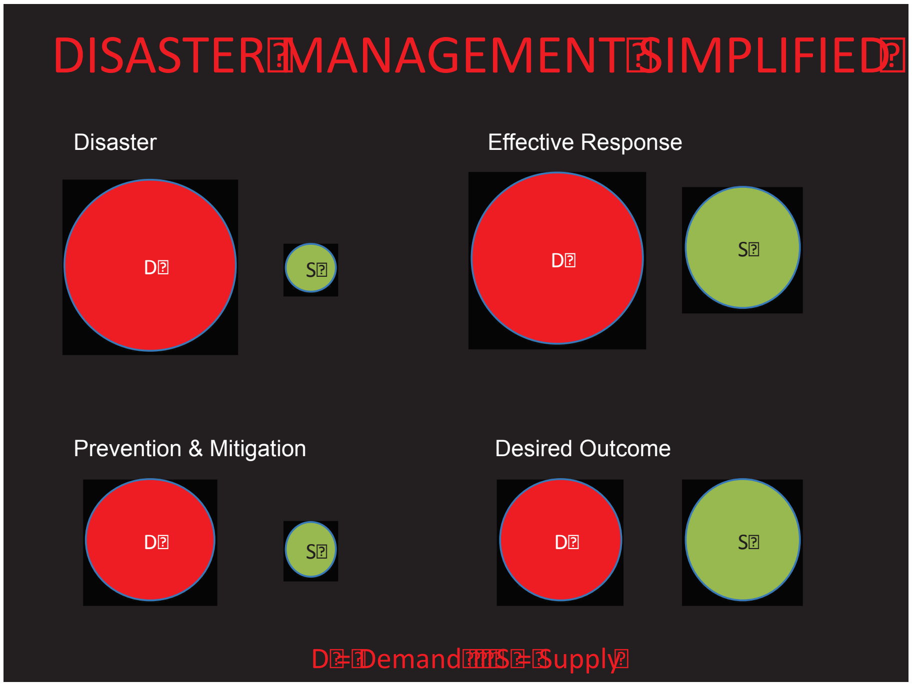

Figure 1.4: Demand and Supply Relationships in Disaster Management

This ability to improve the capacity to respond, often suddenly, can be thought of in terms of surge management. Worldwide, health care systems have few surplus resources. However, the ability to expand capacity to meet health needs during a crisis is imperative. This concept, known as ‘surge capacity’ has been defined as, ‘the ability to manage a sudden, unexpected increase in patient volume (i.e. numbers of patients) that would otherwise severely challenge or exceed the current capacity of the health care system’ (Hick, Hanfling & Burstein et al. 2004, p.254). Surge capacity has also been described in terms of staff, space, supplies and a supporting system (Kaji, Koenig & Bey 2006). These are interdependent and all four of these elements need to be addressed to be successful in improving capacity.

- Space needs to be created for patients to be seen;
- Staff, appropriately trained and equipped, need to be available;
- Supplies and equipment need to be available;
- A system to support mobilisation and coordination of resources as well as distribution and movement of patients.

This is summarised in the original diagram Figure 1.5 below.

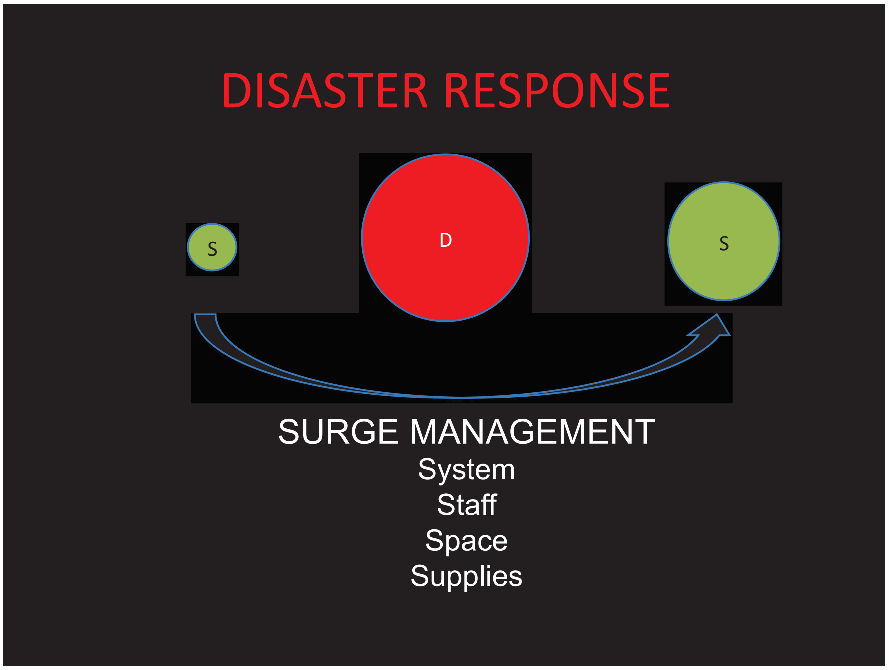

Figure 1.5: Surge Management and Disaster Response

1.2.13 Improving disaster management – the WHO perspective

Prevention and mitigation of, and preparedness for, disasters are longstanding concerns of the World Health Organisation (WHO). This is seen as far back as the 1981 World Health Assembly resolution WHA34.26, which stressed 'despite the undoubted importance of relief in emergencies, preventive measures and preparedness are of fundamental importance' (cited in WHO 2007, p.12). More recently resolution WHA58.1 stressed the importance of clear synergies between preparedness and response (WHO 2007).

The 2007 WHO document "Risk reduction and emergency preparedness: WHO six-year strategy for the health sector and community capacity development" recognizes:

> At national and global levels, all large crises – whether they are technological, environmental or natural disasters, conflicts, epidemics or famines – involve mostly the same partners, pose the same managerial and political challenges and ultimately require the same overall coordination approach and response mechanism. Risk reduction and emergency preparedness measures should therefore be also coordinated within the organization. (WHO 2007, p.18)

The WHO strategy also foresees differing roles at country, regional and global levels. Preparedness however remains relatively neglected in a global sense. The average global economic cost of disasters increasing approximately six-fold from 1970 to 2000 yet this has not impacted preparedness expenditure, as it totaled less than five per cent of all humanitarian funding in 2009 (IFRC 2012). This imbalance is emphasized further by examples cited in the IFRC World Disasters Report (2012):

- ‘From 2005 to 2009, for every US$ 100 spent on humanitarian assistance in the top 20 countries that received humanitarian assistance, only US$ 0.62 went to disaster preparedness’ (IFRC 2012, p.62).”
- ’The World Bank and US Geological Survey suggest that investments of US$ 40 billion in preparedness, prevention and mitigation would have reduced global economic losses caused by disasters in the 1990s by US$ 280 billion’ (IFRC 2012, p.62).
- ‘According to the World Meteorological Organization, every US$ 1 invested in prevention could save US$ 7 in recovery’ (IFRC 2012, p.62).

Improving awareness and understanding of the value of preparedness, from both an economic and treatment perspective, remains a priority.

1.3 Concepts Underlying the Thesis

This program of study will examine the major elements of health system preparedness for disaster response and the issues that impact on this. The significant variables involved can be thought of as:

- The type of disaster
    - Natural; Man Made; Mixed
        - *This influences the type of response*
- The scale of the disaster
    - Local or Regional; National; International
        - *This influences the size of the response*
- The components of surge management
    - System; Space; Staff; Supplies
        - *This enables the response*

A conceptual map of the variables and their relationship to health system preparedness are illustrated in Figure 1.6. To further define the body of work, examples of disasters representative of the Australian experience have been selected for each component. This is described in more detail, in the relevant chapters.

Figure 1.6: Conceptual Map of Thesis

1.4 Aim of the Thesis

The aim of this thesis is to identify factors that can be subsequently targeted to improve preparedness for disaster response.

1.5 Research Question

The specific research questions addressed are:

1. "Are there factors able to be identified, both general and those specific to disaster types, that influence Australian disaster preparedness?"
2. "Can the factors influencing disaster preparedness be expressed in a simple and usable format to help guide preparedness efforts?"

1.6 Objectives of the Thesis

The overall objectives of the thesis are:

1. To identify general factors involved in preparedness for disaster response;
2. To identify specific factors involved in the preparedness of Emergency Departments (ED) in Australia to respond to local disasters;

3. To identify specific factors involved in the preparedness for larger scale disasters;
4. To identify specific factors involved in the preparedness for international disaster response;
5. To compare factors involved in preparedness for local, national and international disaster response, and to different types of disasters, to identify major areas of focus;
6. To identify future directions for disaster health preparedness.

Specific sub-objectives are subsequently described with each chapter.

1.7 Setting for the Research

The research was completed predominantly in Australia, with one study under taken in Hong Kong. While the chapter on international disasters is based on deployed teams experiences in Indonesia and the Maldives the research was undertaken after the teams returned home to Australia.

1.8 Context of the Research

The work presented in this thesis was conceived from the early 2000s and has been conducted during a period of tremendous development of the specialty of disaster medicine. This has been stimulated not just by the large-scale disasters that have occurred in the past decade but through the unprecedented media involvement in these and associated political interest. As a result of this, there has been a significant growth in disaster research, willingness to improve disaster preparedness and overall professionalisation of the response to disasters.

1.9 Research Methods

The specific methods used are described in detail in the appropriate chapters. The research was collaborative in nature and involved the development of research partnerships with a large number of individuals, organisations and universities. The collaboration with individuals is described in Table 1.10. There were 63 different individuals who were co-authors of the papers presented in this thesis. Most individuals co-authored only one paper, with the exception being the three supervisors as the main co-authors.

Table 1.10: Collaborative Partnerships in the Research Projects

Papers	Collaborators	Names of Collaborators
13	1	Leggat P (Supervisor)
11	1	Speare R (Supervisor)
9	1	FitzGerald G (Supervisor)
6	2	Leclercq M; Harley H
5	1	Robertson A
4	1	Tippett V
3	9	Arbon P; Brown L; Clark M; Considine J; Fielding E; Holzhauser K; Patrick J; Shaban R; Toloo S
2	7	Bradt D; Finucane J; McCarthy S; Neville G; Ting J; Tong S; Vaneckova P
1	40	Archer F; Barnett AG; Bartley B; Burns J; Caldicott D; Canyon D; Chu K; Cloughessy L; Cooper D; Cullen P; Davis E; Edwards N; Elcock M; Eliseo T; Finn E; Gillard N; Goggins WB; Graham CA; Hodge J; Humble I; Johnson A; Lee C; Little M; Mantel P; McRae M; Myers C; O'Reilly G; Rotheray K; Rainer TH; Reeves J; Rego J; Seidl I; Stone R; Stone T; Swift R; Tarrant M; Verall K; Wang XY; Wolff R; Yu W

1.10 Presentation of the research and the thesis

The thesis is presented so that it reflects the concepts underlying the thesis. A literature review (Chapter 2) outlines existing work and the current state of knowledge. This is followed by separate chapters (Chapter 3-5) for local / regional; national and international response which are mapped against examples of the main disaster types (natural; man-made; mixed). Chapter 6 then brings together the findings to allow development of conclusions and identify future directions.

Novel sources of data have been used in the thesis. This includes the first published survey of the disaster preparedness of Australian Emergency Departments, the first survey of Australian health team members deployed internationally and the first study looking at the impact of Pandemic H1N1 2009 on Australian EDs.

1.10.1 Publications from the thesis

In all, 26 publications are submitted as the core of the thesis. This is comprised of two editorials, three monographs, one textbook chapter and 20 peer reviewed research papers. These are displayed in Table 1.11. Of the 26 publications, nine are first author (7/20 research papers), six are second author with the remainder as subsequent or last author papers. A statement of contribution to these papers is provided in Appendix 1. All papers are included in full as Annex 1.

Table 1.11: Bibliographic data for publications presented in the thesis

Paper	Reference	Type
2.1	**Aitken, P** & Leggat, P 2012, 'Considerations in mass casualty and disaster management', in M Blaivas (ed.), *Emergency medicine – an international perspective*, Intech, Croatia, pp. 143-82.	Chapter
2.2	Toloo, S, FitzGerald, G, **Aitken, P,** Ting, J, Tippett, V & Chu, K 2011, *Emergency health services: Demand and service delivery models. Monograph 1: Literature review and activity trends,* Queensland University of Technology, Brisbane, Queensland.	Monograph
2.3	FitzGerald, GJ, Patrick, JR, Fielding, E, Shaban, R, Arbon, P, **Aitken, P**, Considine, J, Clark, M, Finucane, J, McCarthy, S, Cloughessy, L & Holzhauser, K 2010, *H_1N_1 influenza 2009 outbreak in Australia: Impact on emergency departments,* Queensland University of Technology, Brisbane, Queensland.	Monograph
2.4	**Aitken, P**, Canyon, D, Hodge, J, Leggat, P & Speare, R 2006, *Disaster medical assistance teams – a literature review*. Health Monograph Series, Health Protection Group, Perth, Western Australia.	Monograph
3.1	Edwards, NA, Caldicott, DGE, **Aitken, P,** Lee, CC & Eliseo, T 2008, 'Terror Australis 2004: preparedness of Australian hospitals for disasters and incidents involving chemical, biological and radiological agents', *Critical Care and Resuscitation,* vol. 10, no. 2, pp. 125-36,<http://search.informit.com.au/documentSummary;dn=514742498811930;res=IELHEA>.	Research
3.2	FitzGerald, G, Toloo, S, Rego, J, Ting, J, **Aitken, P** & Tippett, V 2012, 'Demand for public hospital emergency department services in Australia: 2000-2001 to 2009-2010', *Emergency Medicine Australasia*, vol. 24, no. 1, pp. 72-78, doi:10.1111/j.1742-6723.2011.01492.x	Research
3.3	Bradt, DA, **Aitken, P,** Fitzgerald, G, Swift, R, O'Reilly, G & Bartley, B 2009, 'Emergency department surge capacity: Recommendations of the Australasian Surge Strategy Working Group', *Academic Emergency Medicine*, vol. 16, no. 12, pp. 1350-58, doi:10.1111/j.1553-2712.2009.00501.x	Research
3.4	Rotheray, KR, **Aitken, P**, Goggins, WB, Rainer, TH & Graham, CA 2012, 'Epidemiology of injuries due to tropical cyclones in Hong Kong: A retrospective observational study', *Injury,* vol. 43, no. 12, pp. 2055-59, doi:10.1016/j.injury.2011.10.033	Research

3.5	Little, M, Stone, T, Stone, R, Burns, J, Reeves, J, Cullen, P, Humble, I, Finn, E, **Aitken, P**, Elcock, M & Gillard, N 2012, 'The evacuation of Cairns hospitals due to severe Tropical Cyclone Yasi', *Academic Emergency Medicine*, vol. 19, no. 9, pp. 1088-98, doi:10.1111/j.1553-2712.2012.01439.x	Research
3.6	Wang, XY, Barnett, AG, Vaneckova, P, Yu, W, Fitzgerald, G, Wolff, R, Tippett, V, **Aitken, P**, Neville, G, McRae, M, Verall, K & Tong, S 2012, 'The impact of heatwaves on mortality and emergency hospital admissions in Brisbane, Australia', *Occupational and Environmental Medicine*, vol. 69, no. 3, pp. 163-69, doi:10.1136/oem.2010.062141	Research
3.7	Vaneckova, P, Neville, G, Tippett, V, **Aitken, P**, FitzGerald, G & Tong, S 2011, 'Do biometeorological indices improve modeling outcomes of heat-related mortality?', *Journal of Applied Meteorology and Climatology,* vol. 50, no. 6, pp. 1165-76, doi: http://dx.doi.org/10.1175/2011JAMC2632.1	Research
3.8	Fitzgerald, G, **Aitken, P**, Arbon, P, Archer, F, Cooper, D, Leggat, P, Myers, C, Robertson, A, Tarrant, M & Davis, E 2010, 'A national framework for disaster health education in Australia', *Prehospital and Disaster Medicine,* vol. 25, no. 1, pp. 70-77, doi: http://dx.doi.org/10.1017/S1049023X00007585	Research
3.9	Bradt, D & **Aitken, P** 2010, 'Disaster medicine reporting: The need for new guidelines and the CONFIDE statement', *Emergency Medicine Australasia,* vol. 22, no. 6,pp. 483-87, doi: 10.1111/j.1742-6723.2010.01342.x	Editorial
4.1	Leggat, P, Speare, R & **Aitken, P** 2009, 'Swine flu and travellers: a view from Australia', *Journal of Travel Medicine,* vol. 16, no. 6, pp. 373-76, doi:10.1111/j.1708-8305.2009.00372.x	Editorial
4.2	Brown, L, **Aitken, P,** Leggat, P & Speare, R 2010, 'Self-reported anticipated compliance with physician advice to stay home during pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey', *BMC Public Health,* vol. 10, no. 138, pp.1-6, doi:10.1186/1471-2458-10-138	Research
4.3	Leggat, P, Brown, L, **Aitken, P** & Speare, R 2010, 'Level of concern and precaution taking amongst Australians regarding travel during Pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey', *Journal of Travel Medicine,* vol. 17, no. 5, pp. 291-95, doi: 10.1111/j.1708-8305.2010.00445.x	Research
4.4	**Aitken, P**, Brown, L, Leggat, P & Speare, R 2010, 'Preparedness for short term isolation among Queensland residents: Implications for pandemic and disaster planning', *Emergency Medicine Australasia*, vol. 22, no. 5, pp. 435-41, doi: 10.1111/j.1742-6723.2010.01319.x	Research
4.5	Considine, J, Shaban, R, Patrick, J, Holzhauser, K, **Aitken, P**, Clark, M, Fielding, E & FitzGerald, G 2011, 'Pandemic (H1N1) 2009 influenza in Australia: Absenteeism and redeployment of emergency medicine and nursing staff', *Emergency Medicine Australasia,* vol. 23, no. 5, pp. 615-23, doi: 10.1111/j.1742-6723.2011.01461.x	Research

4.6	FitzGerald, G, **Aitken, P**, Shaban, RZ, Patrick, J, Arbon, P, McCarthy, S, Clark, M, Considine, J, Finucane, J, Holzhauser, K & Fielding, E 2012, 'Pandemic (H1N1) 2009 influenza and Australian emergency departments: Implications for policy, practice and pandemic preparedness', *Emergency Medicine Australasia,* vol. 24, no. 2, pp.159 – 65, doi: 10.1111/j.1742-6723.2011.01519.x	Research
4.7	Seidl, I, Johnson, A, Mantel, P & **Aitken, P** 2010, 'A strategy for real time improvement (RTI) in communication during the H1N1 emergency response', *Australian Health Review,* vol. 34, no. 4, pp. 493-98, doi: http://dx.doi.org/10.1071/AH09826	Research
5.1	**Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2009, 'Pre and post deployment health support provided to Australian disaster medical assistance team members: Results of a national survey', *Travel Medicine and Infectious Disease,* vol. 7, no. 5, pp. 305-11, doi:10.1016/j.tmaid.2009.03.001	Research
5.2	**Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2009, 'Health and safety aspects of deployment of Australian disaster medical assistance team members: Results of a national survey', *Travel Medicine and Infectious Disease,* vol. 7, no. 5, pp. 284-90, doi:10.1016/j.tmaid.2009.03.005	Research
5.3	**Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2011, 'Education and training requirements for Australian disaster medical assistance team members: Results of a national survey', *Prehospital and Disaster Medicine,* vol. 26, no. 1, pp. 41-48, doi: http://dx.doi.org/10.1017/S1049023X10000087	Research
5.4	**Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M and Speare, R 2012, 'Leadership and standards for Australian disaster medical assistance team members: Results of a national survey', *Prehospital and Disaster Medicine,* vol. 27, no. 2, pp. 1-6, doi: http://dx.doi.org/10.1017/S1049023X12000489	Research
5.5	**Aitken, P**, Leggat, P, Harley, H, Speare, R & Leclercq, M 2012, 'Logistic support provided to Australian disaster medical assistance teams: results of a national survey of team members', *Emerging Health Threats,* vol. 5, doi: 10.3402/ehtj.v5i0.9750	Research
5.6	**Aitken, P**, Leggat, P, Harley, H, Speare, R & Leclercq, M 2012, 'Human resources support provided to Australian disaster medical assistance teams: results of a national survey of team members', *Emerging Health Threats*, vol. 5, doi: 10.3402/ehtj.v5i0.18147	Research

1.10.2 Chapter 2 Literature Review

This chapter provides a focused literature review on the elements that need to be considered in preparedness for disaster response. This is from a general perspective and aligns with Objective 1 "To identify general factors involved in the preparedness for disaster response". Four papers are presented including one textbook chapter and three monographs.

The first paper is a textbook chapter describing the main considerations in mass casualty and disaster management (Aitken & Leggat 2012).

The second paper is a monograph containing the literature review from an Australian Research Council (ARC) Linkage Grant funded research program on Emergency Health System demand. This growth in demand is one of the contributors to ED over-crowding and potentially impacts on the ability to manage the patient load associated with a disaster (Toloo et al 2011).

The third paper is a monograph from a National Health and Medical Research Council (NHMRC) funded project and presents the findings of a literature review and first study of the impact of H1N1 on Australian EDs (FitzGerald et al 2010).

The fourth paper is a monograph published by the Western Australian Department of Health, which funded an extensive literature review of the role of disaster medical assistance teams. This was subsequently updated as part of a national project examining the ‘Development of Workforce Models for Disaster Medical Assistance Teams’ funded by the Public Health Education and Research Program (PHERP) (Aitken et al 2006).

1.10.3 Chapter 3 Preparedness for Local Response

This chapter examines the major issues affecting preparedness for local and regional response to disasters. The chapter aligns with Objective 1 “To identify general factors involved in the preparedness for disaster response” but more specifically to Objective 2 “To identify specific factors involved in the preparedness of Emergency Departments (ED) in Australia to respond to local disasters”.

As such the focus is on Emergency Departments as the ‘front door’ to the health system, their levels of preparedness and the other factors that impact on this such as existing service load and ED demand.

The most common types of disaster in Australia are windstorms (including cyclones), floods and transport disasters. Cyclones are used on this basis as a representative selection for natural disasters along with heat waves. Heat waves were selected as they have killed more people Australia wide than any other form of disaster and remain an under recognized disaster. Terrorism, and particularly bioterrorism with use of chemical, biological or radiological (CBR) weapons, has been a major concern, and area of focus, in the past decade and has been used as an example of man made disasters for this reason.

This chapter reviews a number of different aspects of disaster management and analyses them in the context of the existing literature.

Nine papers are presented, including one editorial and eight original research papers; all published in peer-reviewed journals.

The first paper is a survey, which examines the levels of disaster preparedness of all EDs accredited for specialty training in Australia. CBR disaster preparedness is specifically explored (Edwards et al. 2008).

The second paper is drawn from an ARC Linkage Grant funded research program on Emergency Health System demand. As documented by this study, there has been significant growth in demand, which is one of the contributors to ED over-crowding and potentially impacts on the ability to manage the increase in patient load associated with a disaster. The second paper is a retrospective data analysis of the demand for public hospital ED services in Australia from 2000-2001 to 2009-2010 (FitzGerald et al. 2012).

The third paper uses a modified Delphi technique and an expert working group to identify strategies recommended to assist ED surge capacity (Bradt et al. 2009).

The fourth paper is a retrospective data analysis, which uses the Hong Kong trauma registry and ED database to describe the epidemiology of injuries due to tropical cyclones in Hong Kong (Rotheray et al. 2012).

The fifth paper is a review, using all available after action reports, of the evacuation of the Cairns hospitals due to Tropical Cyclone Yasi. This was the largest aeromedical evacuation in Australian history with over 350 patients transported more than 1500 km from Cairns to Brisbane (Little et al. 2012).

Papers six and seven are drawn from an ARC Linkage Grant funded program on the health impact of heatwaves.

- The sixth paper describes the impact of heatwaves on mortality and emergency hospital admissions in Brisbane. This is the first paper to describe the impact of heatwaves on a subtropical population (Wang et al. 2012).
- The seventh paper reviews the effectiveness of different biometeorological indices in modelling outcomes of heat-related mortality and the possibility for use of a simple, standard definition (Vaneckova et al. 2011).

Paper eight describes a template for the development of education and training in disaster health in Australia, which is consistent with international models. An expert national working group developed this model, using a modified Delphi approach (Fitzgerald et al. 2010).

Paper nine is an editorial stating the need for consistency in the format of case reports. The provision of contextual information is necessary if descriptions of lessons observed are being considered for implementation in other systems. A model format developed by the authors is described (Bradt & Aitken 2010).

1.10.4 Chapter 4 Preparedness for National Scale Disasters

This chapter examines the major issues affecting preparedness for disasters of national importance.

The chapter aligns with Objective 1 “To identify general factors involved in the preparedness for disaster response” but more specifically Objective 3 “To identify specific factors involved in the preparedness for larger scale disasters”.

Disasters may have a national impact because the sheer scale of the disaster means a national response is needed or because the scope of the disaster means most of the country is directly affected. Natural disasters such as drought may affect entire countries while cyclones, tsunami or floods may affect entire small countries, particularly island nations. Australia covers a large geographic area and natural disasters are less likely to directly affect the entire country.

Pandemics by their very nature, and definition, have a very wide area of impact. This chapter reviews a number of different aspects of disaster management during Pandemic (H1N1) 2009 and analyses them in the context of the existing literature.

Seven papers are presented, including one editorial and six original research papers, all published in peer review journals.

The first paper is an invited editorial reviewing the impact of Pandemic (H1N1) 2009 in Australia and was part of a series of invited commentaries in that issue of the journal describing the international experience. This has been included in the thesis as it involved the collation and presentation of data from a number of public information sources (Leggat, Speare & Aitken 2009).

Papers two to four are part of a statewide population based survey conducted in Queensland during the pandemic. This was done in conjunction with Central Queensland University and utilised the Queensland Social Survey 2009.

- Paper two examines the willingness of the population to adhere to recommendations from health authorities (Brown et al. 2010).
- Paper three examines the levels of preparedness for short-term isolation of the Queensland population (Leggat et al. 2010).
- Paper four examines the impact of the pandemic on travel plans and whether people were still willing to travel (Aitken et al. 2010).

Papers five and six are publications arising from an NHMRC funded study of the impact of Pandemic (H1N1) 2009 on EDs in Australia. National data was collected from contributing state health departments and supplemented with a national survey of ED medical and nursing staff supported by all three professional colleges (ACEM, CENA, ACEN).

- Paper five examines workforce issues in EDs during the pandemic, particularly the impact of staff illness and relationship with use of protective measures (Considine et al. 2011).
- Paper six examines policy implications arising from the pandemic (FitzGerald et al. 2012).

Paper seven examines preferred information sources during a disaster, while also providing a description and review of the effectiveness of a tool to improve communication during a protracted disaster such as a pandemic (Seidl et al. 2010).

1.10.5 Chapter 5 Preparedness for International Response

This chapter focuses on Australia's role in the region and the issues that arise with international deployment and the preparedness needed for this.

The chapter aligns with Objective 1 "To identify general factors involved in the preparedness for disaster response" but more specifically Objective 4 "To identify specific factors involved in the preparedness for international disaster response".

This research was conducted as part of a national project examining the 'Development of Workforce Models for Disaster Medical Assistance Teams' funded by the Public Health Education and Research Program (PHERP) of the Department of Health and Ageing (DoHA).

In the PHERP funded project a survey was conducted to review the experiences of those deployed internationally following the South East Asian Tsunami. This allowed a form of modified epidemiological triangulation to occur that incorporated the literature, the experience of deployed team members and benchmarking with other organisations to identify priorities among the issues that were identified. This work was also performed with the endorsement of the Australian Health Protection Committee (AHPC), the peak health disaster management group. For the purposes of accuracy this group has since changed names to become the Australian Health Protection Principal Committee (AHPPC).

Six papers are presented, which are all original research papers that have been published in peer-reviewed journals.

Papers one to six are the outcomes of the experiential survey of team members who deployed following the tsunami.

- Paper one examines the pre and post health care arrangements needed for members of deployed teams (Aitken et al. 2009a).
- Paper two examines the levels of health care support available to members of deployed teams while on ground or in country (Aitken et al. 2009b).
- Paper three examines the education and training needs of members of deployed teams (Aitken et al. 2011).
- Paper four examines the needs for standards and the role of leadership in deployed teams (Aitken et al. 2012c).

- Paper five examines the logistic support needed for deployed teams (Aitken et al. 2012b).
- Paper six examines the importance of human resources support for members of deployed teams (Aitken et al. 2012a).

1.10.6 Chapter 6, Summary and Integration

This is the final chapter and draws the above research together to describe the outcomes of the thesis.

The chapter aligns with Objective 5 “To compare factors involved in preparedness for local, national and international disaster response, and to different types of disasters, to identify major areas of focus” and Objective 6 “To identify future directions for disaster health preparedness”.

It provides a series of key findings, linked to the original conceptual model and mapped against the thesis objectives. Importantly, it also shows evidence of translation into practice, recommendations for future development and suggestions for future research directions.

1.10.7 Appendices

Appendix 1 outlines my personal contributions to each of the published papers and is mapped against components such as concept, project design and approval, data gathering and analysis, writing and editing, version control and submission.

1.10.8 Annex

All papers included in the thesis are reproduced in full in Annex 1.

Chapter 2 : Literature review

2.1 List of peer-reviewed and published papers presented in chapter

(2.1) **Aitken, P** & Leggat, P 2012, 'Considerations in mass casualty and disaster management', in M Blaivas (ed.), *Emergency medicine – an international perspective*., Intech, Croatia, pp. 143-82.

(2.2) Toloo, S, FitzGerald, G, **Aitken, P,** Ting, J, Tippett, V & Chu, K 2011, *Emergency health services: Demand and service delivery models. Monograph 1: Literature review and activity trends,* Queensland University of Technology, Brisbane, Queensland.

(2.3) FitzGerald, GJ, Patrick, JR, Fielding, E, Shaban, R, Arbon, P, **Aitken, P**, Considine, J, Clark, M, Finucane, J, McCarthy, S, Cloughessy, L & Holzhauser, K 2010, *H_1N_1 influenza 2009 outbreak in Australia: Impact on emergency departments,* Queensland University of Technology, Brisbane, Queensland.

(2.4) **Aitken, P**, Canyon, D, Hodge, J, Leggat, P & Speare, R 2006, *Disaster medical assistance teams – a literature review*. Health Monograph Series, Health Protection Group, Perth, Western Australia.

2.2 Introduction to the Chapter

Disaster health is a relatively new field, which has not had time to develop a strong base of evidence on which to establish practice. Most literature consists of anecdotal reports of experiences in disaster relief, with few providing any standardised review of effectiveness or in-depth analyses of lessons learned (Lewis-Rakestraw 1991; Tryon 1997). Most literature is thus seen as low-level evidence. The reasons for this paucity of evidence lie in the nature of disasters. Conducting randomized controlled trials in the middle of a disaster, while theoretically possible, poses significant ethical concerns. Instead there has been a growth in post event descriptive literature, epidemiological studies and qualitative research. Deployment of dedicated research teams following a disaster also offers the chance for standardized live data management as opposed to retrospective collection and review (Schwartz et al. 2006).

Another barrier is the diversity and scope of disaster health with publications spread across an increasingly large number of journals. Not only are there low levels of evidence, the evidence available is spread far and wide making it difficult to stay abreast of the existing literature. To address this, most personnel with disaster health involvement limit themselves to specific areas and develop niche areas of expertise. Publication patterns in disaster medicine over the last 50 years are seen in Table 2.1.

Table 2.1: Frequency of disaster medicine literature by decade

SEARCH TERM	**1956-1965**	**1966-1975**	**1976-1985**	**1986-1995**	**1996-2005**
"Disaster"	16	336	1152	2104	4939
"Disaster medicine"	2	15	15	80	75

This literature review, while broad in scope, is similarly limited by a number of self-imposed boundaries, which comply with the conceptual framework of the thesis. The literature review will focus on generic problems, but with an emphasis on the preparedness requirements for disaster response in the health sector. It will also consider this from the perspective of ocal or regional, national and international response in the context of mass casualty incidents, pandemics and other emerging disaster types.

2.3 Objectives of the Chapter

This chapter is directly related to Objective 1 of the thesis:

> "To identify general factors involved in preparedness for disaster response";

The specific objectives of this chapter are to:

- Provide an overview of disaster epidemiology and the definitions and principles of practice;
- Outline common problems associated with mass casualty incidents and disaster management;
- Describe the potential roles of emergency department staff in mass casualty incidents, international response and pandemics and the specific issues associated with these;
- Identify emerging issues in mass casualty incidents and disaster management, future developments and research areas.

2.4 Methods

The literature search was conducted in a series of phases.

Phase 1 – Introductory including local and regional issues

Phase 2 – Pandemic

Phase 3 – International response

For all phases only papers written in English were included. Bibliographies of selected peer reviewed articles were manually searched and articles of interest retrieved and reviewed. Other sources included government websites from Australia and overseas. Library holdings for The Townsville Hospital Medical Library, the James Cook University Eddie Koiki Mabo Library and the Australian Emergency Management Institute Library were also specifically reviewed

In Phase 1 the search terms 'disaster', 'disaster medicine' and 'disaster health' were used. Papers excluded were those not written in English, or those did not apply to health, health care systems or the impact of disasters. The phase 1 literature review was linked to a larger research program, the Emergency Health Services Queensland (EHSQ) study, which examined factors influencing the growing demand for emergency health care and to establish options for alternative service provision that may safely meet patient's needs. The EHSQ study was funded by the Australian Research Council (ARC) through its Linkage Program and supported financially by the Queensland Ambulance Service (QAS). The EHSQ research program comprised four sub-studies including literature review, data analysis, structured interviews and surveys, and development of models. Study 1 was an examination of the literature, and current operational context, to help develop a conceptual understanding of the factors influencing growth in demand. Paper 2.2 (Toloo et al 2011) is a monograph and presents the outcomes of Study 1. Literature was sourced using standard search approaches and a range of databases as well as a selection of articles cited in the reviewed literature.

The literature review for phase 2 was part of a larger competitive grant directed specifically at H1N1 funded by the National Health and Medical Research Council (NHMRC) through the Commonwealth Department of Health and Ageing (Application No 614290). The literature search identified articles of relevance from a search of documents using Google Scholar, and a PubMed search using the MeSH terms 'SARS' 'immunisation', 'H1N1', 'swine flu', 'pandemic', 'influenza', 'emergency AND department', and 'surge capacity'. Paper (2.2), as stated, is the monograph of the project and includes the literature search (Toloo et al 2011).

In Phase 3 the literature search was performed using the key words, search phrases and search engines and databases listed in Table 2.2.

Table 2.2: Summary of literature search results

Key word or search phrase	Medline	CINAHL	Ovid	Cochrane	Google
"DMAT"	24	11	64	0	200,000
"Disaster medical assistance teams"	17	12	57	1	29,500
"Disaster medical teams"	1	0	7	1	3,520,000
"Disaster teams"	8	5	25	1	11,900,000
International disaster medical assistance teams"	0	0	0	0	7,080,000
"International disaster medical assistance"	0	0	0	1	13,600,000
"International disaster assistance"	0	0	2	1	18,100,000
"Foreign disaster assistance"	10	0	25	0	8,030,000
"Disaster assistance"	27	7	68	1	4,300,000
"Disaster response team"	4	5	12	1	5,600,000
"International disaster response"	5	0	7	2	25,300,000
"Disaster response"	192	118	419	4	55,100,000
"Disaster aid"	11	24	12	2	35,600,000
"Disaster medicine"	187	125	201	4	13,300,000
"International humanitarian response"	2	0	5	1	12,600,000
"Humanitarian response"	13	2	51	2	15,600,000
"tsunami medical assistance"	0	0	0	0	1,450,000
"tsunami assistance"	1	2	0	0	5,120,000
"tsunami'	198	135	532	1	87,100,000
"Disaster units"	0	47	2	4	11,100,000
"Disaster care"	10	400	17	5	48,200,000
"Disaster review"	2	23	3	5	42,800,000
"Disaster lessons"	8	4	5	1	11,700,000

2.5 Introduction to Findings

An understanding of disaster epidemiology and the definitions and principles of practice is essential to the rationale and context of the thesis. A review of the main concepts underpinning disaster management has been described in Chapter 1 (Introduction to the Thesis) and is not repeated in this chapter. This chapter provides an overview of the literature addressing the first objective, which is related to general factors related to disaster response across regional activities as well as during pandemics and international response.

2.6 Context

2.6.1 Emergency Departments

Emergency Health Services (EHS) are a key component of, and often the 'front door' to, the health care system. Advances in emergency health care are often the result of conflict or disaster management with systematic approaches to EHS having their primary origins in the military, where the sudden arrival of large numbers of casualties require an organised and systemic approach.

Emergency Departments are operational units within hospitals, which provide emergency reception, clinical evaluation, and intervention for patients suffering from acute health crises. Emergency Medicine is defined by ACEM as:

> The field of practice based on the knowledge and skills required for the prevention, diagnosis and management of acute and urgent aspects of illness and injury affecting patients of all age groups with a full spectrum of undifferentiated physical and behavioural disorders. It further encompasses an understanding of the development of prehospital and in-hospital emergency medical systems and skills necessary for this development. (Australasian College of Emergency Medicine [ACEM] 2002, p337*)*

2.6.2 ED Congestion

Congestion of EDs is a function of many factors both intrinsic and extrinsic to the broader health system. The Input-Throughput-Output model, developed by Asplin et al. (2003), provides a rational and all-inclusive approach to the understanding of ED patient flow. Under this model ED congestion can be attributed to the collective impact of demand (input), processes related to provision of care to the patient in the ED and the hospital (throughput), and access to ongoing care for the patient after being seen and treated at the ED (output) (Asplin et al. 2003). Each of these factors can be influenced and affected by other forces such as population shifts, seasonal variations, individual preferences and circumstances, resource limitations, and policy changes.

2.6.3 The consequences of ED congestion

The consequences of ED congestion impact patient outcomes, staff outcomes, and system-wide outcomes. Review of the literature on the negative impacts of ED congestion shows that it threatens public health by compromising patient safety (Bernstein et al. 2009; Cowan & Trzeciak 2005; Pines & Pollack 2009; Trzeciak & Rivers 2003), reducing timely treatment (Hwang 2006; Hwang 2007; McCarthy et al. 2009; Richardson, Asplin & Lowe 2002; Richardson & Hwang 2001; Richardson & Mountain 2009) including time to analgesia (Pines & Hollander 2009), increasing patient waiting times (Stahl 2008) and decreasing patient satisfaction (Pines et al.

2008). These impacts occur as a result of congestion during normal business, but this suggests that congestion during disaster response may also be associated with adverse outcomes and there may be limits to surge capacity.

The ultimate impact on patient safety is mortality. A retrospective stratified cohort analysis of patient mortality ten days after ED presentation was measured in relation to occupancy rate as a proxy measure for congestion in the ED at the Canberra Hospital, Australia (Richardson 2006). The mortality rate was significantly higher at overcrowded times (0.42%) than non-overcrowded times (0.31%). The relative risk of death was 1.34 (95% CI: 1.04-1.72) and even after controlling for triage category, congestion was still associated with excess death (Richardson 2006). In another retrospective study of ED occupancy (as a measure of congestion) in three tertiary metropolitan hospitals in Western Australia, the investigators analysed the mortality rate on specified intervals after admission to ED using three years of data spanning from July 2000 to June 2003. Using an Overcrowding Hazard Scale (OHS), the researchers found that regardless of age, diagnosis, urgency, mode of transport, referral source, or hospital length of stay, an OHS of larger than two was associated with relative increase in deaths at two days (Hazard Ratio=1.3, CI: 1.1-1.6), seven days (Hazard Ratio=1.3, CI: 1.2-1.5) and thirty days (Hazard Ratio=1.2, CI: 1.1-1.3) after admission (Sprivulis 2006).

2.6.4 Factors Affecting EHS Demand (Input)

Entry overload, defined as an ‘overwhelming number of patients presenting to the ED in a short space of time’ (Fatovich & Hirsch 2003, p.408). Early studies focussed on “inappropriate users” and point to them for the excess load on EDs (Green & Dale 1992). Focus is shifting now towards how demand can be managed to prevent or minimise ED congestion and improve the care for patients (Bezzina et al. 2005; Callen, Blundell & Prgomet 2008).

Demand for EHS is growing in Australia (Australian Institute of Health and Welfare [AIHW] 2008; AIHW 2009; Productivity Commission 2010; QAS 2009) and elsewhere in the western world, most notably in the UK (NHS 2009; Wrigley et al. 2002; Peacock et al. 2005), the US (Derlet 2002; Schafermeyer & Asplin 2003; Larkin et al. 2006) and Canada (Bond et al. 2007; Schull et al. 2001; Schull et al. 2003). Similar effects have also been reported in Japan (Ezaki & Hashizumi 2007; Ohshige & Tochikubo 2003). The growth and ageing of the population are contributors, but these factors alone cannot explain either the extent of the growth in demand or the variations in utilisation rates observable across jurisdictions.

- ED utilisation varies by different age groups. Statistics consistently report that, except for infants and young children, elderly patients comprise a disproportionately higher percentage of ED users (Lowthian et al. 2010; Nawar, Niska & Xu 2007).
- Gender may be a factor affecting demand. While numbers of men and women are almost equal in the Australian population, men (except for > 75), consistently outnumber women in ED utilization (AIHW 2005; AIHW 2006; AIHW 2008a; AIHW 2008b; AIHW 2009). Similar findings have been reported in Canada (McCusker 1997); the US (Young et al. 2005) and Israel (Anson, Carmel & Levin 1991).
- It is suggested that people living alone or without family support, particularly in older age groups, are more likely to visit EDs (Lowthian et al. 2010; Stathers, Delpech & Raftos 1992) or be directed to ED if they called a health information line (Han et al. 2007).
- Socio-economic status affects individual utilisation of health services. In the US, homeless populations have a much higher rate of using ED services (Kushel et al. 2002), while in Australia an Aboriginal or non-English speaking background is also associated with higher use of EDs (Thomas & Anderson 2006).
- Demand for ED care is also associated with actual and/or perceived presence of an illness/injury as well as actual and/or perceived acuity and severity/urgency of the condition (Bezzina et al. 2005; Hoot & Aronskey 2008; Ragin et al. 2005; Reeder et al. 2002). This is not to say that all patients attending an ED have an acute illness, or that all people with an acute illness attend an ED (Brown et al. 2000; Clark et al. 2002).
- Studies suggest that patients, who visit an ED directly or after seeking alternative primary care, are of the belief that the care they receive in an ED is of a higher quality than the care provided by a primary health practitioner (Han et al. 2007). Considering that many patients regard their condition as serious enough to justify seeking urgent medical attention (Callen, Blundell & Prgomet 2008) it makes sense for them to visit an ED where appropriate facilities and expertise will assure them of the care they need.

2.6.5 Factors Affecting EHS Throughput

Throughput factors describe internal processes and procedures for care of patients in the ED from the moment they arrive to the moment they are discharged or depart. In their editorial "If you want to fix congestion, start by fixing your hospital" Asplin and Magid (2007) emphasise the importance of a holistic approach to solving the issue of congestion.

- Registration or triage is the first point of contact for patients. Any delays or shortcomings at triage not only create a backlog of waiting patients but can also adversely affect the health of patients and consequent processes and functions in the ED (Asplin et al. 2003). Slow registration/triage may be a result of factors such as staff shortage or inexperience, inefficient equipment (e.g. IT systems), and inappropriate location of the triage station.
- Care and service processes are also crucial components of throughput factors (Asplin et al. 2003). Specialty consultation and use of imaging and laboratory testing have varying effects, depending on the type of consultation and tests, on prolongation of stay in ED (Yoon, Steiner & Reinhardt 2003), while staff shortage, reduced capacity, and boarding of inpatients are commonly cited throughput factors associated with ED congestion (Asplin et al. 2003; Hoot & Aronskey 2008; Olshaker & Rathlev 2005). The level of seniority of staff, as well as numbers, is crucial to improving ED performance (Thornton & Hazell 2008; White, Armstrong & Thakore 2010).

2.6.6 Factors Affecting EHS Output

Output factors encompass all services, facilities, procedures, resources, and events happening outside the ED, which relate to follow-up care for the patient when exiting the ED. These include inpatient admission, hospital resources, transport services, and community capacities (e.g. post-acute care, primary and specialty care). Shortage of resources in any of these areas affects ED function with access block to inpatient beds blamed as the main cause of ED congestion (ACEM 2011; Cameron, Joseph & McCarthy 2009; Chu & Brown 2009; Duke et al 2009; Dunn 2003; Fatovich, Hughes & McCarthy 2009; Fatovich, Nagree & Sprivulis 2005; Gomez-Vaquero et al. 2009; Olshaker & Rathlev 2005; Paolini & Fowler 2008; Richardson & Mountain 2009; Sammut 2009; Steele & Kiss 2008; Stuart 2004; Thomas & Cheng 2007; Walters & Dawson 2009). Accordingly, increasing the number of beds, and solutions of this nature, have been recommended as a solution (Fatovich, Hughes & McCarthy 2009; Sammut 2009).

2.6.7 Implications from the Literature

EHS utilisation load may increase quickly as a result of seasonal outbreaks of diseases such as influenza or pandemics (Hoot & Aronskey 2008) and during disasters. In addition, normative factors such as general expectations of higher quality care, better specialised services, easier accessibility, and increased convenience for people who may not need urgent medical attention, can all lead to a greater demand for ED services during disasters.

The congestion associated with demand during a disaster may lead to adverse patient outcomes compromising patient safety, increasing time to triage, analgesia and treatment, increasing patient waiting times and increasing mortality.

2.7 Common Problems in Disasters

A number of other papers review disaster experiences and try to identify issues common to all disasters or a specific disaster type. One of the earliest review papers identifying problems in disaster management was by Frank Berry M.D, the US Assistant Secretary of Defence (Health and Medical) in 1955 (Berry 1956). This was based on a presentation to the Southern Surgical Association and included five references. Berry noted issues with the availability of infrastructure, supplies and personnel, managing the welfare of personnel to optimise performance, appropriate distribution and prioritisation of patients and above all system wide coordination of effort. He suggested the following as issues for consideration in improving preparedness:

1. There must be unified and efficient organisation with overall coordination, which will function not only in a given city or state but throughout the nation.
2. There must be proper storing and dispersal of sufficient medical supplies
3. We should have universal immunisation against tetanus.
4. We should continue to place emphasis on the principles of surgery ….. with proper timing and staging of surgical procedures.
5. There should be blood typing and Rh determination for all. (Berry 1956, p.571)

There have been many reviews since then with growing numbers of publications.

2.7.1 System Issues in Emergency Department Response to Disasters

2.7.1.1 Planning

The attack on the World Trade Center in the USA on 11 September 2001, the experience of Severe Acute Respiratory Syndrome (SARS) in 2002–03, various threats of biological warfare, and the Asian Tsunami on 26 December 2004 have heightened worldwide awareness of the need for medical communities to develop plans to create surge capacity within hospitals and communities to better cope in a pandemic or mass casualty situation.

Planning is the most important element of preparedness with the planning process as important as the plan itself. The planning process should bring a representative group of people and organisations together to allow relationships to be developed that will support the ability to operationalise the plan and ensure consistency across agencies. Standardisation (compatibility, inter-operability, inter-changeability, and commonality) with mutual cooperation is essential (Cruz Vega et al. 2001; Dauphinee 2000). All of this helps prevent the plan sitting on a shelf because it is not meaningful to the users - the 'paper plan' concept.

2.7.1.2 Vulnerable groups

It is important to remember the special needs of the more vulnerable members of society such as women and children, the elderly, disabled, chronically ill and those who have been displaced (Abbott 2000; Bremer 2003; Brennan et al. 2001; Burkle et al. 1995; Leus, Wallace & Loretti 2001; Mudur 2005; Redmond 2005a; Seamen & Maguire 2005). Pregnant women still have babies, diabetics still need insulin and mental health needs remain (Leus, Wallace & Loretti 2001), as do all other existing chronic medical problems (Rios & Cullen 2006).

2.7.1.3 Communication

Communication and information management is one of the most consistent challenges and problems in disaster response (Arnold et al. 2004; Bradt, Abraham & Franks 2003; Braham et al. 2001; Chan et al. 2004; Gerace 1979; Kizer 2000; McEntire 1998). Valid information is critical to enable decision-making and resource prioritisation (Chen et al. 2003) and the quality of disaster management may depend on the quality of communication and information (Benner et al. 2003). While information is acknowledged as needing wider distribution in a disaster situation (McEntire 1999), communication issues, both technical and organisational, are important considerations in coordinating the health response (Noji et al. 2001). Normal communication networks may not be functioning (Chen et al. 2001) while poor coordination between agencies and limited evidence of organisational learning are two common criticisms (Sondorp, Kaiser & Zwi 2001).

Improved communications and awareness of the correct lines of communications are needed (Waxman et al. 2006) and the importance of a pre-planned, independent and dedicated communication system to effectively coordinate and manage disasters is seen as one of the most critical areas needing attention (Hickson et al. 2001).

Information technology is playing an increasingly important role in information sharing during disasters (Arnold et al. 2004; Chan et al. 2004; Mathew 2005), including both technical and organisational considerations (Noji et al. 2001). The further development of wireless technology and peer networks may offer increasing solutions (Arnold et al. 2004; Bradt, Abraham & Franks 2003). Satellite communications has been used for telehealth in India and disaster management in large remote areas (Anderson et al. 2001; Mathews 2005). Personal Digital Assistants (PDA) have been used in support of information sharing including routine EHS and public health use and database access for chemical disasters (Arnold et al. 2004) and determining replacement drugs (Gaudette et al. 2002).

2.7.2 Space Issues in Emergency Department Response to Disasters

2.7.2.1 Creating space

Surge capacity can be created in a number of ways. Non-essential and non-emergency functions within hospitals may need to be suspended for the duration of the crisis. This may include cancelling elective surgery and admissions, earlier than usual discharge of patients, removal of ambulatory care from hospitals, and reallocation of physical space and roles (Hick et al. 2004). When individual hospitals reach the limit of their capacity to cope, they must be able to move patients or services to other hospitals or centres (Bonnett et al. 2007; Runge et al. 2009).

2.7.2.2 Predictors of Numbers

Having an idea of numbers is important. While communication from the site may provide this information, it does not always hold true. The Centers for Disease Control and Prevention (CDC) has developed a ‘calculator’ based on analysis of a number of disasters (CDC 2005). For sudden onset urban disasters (this distinction is important) an ED can expect in total, twice the number of patients that present in the hour following the arrival of the first patient. Two axioms should also be remembered - in widespread natural disasters (e.g. tsunamis) the initial estimates are likely to be under while in localised man-made disasters (e.g. transport / industrial) the initial estimates are usually over the actual figure (Rutherford 1990).

2.7.3 Supply Issues in Emergency Department Response to Disasters

2.7.3.1 Resource management

Worldwide, health care systems have few surplus resources. However, the ability to expand capacity to meet health needs during a crisis is imperative (Hick et al 2004). Supplies such as ventilators, drugs, and PPE need to be stockpiled; and there must be increased capacity for cleaning, security and crowd management. Morgue facilities must also be able to expand, and laboratory capacity may need to expand exponentially with screening and testing available for patients and health care workers (Hick et al 2004).

Access to diagnostic facilities at medical sites may help decrease the number of people transferred to remaining hospital facilities (Nufer et al. 2006). Hurricane Katrina demonstrated the value of Point of Care Testing (POCT) with recommendations that handheld POCT be used for airborne critical care and disaster specific mobile medical units (Grissom & Farmer 2005; Kost et al. 2006). However power supply and battery life needs to be considered (Grissom & Farmer 2005). Of the 104 teams at the Chi Chi earthquake only 13% brought emergency power generators with them (Hsu et al. 2002).

2.7.3.2 Personal Protective Measures (PPE)

If subject to working in hazardous conditions, a hard-hat or light helmet, heavy work gloves, eye protection and safety boots that all meet appropriate standards are also needed (Wallace 2002). To both prevent confusion and protect responders, the identification of the medical on-site coordinator and other members of medical teams should be simplified using colour-coded hard hats and clothing (Gates et al. 1979; Gerace 1979; Noji et al. 2001). A logo on team clothing is also an identifier (Noji et al. 2001) and helps ‘to promote esprit de corps’ (Zavotsky, Valendo & Torres 2004).

2.7.4 Staff Issues in Emergency Department Response to Disasters

2.7.4.1 Local response

The timeliness of response is critical to the administration of medical care and reduction of immediate mortality (Hsu et al. 2002; Schultz et al. 1996). External medical assistance is typically delayed from providing immediate care and only arrives after local services have already provided emergency care (Hsu et al. 2002; Judd 1992; Telford et al. 2006).

Many authors have been critical of disaster relief teams, and their efforts, over many years but their comments provide the opportunity for improvement with recognition of problems and identification of potential solutions. Many of the issues identified are not new problems. In 1972, Karl Western wrote:

- physicians and nurses will be sent to a disaster far in excess of actual needs
- surgeons will be sent when psychiatrists, paediatricians or public health physicians would have been more appropriate
- physicians on the scene may find that emergency relief supplies are completely inappropriate, or contain surgical rather than medical supplies (Leus, Wallace & Loretti 2001).

There is also increased need for non-medical staff to fulfil roles in administration, communication, transportation, security and crowd control. However, surge capacity applies across the entire community, with health, government, and community groups required to act in an integrated and cooperative manner.

Resultant loss of workforce numbers needs to be planned for and covered by casual staff, retired staff and volunteers (Hick et al. 2004).

2.7.4.2 Leadership

How well a society survives a disaster is directly related to the skills possessed by its leaders and the advanced preparations they have made (Aghababian 2000). Public health emergency management is not a democratic process (Kizer 2000). It is essential that one person is in charge of the emergency response and everyone knows the chain of command. The incident leader must be able to make appropriate decisions quickly, and often on the basis of incomplete or uncertain data. This autocratic style of leadership is more customary in law enforcement, military and fire fighting, and is different to the more group focussed approach used in health. Therefore leadership and management roles among the potentially responding entities need to be clearly established and understood in advance (Kizer 2000)

The Incident Command System (ICS) has become the accepted standard for disaster response in many countries (Briggs 2005). Adherence to this is necessary to integrate successfully into the response. Failure to do so may lead to death of personnel, lack of adequate medical supplies and staff working beyond their training or certification (Briggs 2005). An ICS can also help ensure resources are directed to areas in most need (Yamada et al. 2006).

2.7.4.3 Education, training and exercises

There is widespread agreement on the need for improved education and training in disaster medicine (Birch 2005; Birnbaum 2005; Gaudette 2002; Marmor 2005; PAHO 1999; Russbach 1990; Sharp 2001; VanRooyen 2005). Current training for health staff, with its need to focus on hospital and community care, does not adequately prepare personnel for work in a disaster. As Birnbaum (2005) has noted, we need to move from the era of the well-intentioned amateur, to that of the well-trained professional.

There are often significant intervals between training and exposure and there may be difficulties in application due to different conditions (Ford 2000). Also many of those who are involved in disaster response do not experience this again. This means they do not have a chance to pass on the lessons of experience and each responding group consists of novice disaster practitioners (Birnbaum 2005). Key areas are decision making (Frisch 2005), with trained staff able to make better decisions (Moresky 2001; VanRooyen et al. 2001a). Teamwork skills also need to be specifically addressed (Ford 2000*)* to improve team efficiency during a crisis (DeVita 2004). A number of developments have occurred to address this need including education frameworks (Archer & Synaeve 2007), a model curriculum (ISDM 1993) and short courses such as Major Incident Medical Management and Support (MIMMS) (Advanced Life Support Group 2005).

2.7.5 Implication from the Literature

The surge associated with disasters and mass casualty incidents creates additional demand on EDs. While many of the issues are system wide such as communication, it is important to recognise that preparedness needs to ensure focus on sufficient space, supplies and staff training and protection. This extends to preparation of the individual, the department, the hospital and the community.

2.8 Pandemic

2.8.1 Influenza pandemics

Influenza viruses are myxoviruses, with three main genera—Influenza A, B, and C—all of which are capable of causing infection in humans (Lee & Bishop 2006).

- Influenza A is responsible for epidemics, and occasional pandemics in humans (WHO 2005).
- Influenza B does not cross the species barrier, but can cause epidemics (Lee

& Bishop 2006).

- Influenza C has, to date, only caused mild illness, and does not cause epidemics (Lee & Bishop 2006; Mandell, Bennett & Dolin 2009).

The outer coat of the influenza virus has two antigens: haemagglutinin (H), which anchors the virus to cells it invades; and neuraminidase (N), which helps the virus both enter and exit individual host cells (Lee & Bishop 2006). Influenza A subtypes are named according to which antigen they possess. Humans manufacture antibodies to these antigens during the immune response (Lee & Bishop 2006). Only Influenza A subtypes H1, H2, and H3 have been readily transmitted between humans. However, these antigens are altered over time by a process of drift (repeated minor mutations), or shift when two different influenza viruses invade a host simultaneously and recombine to produce marked changes in surface antigens (Mandell, Bennett & Dolin 2009). Shift commonly occurs in Influenza A, but not in Influenza B or C.

Epidemics are local outbreaks of disease while global spread is the hallmark of pandemics (Lee & Bishop 2006), as reflected in the WHO definition:

> An epidemic occurring worldwide or over a very wide area, crossing boundaries of several countries, and usually affecting a large number of people. (WHO 2007b. p.9)

Pandemics can persist for months, years, or decades and pandemic influenza includes rapid transmission with the disease occurring outside usual seasonal patterns, with high attack rates across all age groups and high mortality rates in young, healthy adults (Mandell, Bennett & Dolin 2009). Epidemics and pandemics of influenza occur when a new virus emerges, or an existing virus mutates sufficiently for little or no immunity to exist (Department of Health and Ageing [DoHA] 2008; Lee & Bishop 2006). Influenza pandemics have occurred regularly over the course of history. They arise when a virus develops to which the population has little or no immunity, and efficient human-to-human transmission occurs.

The predominant virus type causing epidemics has evolved over time. The ‘Spanish Flu’ of 1918–19 was caused by Influenza A virus of subtype H1N1. It killed more people than died in World War I (DoHA 2008). Subsequent influenza pandemics occurred in 1957 (‘Asian Flu’: H2N2); in 1968 (‘Hong Kong Flu’: H3N2); in late 1976 (re-emergence of H1N1 with an outbreak at a North American military base); and in 1977 the ‘Russian Flu’ (Anderson, Hart & Kainer 2003; Garten, Davis & Russell 2009). The 1976 outbreak was feared to be the start of a pandemic of similar proportions to that of 1918–19, with a vaccine rapidly rolled out and US citizens compulsorily immunised. This immunisation campaign was halted when a higher than normal rate of Guillain–Barré Syndrome was detected amongst those immunised and a pandemic failed to eventuate (Fineberg 2009).

Previous major pandemics occurred before the development of modern health care innovations that are now considered standard care. During the 1918–19 Spanish Flu pandemic, before the advent of antibiotics, most people died from bacterial infections (Kapelusznik, Patel & Jao 2009). In Australia, the 1968 pandemic occurred when intensive care units were only in development (Anderson, Hart & Kainer 2003).

Since 1918–19, there have been many societal changes that have altered the potential risk profile of the community. Populations in large cities are bigger and also relatively far more mobile. High-speed international travel means that pandemics spread around the world very quickly (Lee & Bishop 2006). Travel during the incubation period of viruses devalues any benefits of border controls.

However, there are also positive societal changes that may mitigate some of these risks. Populations are now healthier with fewer chronic infectious diseases (especially tuberculosis); improved infection control practices, people in the developed world live mostly in relatively isolated, separate quarters, benefit from better environmental standards and have more access to sophisticated medical care than in 1918–19 (Lee & Bishop 2006).

However, in developing countries, illnesses such as HIV/AIDS, tuberculosis, and malaria together with vaccine preventable childhood diseases remain significant contributors to both mortality and disease burden (Lee & Bishop 2006). The outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003, followed by Avian Influenza (H5N1), raised awareness of the potential impact of novel viruses on human health and led to enhanced preparedness for pandemic management. Avian Influenza is spread by migratory birds, is highly infectious for chickens, and lethal when contracted by humans with a mortality rate of 60% (Lee & Bishop 2006). Concern that H5N1 may mutate into a human-to-human transmissible form has sensitised the world to potential impact of a major pandemic.

2.8.2 The planning context for pandemics

Planning for pandemics requires building large-scale surge capacity into the health care system. Unlike other disasters, pandemics last up to 7–10 months, and can cause significant health, economic, and social impacts for extended periods (Council Of Australian Governments [COAG] 2008).

Hawryluck, Lapinsky and Stewart (2005) in their review of SARS identify domains of crucial importance that form the basis of responsibility for a central coordination team. The domains identified include:

> Clinical management, infection control, education, communication, team morale and manpower, moving from silos to system based thinking, data collection, research and, finally, lobbying to ensure resources are available to meet critical care needs. (Hawryluck, Lapinsky & Stewart 2005, p.385)

In 2004, the WHO developed a checklist for developing pandemic plans. The essential features of the checklist included preparation for an emergency; surveillance; investigation of cases and treatment; prevention of community spread; maintenance of essential services; research and evaluation; and the implementation, testing and revision of the plan (WHO 2005).

In Australia, the DoHA devised the Australian Health Management Plan for Pandemic Influenza (AHMPPI), which was tested using a simulation exercise in 2006. Key recommendations that emerged from ‘Exercise Cumpston 06’ included streamlining decision-making processes, increased flexibility to respond according to severity of the pandemic and the available resources; improved communication systems including sharing information between jurisdictions; public health education campaigns ahead of time; a national surveillance framework; clarification of quarantine, border control, and emergency legislation; and integration of primary care providers in pandemic planning (DoHA 2007).

In 2008, ‘Exercise Sustain 08’ was held to further review the AHMPPI for government preparedness at a national level to respond to and recover from pandemic influenza. Exercise Sustain 08 underscored the impact a pandemic would have, both during the outbreak and in the recovery phase, on all facets of the community. It identified differences between the response required during a pandemic, and that required for other disaster situations such as floods, fires, and mass casualty situations, which are usually geographically defined and of shorter duration (COAG 2008).

All Australian states have pandemic plans designed to complement or augment the AHMPPI (Australian Capital Territory [ACT] Health 2007; CDC Unit Vic 2007; Department of Health SA 2015; Department of Health WA 2009; Qld Department of Premier and Cabinet [DPC] 2009; NSW Health 2007; NSW Health 2008; NT Counter

Disaster Council 2006; Tasmania Pandemic Influenza Project 2008). These plans agree that flu clinics should be established to minimise the impact of a pandemic on EDs. Flu clinics allow EDs to continue to meet emergency care needs of communities. Pandemic plans also recommend separating influenza patients from other patients at triage, with the designation of ‘flu hospitals’ to keep those infected separated from patients, who do not have the virus. Other recommendations include priority vaccination for at-risk staff, pre and post-exposure prophylaxis for staff, who come into contact with suspected and confirmed cases, and the use of PPE with access to pandemic stockpiles as required. Hospital staff are expected to self-isolate if exposed or ill (ACT Health 2007; CDC Unit Vic 2007; Department of Health SA 2015; Department of Health WA 2009; Qld DPC 2009; NSW Health 2007; NSW Health 2008; NT Counter Disaster Council 2006; Tasmania Pandemic Influenza Project 2008).

2.8.3 The Operational Context of Emergency Departments (EDs)

In normal times, patients who use EDs as General Practitioner (GP) services have a relatively low level of impact on how the ED functions because they pass through the department relatively quickly (Richardson & Mountain 2009). However, in a pandemic situation, waiting room overcrowding poses a significant public health risk. Patients with a potentially highly infectious illness may cross-infect other patients or visitors, as happened during the SARS outbreak in Canada in 2003 (Borgundvaag, Ovens & Goldman 2004). Seasonally, influenza has been recognised to put pressure on EDs in winter through increased numbers of presentations (Runge, Almeida & Bern 2009) with this surge generally associated with people over the age of 65 with pre-existing medical conditions (Schull, Mamdani & Fang 2005). In a pandemic situation, extra presentations may come from all age groups.

2.8.4 System Issues in Emergency Department Pandemic Response

During the Toronto experience of SARS, where one patient infected many others in an ED, rigorous infection control was applied to everyone entering hospitals. At one Toronto hospital, anyone with the potential to be infected was masked and immediately moved to a negative pressure room, regardless of presenting complaint. Other measures employed to prevent spread of the disease included rigorous cleaning and isolation principles, procedure and protocol lists for the use of PPE, closure of some hospital entrance points with guards at available entrances to exclude or control access to ED, exclusion of all non-essential personnel from the hospital, protocols to govern patient movements, alteration in ventilation to create negative pressure rooms and the removal of all hallway stretchers. Staff updates were provided daily via bulletin boards and email. Extra housekeeping and transport staff were employed within hospitals (Borgundvaag, Ovens & Goldman 2004; Farquharson & Baguley 2003).

The 2003 experience of SARS in Toronto highlighted how changed operational practices necessitated by an infectious disease outbreak can add to the burden of work in the ED. Many of these changes added to an already overburdened system. The need to screen and redirect patients presenting to the ED added to the triage time by requiring additional processes. Patient education for suspected cases to follow masking and isolation protocols whilst within the ED was also time-consuming (Borgundvaag, Ovens & Goldman 2004; Farquharson & Baguley 2003).

Whilst vaccination is vital to stop the spread of pandemic influenza, vaccine development takes time. Community mitigation strategies such as social distancing, cough and sneeze etiquette, and frequent thorough hand washing are needed to reduce the spread of disease as much as possible in the interim (Runge, Almeida & Bern 2009).

One method of social distancing is to triage patients over the phone. However, misdiagnoses of serious illnesses were reported in the UK where staff in call centres, with no medical training, used an algorithm to diagnose and recommend treatment for people concerned that they had Pandemic (H1N1) 2009 Influenza (Bourke & Shields 2009; Houlihan et al. 2010; Payne, Darton & Greig 2009). Wales opted out of this system for pandemic management from the beginning, as it was felt patients should be seen by clinicians (‘Swine flu’ 2009).

However hand hygiene amongst the general public entering one New Zealand hospital after the start of the pandemic was noted to be poor, despite media campaigns, extensive signage at the hospital entrance and obvious provision of alcohol gel. It was reported that only 18% used the alcohol gel, with more using it going into the hospital than leaving (Murray, Chandler & Clarkson 2009).

In the USA, it was reported that increased biosurveillance reporting requirements and increased workload during the Pandemic (H1N1) 2009 Influenza outbreak led to poor levels of reporting compliance in hospitals without automated reporting systems, compared with full compliance from hospitals with automated reporting systems (Eizenberg 2009).

Rapidly changing guidelines also created confusion for the use of PPE and other issues. Participants in a Californian workshop in September 2009 voiced frustration over rapidly changing guidelines that were not dated or timed, making it difficult to rapidly determine pertinent changes. Workshop participants also found disparities between guidance from different sources, leading to a call for a common credible source of information (Dorian et al. 2009).

2.8.5 Space Issues in Emergency Department Pandemic Response

Physical space limitations in EDs mean that patient throughput is constrained by how many patients can be seen in the available area (Farquharson & Baguley 2003). Outdoor screening areas were used in Toronto during SARS with potentially infected patients transferred directly from this area to isolation facilities (Borgundvaag, Ovens & Goldman 2004; Farquharson & Baguley 2003).

During the peak of the Pandemic (H1N1) 2009 Influenza epidemic, the Texas Children's Hospital in Houston implemented a mobile paediatric emergency response team (MPERT). The MPERT was set up in a covered, open-air car park close to the ED, and all patients were triaged before entry to the hospital (Cruz et al. 2010). Point-of-care influenza test kits were used initially, but the supply quickly ran out. Patients assessed as being probably infected with Pandemic (H1N1) 2009 Influenza were isolated, evaluated, treated and discharged without entering the hospital unless their condition was assessed as needing emergency care or admission. Social distancing for staff was performed through infection control techniques including symptom screening, isolation, contact precautions and the use of N95 respirators. Streamlining processes including paperwork, simultaneous nursing and medical assessment, and a designated discharge nurse educator facilitated dealing with this large influx of patients to an already stressed system. Current, multilingual advice was placed on the hospital website and both nursing staff and automated phone lines were available to answer frequently asked questions. Printed advice was issued to parents on discharge (Cruz et al. 2009).

The Joe DiMaggio Children's Hospital in Florida reported setting up an initial triage point outside the entrance to the paediatric ED and high-risk patients were directed for further triage in the ambulance bay (Boehm et al. 2010). Keeping patients cool, comfortable, hydrated and fed in this environment proved to be challenging; and patient satisfaction dropped significantly during this time. However, no staff members tested positive for Pandemic (H1N1) 2009 Influenza and no cases of cross- infection were reported whilst this system was in operation. Stores of PPE and testing swabs were quickly depleted. Extra costs of more than US$3000 per day were incurred for extra staffing and equipment (Boehm et al. 2010).

A trial conducted at Stanford University Hospital after the initial epidemic used volunteers acting as patients with de-identified real patient data to run a simulation trial in a covered car park near the hospital. The results indicated that off-site assessment areas may be a feasible method of rapid assessment that limits waiting times, frees space in EDs for more critically ill patients and provides social distancing of potentially infectious patients to reduce the risk of cross-infection (Weiss et al. 2010).

There is also contradictory information in pandemic plans devised for different sections of the health care system. For example a 2003 survey, undertaken on behalf of the Australian and New Zealand Intensive Care Society, identified hospital EDs as additional short-term bed spaces for ventilated patients in the event of a pandemic (Anderson, Hart & Kainer 2003). This ignores the issue that, during a pandemic, EDs have increased demand on their space and resources; and cannot be expected to also function as satellite intensive care units (ICU).

2.8.6 Supply Issues in Emergency Department Pandemic Response

Stockpiling resources and equipment is a necessary part of disaster preparedness. Before the Pandemic (H1N1) 2009 the Australian Government stockpiled antiviral agents, ventilators and PPE. However, the distribution and dispersal of stockpiled resources during Pandemic (H1N1) 2009 became an issue with criticism of slow distribution of PPE and antiviral medications from the national stockpile (Grayson & Johnson 2009).

There have been reports of hospitals having experienced problems obtaining sufficient supplies of PPE and antivirals during Pandemic (H1N1) 2009 (Hanfling & Hick 2009). In the USA, hospitals experienced storage problems for PPE and antivirals once dispensed from the national stockpile (Dorian et al. 2009). In Canada and the USA, it was reported that stockpiled ventilators were too old or too simple to cope with the complex ventilation strategies required in severe Pandemic (H1N1) 2009, with ECMO needed rather than normal ventilators (Eggerston 2009; Sandrock 2009).

Centers for Disease Control and Prevention (CDC) Guidelines assume Pandemic (H1N1) 2009 infection occurs via droplet, contact and small aerosol transmission with recommendations for PPE for frontline workers based on these assumptions (CDC 2009b). PPE for health care workers in close contact with a suspected influenza patient during Pandemic (H1N1) 2009 consisted of protective eyewear, an impervious gown or apron, gloves and a fluid-repellent surgical mask.

There is consensus that P2 (N95) particulate filter masks, eye protection disposable impervious gowns and gloves should be used for all aerosol-generating procedures, and that these procedures should be undertaken in a negative pressure room, if one is available (CDC 2009b; Cheng, Dwyer & Kotsimbos 2009; Stuart et al. 2009; WHO 2009). Particulate filter masks are recommended as they provide a greater degree of protection than general surgical masks, with acceptable disposable models being the P2 or P3 in Australia and New Zealand and N95, N99 or N100 in the United States (WHO 2007b).

PPE and other barrier methods are vital to ED staff, who cannot be protected in any other way before an effective vaccine is developed. Many staff reported poor compliance with donning and removing PPE due to time constrains and discomfort; especially when the wearing of gloves, gowns, eye protection, and masks were required for prolonged periods (Hanfling & Hick 2009; Gershon, Pearson & Westra 2009; Seale et al. 2009). Users often find N95 masks uncomfortable, with somatic complaints including breathing difficulties, itching, rashes and acne having been reported. Some users have found the masks cause difficulties with communication and establishing a therapeutic relationship with patients (Farquharson & Baguley 2003; Gershon, Pearson & Westra 2009; Jefferson et al. 2008; Seale et al. 2009). Inconsistencies in recommendations between authorities need to be resolved to improve staff compliance (Hanfling & Hick 2009). Canadian research has found that for influenza; N95 masks are no more protective than normal surgical masks 94. Where tolerated, masking patients is probably more effective than masking health care workers (Mermel 2009).

Alternatives to the use of nebulised medications and non-invasive assisted ventilation had to be found to prevent the potential airborne spread of disease (Farquharson & Baguley 2003). Many of these challenges were replicated in the experience with Pandemic (H1N1) 2009. Extra pathology testing was required with suspected cases of Pandemic (H1N1) 2009 requiring nasopharangeal swabs. At the peak, laboratory testing was taking three to five days, by which time the optimal time for prescription of antivirals had passed. Whilst many EDs used rapid antigen point-of-care testing, these tests have been shown to have limited accuracy for known Pandemic (H1N1) 2009, with rates of detection reportedly as low as 11.1% (Drexler, Helmer & Kirberg 2009).

There was also a widespread perception in 2009 that the Pandemic (H1N1) 2009 Influenza vaccine has been ‘rushed’ into production and not comprehensively tested (Neale 2009). When the current vaccine was released, multi-dose vials posed a problem, with insurance companies initially refusing to cover GPs who administered it (Herbert 2009). The potential use of multi-dose vials for mass immunisation campaigns has been part of Australia's pandemic plan for several years, and although there are known risks associated with their use these risks can be minimised by providing clear guidelines and appropriate and timely education (Gardner 2009). In Canada, there has been a proposal to extend pharmacists' scope of practice to include administering influenza vaccine to reach more people (Ministry of Health Services British Columbia 2009), whilst in the UK guidelines for the administration of vaccines by health care assistants were developed (Hand 2009).

2.8.7 Staffing Issues in Emergency Department Pandemic Response

Staffing problems occur due to the large influx of patients, staff illness and family obligations (Hick, Hanfling & Burstein 2004). UK surveys have indicated a potential staff absenteeism rate of up to 85% during influenza pandemic (Damery, Wilson & Draper 2009), whilst an Australian study (Martinese et al. 2009) predicted absenteeism rates of between 17% and 53%, depending on a variety of factors. However, staff in ED and acute medical wards expressed more willingness to present for work than those working in areas in which they were less likely to be exposed (Martinese et al. 2009). In another UK survey, staff expressed a strong sense of duty to both patients and colleagues and intended to come to work regardless of the severity of the illness, unless their family, particularly children, needed them at home; if they were too ill to work themselves; or they had no means of getting to work if the pandemic disrupted transport (Ives, Greenfield & Parry 2009).

In an Australian survey of ED nurses (Considine & Mitchell 2009), most participants gave positive responses about their willingness to participate in a biological incident; however, there was a significant decrease in reported comfort levels in dealing with unknown biological agents. This survey showed that over 70% of nurses surveyed reported undertaking CBR training; however, the average time to last training was 19.2 months (SD=12) (Considine & Mitchell 2009).

The experience of SARS gives potential insights into how health care workers may behave during a pandemic. Thirty per cent of SARS cases were health care workers, some of who died. Whilst many workers performed with commendable dedication, there were reports of workers who refused to work with SARS patients, or who refused to work at all. Some left health care work voluntarily and their employers dismissed some. Shortly after the SARS experience, professional codes of ethics came under examination, particularly in Canada, as these are useful tools for establishing both workers' rights and responsibilities, their ethical duties and obligations (Ruderman et al. 2006; Singer et al. 2003). At the time there were mixed views about the degree of duty of care that exists during outbreaks of infectious disease. Working groups could not reach consensus on the degree to which health care workers owe a duty of care when their own lives, and that of their family and friends, are at risk in the course of patient care (Ruderman et al. 2006; Singer et al. 2003).

Whilst there has been a great deal made of an expectation of staff absenteeism during a pandemic, it is known that health workers worldwide often come to work even when ill. In the tropics, influenza is under-recognised and under-diagnosed, which can lead to staff infecting their families, colleagues and patients inadvertently (Leo, Lye & Chow 2009). In Scotland, a 1996 study showed that whilst 23% of staff in the study had serological evidence of influenza infection, there was only an 8% absenteeism rate in the same influenza season (Elder et al. 1996). A 2007 Australian study, found that 24% of medical staff and 26% of ancillary staff would present to work in spite of being symptomatic for pandemic influenza if there was a staff shortage (Seale et al. 2009). This survey also found that whilst most staff would adhere to quarantine and antiviral medication directives; a large proportion would be very unhappy to do so, which could impair their adherence to these measures (Seale et al. 2009). A single hospital study in the USA undertaken after the peak of the (H1N1) 2009 Pandemic found that health care worker infection was highest in the adult ED, followed by the paediatric ED. There was no commensurate increase in sick leave in these departments, leading to the conclusion that some health care workers may have continued to work in spite of being infected with the virus (Santos, Bristow & Vorenkamp 2010).

Recommendations from the WHO and the CDC were to redeploy staff with risk factors for severe Pandemic (H1N1) 2009 Influenza infection, which caused depletion in the ED workforce. However, not all authorities agreed with the WHO (WHO 2009) and CDC (CDC 2009b) guidelines regarding staff redeployment. A joint paper published by the Society for Healthcare Epidemiology of America (SHEA), Association for Professionals in Infection Control and Epidemiology, Inc. (APIC), the Infectious Diseases Society of America (IDSA), and the American College of Occupational and Environmental Medicine (ACOEM) felt that this approach was neither feasible nor desirable. The paper stated redeploying staff would not only erode confidence in the efficacy of PPE and infection control guidelines, but would invade the privacy of staff who may not wish to divulge risk factors to their employers. They also cited subjectivity about risk factors such as obesity and severe asthma (SHEA et al. 2009). However, it would seem irresponsible for any hospital to expect people with known risk factors to expose themselves to an infection, which poses greater risk to them than it does to others. Given that hospitals owe a duty of care to employees, it would also potentially open the door to litigation should they become unwell. In the UK, the nurse registering body refused to indemnify nurses who worked outside their usual field of practice during the pandemic (Dean 2009). Hospital management should provide timely education and support, pre-training, evidence that staff are valued and support for staff working outside their usual sphere of expertise (Perrin et al. 2009).

Traditionally, there is a poor level of uptake of seasonal influenza immunization by hospital staff, with rates reported as being between 20% and 50% across Australia (Influenza Specialists Group 2006). Various reasons cited for this include a lack of perception of personal risk, poor knowledge levels of how immunisation works, doubts about vaccine efficacy or safety, self-perceived contraindications and inconvenient access (Hollmeyer et al. 2009). A study in Hong Kong conducted before and repeated after the Pandemic (H1N1) 2009 outbreak reported no significant increase in intention to receive immunisation, with participants citing fears of side effects and doubt of efficacy as their main reasons for refusing. This result is in spite of the Hong Kong experience of SARS, which was expected to increase health care workers' acceptance of vaccination (Chor et al. 2009).

2.8.8 Implication from the Literature

International experience with influenza pandemics confirms the potential of pandemics to cause a significant increase in the annual burden of disease. Influenza pandemics have significant consequences for health systems and hospital EDs, which are the hub of the health systems' required response. The prolonged duration of a pandemic, along with the risk to the health of healthcare workers and their famiies, place a significant burden on all aspects of preparedness.

2.9 International Response

2.9.1 Anticipated need for disaster response teams

It is likely that there will be calls for disaster medical assistance and humanitarian aid following international disasters (McEntire 1998; Lennquist 2004). Worldwide understanding of disaster management has changed in recent years with relief seen not as a charity but a right and a humanitarian obligation (Gunn 2005). This is underpinned by the precept that health and security are a basic human right (Judd

1992; WHO 2005). It is not just response however: ‘less developed countries are increasingly requesting assistance in developing programs leading to improved disaster preparedness, prevention and mitigation’ (Burkle 2001b, p.144).

Disasters and complex emergencies are associated with a tremendous outpouring of humanitarian assistance (Burkle 2001a), which is normal and natural (PAHO/WHO 1999). Improvements in telecommunications mean more immediate reporting of a crisis, which often results in tremendous public attention, and calls for governments not directly affected by the event to, ‘do something’ (Abrams 1990; Redmond 2005b).

After the Asian tsunami, Frist (2005), the majority leader of the US Senate, noted that ‘individual contributions of medical assistance can rank among the world’s most precious and meaningful currencies’ (p.438). Unfortunately, if that something is not what is needed, its uninvited dispatch may do more harm than good. There is no longer a role for ‘good intentions’ and the overriding message is that the ‘well intentioned amateur’ needs to be replaced by a more ‘professional’ approach to disaster medical assistance. Instead, a highly technical approach based on strict prioritisation of tasks is necessary (Gunn 2005; Lamberg 2005; Leus 2000; Schull & Schanks 2001).

There are numerous reasons for this, apart from a humanitarian desire to provide the best possible care, which include donor and political interests and the accountability of providers. Donors demand value for money and evidence based interventions, although many of these efforts have been ineffective (Griekspoor & Sondorp 2001; VanRooyen et al. 2001a). Griekspoor and Sondorp (2001) describe a tenfold increase in the amount given by donor governments from 1980 to 1994 partly as a response to humanitarian need and partly as a realisation that aid could be used as a political tool. The U.S Surgeon general Richard Carmona described this as “health diplomacy” (Vanderwagen 2006) with research showing the proportion of Indonesians that viewed the United States favourably increased from 13% in 2003 to 38% in 2005 following tsunami assistance (Tarantino 2006).

2.9.2 International, national and regional response

Despite an excellent level of preparedness, some dramatic situations in the wake of a large scale disaster will make the mobilisation of international resources necessary, particularly in developing nations (Russbach 1990). These include but are not limited to disasters such as earthquakes, severe hurricanes, trans-border conflict and certain acts of terrorism (Aghababian 2000). A finding from the Tsunami Evaluation Coalition was that the quality and capacity of the international relief system is inadequate given the scale and frequency of modern emergencies (Telford et al. 2006).

2.9.3 Factors Guiding Reviews

The effectiveness of emergency interventions may be difficult to measure (VanRooyen & Leaning 2005) helping explain why much of the response to emergencies is poorly evaluated (Sondorp, Kaiser & Zwi 2001; VanRooyen et al. 2001b). This is contributed to by the lack of available standards, benchmarks and indices, which makes assessment and the ability to learn from experience more difficult. There is also a lack of standards available to train personnel or to judge competence; and no way to assess the abilities and competencies of the organisations and people who volunteer to help an affected population (Birnbaum 2005). The international law of humanitarian response in peacetime is also remarkably undeveloped (Hoffman 2003). Hoffman (2003) also notes that the establishment of international rules and standards does not mean people will comply. Compliance and adherence to standards also requires funding; quality control through supervision is indispensable but expensive (Sondorp, Kaiser & Zwi 2001).

Cuny (1983) wrote that the primary responsibility for disaster response remains with the host government, that international aid has limited effects and that intervention is not totally positive. Expressed more strongly still was the view that emergency work is often regarded as too short-term and cowboy-like, creating a dependence in potential beneficiaries, not sufficiently developmental and lacking in accountability (Sondorp, Kaiser & Zwi 2001). Birnbaum (2005) simply asked, ‘why do we not learn from our experiences?’ (p.210)

Too often untrained people coming with good will but no professional skills, have disrupted relief operations by mobilising already overworked local people, and overloading logistic means for their own purposes, while not efficiently helping to meet the priority needs (Russbach 1990). Excessive and unwanted personnel may arrive at the disaster site too late; be unable to contribute to the efforts; speak the language; require maintenance by the already stressed and affected population; and tend to operate outside of ‘Command and Control’, all rapidly exacerbating the problem rather than alleviating it (Abrams 1990; Birnbaum 2005; Bremer 2003; Burkle et al. 1995;

Campbell 2005; Kizer 2000; McEntire 1998; PAHO/WHO 1999; Roy et al. 2002; Rubin et al. 2000; Tyron 1997).

Reasons why this pattern persists may be related to the demands of public opinion and the perceptions of both the public and the relief workers from donor countries. A common myth in disaster management is that the 'affected local population is helplessly waiting for the western world to save it', often perpetuated by press coverage (de Ville de Goyet 2000, p.213). The WHO's de Ville de Goyet (2000) notes that most survivors are saved by their neighbours or local authorities, and that western medical teams are not necessarily the best equipped to deal with local conditions. He also raises concerns that foreign assistance is sponsored by donor countries responding to the pressure and expectations of public opinion rather than to the real needs of the affected country, and questions who is really benefiting. Less developed countries have come to realise that funding for highly visible teams comes from the same budget as other, more valuable and productive forms of assistance. The international teams may be seen as a sign that the system has been unable to cope and are critical of the efforts of the host government. If the effectiveness is measured as a humanitarian gesture, they are tremendously effective from a media/public relations viewpoint (Abrams 1990).

Concerns about the effectiveness of international response teams are not restricted to 'physical' care. The WHO (van Ommeren, Saxena & Saraceno 2005) has expressed concerns that clinical interventions, such as psychotherapy focused on post-traumatic stress disorder, are being introduced in an uncoordinated and stand-alone manner. Lamberg (2005) raises concerns about deployment of international teams of mental health professionals, few if any spoke any Asian languages, rushing to offer counselling services to tsunami survivors in Sri Lanka and Indonesia.

If disaster medical assistance is to improve, then the international relief community must develop and streamline systems for data collection and analysis, then translate the information into implementing change to improve their programs (VanRooyen et al. 2001b). There may also be differences in evaluation due to the significant cultural differences between the military and non government organisations (NGOs) (PAHO/WHO 1999) and the latter's independent nature (VanRooyen et al. 2001b).

The coordinator of the Swiss Government's aid response to the Asian tsunami, stated 'again, many well doers and uncoordinated, brainless 'helpers' arrived and were a burden for the country. This is not professional humanitarian aid' (Frisch 2005. pp.22-23). This identifies the issue of 'disaster tourism' as described after the Gujarat earthquake (Roy et al. 2002). The Tsunami Evaluation Coalition has aimed to improve the quality of natural disaster response policy and practice and consists of a Synthesis Report (Telford et al. 2006) along with thematic explorations of coordination, needs assessment, impact on local and national capacities, links between relief, rehabilitation and development, and the funding response. The four main recommendations from the TEC Synthesis Report (Telford et al. 2006) are shown in Table 2.3, which includes the major issues identified by a WHO Special Report from the Health Aspects of the Tsunami Disaster Conference (Nabarro 2005).

Table 2.3: Lessons Learned from Major Reviews of the Tsunami Response

Source	Lessons Learned
TEC Synthesis Report (Telford et al. 2006, p.23)	1. 'The international humanitarian community needs a fundamental reorientation from supplying aid to supporting and facilitating communities own relief and recovery priorities. 2. All actors should strive to increase their disaster response capacities and improve the linkages and coherence between themselves and other actors in the international disaster response system, including those from affected countries. 3. The international relief system should establish an accreditation and certification system to distinguish agencies that work to a professional standard in a particular sector. 4. All actors need to make the current funding system impartial, and more efficient, flexible, transparent and better aligned with principles of good donor-ship.'
WHO Special Report (Nabarro 2005)	1. Improved national capacity for risk management and vulnerability reduction. 2. Importance of needs assessments and program management. 3. Need for best public health practice in vulnerability reduction and disaster response. 4. Need for benchmarks, standards and codes of practice. 5. Improved management and coordination of disaster responses. 6. Need for effective supply systems, communications and logistics. 7. Recognition of key role of voluntary agencies and organisations in preparedness and response and coordination of this. 8. Principles of providing good donor-ship are relevant. 9. Need to develop further cooperation with military forces and the commercial private sector. 10. Need to establish more effective relations with media groups. 11. All health humanitarian actors must become fully transparent in terms of performance standards, accountability and evaluation. 12. Local communities must be supported to develop capacity in disaster preparedness.

2.9.4 System Issues in International Disaster Response

2.9.4.1 International Policy

In international politics, assistance is only provided if formally requested by the affected country with territorial boundaries respected. The request for aid travels via diplomatic channels once the affected country has determined that its own resources have been overwhelmed or destroyed (Abrams 1990; Dara et al. 2005; Haddow & Bullock 2003). While this takes time, 'shortcutting' the procedure may have unwanted consequences including perceived invasion, incarceration of relief staff and political 'nightmares' (Abrams 1990). Teams and individuals who respond to disasters without authority or accreditation only add to the problems of the affected country, further draining their resources (Holland & Wilson-North 2005; PAHO/WHO 1999).

International humanitarian aid is increasingly treated as part of foreign policy. This trend also explains the growing involvement of the military in operations (Dufour et al. 2004). As an example, the USA position stated by the Office of Foreign Disaster Assistance is that, following a request for aid, an assessment of value is made; if sending of aid is to the 'advantage' of the USA then authorisation is given, otherwise the answer is 'no' (Abrams 1990). Some governments, such as India following the Asian tsunami (Frisch 2005), may not want international assistance given the politics of aid (McEntire 1999). This may confuse other governments (Roy 2005) or be misunderstood which can be a very sensitive matter diplomatically (Russbach 1990).

2.9.4.2 Needs Assessment

There is a need for improving field operations (VanRooyen et al. 2001a) with the humanitarian response occurring in accordance with the needs of the affected population (de Ville de Goyet 2000; Redmond, Watson & Nightingale 1991; Russbach 1990) and based on an appropriate needs assessment (Malilay 2000; McCartney 2006; Schull & Shanks 2001). Response needs to be based not only on a full understanding of the type of disaster and expected injury patterns, but local information specific to the disaster (Lennquist 2004). Efficient matching of resources to needs will mitigate against further adverse health effects (Brennan & Nandy 2001; Noji et al. 2001; Noji 2000), with limited resources allocated in a way that provides the greatest good for the greatest number of people (Brennan & Nandy 2001). 'If aid is to do the most good for the most people it must be targeted' (Redmond 2005b, p.1320).

Rapid needs assessments have thus become the modus operandi for gathering information about the status of an affected population (Keim & Rhyne 2001; Malilay 2000; Redmond 2005b) with results forming the basis for directing relief efforts (Asari et al. 2000; Chen et al. 2003). United Nations (UN) Disaster Assessment and Coordination (UNDAC) teams now try to establish an onsite operations and coordination centre early after a disaster, consisting of a two to six-person team, drawn from member countries, that travels quickly to a disaster scene to report the immediate needs to the international community (Redmond 2005b).

Problems still exist with rapid needs assessments as they are often limited by a lack of time, money and the use of mono-disciplinary analyses (Maury & Russbach 2004). Only a moderate number of relief organisations were able to identify victims' needs with little or no problem (McEntire 1998). Some needs assessments post tsunami were also performed by people untrained for this role and without use of standardized tools (Birnbaum 2005).

Needs assessments should be done by people who understand local customs, and culture, and hence are best done by locals (Birnbaum 2005). However in a review of the disaster preparedness of Oceania nations, only 20% of public health plans had any reference to rapid health assessments (Keim & Rhyne 2001). This was a finding post tsunami as well when it was noted the lowest level of coordination and control may be at the national level (Birnbaum 2005). This forces a reliance on external reviews with their associated delays and possibly different focus. The TEC found there was a profusion of assessments with most conducted by donor agencies for their own needs. "Almost all international assessments however relied on data culled from national and local sources. Better national and local preparedness would have made a big difference" (Telford et al. 2006, p.22).

The destruction of communication systems may result in slow and inaccurate estimations of the extent of the damage (Braham et al. 2001; McEntire 1998; McEntire 1999). Time may not improve this; the Japanese review of needs on day seven after the Aitape tsunami found that information was often still inaccurate or incomplete (Asari et al. 2000). Improvements in technology may help however with Bradt, Abraham & Franks (2003) envisioning technicians with laptops, GIS software and plotters appearing at the disaster site as information first responders.

A number of problems have been identified in performance of rapid needs assessments, including:

- being inaccurate (Asari et al. 2000; Birnbaum 2005; Braham et al. 2001; Malilay 2000; Maury & Russbach 2004; McEntire 1998; McEntire 1999), and/or self-serving (Rubin & Heuvelmans 2000).
- being incomplete (Asari et al. 2000; Mallilay 2000; Maury et al. 2004). Malilay (2000) found that assessments commonly addressed range of needs but the magnitude was often neglected.
- being delayed (Asari et al. 2000; Braham et al. 2001; Malilay 2000; Maury & Russback 2004; McEntire 1998, McEntire 1999).
- being duplicated by different agencies leading to assessment fatigue, time wasting, duplicating effort and frustrating the local community (Malilay 2000; Nabarro 2005; PAHO/WHO 1999; Redmond 2005b).
- requirement for a validated tool for needs assessment (Malilay 2000) and standardisation of the content of needs assessment to minimise subjective analysis and provide consistency (Bradt & Drummond 2003; Malilay 2000).
- level of experience of those performing needs assessments (Redmond 2005b).
- not involving the local population (Redmond 2005b).

Newer, less fragmentary approaches, using epidemiological study designs and sampling approaches have been developed (Malilay 2000). Bradt and Drummond (2002) propose improvements to health needs assessments by refining the criteria in the protocol evaluation and recommend the development, acceptance and use of standardised Minimum Essential Data Sets. The WHO has also developed a "First Needs Assessment Reporting Template" which uses both international standards and a standard format to help quicker and comparable analysis hopefully promoting faster decisions (WHO 2006). This was used by the US Military as part of their response to the Tsunami in Asia (Guerena-Burgueno 2006; McCartney 2006).

2.9.4.3 Global Coordination of Needs, Response and Donors

Coordination of disaster assistance is a major priority for effective humanitarian aid operations (Bradt & Drummond 2003b; Moore & Blasser 1991). Disasters require a multi-organisational approach, with coordination and cooperation the key to success (Burkle et al. 2001; Kipor & Goncharov 1999; Libman et al. 1997; Nnoaham 2005). There is a:

> 'need for coordination between both supporting countries, and between supporting and supported' with 'increased international coordination and

collaboration….. at the planning and preparatory stages'. (Lennquist 2004, p.71)

In a multi-agency humanitarian response, it is necessary to spend time and energy generating consensus for any plan (Bricknell & MacCormack 2005). Flooding the scene with people and equipment in an unorganised manner creates a hazard for rescuers and logistical problems for the command structure (Romundstad et al. 2004). Historically, there is a natural outpouring of unorganised volunteers willing to provide medical assistance with any disaster (Birnbaum 2005; Gates et al. 1979) and unsolicited volunteers and aid are inevitable and must be planned for (Kizer 2000).

A centralised authority to coordinate international assistance appears to be essential (Hickson et al. 2001), with more, and better, linkages between civil society, military, government institutions and NGOs (Cruz Vega et al. 2001; Kipor & Goncharov 1997). A World Disaster Coordinating Centre was proposed as far back as 1983 (Cuny 1983), while Bremer (2003) repeated the call after the Gujarat earthquake. The capacity to deploy international, 'neutral' experts through external assistance remains critical (Loretti, Leus & Van Holsteijn 2001) with the appointment of a high profile UN Special Envoy for the tsunami response seen as a positive step (Telford et al 2006). Despite this, the proliferation of international aid agencies and their insistence on distinct programs led to a fragmented approach following the Asian tsunami (Telford et al. 2006) with coordination and logistic support being major challenges, which worsened as more agencies arrived (VanRooyen & Leaning 2005).

International experiences in inter-agency coordination reveal numerous issues of jurisdiction, authority, capacity and competency (Bradt & Drummond 2003) with international NGOs also tending to be fiercely independent (VanRooyen et al. 2001b). Coordination remains problematic, with no single agency equipped to do this (Sondorp, Kaiser & Zwi 2001). Many organisations participate in the provision of assistance during a disaster but often their relationship with a national coordination and control function is not clear (Nabarro 2005; Rubin & Heuvelmans 2000).

While clearly defined roles and responsibilities enable effective collaboration, there is a need for greater standardisation of language (Noji et al. 2001). Specific barriers to cooperation and coordination include weak leadership, the absence of accountability, the lack of credentialing, the diverse goals of the responding agencies and the weaknesses in the coordination process itself (Zoraster 2006).

2.9.4.4 Integration with Existing Services

Integration with existing services is an essential component of the goal of disaster medicine and supporting national and local ownership is a core principle of international development and humanitarian aid (Telford et al. 2006). Birch and Miller (2005) noted that 'life didn't start for anyone when you got off the plane…Your intervention needs to fit into the local response to the crisis' (Birch & Miller 2005, p.1201). It is thus critical to work closely with local government, organisations and other sectors (Campbell 2005; Robertson, Dwyer & Leclerq 2005). The international response to the Indian Ocean tsunami was most effective when enabling, facilitating and supporting local agencies (Telford et al. 2006). Failure to include local agencies can lead to mistrust, resentment and a lack of cooperation, or undermine the capacity of local people to solve their own problems (Brennan et al. 2001; Judd 1992; Leus et al. 2001). It is the host nation who has the lead (McCartney 2006).

It is easy for outsiders to ignore national and local health systems, bringing immediate and valuable relief at the expense of sustainable, long-term health care (Loretti, Leus & Van Hosteijn 2001). The actions of some international agencies following the Indian Ocean tsunami strengthened their own capacity at the expense of the local response leaving locals more vulnerable (Telford et al. 2006). There were unfortunate examples of well intentioned, but misguided attempts by some international medical teams to take over the local health system placing extra strain on Ministry of Health staff (Robertson, Dwyer & Leclerq 2005). Local civil society capacity for responding to future disasters may not have been developed, which can result in increased dependence on international NGOs (Moore & Blasser 1991). However, in a review of the Mozambique floods in 2000, measures of network centrality were far higher for international than local NGOs, suggesting local NGOs tend to remain peripheral to the coordination process (Moore, Eng & Daniel 2003). Organisations must 'rise above their independent and individualistic perspectives to work with local governments and communities' (VanRooyen & Leaning 2005, p.437).

2.9.4.5 Standards and Laws

The 100,000 avoidable deaths in the Rwanda crisis were attributed to poor performance on the part of relief agencies (Hickson et al. 2001; Relief and

Rehabilitation Network 1996) while the 1994 wide-scale mismanagement of cholera by inexperienced relief workers in Zaire led to recognition of the need to improve professional standards and effectiveness of the response (Salama, Buzard & Speigel 2001).

Methodologies for quality management have been slowly developed (Sondorp, Kaiser & Zwi 2001), but there is still a need for agencies and governments to agree to benchmarks, standards and codes of practice for health disaster preparedness and response, and also to guide recovery. There needs to be honest and transparent accountability, responsibility and evaluation against agreed standards of performance (Nabarro 2005). An evidence-based grading system incorporating indicators to measure the effectiveness of a humanitarian response is required. Different methodologies may be needed to assess indicators in countries without access to data (Bradt & Drummond 2003; Burkle 2001a).

The Sphere Project has been one of the first systematic efforts to improve accountability (The Sphere Project 2011). Sphere addresses key indicators for five sectors: water supply and sanitation, nutrition, food aid, shelter and site management, and health services (Sondorp, Kaiser & Zwi 2001) with clearly defined guidelines and minimum standards (Brennan et al. 2001). Reluctance in accepting these standards has arisen due to concerns about levels of flexibility and the potential use of minimum standards as a punitive tool, despite these being a collective expert opinion recognising context and constraints (Dufour et al. 2004; Salama, Buzard & Speigel 2001). The debate should shift from potential threats to NGOs, to the rights of people affected by disasters, and 'ultimately, all humanitarian organizations should be held accountable when they do not meet minimum standards when there is a reasonable expectation of doing so' (Salama, Buzard & Speigel 2001, p.532).

The other development that arose at approximately the same time was the 1994 voluntary Code of Conduct, with ten underpinning principles, which promote the impartial character of aid, respect of local cultures, building on local capacities, involvement of beneficiaries, and respect for local dignity (Griekspoor & Sondorp 2001). More than 300 organisations have now subscribed to it (Hilhorst 2005). Although its ability to retain its relevance ten years on has been questioned (Hilhorst 2005; Walker 2005) its future is thought to lie in the ability of signatories to demonstrate accountability (Walker 2005).

The Tsunami Evaluation Coalition found that many international agencies did not live up to their own standards with regard to respect and support for local and national ownership (Telford et al. 2006). The lack of quality enforcement mechanisms means the same problems keep reappearing. Telford (2006) suggests that is due to the lack of external pressure for improvement in the humanitarian sector. Normally market forces lead to quality improvement in a consumer driven market. This does not apply in humanitarian aid and the failure of agencies to meet their formal commitments to Sphere or Good Humanitarian Donorship principles, suggests that the various quality initiatives are not having sufficient impact (Telford et al. 2006). The TEC feels that, if improvement is to occur, there is a need for a regulatory system to ensure agencies put the affected population at the centre of measures of effectiveness, and to provide detailed and accurate information to the donor public on assistance outcomes, including the affected populations' views of that assistance (Telford et al. 2006).

The importance of standards is seen in a study by Rubin & Heuvelmans (2000) who reviewed the perceived effectiveness of health related disaster relief in the former Yugoslavia, finding significant differences between those providing and receiving international assistance. International organisations and workers appeared to believe their efforts were more effective than the recipients did. All groups believed that approximately half the needs were being met, but international organisations believed that a higher proportion were being met by their assistance (73.4%) than did the locals (52.1%, $p<0.001$). Interestingly, 87% of the international interviewees believed the affected population was requesting more than it actually needed. Twenty-seven per cent of the international participants compared to 80% of the recipients felt that a quarter of what was provided was unusable (Rubin & Heuvelmans 2000).

2.9.4.6 Timeline of Response

The effectiveness of international medical teams is limited by the delay in getting to the affected area. While survival from entrapment declines rapidly after 24 to 36 hours (Redmond, Watson & Nightingale 1991), international medical relief activities in disasters often do not begin until days five to seven after the event, mainly due to the distances involved (Asari et al. 2000; Noji 2000; Redmond 2005a). After the Gujarat earthquake, outside medical assistance arrived only after local health services had provided emergency assistance and immediate care. Specialised field hospitals, set up a week or more afterwards, were too late to reduce morbidity and mortality (Bremer 2003; Roy et al. 2002). These teams need to arrive in the first 24 to 48 hours to handle the vast bulk of the casualties (Bremer 2003). Local medical facilities may, however, be disrupted and require international help, not only in dealing with the disaster, but also to maintain routine health facilities for unrelated conditions. International aid may help restore routine medical and surgical facilities overwhelmed by a disaster and may later support specialist elective services (Redmond 2005a).

2.9.4.7 Deployment Decisions

The reasons for sending a team should be carefully evaluated (Abrams 1990), particularly in assessing the likely efficacy of the response. Once a decision has been made to deploy teams need to have a rapid response structure and strategy in place that can be activated immediately (Holland & Wilson-North 2005; Noji et al. 2001). Military models are instructive examples and have clearly defined mission statements, roles and objectives and a strong chain of command (Noji et al. 2001), coupled with measures of effectiveness and end-points (Sharp et al. 2001). Rules of humanitarian engagement should be defined as clearly as are the rules of military engagement (PAHO/WHO 1999). This includes an evaluation of the environment, hostile forces, friendly forces and the population at risk, casualty estimates, security, medical force protection, time, medical capabilities and logistics, medical command and control, communications and computers, humanitarian factors and assessment of tasks. These are often designed as a series of checklists to determine ‘how to do it’ (Bricknell & MacCormack 2005).

To avoid delays, pre-event simplification of bureaucracy is essential. A Japanese field hospital was only released after two days in customs because equipment lists were lacking (Bremer 2003). The UN has attempted to ensure application of simplified customs procedures in order to speed up the delivery of international humanitarian assistance, including military and civil assets. This includes advance submission of documents, waiving of economic restrictions, duties and taxes, expeditious processing without examination and simplified inspection procedures (Balabanov 1996).

Members of the team should be fully briefed on what to expect on arrival (Abrams 1990). There also needs to be a clear exit strategy consistent with a military approach to operation planning to keep to the initial mandate and to maintain efficiency of the operation, avoiding overload or fatigue of deployed staff. Redmond, Watson and Nightingale (1991) note that, after five days on the scene, both mental and physical exhaustion can set in, reducing the effectiveness of the team and increasing the risk to patients. As it is hard to turn your back on suffering, a strict rule to disengage after five days must be accepted by the team before departing.

Consideration also has to be given to the ability of staff to practice medicine in the affected country such as a review of standards, licensing arrangements and reciprocity agreements. Some governments are reluctant to allow foreign physicians to administer aid to their population, as seen in the 1985 Mexico City and the 1988 Armenian earthquakes (Abrams 1990).

The Operational Room is vital to any team deployed overseas and should be staffed 24 hours a day until the team returns home. Training is also needed for staff working in the operational room. This addresses desk top exercises, experiences, media training, IT skills, telephone skills, report log training, press releases, dealing with next of kin and handling specific requests (Holland & Wooster 2004).

2.9.4.8 Type and Level of Care

The interventions that produce the greatest health benefit are based on models of public health and primary care (Brennan et al. 2001). The presence of a foreign military hospital may also raise the expectations of the community to an impossibly high level (Reade 2000), which may also create dependency issues (McEntire 1999; Reade 2000). If life-saving priorities are addressed through an integrated, primary health care approach, the local health care system can be preserved and strengthened (Loretti et al. 2001). Teams are there to 'help local people help themselves, not create dependency' (Palmer 2005, p.152).

2.9.4.9 Civil–Military Issues

Civil and military integration and collaboration is important and productive (Anderson et al. 2001) with military and relief organisations being mutually dependant on each other for a successful outcome (Burkle et al. 1995). Redmond et al. (1991) even state that 'many of the problems inherent in disaster management are solved when the military combine with specialist civilian teams' (p.1523). However, the civilian-military interface and promotion of closer ties between civilian and military units needs further development (Hampson, Cook & Frederiksen 2002; Moore & Blasser 1991; Nabarro 2005; Palmer et al. 2003; Read & Ashford 2004). The TEC found that there was little joint planning and planning between the military and traditional humanitarian actors and coordination between them remains weak (Telford et al. 2006), which is is thought to have eroded by neglect rather than design (Eiseman & Chandler 2006).

2.9.4.10 Team Security

Security is an increasing concern for humanitarian aid and disaster relief teams. There is a clear perception amongst relief workers that safety and security are becoming worse (Brennan et al. 2001; Burkle et al. 1995; Holland & Wooster 2004; Schull et al. 2001; VanRooyen et al. 2001b). The major cause of death and injury among humanitarian staff was reportedly motor vehicle accidents during the 1970s and 1980s (Birch & Miller 2005; Brennan et al. 2001), but the commonest cause of death in the most recent study was violent trauma including gunshot, shrapnel and land mine wounds (Brennan et al. 2001). In an analysis of 382 deaths, Sheik et al. (2000) found that death from intentional violence accounted for 67% of all humanitarian workers deaths with the number of deaths due to hostile acts increasing. Some types of disaster are becoming increasingly hostile (Birch & Miller 2005) and combatants in complex humanitarian emergencies increasingly regard the medical workers as targets (Bricknell & MacCormack 2005). There needs to be a clear understanding of who is responsible for security issues, and organisations need to brief staff appropriately (Birch & Miller 2005) with the security of the humanitarian community given a high priority (Bricknell & MacCormack 2005).

2.9.5 Space Issues in International Disaster Response

Foreign Field Hospitals (FFHs) often place a logistical and technical support load on the affected country with debatable efficiency (Bar Dayan et al. 2005a; Noji 2000; PAHO/WHO 1999). For example, the field hospital capacity after the Gujarat earthquake exceeded the need for surgery while other medical needs were neglected. When the acute phase was over and the foreign staff had left, the local health personnel who had died in the earthquake were still not replaced meaning the remaining local staff were still overstretched and exhausted as the workload had still not returned to normal (Bremer 2003). The cost-efficiency of an advanced surgical centre that handles minimal cases is also questionable if other needs are left unmet. (Braham et al. 2001; Riddez 2005).

When surgery is performed, the type of surgical work performed post-disaster in field hospitals or remaining facilities is also different to standard care. Roy (2002) notes that, after the Gujarat earthquake, trained orthopaedic surgeons performed too much implant work, inappropriate for the rural area and nature of injuries, resulting in a high post-operative infection rate. A standard policy of surgery with initial wound management, consisting of an aggressive approach to debridement followed by delayed primary closure, may be helpful (Taylor, Emonson & Schlimmer 1998) as may wound management following ICRC guidelines (Waxman et al. 2006) or military approaches (Read and Ashford 2004).

The controversy over the use and efficiency of FFHs in disaster management has resulted in the WHO and Pan American Health Organization (PAHO) convening a meeting of experts to review guidelines regarding the dispatch or donation of FFHs to disaster zones, particularly in developing countries. They define a field hospital as a 'mobile, self-contained, self-sufficient health care facility capable of rapid deployment and expansion or contraction to meet immediate emergency requirements for a specified period of time' (WHO/PAHO 2003, p.279).

The three distinct purposes for FFHs defined by the WHO/PAHO are outlined below (WHO/PAHO 2003):

Phase 1: Early Emergency Care

- Provide early emergency medical care, including Advanced Trauma Life Support (ATLS). This period lasts up to 48 hours following onset of an event.

Phase 2: Follow Up Trauma and Medical Care

- This stage provides follow up care for trauma cases, emergencies, routine health care, and routine emergencies during the period when health services are progressively overwhelmed by the need for ongoing, secondary care of trauma victims and routine medical care. The health facilities may not be fully operational and local staff may urgently need time to rest and care for possible personal losses.
- If local health structures and systems remain functional, this need is better met by in-country resources or culturally compatible neighbours. The primary role of the FFH is to temporarily fill the gaps in emergency medical assistance. This period lasts from day 3 to day 15, not exceeding 15 days.

Phase 3: Temporary Health Facility

- This is to substitute for damaged installations pending final repair or reconstruction, usually from the second month to 2 or more years.

2.9.6 Supply Issues in International Disaster Response

Some aspects of the disaster response are constant, such as food, water, clothing and shelter. Teams must be adaptable, self-sufficient and trained to work in the environment (Redmond, Watson & Nightingale 1991). Critical to a successful medical response are important non-medical elements such as communication, sanitation, safety and security (Schnitzer & Briggs 2004), and logistics, supply systems, administration and finance (Brennan et al. 2001; Moore & Blasser 1991; Nabarro 2005).

2.9.6.1 Self Sufficiency

Teams must be self-sufficient (Aghababian 2000; Kizer 2000; Nabarro 2005; Redmond 2005a; Roschin & Mazurenko 2002; Russbach 1990). They need to be equipped to make the individuals safe, relatively comfortable and, very importantly, self-sufficient or the victim country is then forced to find food, water and shelter for extra people from already limited resources (Holland & Wilson-North 2005; Roschin & Mazurenko 2002). These also need to be easily transportable, durable, adaptable and consider also security, finances, communications and possibly transportation (Abrams 1990). All of this may be difficult in austere environments such as the tsunami in Banda Aceh (Cooper 2005), or the Bam earthquake, where no water or electricity was available for the first two days (Abdaliha 2005).

2.9.6.2 Food and Water

An adequate amount of reasonably safe water is generally preferable to a lesser amount of pure water (Redmond 2005a). A minimum of three to five litres/person/day is needed for survival, with 15 to 20 litres for fluid replacement, personal hygiene, cooking and sanitation (Abbott 2000).

Food and water safety is also important. Hazards include lack of hand washing facilities, inadequate refrigeration, use of unsafe ingredients and improper temperature controls. One of the urban search and rescue teams responding to the Oklahoma City bombing all suffered from food poisoning (Abbott 2000). Water safety methods include boiling for at least a minute (although fuel supplies may be limited) and chemical disinfection of water using sodium hypochlorite solution, iodine or halogen tablets (Abbott 2000; Doocy and Burnham 2006). Other options include reverse osmosis water purifiers capable of mass water production (McCurdy 1999).

Food options include rations airlifted weekly (McCurdy 1999), prepared meals such as the US Military ‘Meals Ready to Eat’ which can be eaten hot or cold (Owens, Forgione & Briggs 2005) or in larger operations, a self-serve area with food and water enabling ready access by staff (Gaudette et al. 2002). Providing catering facilities for responding staff must be complemented by organised and enforced breaks, as staff will be reluctant to ask for rest, food or water while they perceive there are victims in need of assistance (Nocera 2000). Locally prepared food with local ingredients is best received by patients and also supports the local economy. The minimum level is 2100 kcal/day (Redmond 2005a) which is 8786 Kj/day.

2.9.6.3 Sanitation

Sanitary disposal of human waste is essential to prevent the contamination of water supplies and spread of communicable disease by insect or rodent vectors (Abbott 2000). As a guide, there should be one latrine seat per 20 people, each dwelling no more than one minute’s walk from a toilet, and a communal refuse pit measuring 2 x 5 x 2 metres for every 500 people (Redmond 2005a). Chemical toilets (1/20 to 25 people) or pit toilets are alternatives (Abbott 2000). Medical and other biohazard waste must also be disposed of carefully (Abbott 2000). The maintenance of personal hygiene may be difficult with fresh water shortage (Cohen and Mulvaney 2004) and waterless hand sanitisers may need to be used (Abbott 2000).

2.9.6.4 Clinical equipment

Detailed planning is needed for the supply of individual items such as oxygen, clinical waste disposal, blood and blood products. Equipment selection needs to consider function in the working environment such as noise, vibration, altitude, decompression and whether they will work in conjunction with radiofrequency transmitting equipment.

Primary care needs are paramount, and WHO emergency health kits for primary health care workers are available to assist a population of 10,000 for three months, and designed to fit on the back of a pick-up truck (Redmond 2005).

The storage and distribution chain also needs to be considered to ensure medical material is kept within specified temperatures (Bricknell & MacCormack 2005) and refrigeration for these special drugs needs to be considered (Gaudette et al. 2002). Tetanus immunisation needs to be available for workers during the phase of debris removal. However, vaccines not part of the affected countries basic immunisation scheme should not be sent without prior approval from the national coordinating institution (PAHO/WHO 1999).

Effective pain management is one of the benchmarks for health care in a crisis, disaster or war, and must be simple, effective and inexpensive. Centrally acting analgesics should be the minimum available in a disaster (Domres et al. 2003). Narcotic analgesia is always in short supply and may be impossible to obtain locally (Roshchin et al. 2002). Emergency workers also need to take care if such drugs are imported and used in a crisis (Domres et al. 2003) with attention to security of controlled substances (Gaudette et al. 2002). Ketamine offers easy administration (intravenous, intramuscular or subcutaneous), a wide margin of safety, and provides both analgesia and anaesthesia (Read & Ashford 2004; Taylor, Emonson & Schlimmer 1998).

2.9.6.5 Personal Equipment for Team Members

A dual bag approach is frequently used (Cohen & Mulvaney 2004; Holland & Wilson-North 2005). One bag contains everything the member needs for the first three days and can be used in the event the remaining bag is delayed during transport (Cohen & Mulvaney 2004). Each member is responsible for carrying their own gear with weight limitations of 30 kg for warm weather and 40 kg for cold weather (Wallace 2002). Equipment lists help minimise weight and volume of packs, and ensures essential items are not forgotten (Gaudette et al. 2002).

2.9.6.6 Communication Equipment

Team members need to have the equipment to reliably communicate with coordination centres locally and at home, with other team members (Holland & Wilson-North 2005), and with family in the outside world, which greatly aids morale (Cohen & Mulvaney 2004; Timboe 2006). To achieve a broadly-based, proficient handling of communications technology, it must be appropriate, easy to use, meaningful to the user, and capable of overcoming language and cultural barriers (Anderson et al. 2001; Chan et al. 2004). It is worth noting however that there are applications, communications and security challenges with the use of any technology (Arnold et al. 2004). Failure of ground communication led to Australian Defence Force (ADF) personnel using personal mobile phones to maintain links during Operation Bali Assist (Cook et al. 2006). Other teams have found only a few members had mobile phone capacity or portable radios to receive news reports and that batteries and recharging were problematic (Cohen & Mulvaney 2004). Confidentiality can also be a problem with non-secure networks, as a UK team found when media listened in on their mobile phone conversations (Braham et al. 2001)

2.9.6.7 Transport to Site

Transportation is a key issue as it can severely restrict operations and response. Air transport support is critical in times of disaster (Hickson et al. 2001), but all avenues of transport may be affected depending on the disaster and local conditions. Transport was a major problem in Asia after the tsunami (Frisch 2005; Maegele et al. 2005; Van Rooyen & Leaning 2005). The Japanese found that the use of land routes was extremely difficult following the Hanshin earthquake in Kobe (Shiozaki & Hatada 1999). An advantage of national or military affiliation is improved access to transportation capacity to and from the disaster area (Hogan, Rega & Forkapa 1990). The importance of a logistics function is the ability to secure other means of transport such as buses (Cohen & Mulvaney 2004) and address communication problems, which may exacerbate difficulties (Braham et al. 2001).

2.9.6.8 Logistic Support

The logistical challenge is evident when the size of the load is reviewed. The basic load for Disaster Medical Assistance Teams (DMATs) can occupy at least six military pallets on a cargo aircraft. (Hogan, Rega & Forkapa 1992; Moore & Blasser 1991) while the equipment for the Australian team deployed to Banda Aceh included 17 tons of medical and logistics equipment on 16 pallets, including pharmaceuticals, generators, lighting, tents, water and ration packs, completely filling a Boeing 707 jet aircraft (Cooper 2005).

Co-ordinated medical equipment caches need to be organized (Waxman et al. 2006) which also needs to include base camp equipment (Holland & Wilson-North 2005; Roschin & Mazurenko 2002). Given the need for large volumes of supplies and the low likelihood of use, there are obvious cost considerations. A loan arrangement with a supplier, with the return of unused supplies, is convenient and economical (Sullivan et al. 1999). Stock rotation is not just important from a cost perspective, but also for functionality and product expiry (Cohen & Mulvaney 2004).

Needs assessments should help determine what equipment is needed with the type and amount tailored to the specific needs of the assignment. A basic key can be used with final fit-out based on information from the forward team (Marmor et al. 2005; McCartney 2006). This also avoids arriving with too many assets without a clear strategy on how they will be used (logistical push method) which may overload local resources (McCartney 2006). Pre-determined lists may prevent materials being left behind (Hsu et al. 2002) while pre-packaging means equipment manifests can be prepared in advance to help smooth international travel and customs procedures (Holland & Wooster 2004) and ensures equipment can be loaded in a timely manner (Cohen & Mulvaney 2004).

2.9.7 Staff Issues in International Disaster Response

2.9.7.1 Team Selection

The selection of the right person for a specific job is crucial in both normal and emergency situations (Cuny 2000c). The skills required at a disaster are dependent on the disaster type (Abrams 1990; McEntire 1998), and team selection must be tailored to meet the needs of the affected community (VanRooyen et al. 2001a).

To be effective, health teams need to be multidisciplinary, have the appropriate training, and have predefined strategies for completing tasks. Understanding both the physical and mental problems that accompany relief work will help predict problems, and properly prepare for and mitigate against these (Noji et al. 2001). Those selected should have as broad an experience base and expertise as possible to increase their value and ability to work in a variety of situations (Abrams 1990). Selection should not be based entirely on skills however; fitting into a team and being able to carry out the work in the field is as desirable (Holland & Wooster 2004).

2.9.7.2 Experience and Availability

The growing need for disaster relief work and a rapid response has led many organisations to place inexperienced or inadequately trained personnel in the field (Telford et al. 2006). Such workers may be of limited or decreasing usefulness (Campbell 2005; Moresky et al. 2001), and may even have a negative impact as they can threaten the success of a program, frustrate beneficiaries and donors, and damage the credibility of the agency (Brennan & Nandy 2001a). In a study conducted by Moresky et al. (2001), only 18/53 (34%) NGOs surveyed required previous international experience, although Birch and Miller (2005) note many humanitarian aid agencies now require two years' post-qualification and overseas experience before considering a candidate.

2.9.7.3 Training and Preparation

International relief teams must be well qualified and professionally trained, know their equipment and be flexible (Gaudette et al. 2002; Holland & Wooster 2004; Russbach 1990). Staff trained in basic principles will make more appropriate decisions and fewer mistakes (Moresky et al. 2001; VanRooyen et al. 2001b). Disasters are different to the usual environment of deployed health personnel (Birch and Miller 2005; DeZee 2006) and there is general acknowledgment that training needs to be improved (Campbell 2005; PAHO/WHO 1999; Yamada 2006). PAHO states that basic training in disaster management should be strengthened at all levels of education (PAHO/WHO 1999) with a need to develop internal training programs and guidelines (Griekspoor & Sondorp 2001). However many organisations lack capacity to train field personnel in areas such as security, management, standardised programs and cultural sensitivity (Moresky et al. 2001) and existing education programs need support (Waxman et al. 2006).

2.9.7.4 Culture

Cultural factors must be specifically addressed to appreciate the context of disasters for a population (Aghababian 2000; Keim & Rhyne 2001). Cultural sensitivity is an important but often overlooked area, which may impact on the ability to integrate team response with local organisations (Moresky et al. 2001). Local culture should be integrated into plans (Roschin & Mazurenko 2000), team preparation (Birch & Miller 2005; Moresky et al 2001) and analysis of program goals and performance (Ha-Redeye 2005). Cultural awareness should also ensure that parts of the population are not marginalized by aid or its methods of distribution (Telford et al. 2006). Cultural sensitivity is not confined to the affected community with a merging of cultures between military, civilian and NGO responding to the disaster (Ritchie 2006).

2.9.7.5 Language

Teams must be able to communicate well with the local population (Gaudette et al. 2002; Russbach 1990); however language barriers are common in international deployment both with the local population and other international disaster teams (Noji et al. 2001). The language barrier is also a cause of stress for responders with the provision of translators alleviating that stress (Bar-Dayan et al. 2005c). Potential solutions include language requirements (Moresky et al. 2001), which is a natural advantage for teams from bilingual countries (McCurdy 1999) and training, which is limited by time constraints (Moresky et al. 2001). Interpreters are critical assets (Schnitzer & Briggs 2004) and are the most commonly used solution (Moresky et al. 2001). Some hire local interpreters (Redmond, Watson & Nightingale 1991), who may act as local cultural advisors, improving integration with local services (McCurdy 1999). Partnering aid providers with local colleagues, may increase efficiency, minimise organisational conflict and also help avoid cultural and linguistic misunderstandings (Vanholder et al. 2001). Considerable local resources may be needed to bridge this gap however (Yamada et al. 2006).

2.9.7.6 Health Preparation Prior to Deployment

People should only deploy if they are in good physical and mental health (Palmer 2005), and teams need to be prepared physically (Cruz Vega et al. 2001). About half of the NGOs surveyed by Moresky et al. (2001) did not require a pre-field physical examination of their volunteers.

Preventive medical actions are necessary pre-deployment. These include:

- Immunisation, particularly tetanus, needs to be current (Abrams 1990; Birch & Miller 2005; Bricknell & MacCormack 2005; PAHO/WHO 1999) and others considered in light of the deployment location, with guidance sought from specialist areas such as travel clinics (Birch & Miller 2005).
- Measures to prevent insect bites (Bricknell & MacCormack 2005; Wallace 2002) such as insect repellent, impregnated mosquito nets and suitable clothing (Birch & Miller 2005).
- Chemoprophylaxis against malaria (Birch & Miller 2005; Bricknell & MacCormack 2005).
- Adequate stocks of personal medications (Abrams 1990; Wallace 2002) and advice about what other drugs to take (Birch & Miller 2005).
- Arrangements for medical care and evacuation if needed (Birch & Miller 2005).

2.9.7.7 Personality, Motivation and Psychological Profile

Psychological stress in the aftermath of a disaster and its long-term effects are only beginning to be understood (VanRooyen & Leaning 2005). It becomes harder for field staff to respond if they are struggling to cope themselves (Lamberg 2005) which impacts upon the overall efficiency of a response (Nocera 2000). There is a need for better training and preparation in stress management for responders (Auf der Heide 1989; Cruz Vega et al. 2001). This may include pre deployment briefings by a consultant psychiatrist to all team members (Wong et al. 2006) and counselling being made available for team members (Cruz Vega et al. 2001).

The emotional toll on these workers may be high (VanRooyen et al. 2001b) and psychological factors are usually greater than anticipated (Kizer 2000). In general, the more problematic the deployment has been, the more problematic the readjustment (Palmer 2005). Approximately 90% of responders experience psychological reactions in response to an event, and up to 7% of these may develop post-traumatic stress disorder (PTSD) (Hodgkinson & Stewart 1992). PTSD was diagnosed in 24% of members of the Turkish Red Crescent Disaster Relief team one month following their deployment to the Asian tsunami. No significant difference was noted in the distribution according to gender, age, profession or previous disaster experience but the symptoms were significantly greater in women, nurses and those with less than three previous disaster experiences (Armagan et al. 2006). In the USA, a legal precedent has been set for providing psychological support to fire and police personnel who have been emotionally traumatised in their work with relief organisations likely to have the same responsibilities for their staff (VanRooyen et al, 2001b).

2.9.7.8 Leadership

Team leaders have a broad range of responsibilities other than mission success and must be concerned with team composition, transportation, communication, re-supply and safety of team members (Aghababian 2000). Good leadership is crucial for effective function (Bar-Dayan et al. 2005c), with performance standards noted to suffer, at least in part, due to mismanagement (Burkle et al. 2001) and problems in coordination possible without a strong chain of command and proper protocols (Hickson et al. 2001). Leadership is generally a learned skill (Campbell 2005; Cuny 2000a) and the leadership characteristics required in situations of extreme adversity being very different to those needed in a time of stability (McCormick & Wardrope 2003). Maintaining effective team welfare and dynamics in a physically and psychologically challenging environment requires conscious effort (Grantham 2005).

2.9.7.9 Group Work and Morale Management

The team has to work together as a team (Gaudette et al. 2002) and team members need to be flexible, willing to deal with ambiguity, and have an ability to innovate

(Gaudette et al. 2002; Palmer 2005). Team cohesiveness makes them better able to withstand prolonged exposure to the stresses generated by the disaster (Bar-Dayan et al. 2005c). There should be a clear understanding of team members' roles and responsibilities, and how they contribute to the overall objectives (Birch & Miller 2005). The ability of team members to reliably communicate with family in the outside world, also greatly aids morale (Cohen & Mulvaney 2004). Understanding group dynamics is thus essential for disaster managers and team leaders (Cuny 2000c). Some individuals cannot adapt to group work and conflict arises (Cuny 2000b). Once conflict has arisen, potential solutions, depending on the situation, include changing leadership, removing a member, reducing the group size and dissolving the group altogether (Cuny 2000b).

2.9.7.10 Healthcare While Deployed

Taking care of your own health is a responsibility of the individual (Birch & Miller 2005), as well as the team leader and the lead agency. Team leaders must recognise stress, both environmental and mental, and monitor for illness and injury among members (Wallace 2002). There is a need for planning for extended operations in disaster response, including the provision of rest cycles, food, temporary accommodation and rest areas for staff as an aid to management of stress and morale (Lee et al. 2000). There should also be limitations on the physical activity of team members (Moore, Eng & Daniel 2003). Sufficient breaks should be taken as they contribute to good relationships in the field, although such breaks may need to be enforced (Birch & Miller 2005; Nocera 2004; Wallace 2002). Adequate rest is often difficult however as teams work in 12-hour shifts at a minimum, and are often exhausted after five days. Leisure time activities are also often limited due to safety concerns, power shortages, curfews, transport difficulties and the closure of local businesses (Cohen & Mulvaney 2004).

As the mission proceeds, lack of sleep, missed meals, long shifts and exposure to infections may result in some members becoming sick, which can be exacerbated by environmental and weather extremes (Cohen & Mulvaney 2004; Wallace 2002). Team members should have access to insect repellent, impregnated mosquito nets and suitable clothing. Clear guidance is available from specialist areas such as travel clinics (Birch & Miller 2005). A medical cache specifically for team members should always be available (Wallace 2002) with awareness that while team members may have different health problems to the disaster victims (Yoshinaga et al. 2003) this may include serious medical problems or trauma (Partridge et al 2006).

2.9.7.11 Recognition, Reward, Insurance and Indemnity

Team members need to have job security and be safe from financial penalty and medico-legal liability, as well as have personal financial protection for themselves and any dependants (Abrams 1990). The US process of 'federalising' members for operational deployment eliminates a number of potential problems (NDMS 2006; Roth 1993; Stopford 2005; Wallace 2002). In return, team members are required to maintain appropriate certification and licensing within their discipline (NDMS 2006).

2.9.7.12 Performance Review

Post event evaluation is important and must be coordinated (Kizer 2000). Reviews and post-disaster appraisals serve two purposes; improving performance and helping transition to normal life. To help improve performance, formal feedback should be provided (Cuny 2000c). Appraisals need to be more frequent in the post disaster environment and occur each time a program makes a transition from one phase to another, not just at the end of the operation (Cuny 2000c).

2.9.7.13 Use of Local Workers

It is important to manage the situation through local providers rather than imposing preconceived solutions on an already traumatised community (Grantham 2005). International aid can be detrimental by hiring away local workers and duplicating services (Leus, Wallace & Loretti 2001; Reade 2000). This may be more difficult when there is complete devastation such as after the Aitape tsunami or the Bam earthquake, where none of the health care facilities were functional, and local health care workers are unavailable (Abdaliha 2005, Taylor, Emonson & Schlimmer 1998). However, there is often more capability present than expected, and failure to include these people or poaching of national staff by international agencies may actually undermine local capacity (Telford et al. 2006).

2.9.8 Implication from the Literature

Disaster medical assistance should, at a minimum, be based on a full understanding of disaster epidemiology and realistic response times. Teams need to recognise what their capabilities are within this timeframe, and base their response on a needs assessment of the affected area/country. Efforts should match needs rather than be imposed on the victims. This entails prior planning regarding purpose, duration of stay and an exit strategy.

The response should be of benefit to the local community rather than the donor country/agency, integrate with local services, and be culturally appropriate and consistent with local practice. There should be clear lines of communication between the team, the local coordination, and an operations centre at home. This entails adequate equipment, organisational policy and leadership. The response should be self-sufficient with respect to both the team needs and their ability to provide care, for a minimum of 72 hours, but ideally for the duration of their stay. Team members need to be adequately trained prior to the mission, and supported during and after the mission. There also need to be meaningful, evidence-based standards developed, and used by all those involved.

Chapter 3 : Identification of Priorities in Disaster Health Preparedness: Local

3.1 List of peer-reviewed and published papers in chapter

(3.1) Edwards, NA, Caldicott, DGE, **Aitken, P,** Lee, CC & Eliseo, T 2008, ‘Terror Australis 2004: preparedness of Australian hospitals for disasters and incidents involving chemical, biological and radiological agents’, *Critical Care and Resuscitation,* vol. 10, no. 2, pp. 125-36, <http://search.informit.com.au/documentSummary;dn=514742498811930;res=IELHEA>.

(3.2) FitzGerald, G, Toloo, S, Rego, J, Ting, J, **Aitken, P** & Tippett, V 2012, ‘Demand for public hospital emergency department services in Australia: 2000-2001 to 2009-2010’, *Emergency Medicine Australasia*, vol. 24, no. 1, pp. 72-78, doi:10.1111/j.1742-6723.2011.01492.x

(3.3) Bradt, DA, **Aitken, P,** Fitzgerald, G, Swift, R, O’Reilly, G & Bartley, B 2009, ‘Emergency department surge capacity: Recommendations of the Australasian Surge Strategy Working Group’, *Academic Emergency Medicine,* vol. 16, no. 12, pp. 1350-58, doi:10.1111/j.1553-2712.2009.00501.x

(3.4). Rotheray, KR, **Aitken, P**, Goggins, WB, Rainer, TH & Graham, CA 2012, ‘Epidemiology of injuries due to tropical cyclones in Hong Kong: A retrospective observational study’, *Injury,* vol. 43, no.1 2, pp. 2055-59, doi:10.1016/j.injury.2011.10.033

(3.5) Little, M, Stone, T, Stone, R, Burns, J, Reeves, J, Cullen, P, Humble, I, Finn, E, **Aitken, P**, Elcock, M & Gillard, N 2012, ‘The evacuation of Cairns hospitals due to severe Tropical Cyclone Yasi’, *Academic Emergency Medicine*, vol. 19, no. 9, pp. 1088-98, doi:10.1111/j.1553-2712.2012.01439.x

(3.6) Wang, XY, Barnett, AG, Vaneckova, P, Yu, W, Fitzgerald, G, Wolff, R, Tippett, V, **Aitken, P**, Neville, G, McRae, M, Verall, K & Tong, S 2012, ‘The impact of heatwaves on mortality and emergency hospital admissions in Brisbane, Australia’, *Occupational and Environmental Medicine*, vol. 69, no. 3, pp. 163-69, doi:10.1136/oem.2010.062141

(3.7) Vaneckova, P, Neville, G, Tippett, V, **Aitken, P**, FitzGerald, G & Tong, S 2011, 'Do biometeorological indices improve modeling outcomes of heat-related mortality?', *Journal of Applied Meteorology and Climatology,* vol. 50, no. 6, pp. 1165-76, doi: http://dx.doi.org/10.1175/2011JAMC2632.1

(3.8) Fitzgerald, G, **Aitken, P**, Arbon, P, Archer, F, Cooper, D, Leggat, P, Myers, C, Robertson, A, Tarrant, M & Davis, E 2010, 'A national framework for disaster health education in Australia', *Prehospital and Disaster Medicine,* vol. 25, no. 1, pp. 70-77, doi: http://dx.doi.org/10.1017/S1049023X00007585

(3.9) Bradt, D & **Aitken, P,** 2010, 'Disaster medicine reporting: The need for new guidelines and the CONFIDE statement', *Emergency Medicine Australasia,* vol. 22, no. 6, pp. 483-87, doi: 10.1111/j.1742-6723.2010.01342.x

3.2 Introduction to the Chapter

The IFRC estimates that over 15 million Australians and 28,000 New Zealanders were affected by disaster during the decade 1991-2000 (Bradt, Abraham & Frank 2003). Natural disasters alone have caused over 500 deaths and 6,000 injuries in Australia over the last 30 years of the 20th century (Abrahams 2001).

The relevance of mass casualty incidents and disaster management to Emergency Medicine is obvious. EDs are the 'front door' of the hospital component of the health system to which the injured or unwell will present for care. Community members will follow normal paths of action to seek assistance, which for health care is likely to be the ED. External assistance, if required, will not arrive immediately. For EDs to respond effectively means advance planning and preparedness based on a full understanding of disasters.

The ability of hospitals in developed countries to respond to disasters, has been questioned however, raising concerns about levels of planning and preparedness, and 'surge capacity'.

- Kizer (2000) notes that a relatively mild and short-lived influenza outbreak in the USA in the winter of 1999, resulted in widespread ED and ICU shortages.
- Many hospitals have been destroyed during disasters including hurricanes Andrew and Hugo, and the Northridge earthquake (Milsten 2000).

- Dara (2005) notes most hospitals in the USA are one industrial accident away from the ‘tipping point’ for a disaster and a resultant acute shortage of critical care beds and staff.
- Born & DeLong (2004) note that the civilian medical community in the USA is relatively unprepared to deal with the type of events that can rapidly overwhelm local and regional medical systems, and not considered the paradigm shift that occurs in disasters, where the focus shifts from unlimited resources used to provide the greatest good for the individual patient to limited resources allocated to the greatest number of victims.
- Disaster preparedness and ability to cope may also not equate with awareness of risk. A simulation exercise in New Orleans accurately predicted the Hurricane Katrina scenario, but was not matched by funding (Nates & Moyer 2005).

It will always be necessary to have a local health service respond to a disaster, but depending upon the scale, nature or geographical site of the incident, support from other areas may be required (Steedman 1991). Similarly, any large terrorist event in Australia would require a response from both Federal and State Governments, with most hospitals unlikely to cope with any more than small numbers of seriously injured patients (Rosenfeld et al. 2005).

This chapter examines local preparedness from the perspective of the ED. It specifically looks at levels of preparedness and how this acute surge may be managed. It uses common disaster types in the Australian context, including cyclones and heat waves, to gather information. These are specifically chosen based on the frequency of cyclones (windstorms) across nearly all continents as a major cause of disasters and heatwaves as an unrecognized but serious cause of mortality and morbidity. CBR incidents are also reviewed as an example of a mass casualty incident or disaster with specific preparedness issues.

The impact of existing ED activity is also considered - ED overcrowding is common internationally and means that most EDs already run beyond capacity. The ability to then manage an additional acute surge of patients in a system with potentially damaged infrastructure is a significant challenge.

This approach enables this chapter to identify both generic and specific factors that not just impact on local disaster preparedness, but can also be addressed to guide improvement. Potential improvements are identified including approaches to education and training as well as standardized reporting.

3.3 Objectives of the Chapter

This chapter is aligned with Objective 1

> "To identify general factors involved in preparedness for disaster response";

It is linked directly to Objective 2.

> "To identify specific factors involved in the preparedness of Emergency Departments (ED) in Australia to respond to local disasters";

The specific objectives of this chapter are:

- To assess the level of preparedness of Australian EDs, as well as the resources and training available;
- To clarify trends in the use of public ED services across Australia to determine levels of baseline demand prior to a disaster occurring;
- To identify strategies that may guide surge management in the ED;
- To describe the numbers and types of injuries due to tropical cyclones, as well as their relation to tropical cyclone characteristics.
- To describe the impact of a major cyclone on an ED when evacuation of facilities and establishment of alternative care sites is needed;
- To identify the impact of heatwaves on mortality and emergency hospital admissions;
- To compare the performances of several common temperature measures and indices in evaluating heat-related mortality;
- To identify, or develop, potential solutions to standardising preparedness efforts and improve the ability to learn from experience.
- To describe a National Framework for Disaster Health Education in Australia with a view to ensuring consistency in educational outcomes and a more standardized and integrated approach to education itself;
- To improve the quality of case reports from deployments by providing contextual information and a standardized format for use.

3.4 Methods

Paper (3.1) Research

Detailed questionnaires were mailed to the directors of the 86 hospital EDs in Australia accredited, at the time, by the Australasian College for Emergency Medicine. Questions covered hospital planning, available resources and training, and perceived preparedness. Descriptive statistics were used to present collated results so that no individual department could be identified (Edwards et al. 2008).

Paper (3.2) Research

This paper was part of a larger research program, the Emergency Health Services Queensland (EHSQ) study, which examined factors influencing the growing demand for emergency health care and to establish options for alternative service provision that may safely meet patient's needs. The EHSQ study was funded by the ARC through its Linkage Program and supported financially by the QAS.

The EHSQ research program comprised four sub-studies:

- Study 1: Examination of the literature, and current operational context, to develop a conceptual understanding of the factors influencing growth in demand so as to identify demand trends.
- Study 2: Examination of data privately held by the QAS and Queensland Health EDs on patient trends, to determine the characteristics of users.
- Study 3: Structured interviews with patients to identify quantitatively and qualitatively the factors that they take into consideration in seeking acute medical assistance.
- Study 4: Analysis and synthesis of all data to provide a structured predictive model of demand and of the policy options for demand management, in consultation with EHS stakeholders.

The data for Paper 3.2 have been extracted, compiled and analysed from publicly available sources for the ten-year period between 2000–2001 and 2009–2010 (FitzGerald et al. 2012).

Paper (3.3) Research

A working group of individuals experienced in disaster medicine from the Australasian College for Emergency Medicine Disaster Medicine Subcommittee (the Australasian Surge Strategy Working Group) was established to undertake this work. The Working Group used a modified Delphi technique to examine response actions in surge situations and identified underlying assumptions from disaster epidemiology and clinical practice. The group then characterized surge strategies from their corpus of experience; examined them through available relevant published literature; and collated these within domains of space, staff, supplies, and system operations (Bradt et al. 2009).

Paper (3.4) Research

The records of all patients presenting to Hong Kong's public hospital emergency departments from 1st January 2004 to 31st December 2009 with tropical cyclone related injuries were reviewed and information regarding patient and injury characteristics was collected. Meteorological records for the relevant periods were examined and data on wind speed, rainfall and timing of landfall and warning signals was recorded and compared with the timing of tropical cyclone related injuries (Rotheray et al. 2012).

Paper (3.5) Research

This paper describes the events around the evacuation of 356 patients, staff and relatives to Brisbane (approximately 1700km away by road), closure of the hospitals and the provision of a temporary Emergency Medical Centre for 28 hours during the height of the cyclone (Little et al. 2012).

Paper (3.6) Research

This paper used acquired daily data on weather, air pollution, and emergency hospital admissions (EHAs) (aged 15 and over) in Brisbane between January 1996 and December 2005; and mortality between January 1996 and November 2004. A local definition of heatwave (daily maximum ≥ 37 C for two or more consecutive days) was adopted. Case–crossover analyses were used to assess the impact of heatwaves on cause-specific mortality and EHAs (Wang et al. 2012).

Paper (3.7) Research

We used daily counts of deaths from organic causes (ICD9: 001–799; ICD10: A00-R99) during the period of January 1st, 1996 to November 30th, 2004. We considered several composite biometeorological indices, such as Apparent Temperature, Relative Strain Index, Thom Discomfort Index, Humidex and Wet Bulb Globe Temperature. Hot days were defined as those days falling into the 95th percentile of each temperature indicator. We applied case-crossover analysis to estimate the relationship between exposure to heat and mortality. The performances of various biometeorological indices and temperature measures were compared using the Jack-knife resampling method (Vaneckova et al. 2011).

Paper (3.8) Research

This framework was developed through the cooperative efforts of the National Collaborative for Disaster Health Education and Research.

Preliminary research included the identification of existing programs in disaster health education and research from around Australia, the WADEM education framework, and generic educational frameworks, such as Blooms taxonomy. The Collaborative that produced this document includes individuals from academic institutions and various government agencies.

The Collaborative met on several occasions, either by teleconference or in person, to develop the framework and the learning outcomes for each of the elements. Following initial development of the framework, a modified Delphi approach was used to identify the alignment of learning outcomes to levels. Each member of the Collaborative independently assigned a value based on a three-star rating, the ratings were compiled and levels of agreement identified and areas of disagreement re-circulated until agreement was reached. A final teleconference of members was conducted to finalize a small number of outstanding elements (Fitzgerald et al. 2010).

Paper (3.9) Editorial

The case report guidelines described were developed by the authors and based on available evidence and existing benchmarks for other research methods. The editorial was also peer reviewed by the Editor-in-Chief (Bradt & Aitken 2010).

3.5 Summary of Findings

There were eight research papers and one editorial in this chapter. The abstract of each paper, or summary of the editorial, in is included below while a full copy is included as an Annex at the end of the thesis.

(3.1) Edwards, NA, Caldicott, DGE, **Aitken, P,** Lee, CC & Eliseo, T 2008, 'Terror Australis 2004: preparedness of Australian hospitals for disasters and incidents involving chemical, biological and radiological agents', *Critical Care and Resuscitation,* vol. 10, no. 2, pp. 125-36, <http://search.informit.com.au/documentSummary;dn=514742498811930;res=IELHEA>.

Objective: To assess the level of preparedness of Australian hospitals, as perceived by senior emergency department physicians, for chemical, biological and radiological (CBR) incidents, as well as the resources and training available to their departments.

Methods: Detailed questionnaires were mailed to the directors of the 86 hospital emergency departments (EDs) in Australia accredited by the Australasian College for Emergency Medicine. Questions covered hospital planning, available resources and training, and perceived preparedness.

Results: Responses were received from 76 departments (88%): 73 reported that their ED had a disaster plan, with 60 (79%) having a contingency plan for chemical, 57 (75%) for biological, and 53 (70%) for radiological incidents. Specific staff training for managing patients from a conventional mass casualty incident was given in 83% of EDs, falling to 66% for a CBR incident. Forty-three per cent reported that their plan involved staff managing contaminated patients, but availability of personal protective equipment and decontamination facilities varied widely. Although 41% believed their ED could cope with a maximum of 20 patients in the first 2 hours after a conventional incident, this increased to 71% for a CBR incident. Staff training was considered the main funding priority (59%).

Conclusions: This survey raises significant questions about the level of preparedness of Australian EDs for dealing with patients from both conventional and CBR incidents. Hospitals need to review their plans and functionality openly and objectively to ensure that their perceived preparedness is consistent with reality. In addition, they urgently require guidance as to reasonable expectations of their capacity. To that end, we recommend further development of national standards in hospital disaster planning and preparedness.

(3.2) FitzGerald, G, Toloo, S, Rego, J, Ting, J, **Aitken, P** & Tippett, V 2012, 'Demand for public hospital emergency department services in Australia: 2000-2001 to 2009-2010', *Emergency Medicine Australasia*, vol. 24, no. 1, pp. 72-78, doi:10.1111/j.1742-6723.2011.01492.x

Introduction: Hospital EDs are a significant and high-profile component of Australia's health-care system, which in recent years have experienced considerable crowding. This crowding is caused by the combination of increasing demand, throughput and output factors.

Objective: The aim of the present article is to clarify trends in the use of public ED services across Australia with a view to providing an evidence basis for future policy analysis and discussion.

Methods: The data for the present article have been extracted, compiled and analysed from publicly available sources for a 10 year period between 2000–2001 and 2009–2010.

Results: Demand for public ED care increased by 37% over the decade, an average annual increase of 1.8% in the utilization rate per 1000 persons. There were significant differences in utilization rates and in trends in growth among states and territories that do not easily relate to general population trends alone.

Conclusion: This growth in demand exceeds general population growth, and the variability between states both in utilization rates and overall trends defies immediate explanation. The growth in demand for ED services is a partial contributor to the crowding being experienced in EDs across Australia. There is a need for more detailed study, including qualitative analysis of patient motivations in order to identify the factors driving this growth in demand.

(3.3) Bradt, DA, **Aitken, P,** Fitzgerald, G, Swift, R, O'Reilly, G & Bartley, B 2009, 'Emergency department surge capacity: Recommendations of the Australasian Surge Strategy Working Group', *Academic Emergency Medicine*, vol. 16, no. 12, pp. 1350-58, doi:10.1111/j.1553-2712.2009.00501.x

For more than a decade, emergency medicine (EM) organizations have produced guidelines, training, and leadership for disaster management. However to date there have been limited guidelines for emergency physicians (EPs) needing to provide a rapid response to a surge in demand.

The aim of this project was to identify strategies that may guide surge management in the emergency department (ED).

A working group of individuals experienced in disaster medicine from the Australasian College for Emergency Medicine Disaster Medicine Subcommittee (the Australasian Surge Strategy Working Group) was established to undertake this work. The Working Group used a modified Delphi technique to examine response actions in surge situations and identified underlying assumptions from disaster epidemiology and clinical practice. The group then characterized surge strategies from their corpus of experience; examined them through available relevant published literature; and collated these within domains of space, staff, supplies, and system operations.

These recommendations detail 22 potential actions available to an Emergency Physician working in the context of surge, along with detailed guidance on surge recognition, triage, patient flow through the ED, and clinical goals and practices. The article also identifies areas that merit future research, including the measurement of surge capacity, constraints to strategy implementation, validation of surge strategies, and measurement of strategy impacts on throughput, cost, and quality of care.

(3.4) Rotheray, KR, **Aitken, P**, Goggins, WB, Rainer, TH & Graham, CA 2012, 'Epidemiology of injuries due to tropical cyclones in Hong Kong: A retrospective observational study', *Injury,* vol. 43, no. 12, pp. 2055-59, doi:10.1016/j.injury.2011.10.033

Background: Tropical cyclones are huge circulating masses of wind which form over tropical and sub- tropical waters. They affect an average of 78 million people each year. Hong Kong is a large urban centre with a population of just over 7 million, which

is frequently affected by tropical cyclones. We aimed to describe the numbers and types of injuries due to tropical cyclones in Hong Kong, as well as their relation to tropical cyclone characteristics.

Methods: The records of all patients presenting to Hong Kong's public hospital emergency departments from 1st January 2004 to 31st December 2009 with tropical cyclone related injuries were reviewed and information regarding patient and injury characteristics was collected. Meteorological records for the relevant periods were examined and data on wind speed, rainfall and timing of landfall and warning signals was recorded and compared with the timing of tropical cyclone related injuries.

Results: A total of 460 tropical cyclone related injuries and one fatality across 15 emergency departments were identified during the study period. The mean age of those injured was 48 years and 48% were female. 25.4% of injuries were work related. The head (33.5%) and upper limb (32.5%) were the most commonly injured regions, with contusions (48.6%) and lacerations (30.2%) being the most common injury types. Falls (42.6%) were the most common mechanism of injury, followed by being hit by a falling or flying object (22.0%). In univariable analysis the relative risk of injury increased with mean hourly wind speed and hourly maximum gust. Multivariable analysis, however, showed that relative risk of injury increased with maximum gust but not average wind speed, with relative risk of injury rising sharply above maximum gusts of greater than 20m/s. Moderate wind speed with high gust (rather than high average and high gust) appears to be the most risky situation for injuries. Relative risk of injury was not associated with rainfall. The majority of injuries (56%) occurred in the 3 h before and after a tropical cyclone's closest proximity to Hong Kong, with relative risk of injury being highest mid-morning.

Conclusions: In tropical cyclone related injuries in Hong Kong the head and upper limb are the most commonly affected sites with falls and being hit by a falling or flying object being the most common mechanisms of injury. Hourly maximum gust appears to be more important that mean hourly wind speed in determining risk of injury. These findings have implications for injury prevention measures and emergency planning in Hong Kong and other regions effected by tropical cyclones

(3.5) Little, M, Stone, T, Stone, R, Burns, J, Reeves, J, Cullen, P, Humble, I, Finn, E, **Aitken, P**, Elcock, M & Gillard, N 2012, 'The evacuation of Cairns hospitals due to severe Tropical Cyclone Yasi', *Academic Emergency Medicine*, vol. 19, no. 9, pp. 1088-98, doi:10.1111/j.1553-2712.2012.01439.x

On the 2nd February 2011, Tropical Cyclone Yasi, the largest cyclone to cross the Australian coast, and a system the size of Hurricane Katrina, threatened Cairns. As a result the Cairns Base Hospital and Cairns Private Hospital were both evacuated, the Hospitals closed and an alternate Emergency Medical Centre established in a sports stadium 15 km from the Cairns Central Business District.

This paper describes the events around the evacuation of 356 patients, staff and relatives to Brisbane (approximately 1700km away by road), closure of the hospitals and the provision of a temporary Emergency Medical Centre for 28 hours during the height of the cyclone.

Our experience highlighted the need for adequate and exercised hospital evacuation plans; the need for clear command and control with identified decision makers; the need for early decision making on when to evacuate; having good communication systems with redundancy; ensuring patients are adequately identified tracked and have their medications and notes; ensuring adequate staff, medications, oxygen for function and equipment.

(3.6) Wang, XY, Barnett, AG, Vaneckova, P, Yu, W, Fitzgerald, G, Wolff, R, Tippett, V, **Aitken, P**, Neville, G, McRae, M, Verall, K & Tong, S 2012, 'The impact of heatwaves on mortality and emergency hospital admissions in Brisbane, Australia', *Occupational and Environmental Medicine*, vol. 69, no. 3, pp. 163-69, doi:10.1136/oem.2010.062141

Objectives: Heatwaves can cause significant health consequences such as increased mortality and morbidity. However, their impact on the people living in tropical/subtropical regions remains largely unknown. This study assessed the impact of heatwaves on mortality and emergency hospital admissions in Brisbane, a subtropical city in Australia.

Methods: We acquired daily data on weather, air pollution, and emergency hospital admissions (EHAs) (aged 15 and over) in Brisbane between January 1996 and

December 2005; and mortality between January 1996 and November 2004. A local definition of heatwave (daily maximum ≥ 37 °C for two or more consecutive days) was adopted. Case–crossover analyses were used to assess the impact of heatwaves on cause-specific mortality and EHAs.

Results: During heatwaves, there was a statistically significant increase in total mortality (odds ratios (OR): 1.46 (95% Confidence Interval (CI): 1.21–1.77)); cardiovascular mortality (1.89; 95% CI: 1.44–2.48); diabetes mortality in those aged 75+ (9.96; 95% CI: 1.02–96.85); total EHAs (1.15; 95% CI: 1.07–1.23); and EHAs from renal diseases (1.41; 95% CI: 1.09–1.83). The elderly were found to be particularly vulnerable to heatwaves (eg, for total EHAs, OR: 1.24 for 65–74 years-old; and 1.39 for those aged 75+).

Conclusions: Significant increases in mortality and EHAs were observed during heatwaves in Brisbane where people are well accustomed to hot summer weather. The most vulnerable were the elderly and people with cardiovascular, renal or diabetic disease.

(3.7) Vaneckova, P, Neville, G, Tippett, V, **Aitken, P**, FitzGerald, G & Tong, S 2011, ‘Do biometeorological indices improve modeling outcomes of heat-related mortality?’, *Journal of Applied Meteorology and Climatology,* vol. 50, no. 6, pp. 1165-76, doi: http://dx.doi.org/10.1175/2011JAMC2632.1

Introduction: Various biometeorological indices and temperature measures have been used to assess heat-related health risks. Composite indices are expected to assess human comfort more accurately than temperature measures alone. We compared the performances of several common biometeorological indices and temperature measures in evaluating the heat-related mortality in Brisbane, Australia - a city with subtropical climate.

Methods: We used daily counts of deaths from organic causes (ICD9: 001–799; ICD10: A00-R99) during the period of January 1st, 1996 to November 30th, 2004. We considered several composite biometeorological indices, such as Apparent Temperature, Relative Strain Index, Thom Discomfort Index, Humidex and Wet Bulb Globe Temperature. Hot days were defined as those days falling into the 95th percentile of each temperature indicator. We applied case-crossover analysis to estimate the relationship between exposure to heat and mortality. The performances of various biometeorological indices and temperature measures were compared using the Jackknife resampling method.

Results: The results show that more deaths were likely to occur on hot days than on other (i.e., control) days regardless of the temperature measure or biometeorological index considered. The magnitude of the odds ratios varied with temperature indicators, between 1.08 (95% CI: 1.02–1.14) and 1.41 (95% CI: 1.22–1.64) after adjusting for air pollutants (particulate matter with aerodynamic diameter less than 10μm and ozone) and other confounders. Average temperature performed similarly to the composite indices, but minimum and maximum temperatures performed relatively poorer. Thus, average temperature may be suitable for the development of weather/health warning systems if our finding is confirmed in different places.

(3.8) Fitzgerald, G, **Aitken, P**, Arbon, P, Archer, F, Cooper, D, Leggat, P, Myers, C, Robertson, A, Tarrant, M & Davis, E 2010, 'A national framework for disaster health education in Australia', *Prehospital and Disaster Medicine,* vol. 25, no. 1, pp. 70-77, doi: http://dx.doi.org/10.1017/S1049023X00007585

Introduction: Recent events have heightened awareness of disaster health issues and the need to prepare the health workforce to plan for and respond to major incidents. This has been reinforced at an international level by the World Association for Disaster and Emergency Medicine, which has proposed an international educational framework.

Objective: The aim of this paper is to outline the development of a national educational framework for disaster health in Australia.

Methods: The framework was developed on the basis of the literature and the previous experience of members of a National Collaborative for Disaster Health Education and Research. The Collaborative was brought together in a series of workshops and teleconferences, utilizing a modified Delphi technique to finalize the content at each level of the framework and to assign a value to the inclusion of that content at the various levels.

Framework: The framework identifies seven educational levels along with educational outcomes for each level. The framework also identifies the recommended contents at each level and assigns a rating of depth for each component. The framework is not intended as a detailed curriculum, but rather as a guide for educationalists to develop specific programs at each level.

Conclusions: This educational framework will provide an infrastructure around which future educational programs in Disaster Health in Australia may be designed and delivered. It will permit improved articulation for students between the various levels and greater consistency between programs so that operational responders may have a consistent language and operational approach to the management of major events.

(3.9) Bradt, D & **Aitken, P** 2010, 'Disaster medicine reporting: The need for new guidelines and the CONFIDE statement', *Emergency Medicine Australasia,* vol. 22, no. 6, pp. 483-87, doi: 10.1111/j.1742-6723.2010.01342.x

Several different types of report have emerged in the literature: the brief case report; the rapid epidemiological assessment; the comprehensive case report and the comprehensive country profile. In our experience, the most common and least useful is the brief case report. These are typically written from a donor's or intervenor's perspective, and are often plagued by anecdotal, descriptive, breathless reporting of process rather than outcome. In this issue of *Emergency Medicine Australasia,* we take the first step in systematizing disaster case reports by drawing up specific Instructions for Authors coupled with our CONsensus Guidelines on Reports of Field Interventions in Disasters and Emergencies (CONFIDE). We seek to help authors report on complex issues of disasters, help the reader make informed judgments about these issues by bringing the reader as close as possible to field data, foster the work of future scholars undertaking critical event analysis, disaster comparisons and translational research and engage with other biomedical journal editors in pursuit of best practice standards for disaster reporting. To these ends, key components of the CONFIDE guidelines are listed and a summary of our case report typology is presented. We believe these guidelines will increase the utility of case reports for the reader and other scholars

3.6 Key messages from this chapter

'Disaster response requires planning and preparation to ensure adequate policies, a viable plan of action, sufficient emergency materials and appropriately trained personnel' (Leggat, Hodge and Aitken 2005, p.17). Emergency Departments are the ‘front door’ of the health system and effective ED response is integral to how the health system will manage the disaster.

At a local and regional level the key messages are:

Paper 3.1 identifies that while many EDs have a disaster plan, far less have subplans for different disaster types, which require specific aspects of preparedness. There is also limited equipment for these specific risks and limited training undertaken with often, unrealistic expectations of the ability to respond and/or planning based on unrealistic assumptions. Importantly there is a need for development and agreement upon standards and funding support (Edwards et al. 2008).

Paper 3.2 identifies the importance of normal activity from which surge capacity is based. Emergency Health Services (ED and Ambulance) are facing increased demand and congestion, which reduces the capacity for disaster response. Demand for public hospital ED care increased by 37% over the decade 2000-2001 to 2009-2010 (5.4 million to 7.4 million) while the average utilisation rate increased from 282/1000 to 331/1000. The rates of growth vary between jurisdictions while the effectiveness of interventions aimed at reducing congestion is disputed. There is a need to consider anticipated behaviour in planning and recognize not just health system factors but social and individual factors as well (FitzGerald et al. 2012).

People attend ED because they see their problem as urgent or severe. In a crisis people will do the same and present to ED, which will further increase ED demand during a disaster. This also means that the effectiveness of diversion strategies may be less effective than increasing surge capacity in the ED (FitzGerald et al. 2012).

Paper 3.3 builds on this and identifies the need for strategies to help improve surge management. Based on these findings an action card was developed for use pre-event and during a disaster to help guide surge management. Identifying patient priorities can help planning and lead to quantifiable measures of disaster preparedness and the ability to measure progress (Bradt et al. 2009).

Paper 3.4 uses cyclones, as one of the most common forms of natural disaster occurring in Australia and internationally, to identify specific aspects of disaster preparedness. Most injuries are minor in developed nations with less than a quarter requiring admission. The head and upper limb are most commonly involved, with falls (slip / blown over) the main cause of injury. The relative risk of injury is increased with maximum wind gust (especially if > 20 m/s) rather than wind speed, which correlates with falls as the main mechanism of injury and in the hours just before cyclone landfall (Rotheray et al. 2012).

Paper 3.5 explores the impact of Tropical Cyclone Yasi and the resulting evacuation of Cairns Base Hospital. All hospitals need plans for evacuation and establishment of alternate facilities while jurisdictions need supporting plans. The other key lessons are the importance of patient tracking, communication, access to equipment and coordination of patient movement. This should consider access to appropriate transport platforms and staff trained in care of patients during transport (Little et al. 2012).

Paper 3.6 explores heat waves as an often, unrecognized disaster type but one which has caused significant loss of life in Australia. Although heatwaves can cause significant health consequences, there is no global definition of a heatwave because local acclimatisation and adaptation influence the impact of extreme heat. Additionally, it remains largely unknown whether heatwaves have any impact on people who are well accustomed to warm weather. We found that heatwaves had significant effects on mortality and emergency hospital admissions in a subtropical city where residents are well accustomed to hot summers. There was an increase in total mortality during heat waves with increased mortality specifically for cardiovascular disease and diabetics aged over 75. While mortality was not increased for those with renal disease there were increased emergency hospital admissions (Wang et al. 2012).

Paper 3.7 builds on this and explores the accuracy of different triggers to predict heat waves. Average temperature was found to be potentially suitable for health warning systems. More deaths were likely to occur on hot days than controls regardless of the temperature measure or index used. Average temperature performed similarly to indices, and better than minimum / maximum temperatures and is convenient, simple to use and easy to understand for the general population (Vaneckova et al. 2011).

Paper 3.8 describes a model national framework for disaster health education. The framework identifies seven educational levels with outcomes, content and depth rating and provides an infrastructure around which future educational programs in disaster health can be based (Fitzgerald et al. 2010).

Paper 3.9 identifies the importance of learning from others, but with appropriate contextual information. The paper identifies the need for a standardized format and introduces a set of guidelines for disaster case reports for the journal Emergency Medicine Australasia. The CONFIDE guidelines consist of an introduction, context, access to the field, self-sufficiency and unmet needs, data environment, patient care and epidemiology and funding (Bradt & Aitken 2010).

3.7 Summary

These findings are summarised in Table 3.1, which collates these learnings in the framework of the thesis, acknowledging the elements of system, staff, space and supplies. An additional row is included for issues identified that relate to a specific disaster type or the introduction of a specific outcome. The paper from which the item has been sourced is provided in parantheses. The 22 specific items from the surge card in paper 3.3 are also labelled as pre-event or during the event in closed brackets.

Table 3.1: Summary of Outcomes from Chapter 3

Element	Issue (Paper from Thesis)
System	**Plans** While many Emergency Departments have a disaster plan, far less have subplans for different disaster types such as CBR (3.1) or hospital evacuation (3.5), which require specific aspects of preparedness. Planning needs to include specific arrangements for CBR disasters (3.1). All hospitals need plans for evacuation and establishment of alternate facilities while jurisdictions need supporting plans (3.5). One group of patients merits particular attention— the nondisaster/ presurge patients (3.3). **Planning Assumptions** Often, unrealistic expectations of the ability to respond and/or planning based on unrealistic assumptions (3.1). Plans need to be realistic (3.1). Planning assumptions need to be accurate / evidence based (3.1, 3.7). Injury patterns can be predicted assisting planning (3.4, 3.7, 3.8). Common language and definitions are needed (3.9). Importance of normal activity from which surge capacity is based (3.2).

	Need to consider anticipated behaviour in planning and recognize not just health system but social and individual factors as well (3.2). People attend ED because they see their problem as urgent or severe. In a crisis people will do the same and present to ED, which will further increase ED demand during a disaster (3.2). This also means that the effectiveness of diversion strategies may be less effective than increasing surge capacity in the ED (3.2). Identifying patient priorities can help planning and lead to quantifiable measures of disaster preparedness and measure progress (3.3). **Standards** Lack of standards and guidance for EDs as to reasonable expectations of their capacity (3.1). Need for development and agreement upon national standards in hospital disaster planning and preparedness in CBR (3.1). Need for a standardized format to assist reporting and research to enable learning from others, with appropriate contextual information (3.9). **Coordination** Importance of patient tracking, and the coordination of patient movement (3.5). Bring in early use of disaster patient tracking system and have a dedicated staff member keep this updated [PRE] (3.3). **Command and Control** Need clear command and control with identified decision makers (3.5). Call rounds or make rounds to force clinical decision-making on remaining ED patients [PRE] (3.3). Announce intent to delegate extensively to free up the senior clinician(s) for decision-making purposes [PRE] (3.3). Delegate extensively [DURING] (3.3). Make frequent rounds to geographic areas of care [DURING] (3.3). Need for early decision making on when to evacuate (3.5). **Work Practices** Surge in demand should prompt review of staff work practices in anticipation of increased workloads. This does not obligate a change in standard of care, but a change in the standard of service (3.3). Announce surge-induced goals of care and investigation and treatment

	processes [PRE] (3.3). Consider the use of Focused Assessment with Sonogram in Trauma (FAST) to assist early disposition [DURING] (3.3). Limit contrast studies [DURING] (3.3). ED staff read films, but insist on real-time reporting of studies as driven by patient instability or provider uncertainty [DURING] (3.3). **Patient Flow** Simple flow measures can improve surge (3.3). Notify EMS to arrange bypass of individual patients unrelated to the surge event [PRE] (3.3). Co-locate triage and security staff to create triage-security surge team(s) [PRE] (3.3). Preposition a surge team to the waiting room entrance [PRE] (3.3). Place security at all entry and exit points to ensure access exclusively to patients and properly badged staff [PRE] (3.3). Minimize return of patients to the ED. A patient sent out of the ED for a special study goes with a provisional diagnosis and a disposition plan [DURING] (3.3). Pursue an appropriate disposition even with no clear diagnosis [DURING] (3.3). If recognized by the local system, invoke preestablished methods of utilizing alternative sites for patient disposition [PRE] (3.3).
Staff	**Staffing Model** Decide if or how the ED must modify its staffing model [PRE] (3.3). Allocate roles and distribute appropriate job action cards [PRE] (3.3). Determine meeting points for new staff to arrive and staff updates to occur [PRE] (3.3). Request surgical and critical care liaison points in ED [DURING] (3.3). Engage nonclinical staff (e.g., medical students) as runners, scribes, and patient transporters [DURING] (3.3). Ensuring adequate staff if alternative sites / evacuation centre (3.5). Access to staff trained in care of patients during transport (3.5). **Prepare and Protect Staff** Need to prepare and protect staff (3.1; 3.5). Staff may be at risk if not supplied with appropriate PPE (3.1).

	Staff need training which may need funding support (3.1.) Re-positioning of staff and ‘aide memoires’ can assist surge (3.4). Staff will also have commitments (family) with local disasters (3.5).
Space	**Controlling Flow** EDs are facing increased demand and congestion, which reduces the capacity for disaster response (3.2). Controlling flow can preserve capacity (3.3). Clear the ED of all admitted patients with cooperation of inpatient units as feasible and the hospital executive as needed [PRE] (3.3). Identify intra-ED expansible areas—corridors, transit lounge, short stay, fast track—for care of stretcher and sitting patients who can be cohorted [PRE] (3.3). Identify and set up an extra-ED diversion area for stable, ambulatory, nonemergency patients [PRE] (3.3). Clear the waiting room of all patients fit for disposition to alternative providers [PRE] (3.3). Send admitted patients to a predetermined holding area (e.g., outpatients, short stay unit) to allow immediate decant, and have inpatient units pick patients up rather than ED staff perform transfer [PRE] (3.3). Maximize cohort care and minimize one-on-one care [DURING] (3.3). Planning should consider alternative care sites (3.5).
Supplies	**Communications** Importance of good communication systems and access to equipment with redundancy (3.5). Distribute tools for redundant communications—cell (mobile) phones, two-way radios, white boards, runners [PRE] (3.3). **Documentation** Importance of good documentation (3.5). Distribute premade ‘‘disaster’’ IDs, chart packs, x-ray, and lab slips [PRE] (3.3). Ensuring patients have their medications and notes (3.3). **Equipment** Ensure adequate equipment (3.3; 3.5). Call for extra patient trolleys and chairs so every patient has a place to lie

	or sit [PRE] (3.3). Call for extra portable suction, ventilators, monitors [PRE] (3.3). Ensure adequate medications, oxygen for function and equipment (3.5). Create at least one portable disaster trolley appropriate for each cohort area. Stock with items such as fluids, dressings, IVs, analgesia, antibiotics [PRE] (3.3). Have a team member dedicated to restocking supplies in main areas, allowing staff in these areas to maintain clinical roles [DURING] (3.3). **Specific Needs** Address specific needs (3.1; 3.5). Access to appropriate transport platforms should be considered (3.5). ED have limited equipment including PPE / decontamination for specific CBR risks (3.1).
Specific	**Introduced an action card** for use pre-event and during a disaster to help guide surge management (3.3). - Detailed 22 potential actions available to an Emergency Physician working in the context of surge and available as an aide memoire, - Detailed guidance on surge recognition, triage, patient flow through the ED, and clinical goals and practices (3.3). Identified **specific aspects** of disaster preparedness findings with implications for injury prevention measures and emergency planning in regions affected by tropical **cyclones** (3.4). - Most injuries are minor in developed nations with less than a quarter requiring admission. - The relative risk of injury is increased with maximum wind gust (especially if > 20 m/s) rather than wind speed. Hourly maximum gust appears to be more important that mean hourly wind speed in determining risk of injury. - The head and upper limb are the most commonly injured regions, with contusions and lacerations the most common injury types. - Falls were the most common mechanism of injury, followed by being hit by a falling or flying object (3.4). Identified **specific aspects** of disaster preparedness findings with implications for injury prevention measures and emergency planning in regions affected by **heatwaves** (3.6).

	- Significant increases in mortality and emergency hospital admissions were observed during heatwaves in Brisbane where people are well accustomed to hot summer weather. - The most vulnerable were the elderly and people with cardiovascular, renal or diabetic disease. - Increase in total mortality during heat waves with increased mortality specifically for cardiovascular disease and diabetics aged over 75. - While mortality was not increased for those with renal disease there were increased emergency hospital admissions (3.6). Identified accuracy of different **triggers to predict heat waves** (3.7). - Average temperature was found to be potentially suitable for health warning systems as it performed similarly to indices, and better than minimum / maximum temperatures and is convenient, simple to use and easy to understand for the general population (3.7). **Introduced a model framework for disaster health education** (3.8). - Provides an infrastructure around which future educational programs in disaster health can be based. - permit improved articulation for students between the various levels and greater consistency between programs so that operational responders may have a consistent language and operational approach to the management of major events (3.8). **Introduced CONFIDE guidelines** (3.9) - CONsensus Guidelines on Reports of Field Interventions in Disasters and Emergencies (CONFIDE). - Consist of an introduction, context, access to the field, self-sufficiency and unmet needs, data environment, patient care and epidemiology and funding. - Increase utility of case reports for the reader and other scholars (3.9).

Chapter 4 : Identification of Priorities in Disaster Health Preparedness: National

4.1 List of peer-reviewed and published papers presented in chapter

(4.1) Leggat, P, Speare, R & **Aitken, P** 2009, 'Swine flu and travellers: a view from Australia', *Journal of Travel Medicine,* vol. 16, no. 6, pp. 373-76, doi:10.1111/j.1708-8305.2009.00372.x

(4.2) Brown, L, **Aitken, P,** Leggat, P & Speare, R 2010, 'Self-reported anticipated compliance with physician advice to stay home during pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey', *BMC Public Health,* vol. 10, no. 138, pp. 1-6, doi: 10.1186/1471-2458-10-138

(4.3) Leggat, P, Brown, L, **Aitken, P** & Speare, R 2010, 'Level of concern and precaution taking amongst Australians regarding travel during Pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey', *Journal of Travel Medicine,* vol. 17, no. 5, pp. 291-95, doi: 10.1111/j.1708-8305.2010.00445.x

(4.4) **Aitken, P**, Brown, L, Leggat, P & Speare, R 2010, 'Preparedness for short term isolation among Queensland residents: Implications for pandemic and disaster planning', *Emergency Medicine Australasia*, vol. 22, no. 5, pp. 435-41, doi: 10.1111/j.1742-6723.2010.01319.x

(4.5) Considine, J, Shaban, R, Patrick, J, Holzhauser, K, **Aitken, P**, Clark, M, Fielding, E & FitzGerald, G 2011, 'Pandemic (H1N1) 2009 influenza in Australia: Absenteeism and redeployment of emergency medicine and nursing staff', *Emergency Medicine Australasia,* vol. 23, no. 5, pp. 615-23, doi: 10.1111/j.1742-6723.2011.01461.x

(4.6) FitzGerald, G, **Aitken, P**, Shaban, RZ, Patrick, J, Arbon, P, McCarthy, S, Clark, M, Considine, J, Finucane, J, Holzhauser, K & Fielding, E 2012, 'Pandemic (H1N1) 2009 influenza and Australian emergency departments: Implications for policy, practice and pandemic preparedness', *Emergency Medicine Australasia,* vol. 24, no. 2, pp. 159 – 65, doi: 10.1111/j.1742-6723.2011.01519.x

(4.7) Seidl, I, Johnson, A, Mantel, P & **Aitken, P** 2010, 'A strategy for real time improvement (RTI) in communication during the H1N1 emergency response', *Australian Health Review,* vol. 34, no. 4, pp. 493-98, doi: http://dx.doi.org/10.1071/AH09826

4.2 Introduction to the Chapter

International experience with influenza pandemics confirms the potential of pandemics to cause a significant increase in the annual burden of disease. Influenza pandemics have significant consequences for health systems and hospital EDs, which are the hub of the health systems' required response. What is not known is the extent and nature of these effects on Australian EDs and their staff. Also unknown are the strategies that are most effective in minimising this impact and maximising the capacity of EDs to protect the health and wellbeing of the community.

Pandemic (H1N1) 2009 provided the opportunity to describe the burden carried by EDs in these circumstances and identify factors associated with preparedness. Pandemic (H1N1) 2009 had a significant impact on EDs with large numbers of patients presenting with influenza-like illness (ILI), which caused considerable demands on ED staff and further impeded the management and flow of ED patients (Collignon 2009; Shaban 2009). This occurred at a time when EDs in Australia are confronting continual problems of overcrowding associated with 'access block' and growing service demands. EDs had to respond to the additional demand caused by Pandemic (H1N1) 2009 and to implement specific precautions to safely manage these patients, whilst also protecting staff members and non-affected patients and visitors from potential cross-contamination.

The response by EDs to the Pandemic (H1N1) 2009 outbreak occurred during a period of evolving knowledge about the disease. Initial reports from Mexico raised serious concerns regarding the severity of the disease and the mortality rate. Although the severity was subsequently shown to be of less concern, the initial response was, and had to be, based on the information available at the time.

4.2.1 The (H1N1) 2009 influenza pandemic

In March and early April 2009, a larger than usual number of cases of ILI were detected in Mexico (CDC 2009a; DoHA 2008). This was first reported to the Pan American Health Organization (PAHO) on 12 April, and enhanced surveillance began in Mexico on 17 April. On 23 April it was shown that the virus involved was the same as that found in two children in Texas on 15 April, and in two more children in California on 17 April. On 23 April, the Public Health Agency in Canada confirmed similar cases (CDC 2009c). A lack of contact with pigs in all the reported cases led to the conclusion that transmission of the virus was human to human (CDC 2009c; Garten et al. 2009).

Investigations revealed the virus was an Avian Influenza virus, which had not previously been known to cause human disease. The virus is known by various names—Swine Flu, swine-origin influenza A (H1N1) virus (S-OIV) infection; Pandemic (H1N1) 2009; and Novel Influenza A (H1N1) Virus. Throughout this paper it is referred to as Pandemic (H1N1) 2009. Pandemic (H1N1) 2009 is a quadruple reassortment virus, with North American and Eurasian swine strains combining with one avian and one human strain (CDC 2009c).

On 25 April 2009, the World Health Organization (WHO) determined that member states and partners should increase their surveillance programs and prepare for an epidemic (WHO 2009). Australia activated its pandemic plan, The Australian Health Management Plan for Pandemic Influenza 2008 [AHMPPI 2008] (DoHA 2008), in line with this recommendation (Bishop, Murnane and Owen 2009). Two days later, the WHO determined that, given the extent of the spread of the disease, containment would not be possible. Countries were advised not to institute border control measures, but to implement plans to lessen the impact of the outbreak. On 27 April, the WHO advised that given the evidence of sustained human-to- human infection, countries should aim for early detection, management, and implementation of appropriate infection control procedures (WHO 2009), and to upgrade assessment of the pandemic from Level 4 to Level 5. Australia's first Pandemic (H1N1) 2009 case was reported on 9 May (Kelly and Grant 2009). Pandemic (H1N1) 2009 appeared to be both highly contagious and virulent. By 29 May, Mexico reported 4910 confirmed cases and 85 deaths (Perez-Padilla et al. 2009).

The AHMPPI 2008 (DoHA 2008) was activated on 25 April 2009 when the WHO advised increased surveillance for unusual outbreaks of ILI and pneumonia and recommended appropriate case management strategies and strengthened infection control measures in health (WHO 2009). Before the virus arrived in Australia, there were predictions of a high mortality rate related to the virus (Bishop, Murnane and Owen 2009). The first case of Pandemic (H1N1) 2009 Influenza in Australia was in a person who arrived on a flight from Los Angeles on 7 May 2009. The person had been ill in the USA from 27 April, and approached staff at Brisbane Airport to inform them on arrival. The swab returned a weak positive result on 9 May and she was deemed non-infectious (‘Australia confirms’ 2009). On 18 May, the first cases were reported in Victoria in three brothers who had recently returned from the USA. Surveillance systems showed the virus spread quickly and it rapidly became the predominant strain over seasonal influenza (Kelly and Grant 2009; Kelly et al. 2009).

As at 9 April 2010, there were 37,693 confirmed cases of Pandemic (H1N1) 2009 in Australia, with 191 Pandemic (H1N1) 2009 related deaths (DoHA 2010). However, the number of reported cases vastly under-represents the total number of cases, as testing was deliberately phased out in the SUSTAIN phase of the disease. Pandemic (H1N1) 2009 Influenza was the dominant influenza of the 2009 winter season. Whilst the peak incidence of Pandemic (H1N1) 2009 in Australia was September 2009, sporadic cases continued throughout the summer. The disease continued throughout the northern hemisphere during the winter.

4.2.2 Clinical Profile of Pandemic (H1N1) 2009 Influenza

Over time and with accumulation of data, it became evident that Pandemic (H1N1) 2009 had a high infection rate, but mainly caused mild to moderate disease, with the usual features of influenza—fever (≥38.0°C), sore throat, cough, runny nose, chills, head and body aches, and fatigue. Pandemic (H1N1) 2009 differed from usual seasonal influenza because approximately half the cases had associated nausea, abdominal pain, and diarrhea (Cheng et al. 2009), and because it affected predominantly younger age groups (Kelly et al. 2009), whereas the major impact of seasonal influenza is on the elderly (Lee and Bishop 2006). It is thought that older people may have cross-reactive antibodies from past exposure to a similar virus (Hancock et al. 2009). The mortality rate from Pandemic (H1N1) 2009 was lower than that from seasonal influenza, though people who died were typically younger than those who die from seasonal influenza (Kelly 2009). In severe cases, Pandemic (H1N1) 2009 causes extremely severe lung disease resulting in higher rates of ICU admissions than seasonal influenza, and a need for advanced ventilation and oxygenation techniques such as ECMO. The most severe respiratory failure occurs in patients aged less than 50 years, with many requiring prolonged ventilation (ANZIC Influenza Investigators 2009; Corley, Hammond and Fraser 2010; Firstenberg et al. 2009; Lum et al. 2009; Patel et al. 2009; Turner et al. 2009).

Those at higher risk of severe disease as a result of Pandemic (H1N1) 2009 included pregnant women; children aged six months to 10 years on long-term aspirin therapy; adults who were moderately to morbidly obese; people with pre-existing respiratory problems, especially asthma; those with pre-existing cardiovascular disease;

immunosupressed people; people with chronic illnesses such as diabetes and metabolic, liver, and neural diseases; people with haemoglobinopathies; homeless people; and people from Indigenous backgrounds (Cheng et al. 2009; Kelly, Mercer and Cheng 2009; Stuart et al. 2009).

4.2.3 Impact of Pandemic (H1N1) 2009 Influenza on Emergency Departments

At the commencement of the outbreak, health departments initially directed patients with Influenza Like Illness (ILI) to ED (Shaban 2009), with television and newspapers reporting ensuing chaos ('Doctors running out' 2009; Cooper 2009; Fynes-Clinton 2009; Medew and Smith 2009; O'Leary 2009; O'Leary and Strutt 2009). In the USA, large influxes of patients with influenza symptoms were reported to be attending EDs, and all patients were tested for the virus, including those without symptoms. This increased demand on EDs was related to the extent of the disease in the community, the degree of testing for the disease within the community, and the interest the local media showed in the outbreak (Hanfling and Hick 2009). In New York City, peak increases in ED presentations occurred on the days following the first reports of Pandemic (H1N1) 2009 in New York City, and subsequently after the report of first death in New York City (Shapiro et al. 2010).

Published figures from Australian health departments show a surge in ED presentations during the 2009 influenza season, although the timing of the increased presentations varied from state to state (DoHA 2010). Victoria also experienced a 30% increase in ED demand during the CONTAIN Phase of (H1N1) 2009 Influenza Pandemic (Lum et al. 2009). As it is already known that there are crowding problems in Australian EDs, it is logical to assume that the crowding problem was exacerbated by the Pandemic (H1N1) 2009 Influenza. Internationally, EDs reported similar experiences (Hanfling and Hick 2009).

4.3 Objectives of the Chapter

This chapter is aligned with Objective 1

> "To identify general factors involved in preparedness for disaster response;

The chapter is directly linked to Objective 3:

> "To identify specific factors involved in preparedness for large scale disasters";

The specific objectives of this chapter are:

- To examine Australian's level of concern regarding travel during the height of Pandemic (H1N1) 2009 and how this impacted on their travel;

- To measure self-reported willingness to comply with physician recommendations to stay home for seven days;
- To determine the degree of prepared- ness for short-term isolation among community members in an Australian state during Pandemic (H1N1) 2009;
- To determine the impact of pandemic on the Australian emergency nursing and medical workforce
- How did presentation rates of Pandemic (H1N1) Influenza 2009 compare with ILI presentations in previous years?
- What impact did Pandemic (H1N1) Influenza 2009 have on the functioning of EDs and their staff?
- What management strategies were deployed by Australian EDs to manage Pandemic (H1N1) Influenza 2009?
- To what extent did existing pandemic planning, policy and procedures prepare Australian EDs for Pandemic (H1N1) Influenza 2009?
- To develop and implement a strategy that would enable the EOC to assess the effectiveness of communication strategies and guide real time improvements within the life cycle of the emergency, specifically Pandemic (H1N1) 2009.

4.4 Methods

Paper (4.1) Editorial

This was an invited editorial, which under went review by the Editor in Chief (Leggat, Speare & Aitken 2009).

Papers (4.2), (4.3), (4.3) Research

These three papers used data collected as part of the Queensland Social Survey (QSS) 2009. This is a Computer Assisted Telephone Interview (CATI) conducted each year by Central Queensland University (CQU), which uses a sampling method that approximates the Queensland population. The survey consisted of a standardized introduction, 37 demographic questions, and research questions incorporated through a cost-sharing arrangement.
Questions incorporated into QSS 2009 were related to respondents:

- Anticipated compliance with a physician's advice to stay home if they had a common cold, seasonal influenza, pandemic (H1N1) 2009 influenza or avian influenza (Brown et al. 2010);

- Anticipated actions regarding travel plans in the event of the common cold, seasonal influenza, pandemic (H1N1) 2009 influenza or avian influenza (Leggat et al. 2010);
- Preparedness for three days of isolation, with and without loss of utilities such as power and water (Aitken et al. 2010).

Responses were recorded using a balanced Likert scale ranging from “very unlikely” to “very likely.” Discordance between responses for different diseases was analysed using McNemar’s test. Associations between demographic variables and anticipated compliance were analysed using Pearson’s chi-square or chi- square for linear-by-linear association, and confirmed using multivariate logistic regression; $p < 0.05$ was used to establish statistical significance.

Papers (4.5), (4.6) Research

This is part of a larger competitive grant directed specifically at H1N1, funded by the National Health and Medical Research Council (NHMRC) through the Commonwealth Department of Health and Ageing (Application No. 614290). ED personnel around Australia were surveyed using the mailing lists of the ACEM, the ACEN and the CENA. Each of these institutes emailed a preliminary alert to members advising them of the nature of the study and seeking their support. An email was then forwarded to members inviting them to complete an online survey implemented with Survey Monkey™. Reminder emails were forwarded on two occasions. Individual follow up was attempted for the Directors of Emergency Medicine following a disappointing response to the emails. These surveys sought data in five broad domains:

- Quantification of the workload of EDs over the period of the pandemic to identify the total impact of the pandemic and to identify the particular impact of patients presenting with ILI;
- Identification of the severity profile of patients with ILI and their outcomes in terms of hospital admission and therapy required;
- Description of the policies and procedures adopted by the EDs towards the management of patients with ILI within the department, and the protection of staff and other patients;
- Qualification of the response to, and the impact of, the pandemic on the operations of the ED, staff availability and support;
- Qualification of the effects of the pandemic on staff personally.

Answers to survey questions were transferred from Survey Monkey™ to PASW 17 (formerly known as SPSS) software for analysis. Data was checked for internal consistency and appropriate values. A few surveys were removed from the analysis because either too few questions were answered or answers were inconsistent. In a small number of cases, answers to individual questions were re-coded or removed as appropriate. Descriptive statistics (frequencies, means, and medians) were calculated for all closed-ended questions. Chi-square tests (for frequency comparisons) and analysis of variance tests (for mean comparisons), were also conducted for most questions to identify differences by professional group - nurses, senior medical officers, ACEM Fellows, and registrars or trainee emergency doctors. Significance levels for these tests are presented. Ethics approval was obtained from Queensland University of Technology.

Paper (4.5) used the survey data to examine the impact of Pandemic (H1N9) 2009 Influenza on the Australian emergency nursing and medical workforce, especially absenteeism and deployment (Considine et al. 2011).

Paper (4.6) comprised an issue and theme analysis of publicly accessible literature, data from jurisdictional health departments, and data obtained from two electronic surveys of ED directors and ED staff. The issues identified formed the basis of policy analysis and evaluation (FitzGerald et al. 2012).

Paper (4.7) Research

This study was conducted during the height of the Pandemic H1N1 (2009) response and consisted of an anonymous internet-based questionnaire featuring multiple choice, and open text, questions, which was administered to stakeholders of the EOC of a regional tertiary hospital.

The main outcome measures were perceptions of sufficiency and relative usefulness of various sources of information on Pandemic (H1N1) 2009, including differences between local, state-wide and authoritative worldwide information sources (Seidl et al. 2010).

4.5 Summary of findings

The abstracts or summary of each chapter is below while a copy of each paper is included as an Annex at the end of the thesis.

(4.1) Leggat, P, Speare, R & **Aitken, P** 2009, 'Swine flu and travellers: a view from Australia', *Journal of Travel Medicine,* vol. 16, no. 6, pp. 373-76, doi:10.1111/j.1708-8305.2009.00372.x

This invited editorial described the Australian experience with Pandemic H1N1 2009, which was of particular importance leading into the Northern Hemisphere winter. The international, and Australian, timeline is outlined as well as the morbidity and mortality of the disease, clinical profile and at risk groups. The impact on the community and health workforce is described and the challenges faced, and lessons observed to date. The broader public health measures instituted, as part of the planning arrangements, are identified, and their impact on travelers actions and intentions.

(4.2) Brown, L, **Aitken, P,** Leggat, P & Speare, R 2010, 'Self-reported anticipated compliance with physician advice to stay home during pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey', *BMC Public Health,* vol. 10, no. 138, pp. 1-6, doi:10.1186/1471-2458-10-138

Background: One strategy available to public health officials during a pandemic is physician recommendations for isolation of infected individuals. This study was undertaken during the height of the Australian pandemic (H1N1) 2009 outbreak to measure self-reported willingness to comply with physician recommendations to stay home for seven days, and to compare responses for the current strain of pandemic influenza, avian influenza, seasonal influenza, and the common cold.

Methods: Data were collected as part of the Queensland Social Survey (QSS) 2009, which consisted of a standardized introduction, 37 demographic questions, and research questions incorporated through a cost-sharing arrangement. Four questions related to respondents' anticipated compliance with a physician's advice to stay home if they had a common cold, seasonal influenza, pandemic (H1N1) 2009 influenza or avian influenza were incorporated into QSS 2009, with responses recorded using a balanced Likert scale ranging from "very unlikely" to "very likely." Discordance between responses for different diseases was analysed using McNemar's test. Associations between demographic variables and anticipated compliance were analysed using Pearson's chi-square or chi- square for linear-by-linear association, and confirmed using multivariate logistic regression; $p < 0.05$ was used to establish statistical significance.

Results: Self-reported anticipated compliance increased from 59.9% for the common cold to 71.3% for seasonal influenza ($p < .001$), and to 95.0% for pandemic (H1N1) 2009 influenza and 94.7% for avian influenza ($p < 0.001$ for both versus seasonal influenza). Anticipated compliance did not differ for pandemic (H1N1) 2009 and avian influenza ($p = 0.815$). Age and sex were both associated with anticipated compliance in the setting of seasonal influenza and the common cold. Notably, 27.1% of health and community service workers would not comply with physician advice to stay home for seasonal influenza.

Conclusions: Ninety-five percent of people report they would comply with a physicians' advice to stay home for seven days if they are diagnosed with pandemic (H1N1) 2009 or avian influenza, but only 71% can be expected to comply in the setting of seasonal influenza and fewer still can be expected to comply if they are diagnosed with a common cold. Sub-populations that might be worthwhile targets for public health messages aimed at increasing the rate of self-imposed isolation for seasonal influenza include males, younger people, and healthcare workers.

(4.3) Leggat, P, Brown, L, **Aitken, P** & Speare, R 2010, 'Level of concern and precaution taking amongst Australians regarding travel during Pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey', *Journal of Travel Medicine,* vol. 17, no. 5, pp. 291-95, doi: 10.1111/j.1708-8305.2010.00445.x

Background. Global disease outbreaks, such as the recent Pandemic (H1N1) 2009 (the so-called Swine flu), may have an impact on travel, including raising the concerns of travelers. The objective of this study was to examine the level of concern of Australians regarding travel during Pandemic (H1N1) 2009 and how this impacted on their travel.

Methods. Data were collected by interviews as part of the Queensland Social Survey (QSS) 2009. Specific questions were incorporated regarding travel and Pandemic (H1N1) 2009. Multivariate logistic regression was used to analyze associations between demographic variables and concern and likelihood of cancelling travel.

Results*.* There were 1,292 respondents (41.5% response rate). The sample was nearly equally divided between males and females (50.2% vs 49.8%). Younger people (18–34 y) were under-represented in the sample; older people (>55 y) were over-represented in the sample. About half (53.2%) of respondents indicated some level of concern about Pandemic (H1N1) 2009 when traveling and just over one-third (35.5%) indicated they would likely cancel their air travel if they had a cough and fever that lasted more than one day. When cross-tabulating these responses, people who expressed concern regarding Pandemic (H1N1) 2009 when they traveled were more likely than those without concern to cancel their air travel if they had a cough and fever lasting more than one day (44.7% vs 27.7%, $\chi2 = 33.53$, $p < 0.001$). People with higher levels of education [adjusted odds ratio (AOR): 0.651], people with higher incomes (AOR: 0.528) and people living outside of metropolitan Southeast Queensland (AOR: 0.589) were less likely to be concerned about Pandemic (H1N1) 2009 when traveling, and younger people (AOR: 0.469) were less likely than others to cancel travel if they had a cough and fever.

Conclusions: Pandemic (H1N1) 2009 was of some concern to more than half of Queensland travelers. None-the-less, the majority of Queenslanders would not have postponed their own travel, even if they exhibited symptoms consistent with Pandemic (H1N1) 2009.

(4.4) **Aitken, P**, Brown, L, Leggat, P & Speare, R 2010, ‘Preparedness for short term isolation among Queensland residents: Implications for pandemic and disaster planning’, *Emergency Medicine Australasia*, vol. 22, no. 5, pp. 435-41, doi: 10.1111/j.1742-6723.2010.01319.x

Objective: Short-term isolation might occur during pandemic disease or natural disasters. We sought to measure preparedness for short-term isolation in an Australian state during pandemic (H1N1) 2009.

Methods: Data were collected as part of the Queensland Social Survey (QSS) 2009. Two questions related to preparedness for 3 days of isolation were incorporated into QSS 2009. Associations between demographic variables and preparedness were analysed using c2, with *P* □□0.05 considered statistically significant.

Results: Most respondents (93.6%; confidence interval [CI] 92.2–94.9%) would have enough food to last 3 days, but only 53.6% (CI 50.9–56.4%) would have sufficient food and potable water if isolated for 3 days with an interruption in utility services. Subpopulations that were less likely to have sufficient food and potable water reserves for 3 days' isolation without utility services included single people, households with children under 18 years of age, people living in South-East Queensland or urban areas, those with higher levels of education and people employed in health or community service occupations.

Conclusions: The majority of Queensland's population consider themselves to have sufficient food supplies to cope with isolation for a period of 3 days. Far fewer would have sufficient reserves if they were isolated for a similar period with an interruption in utility services. The lower level of preparedness among health and community service workers has implications for maintaining the continuity of health services.

(4.5) Considine, J, Shaban, R, Patrick, J, Holzhauser, K, **Aitken, P**, Clark, M, Fielding, E & FitzGerald, G 2011, 'Pandemic (H1N1) 2009 influenza in Australia: Absenteeism and redeployment of emergency medicine and nursing staff', *Emergency Medicine Australasia,* vol. 23, no. 5, pp. 615-23, doi: 10.1111/j.1742-6723.2011.01461.x

Objective: The aim of the present study was to examine the impact of Pandemic (H1N9) 2009 Influenza on the Australian emergency nursing and medical workforce, especially absenteeism and deployment.

Methods: Data were collected using an online survey of 618 members of the three professional emergency medicine or emergency nursing colleges.

Results: Despite significant increases in emergency demand during Pandemic (H1N9) 2009 Influenza, 56.6% of emergency nursing and medical staff reported absenteeism of at least one day and only 8.5% of staff were redeployed. Staff illness with influenza like illness was reported by 37% of respondents, and 87% of respondents who became ill were not tested for the Pandemic (H1N1) Influenza. Of the respondents who became ill, 43% (n = 79) reported missing no days of work, and only 8% of respondents (n = 14) reported being absent for more than five days. The mean number of days away from work was 3.73 (standard deviation = 3.63). Factors anecdotally associated with staff absenteeism (caregiver responsibilities, concern about personal illness, concern about exposing family members to illness, school closures, risk of quarantine, stress and increased workload), appeared to be of little or no relevance. Redeployment was reported by 8% of respondents and the majority of redeployment was for operational reasons.

Conclusions: Future research related to absenteeism, redeployment during actual pandemic events is urgently needed. Workforce data collection should be an integral part of organisational pandemic planning.

(4.6) FitzGerald, G, **Aitken, P**, Shaban, RZ, Patrick, J, Arbon, P, McCarthy, S, Clark, M, Considine, J, Finucane, J, Holzhauser, K & Fielding, E 2012, 'Pandemic (H1N1) 2009 influenza and Australian emergency departments: Implications for policy, practice and pandemic preparedness', *Emergency Medicine Australasia,* vol. 24, no. 2, pp. 159–65, doi: 10.1111/j.1742-6723.2011.01519.x

Objective: To describe the reported impact of Pandemic (H1N1) 2009 on EDs, so as to inform future pandemic policy, planning and response management.

Methods: This study comprised an issue and theme analysis of publicly accessible literature, data from jurisdictional health departments, and data obtained from two electronic surveys of ED directors and ED staff. The issues identified formed the basis of policy analysis and evaluation.

Results: Pandemic (H1N1) 2009 had a significant impact on EDs with presentation for patients with 'influenza-like illness' up to three times that of the same time in previous years. Staff reported a range of issues, including poor awareness of pandemic plans, patient and family aggression, chaotic information flow to themselves and the public, heightened stress related to increased workloads and lower levels of staffing due to illness, family care duties and redeployment of staff to flu clinics. Staff identified considerable discomfort associated with prolonged times wearing personal protective equipment. Staff believed that the care of non-flu patients was compromised during the pandemic as a result of overwork, distraction from core business and the difficulties associated with accommodating infectious patients in an environment that was not conducive.

Conclusions: This paper describes the breadth of the impact of pandemics on ED operations. It identifies a need to address a range of industrial, management and procedural issues. In particular, there is a need for a single authoritative source of information, the re-engineering of EDs to accommodate infectious patients and organizational changes to enable rapid deployment of alternative sources of care.

(4.7) Seidl, I, Johnson, A, Mantel, P & **Aitken, P** 2010, ‘A strategy for real time improvement (RTI) in communication during the H1N1 emergency response’, *Australian Health Review,* vol. 34, no. 4, pp. 493-98, doi: http://dx.doi.org/10.1071/AH09826

Objective. To develop and implement a strategy that would enable the Emergency Operations Centre (EOC) to assess the effectiveness of communication strategies and guide real time improvements within the life cycle of the emergency.

Design, setting and participants. An anonymous internet-based questionnaire featuring multiple choice and open text questions was administered to stakeholders of the EOC of a regional tertiary hospital.

Main outcome measures. The outcomes were perceptions of sufficiency and relative usefulness of various sources of information on Pandemic (H1N1) 2009, including differences between local, state-wide and authoritative worldwide information sources.

Results. A total of 328 responses were received over two rounds of questionnaires. Email communication from the Health Incident Controller (HIC) was the most useful source of information (74% found it very useful, compared with authoritative international websites at 21% (Centers of Disease Control) and 29% (World Health Organization). A total of 94% felt this strategy contributed to improvements. Free text responses also helped the EOC and HIC to tailor communication methods, style, content and tone during the response.

Conclusions. Real time improvement is a useful strategy for implementing change to practice during the life cycle of the current emergency and has broader applicability than Pandemic (H1N1) 2009. Local stakeholders demand local content for their information feed and messages from a trusted local leader are the most superior forms of communication.

What is known about the topic? Communication is crucial in the successful response to an emergency situation, with a link to the quality of the response.

What does this paper add? The use of online surveys, in particular the ability to make improvements immediately during the collection of responses, has not been previously reported in the literature. The key component of this is the ability to implement improvements during the life cycle of the current, rather than the next emergency.

What are the implications for practitioners? Those managing an emergency response, whether in relation to Pandemic (H1N1) 2009, or indeed any other emergency or disaster, should consider internet-based questionnaires as a method for obtaining rapid feedback and making real time improvements to their communication tone, style and methods.

4.6 Key messages from this chapter

The recent experience with Pandemic (H1N1) 2009, while not the severe disease initially expected, has highlighted a number of issues confronting emergency medicine and disaster preparedness.

Paper 4.1 sets the scene for the chapter with an editorial noting the impact of Pandemic H1N1 (2009) Influenza with a summary of the disease activity in Australia. This extends from the time of first case diagnosis to September 22nd 2009 when there were 36,270 confirmed cases, 4,712 patients admitted and 172 deaths. While the travel implications are also explored the need for better integration of planning is noted. The papers that follow explore these planning issues and provide key findings from the literature and the experience of Australian Emergency Department staff involved in the response to the pandemic (Leggat, Speare & Aitken 2009).

Paper 4.2 reviewed the willingness of the community to comply with physician advice to stay home. Social distancing strategies are essential elements in the management of disease spread and consistent with both the Australian Health Management Plan for Pandemic Influenza 2008 (AHMPPI 2008) and WHO recommendations. Compliance with physicians' advice to stay home was different for different diagnostic groupings and most likely based on the community perception of disease severity (Brown et al. 2010).

If diagnosed with H1N1 or avian influenza most (95% and 94.7% respectively) would comply with physicians' advice to stay home. This figure was much less for seasonal influenza (71.3%) or the common cold (59.9 %). A noteworthy finding was that health workers were no different to the general community in their willingness to comply with advice. This means that 27.5% of health workers were unlikely to comply with advice to stay home with seasonal influenza (Brown et al. 2010).

Paper 4.3 reviewed the levels of concern of travellers regarding H1N1 and their attitude to changing travel plans. Again, this is a key element of the management of disease spread. Pandemic (H1N1) 2009 was of some concern to more than half (53.2%) of Qld travellers, but the majority (59.3%) would not have postponed their own travel even if they had symptoms consistent with H1N1. Those less concerned were those from outside Southeast Queensland (SEQ); >14 yrs education; income > $100K. Those with concerns more likely to cancel their travel if they had symptoms ($p < 0.001$), while younger people (18-24) less likely to cancel (Leggat et al. 2010).

Paper 4.4 examined the level of preparedness of the Queensland population for short-term isolation. 93.6% would have enough food & water to last three days but only 53.6% would have enough if utilities were interrupted. Those less likely to have sufficient supplies with loss of utilities included single people, households with children, people in SEQ / urban areas, higher levels of education and health workers (Aitken et al. 2010).

Paper 4.5 examined the direct impact of Pandemic H1N1 (2009) Influenza on people working in EDs. Staff illness with ILI was reported by 37%, with 87% of these not tested for H1N1. Of those reporting ILI, 43% missed no work, 8% were away from work more than five days and the mean days away from work was 3.73. Other factors associated with absenteeism were care-giver responsibilities, school closures, stress and workload and concern about their own or family health. There were also 8% redeployed, mainly for operational reasons (Considine et al. 2011).

Paper 4.6 was derived from the NHMRC study and was an issue and theme analysis of surveys and state data. This identified a need for a range of industrial, management and procedural issues. Major issues were the need for a single source of information; re-engineering of EDs to accommodate infectious patients and organisational changes to enable rapid deployment of alternative care (FitzGerald et al. 2012).

Paper 4.7 was an anonymous internet based questionnaire in a single facility on the use of a 'real time' information system during the pandemic. This found that a strategy using a single known and reliable source of information (in this case the Health Incident Controller) was preferred and contributed to improvements in care. Importantly, the real time information enabled both feedback and improvement strategies to occur in the life cycle of the incident (Seidl et al. 2010).

4.7 Summary

These findings are summarised in Table 4.1, which collates these learnings in the framework of the thesis, acknowledging the elements of system, staff, space and supplies. The paper from which the item has been sourced is provided in parantheses.

Table 4.1: Summary of Outcomes from Chapter 4

Element	Issue (Paper from the Thesis)
System	**Plans** Need for better integration of planning (4.1; 4.2). Staff not aware of plans (4.2). Poor awareness of pandemic plans (4.6). **Planning assumptions** Social distancing and containment difficult with extent of travel (4.1). People will still travel so spread of disease will occur (4.4). **Security** Patient and family aggression (4.6). **Communication** Communications strategies essential (4.2; 4.7). Communication is crucial in the successful response to an emergency situation, with a link to the quality of the response.(4.7). Local stakeholders demand local content for their information feed and messages from a trusted local leader are the most superior forms of communication (4.7). Chaotic information flow to themselves and the public (4.6). Real time improvement is a useful strategy for implementing change to practice during the life cycle of the current emergency (4.7). Communication needs to be in real time and allow feedback (4.7).

	Single source of information needed (4.2; 4.6; 4.7). Need for a single authoritative source of information (4.6). Reporting requirements problematic (4.2). Sub-populations can be identified for public health messaging such as males, younger people, and healthcare workers (4.2; 4.3; 4.4). **Business Continuity** Staff believed that the care of non-flu patients was compromised during the pandemic as a result of overwork, distraction from core business and the difficulties associated with accommodating infectious patients in an environment that was not conducive (4.6). Organizational changes to enable rapid deployment of alternative sources of care (4.6).
Staff	**Workforce** Staff will also become ill which will impact on workforce (4.5). - Staff illness with influenza like illness was reported by 37% - 56.6% of emergency nursing and medical staff reported absenteeism of at least one day - mean number of days away from work was 3.73 (standard deviation = 3.63). Staff will be redeployed (4.5) 8.5% of staff were redeployed. Other factors associated with absenteeism were care-giver responsibilities, school closures, stress and workload and concern about their own or family health (4.5). **Health** Health workers unlikely to comply with advice to stay home if sick (4.3). Of the respondents who became ill, 43% (n = 79) reported missing no days of work (4.5). Low levels of immunisation and willingness to be vaccinated (4.2). **Welfare** Health workers less likely to be prepared for short term isolation (4.5). Staff will also have family commitments (4.5; 4.6). Staff are exposed to ILI and often develop illness but not tested 87%, which has implications for disease spread and insurance re occ exposure (4.5). Workforce needs to receive accurate, timely information (4.2; 4.7).

	Heightened stress related to increased workloads and lower levels of staffing due to illness, family care duties and redeployment of staff to flu clinics (4.6).
Space	**Design** EDs need better design to cope with infectious patients (4.2; 4.6). Alternative sources of care to be planned in advance (4.2; 4.5; 4.6). Re-engineering of EDs to accommodate infectious patients (4.6).
Supplies	**PPE** Access to PPE and vaccinations for staff (4.2; 4.6). Staff identified considerable discomfort associated with prolonged times wearing personal protective equipment (4.6). **Antivirals** Access to antivirals and consistent prescribing practices (4.6).
Specific	**Social Distancing** Social distancing strategies are essential elements in the management of disease spread and consistent with both the Australian Health Management Plan for Pandemic Influenza 2008 (AHMPPI 2008) and WHO recommendations (4.2). - Compliance with physicians' advice to stay home was different for diagnostic groupings and most likely based on the community perception of disease severity (4.2). - 95 percent of people would comply with a physicians' advice to stay home for seven days if they are diagnosed with Pandemic (H1N1) 2009 or avian influenza, but only 71% in the setting of seasonal influenza and 59.9 diagnosed with a common cold (4.2). **Travel and Border Control** Pandemic (H1N1) 2009 was of some concern to more than half (53.2%) of Qld travellers, but the majority (59.3%) would not have postponed their own travel even if they had symptoms consistent with H1N1 (4.3). **Isolation** The majority of Queensland's population consider themselves to have sufficient food supplies to cope with isolation for a period of three days. Far fewer would have sufficient reserves if they were isolated for a

	similar period with an interruption in utility services (4.4).

Chapter 5 : Identification of Priorities in Disaster Health Preparedness: International

5.1 List of peer-reviewed and published papers presented in chapter

(5.1) **Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2009, 'Pre and post deployment health support provided to Australian disaster medical assistance team members: Results of a national survey', *Travel Medicine and Infectious Disease,* vol. 7, no. 5, pp. 305-11, doi:10.1016/j.tmaid.2009.03.001

(5.2) **Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2009, 'Health and safety aspects of deployment of Australian disaster medical assistance team members: Results of a national survey', *Travel Medicine and Infectious Disease,* vol. 7, no. 5, pp. 284-90, doi:10.1016/j.tmaid.2009.03.005

(5.3) **Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2011, 'Education and training requirements for Australian disaster medical assistance team members: Results of a national survey', *Prehospital and Disaster Medicine,* vol. 26, no. 1, pp. 41-48, doi: http://dx.doi.org/10.1017/S1049023X10000087

(5.4) **Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M and Speare, R 2012, 'Leadership and standards for Australian disaster medical assistance team members: Results of a national survey', *Prehospital and Disaster Medicine,* vol. 27, no. 2, pp. 1-6, doi: http://dx.doi.org/10.1017/S1049023X12000489

(5.5) **Aitken, P**, Leggat, P, Harley, H, Speare, R & Leclercq, M 2012, 'Logistic support provided to Australian disaster medical assistance teams: results of a national survey of team members', *Emerging Health Threats,* vol. 5, doi: 10.3402/ehtj.v5i0.9750

(5.6) **Aitken, P**, Leggat, P, Harley, H, Speare, R & Leclercq, M 2012, 'Human resources support provided to Australian disaster medical assistance teams: results of a national survey of team members', *Emerging Health Threats*, vol. 5, doi: 10.3402/ehtj.v5i0.18147

5.2 Introduction to the Chapter

One of the earliest descriptions of international disaster relief occurred in 1755, after an earthquake devastated Lisbon. England's King George II requested that Parliament quickly send sufficient and suitable relief to the victims of the emergency (McEntire 1998). Modern disaster medical assistance teams date back to the efforts of Henry Dunant, who mobilised local assistance after witnessing the 1859 Battle of Solferino, which left 40,000 dead and severely wounded. Moved by this, he called for the formation of national relief societies to render assistance in emergencies, ten years later founding the Red Cross (Dara 2005; Domres et al. 2003).

Australia has a history of regional and national assistance, although often informal.

- Following cyclone Tracy in Darwin, the arrival of interstate medical teams allowed local staff to check on their own families and homes (Nocera 2000).
- Following the Port Arthur shooting, a team of emergency physicians and nurses from Melbourne relieved staff of Royal Hobart Hospital, allowing them a 'day off' and to escape the media scrutiny, without a reduction in service provision (Wilkinson 1999).

This chapter focuses on Australia's role in the region, the issues that arise with international deployment and the preparedness needed for this.

International deployment as part of humanitarian and disaster assistance has historically been the domain of the military in Australia. The Australian Defence Force (ADF) has had the primary agency responsibility for recent team deployments such as the 1998 Aitape tsunami and 2002 Bali bombing. Following the Asian tsunami, civilian teams Alpha to Golf were deployed under AUSASSISTPLAN (Cooper 2005). The South East Asian tsunami was the first time a civilian based Australian medical team had been deployed representing the Australian government. This proved to be a watershed moment in national approaches to international humanitarian assistance as, coupled with increases in the operational tempo of the ADF, has led to a number of subsequent deployments of civilian teams. The deployment following the South East Asian Tsunami represented a unique opportunity to explore the existing literature on international deployment and the experiences of those team members deployed, to inform the development of a future deployment capability.

5.3 Objectives of the Chapter

This chapter is aligned with Objective 1:

> "To identify general factors involved in preparedness for disaster response".

The chapter is directly linked to Objective 4:

> "To identify specific factors involved in preparedness for international disaster response".

The specific objectives of this chapter are:

- To evaluate Australian DMAT experience in relation to pre- and post-deployment health care (Aitken et al. 2009a);
- To evaluate Australian DMAT experience in relation to health and safety aspects of actual deployment (Aitken et al. 2009b);
- To evaluate the education and training of Australian DMATs (Aitken et al. 2011);
- To evaluate leadership issues and use of standards in Australian DMAT (Aitken et al. 2012c);
- To determine the level of support for dedicated logistics in deployable teams and whether specific elements of logistic support are more problematic (Aitken et al. 2012b);
- To evaluate Australian DMAT experience in relation to the human resources issues associated with deployment (Aitken et al. 2012a).

5.4 Methods

Papers (5.1) to (5.6) Research

This series of papers are part of a larger competitive grant funded by the Public Health Education and Research Program (PHERP) through the Commonwealth Department of Health and Ageing. This was PHERP grant RFT 233/0506 "Workforce Planning Models for Disaster Medical Response Teams". The study protocol was reviewed and approved by the James Cook University Human Research Ethics Committee (H2464). Although this project was being funded by the relevant Commonwealth agency, the support of the Commonwealth Australian Health Protection Committee (AHPC) was sought for this purpose.

All team members associated with Australian DMAT deployments from the 2004 Asian Tsunami disaster were surveyed via their State/territory jurisdictions. Representatives of the AHPC through their State and Territory jurisdictions identified all DMAT personnel from Teams Alpha to Golf, and sent out questionnaires with reply paid envelopes on our behalf. Data was collected by means of an anonymous self-reporting questionnaire. A reply paid envelope was included for convenience; however other options for return were given, including facsimile. There were no penalties or rewards for participation, and informed consent was implied if team members completed and returned their questionnaires.

The survey itself was an 11-page A4 sized form, which comprised simple tick-box format, ranking and short answer responses. Data was collected on the following:

- Demographic details
- DMAT model and structure
- Human resources issues
- Logistics
- Preparation-education and training
- Post-deployment
- Overview

Data was entered into a spreadsheet program and analysed using the Statistical Package for the Social Sciences (Version 14.0, SPSS, 2006). Descriptive statistics were used, as the sample was relatively small.

5.5 Summary of findings

The papers in this chapter included six research papers. These are all based on the survey results from what was the first study of the experiences of an internationally deployed Australian civilian disaster medical assistance team. The results from this survey have been used to inform the ongoing development of Australian Medical Assistance Teams (AUSMAT). The response rate for the survey was 50% (59/118) and included participants from all jurisdictions that deployed team members. The group represented an experienced and relatively senior group of clinical staff with a mean level of clinical experience of 21 years and 53% (31/59) aged between 45 and 54. The abstract or summary of each paper in is included below while a full copy is included as an Annex at the end of the thesis.

(5.1) **Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2009, 'Pre and post deployment health support provided to Australian disaster medical assistance team members: Results of a national survey', *Travel Medicine and Infectious Disease,* vol. 7, no. 5, pp. 305-11, doi:10.1016/j.tmaid.2009.03.001

Background: Calls for disaster medical assistance teams (DMATs) are likely to continue in response to international disasters. As part of a national survey, the present study was designed to evaluate Australian DMAT experience in relation to pre- and post-deployment health care.

Methods: Data was collected via an anonymous mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 South East Asian Tsunami disaster.

Results: The response rate for this survey was estimated to be around 50% (59/118). Most of the personnel had deployed to the tsunami affected areas. The DMAT members were quite experienced with 53% of personnel in the 45e55 years age group (31/59). Seventy-six percent of the respondents were male (44/58). Only 42% (25/59) received a medical check prior to departure and only 15% (9/59) received a psychological assessment prior to deployment. Most respondents indicated that both medical and psychological screening of personnel would be desirable. Most DMAT personnel received some vaccinations (83%, 49/59) before departure and most felt that they were adequately immunised. While nearly all DMAT members participated in formal debriefing post-deployment (93%, 55/59), far less received psychological debriefing (44%, 26/59), or a medical examination upon return (10%, 6/59). Three respondents reported experiencing physical ill health resulting in time off work following their return. While only one reportedly experienced any adjustment problems post-deployment that needed time off work, 32% (19/59) found it somewhat difficult to return to work. There were multiple agencies involved in the post-deployment debriefing (formal and psychological) and medical examination process including Emergency Management Australia (EMA), Australian Government, State/Territory Health Departments, District Health services and others.

Conclusions: This study of Australian DMAT members suggests that more emphasis should be placed on health of personnel prior to deployment with pre-deployment medical examinations and psychological assessment. Following the return home, and in addition to mission and psychological debriefing, there should be a post-deployment medical examination and ongoing support and follow-up of DMAT members. More research is needed to examine deployment health support issues.

(5.2) **Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2009, 'Health and safety aspects of deployment of Australian disaster medical assistance team members: Results of a national survey', *Travel Medicine and Infectious Disease,* vol. 7, no. 5, pp. 284-90, doi:10.1016/j.tmaid.2009.03.005

Background: Disaster medical assistance teams (DMATs) have responded to numerous international disasters in recent years. As part of a national survey, the present study was designed to evaluate Australian DMAT experience in relation to health and safety aspects of actual deployment.

Methods*:* Data were collected via an anonymous mailed survey distributed by State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the time of the 2004 South East Asian tsunami disaster.

Results: The response rate for this survey was 50% (59/118). Most of the personnel had deployed to the tsunami affected areas. The DMAT members were quite experienced with 53% of personnel in the 45e55 years age group (31/59) and a mean level of clinical experience of 21 years. 76% of the respondents were male (44/58). Once deployed, most felt that their basic health needs were adequately met. Almost all stated there were adequate shelter (95%, 56/59), adequate food (93%, 55/59) and adequate water (97%, 57/59). A clear majority felt there were adequate toilet facilities (80%, 47/59), adequate shower facilities (64%, 37/ 59); adequate hand washing facilities (68%, 40/59) and adequate personal protective equipment (69%, 41/59). While most felt that there were adequate security briefings (73%, 43/ 59), fewer felt that security itself was adequate (64%, 38/59). 30% (18/59) felt that team members could not be easily identified. The optimum shift period was identified as 12 h (66%, 39/59) or possibly 8 h (22%, 13/59) with the optimum period of overseas deployment as 14-21 days (46%, 27/59). Missing essential items were just as likely to be related to personal comfort (28%) as clinical care (36%) or logistic support (36%). The most frequently nominated personal items recommended were: suitable clothes (49%, 29/59); toiletries (36%, 22/59); mobile phone (24%, 14/59); insect repellent (17%, 10/59) and a camera (14%, 8/59). The most common personal hardship reported during their deployment was being away from home/problems at home (24%, 14/59); however, most felt that their family was adequately informed of their whereabouts and health status (73%, 43/59).

Conclusions: This study of Australian DMAT members suggests that, in the field, attention should be given to basics, such as adequate food, water, shelter and personal hygiene as well as appropriate clothing, sunscreen and vector protection. The inclusion of appropriate personal items can be assisted by provision of a minimum suggested personal equipment list, with local conditions and the nature of the deployment being taken into account. A personal survival kit should also be recommended. There should be medical and psychological support for team members themselves, including the provision of a dedicated team member medical cache. Concern for their own health and ability to communicate with family members at home are major issues for deployed team members and need to be addressed in mission planning. This should also recognise security issues, including briefings, evacuation plans and exit strategies. The team members concerns about adequate security and the risk profile of humanitarian intervention in natural disasters compared with complex humanitarian emergencies may help determine future deployment of civilian or defence based teams.

(5.3) **Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2011, ‘Education and training requirements for Australian disaster medical assistance team members: Results of a national survey’, *Prehospital and Disaster Medicine,* vol. 26, no. 1, pp. 41-48, doi: http://dx.doi.org/10.1017/S1049023X10000087

Introduction: Calls for disaster medical assistance teams (DMATs) are likely to continue in response to international disasters.

Objective: As part of a national survey, the present study was designed to evaluate the education and training of Australian DMATs.

Methods: Data were collected via an anonymous, mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 Southeast Asia tsunami disaster.

Results: The response rate for this survey was 50% (59/118). Most of the personnel had deployed to the tsunami-affected areas. The DMAT members were quite experienced, with 53% of personnel in the 45–55-year age group (31/59). Seventy-six percent of the respondents were male (44/58). While most respondents had not participated in any specific training or educational program, any kind of relevant training was regarded as important in preparing personnel for deployment. The majority of respondents had experience in disasters, ranging from hypothetical exercises (58%, 34/59) to actual military (41%, 24/49) and non-governmental organization (32%, 19/59) deployments. Only 27% of respondents felt that existing training programs had adequately prepared them for deployment. Thirty- four percent of respondents (20/59) indicated that they had not received cultural aware- ness training prior to deployment, and 42% (25/59) received no communication equipment training. Most respondents felt that DMAT members needed to be able to handle practical aspects of deployments, such as training as a team (68%, 40/59), use of communications equipment (93%, 55/59), ability to erect tents/shelters (90%, 53/59), and use of water purification equipment (86%, 51/59). Most respondents (85%, 50/59) felt leadership training was essential for DMAT commanders. Most (88%, 52/59) agreed that teams need to be adequately trained prior to deployment, and that a specific DMAT training program should be developed (86%, 51/59).

Conclusions: This study of Australian DMAT members suggests that more emphasis should be placed on the education and training. Prior planning is required to ensure the success of DMAT deployments and training should include practical aspects of deployment. Leadership training was seen as essential for DMAT commanders, as was team-based training. While any kind of relevant training was regarded as important for preparing personnel for deployment, Australian DMAT members, who generally are a highly experienced group of health professionals, have identified the need for specific DMAT training.

(5.4) **Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M and Speare, R 2012, 'Leadership and standards for Australian disaster medical assistance team members: Results of a national survey', *Prehospital and Disaster Medicine,* vol. 27, no. 2, pp. 1-6, doi: http://dx.doi.org/10.1017/S1049023X12000489

Introduction*:* It is likely that calls for disaster medical assistance teams (DMATs) will continue in response to international disasters.

Objective: As part of a national survey, the present study was designed to evaluate leadership issues and use of standards in Australian DMAT.

Methods: Data was collected via an anonymous mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 Asian Tsunami disaster.

Results: The response rate for this survey was estimated to be around 50% (59/118). Most of the personnel had deployed to the Asian Tsunami affected areas. The DMAT members were quite experienced with 53% (31/59) of personnel in the 45-55 years age group. 75% (44/59) of the respondents were male. 58% (34/59) of the survey participants had significant experience in international disasters although few felt they had previous experience in disaster management (5%, 3/59). There was unanimous support for a clear command structure (100%, 59/59) with strong support for leadership training for DMAT commanders (85%, 50/59). However only 34% (20/59) felt that their role was clearly defined pre deployment and 59% (35/59) felt that team members could be easily identified. Leadership was identified as one of the biggest personal hardships faced during their deployment by two team members. While no respondents disagreed with the need for meaningful evidence based standards to be developed only 51% (30/59) stated that indicators of effectiveness were used for the deployment.

Conclusions: This study of Australian DMAT members shows that there is unanimous support for a clear command structure in future deployments with clearly defined team roles and reporting structures. This should be supported by clear identification of team leaders to assist inter-agency coordination and leadership training for DMAT commanders. Members of Australian DMAT would also support the development and implementation of meaningful evidence based standards. More work is needed to identify or develop actual standards and measures of effectiveness to be used and implemented as well as the contents and nature of leadership training.

(5.5) **Aitken, P**, Leggat, P, Harley, H, Speare, R & Leclercq, M 2012, 'Logistic support provided to Australian disaster medical assistance teams: results of a national survey of team members', *Emerging Health Threats,* vol. 5, doi: 10.3402/ehtj.v5i0.9750

Background: It is likely that calls for disaster medical assistance teams (DMATs) continue in response to international disasters. As part of a national survey, the present study was designed to evaluate the Australian DMAT experience and the need for logistic support.

Methods: Data were collected via an anonymous mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 Asian Tsunami disaster.

Results: The response rate for this survey was 50% (59/118). Most of the personnel had deployed to the South East Asian Tsunami affected areas. The DMAT members had significant clinical and international experience. There was unanimous support for dedicated logistic support with 80% (47/59) strongly agreeing. Only one respondent (2%) disagreed with teams being self sufficient for a minimum of 72 hours. Most felt that transport around the site was not a problem (59%; 35/59), however, 34% (20/59) felt that transport to the site itself was problematic. Only 37% (22/59) felt that pre-deployment information was accurate. Communication with local health providers and other agencies was felt to be adequate by 53% (31/59) and 47% (28/59) respectively, while only 28% (17/59) felt that documentation methods were easy to use and reliable. Less than half (47%; 28/59) felt that equipment could be moved easily between areas by team members and 37% (22/59) that packaging enabled materials to be found easily. The maximum safe container weight was felt to be between 20 and 40 kg by 58% (34/59).

Conclusions: This study emphasises the importance of dedicated logistic support for DMAT and the need for teams to be self sufficient for a minimum period of 72 hours. There is a need for accurate pre deployment information to guide resource prioritisation with clearly labelled pre packaging to assist access on site. Container weights should be restricted to between 20 and 40 kg, which would assist transport around the site, while transport to the site was seen as problematic. There was also support for training of all team members in use of basic equipment such as communications equipment, tents and shelters and water purification systems.

(5.6) **Aitken, P**, Leggat, P, Harley, H, Speare, R & Leclercq, M 2012, 'Human resources support provided to Australian disaster medical assistance teams: results of a national survey of team members', *Emerging Health Threats*, vol. 5, doi: 10.3402/ehtj.v5i0.18147

Background: Calls for disaster medical assistance teams (DMATs) are likely to continue in response to international disasters. As part of a national survey, this study was designed to evaluate Australian DMAT experience in relation to the human resources issues associated with deployment.

Methods*:* Data was collected via an anonymous mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 South East Asian Tsunami disaster.

Results: The response rate for this survey was 51% (59/118). Most personnel had deployed to the Asian Tsunami affected areas with DMAT members having significant clinical and international experience. While all except one respondent stated they received a full orientation prior to deployment, only 34% of respondents (20/59) felt their role was clearly defined pre deployment. Approximately 56% (33/59) felt their actual role matched their intended role and that their clinical background was well suited to their tasks. Most respondents were prepared to be available for deployment for one month (34%, 20/59). The most common period of notice needed to deploy was 6-12 hours for 29% (17/59) followed by 12-24 hours for 24% (14/59). The preferred period of overseas deployment was 14-21 days (46%, 27/59) followed by one month (25%, 15/59) and the optimum shift period was felt to be 12 hours by 66% (39/59). The majority felt that there was both adequate pay (71% 42/59) and adequate indemnity (66%, 39/59). Almost half (49%, 29/59) stated it was better to work with people from the same hospital and, while most felt their deployment could be easily covered by staff from their workplace (56%, 33/59) and caused an inconvenience to their colleagues (51%, 30/59), it was less likely to interrupt service delivery in their workplace (10%, 6/59) or cause an inconvenience to patients (9%, 5/59). Deployment was felt to benefit the affected community by nearly all (95%, 56/59) while less (42%, 25/59) felt that there was a benefit for their own local community. Nearly all felt their role was recognised on return (93%, 55/59) and an identical number (93%, 55/59) enjoyed the experience. All stated they would volunteer again, with 88% strongly agreeing with this statement.

Conclusions*:* This study of Australian DMAT members provides significant insights into a number of human resources issues and should help guide future deployments. The preferred 'on call' arrangements, notice to deploy, period of overseas deployment and shift length are all identified. This extended period of operations needs to be

supported by planning and provision of rest cycles, food, temporary accommodation and rest areas for staff. The study also suggests that more emphasis should be placed on team selection and clarification of roles. While the majority felt that there was both adequate pay and adequate indemnity, further work clarifying this, based on national conditions of service should be, and are, being explored currently by the state based teams in Australia. Importantly, the deployment was viewed positively by team members, who all stated they would volunteer again, which allows the development of an experienced cohort of team members.

5.6 Key messages from this chapter

Paper 5.1 identifies the need to ensure the good physical and mental health of those deployed both pre and post deployment. This should include:

- Physical health checks and consideration of psychological evaluation prior to deployment with potential team members prevented from deploying based on the results of these
- Physical health checks and debriefing, including mental health support, post deployment (Aitken et al. 2009a).

Paper 5.2 identifies the factors needed to support basic health needs of deployed teams. This should include, as well as medical supplies, adequate water, shelter, food, toilet facilities, hand washing, showers and personal protective equipment (PPE) as well as both adequate security and security briefings (Aitken et al. 2009b).

Paper 5.3 identifies the need for improved education and training of deployed teams. Most team members felt that existing training programs were inadequate and a specific training program for deployed teams should be developed. This should include not just clinical skills but specific deployment training including cultural awareness, communications, and use of communications equipment, the ability to use self sufficiency equipment including water equipment and erect tents / facilities (Aitken et al. 2011).

Paper 5.4 identifies the need for a clear command structure, leadership training, role definition and identification of team members. The need for evidence based standards and ‘indicators of effectiveness ‘was also identified (Aitken et al. 2012c).

Paper 5.5 emphasises the importance of, and need for, dedicated logistics support. This should include self-sufficiency, with a minimum period of 72 hours; transport to, and around, the site; communications with local health services and other donor agencies and adequate documentation. Equipment should also be able to be moved easily around the site, which mandates clear labeling and identification of equipment and safe container weights (Aitken et al. 2012b).

Paper 5.6 identifies the need for adequate human resources policy and arrangements to support deployed teams. This should include adequate pay and indemnity as well as appropriate roster practices. These should acknowledge:

- Periods on call for deployment, with one month the preferred option;
- The time needed to deploy, with 6-24 hours the preferred option in this study;
- The duration of deployment, with 14-21 days preferred in this study;
- The shift length worked while deployed, with 12 hours preferred in this study (Aitken et al. 2012a).

5.7 Summary

In summary international disaster assistance, as provided by deployable disaster medical assistance teams,

- Needs to occur as part of an appropriately supported system, rather than as a group of well meaning individuals, to avoid placing an extra burden on the affected community;
- Should be guided by a needs assessment with involvement of the affected communities;
- Response should occur based on an understanding of the epidemiology of injury patterns for different disaster types and the timeline of survival;
- Should recognize the major issues that impact on the ability to provide care including language, culture, security of deployed teams and communications and documentation;
- Should be integrated with and support, the affected community and local health services;
- Needs appropriate preparedness of team members including both physical and mental health, health care while deployed and a system of follow up of deployed team members to ensure their physical health and mental health;
- Needs to be ensure team members are adequately trained and equipped as well as self sufficient on arrival;
- Needs appropriate standards to guide the deployment of teams and their performance while deployed;

- Needs to be supported by adequate, and appropriate, logistics support and human resources policy and arrangements.

The key lesson is that international response, is able to be, and should be prepared for. It should not be an ‘ad hoc’ response based on good intentions. This is essential to maximize the efficiency of the response, the outcomes for those who are affected by the disaster and ensure the welfare of those personnel deployed.

This is summarised in Table 5.1, which collates these learnings in the framework of the thesis, acknowledging the elements of system, staff, space and supplies. The paper from which the item has been sourced is provided in parantheses.

Table 5.1: Summary of Outcomes from Chapter 5

Element	Paper
System	**Communications** Communications is essential and may be problematic (5.5). There is a need for improved and accurate pre deployment information to guide resource prioritisation (5.5). Should be communications with local health providers and other agencies (5.5). **Documentation and Standards** Documentation needs to be improved and easy to use and reliable (5.5). Need for evidence based standards and ‘indicators of effectiveness (5.4). **Command and Leadership** A clear command structure is needed (5.4). Leadership crucial with negative impacts from leadership problems (5.4). Clear identification of team leaders to assist inter-agency coordination (5.4). Clearly defined team roles and reporting structures (5.4). Clear identification of team members to assist team and role identification (5.4). **Security** Security issues should be addressed including adequate security briefings, evacuation plans and exit strategies (5.2). **Team Selection** Process for team selection needed (5.6). Emphasis should be placed on team selection and clarification of roles so actual role matches intended role and clinical background well suited to task (5.6). Better to work with people they know (5.3) or train with (5.3; 5.6).

	Impact on service delivery of donor health service needs to be considered (5.3). Retention allows development of an experienced cohort and should be supported by role recognition on return. Most enjoy the experience and would volunteer again (5.6).
Staff	**Health and Welfare** Only those in good health should deploy (physical and psychological) (5.1). Should be physical health checks and appropriate vaccinations prior to deployment (5.1). Should be psychological screening of personnel prior to deployment (5.1). Should be medical and psychological support available for team members themselves during deployment (5.2). Should be physical and mental health review post deployment (5.1). **Team Welfare** Team performance can be affected by concern for own health and family (5.2). Period of operations needs to be supported by planning and provision of rest cycles, food, temporary accommodation and rest areas for staff (5.2). Minimise personal hardship by being able to communicate with home and keeping family adequately informed of whereabouts and health status (5.2). **HR Issues** Need for adequate indemnity, insurance and pay issues, which should be organised in advance (5.6). Staff preferences need to be considered in rostering to minimize fatigue and ensure both staff welfare and effectiveness of care (5.6) • preferred on call option of one month • period of notice needed to deploy of 6-24 hours • period of overseas deployment of 14-21 days • shift length of 12 hours (5.6). **Training** Teams needed to be adequately trained for deployment (5.3). There should be a specific training program for deployed teams (5.3). Leadership training essential for team commanders (5.3). Should be specific deployment training on cultural awareness (5.3). Should be specific deployment training on communications, and use of communications equipment (5.3).

	Should be specific deployment training on ability to use self sufficiency equipment including water equipment(5.3). Should be specific deployment training on ability to erect tents / shelters (5.3). Should be training as a team (5.3).
Space	**Habitat** Habitat may be needed as part of self sufficiency for team shelter (5.2). All team members should be able to erect tents / facilities (5.3).
Supplies	**Logistics** Importance of dedicated logistics support (5.5). Transport options to the site itself may be problematic (5.5). Equipment should also be able to be moved easily around the site with safe container weights (between 20 and 40 kg) (5.5). Equipment should have clear labeling to aid identification (5.5). **Self Sufficiency** Basic self sufficiency is essential (5.5). Need for teams to be self sufficient for a minimum period of 72 hours (5.5). There should be adequate water and food (5.2). There should be adequate toilet facilities, hand washing, personal hygiene, showers (5.2). **Medical supplies** Medical supplies should include the provision of a dedicated team member medical cache (5.2). **Uniforms and PPE** Staff should have uniforms which clearly identify them (5.6). Uniforms should be appropriate for the deployment environment (5.2). There should be adequate PPE (5.2). **Personal Items** The inclusion of appropriate personal items (5.2). There should be a minimum suggested personal equipment list, which should include suitable clothes, toiletries, mobile phone, insect repellent, camera (5.2). A personal survival kit should also be recommended (5.2).
Specific	**Benefit** Deployment was felt to benefit the affected community by nearly all (5.6). Less felt there was a benefit for their community (5.6).

Chapter 6 : Summary and Integration

6.1 Introduction to the Chapter

This chapter brings together all of the various aspects of the thesis. This extends from the background literature to the findings of the chapters on local, national and international response to disasters, both natural and man made. The identification of generic issues associated with disaster preparedness, as well as those specific to different disaster types, allows the development of a structured approach to improvement. This is done using a surge framework of space, staff, supplies and system and is presented in both a detailed format, which articulates the rationale and underlying evidence and a simple, easy to use guide to improving disaster preparedness.

The chapter also describes in detail the outcomes of the program of study including:

- The integrated summary and conclusions of the thesis;
- How the thesis met the DrPH objectives and answered the underlying research question;
- The academic outputs in terms of published papers and conference presentations at national and international meetings;
- The translation into practice of the thesis and its different components;
- The identification of future research needs and directions;
- The impact on my own personal professional development.

6.2 Objectives

This chapter is directly linked to Objectives 5 and 6:

> "To compare factors involved in preparedness for local, national and international disaster response, and to different types of disasters, to identify major areas of focus";
> "To identify future directions for disaster health preparedness".

6.3 Summary of major findings and additions to the body of knowledge

The model of preparedness that the thesis is based has been described in Chapter 1 and recognizes different disaster types (natural, man-made and mixed), different levels of response (local, national and international) and the elements of surge response (system, space, staff and supplies). This is displayed in Figure 6.1.

Figure 6.1: Model of Health System Preparedness

The main findings from Chapters 3-5 are summarised in the context of this conceptual model and presented in Table 6.1. The relevant paper is included in parantheses.

Table 6.1: Findings from the Thesis Presented in the Conceptual Model

	Local / Regional	National - pandemic	International assistance
SYSTEM			
Plans	Most EDs have disaster plans but should consider specific preparedness (3.1; 3.5) Planning needs specific CBR arrangements (3.1) Need evacuation plans (3.5) Need plans establishment of alternate facilities (3.5) Jurisdictions need supporting plans (3.5)	Need for better integration of planning (4.1; 4.2) Staff not aware of plans (4.2) Poor awareness of pandemic plans (4.6)	

	Local / Regional	National - pandemic	International assistance
Planning assumptions	Unrealistic expectations of ability to respond and/or planning based on unrealistic assumptions. (3.1) Plans need to be realistic (3.1) Planning assumptions evidence based (3.1; 3.7) Injury patterns can be predicted (3.4;, 3.7; 3.8) Important to base surge activity on normal activity (3.2) Consider anticipated behaviour in plans including social / individual factors (3.2) Effectiveness of diversion strategies uncertain: people attend ED as see problem as urgent / severe and likely to do same in disaster (3.2) Identifying patient priorities can help planning (3.3)	Border control as component of social distancing and containment difficult with extent of travel (4.1; 4.3) Social distancing strategies are essential elements in the management of disease spread and consistent with both the AHMPPI 2008 and WHO recommendations. (4.2) Compliance with physician advice to stay home differs for diagnostic groupings and most likely based on perception of disease severity (4.2) Sub-populations can be identified to target public health messaging (4.2).	
Command	Need clear command and decision makers (3.5) Make rounds to force clinical decision-making on remaining ED patients (3.3) Delegate extensively to free up senior clinician(s) for decision-making (3.3) Make frequent rounds to geographic areas of care (3.3) Need early decision making whether to evacuate (3.5)	Need for a single authoritative information source (4.6) Access to antivirals and consistent prescribing (4.6)	Clear command structure is needed (5.4) Negative impact from leadership problems (5.4) Clear identification of team leaders to assist inter-agency coordination (5.4) Clearly defined team roles & reporting structures. (5.4) Clear identification of team members to assist team and role identification (5.4)

	Local / Regional	National - pandemic	International assistance
Communication	Importance of good communication systems and access to equipment with redundancy (3.5) Distribute tools for redundant communications—mobile phones, two-way radios, white boards, runners (3.3) Simple measures suitable for health warning systems as convenient and easy to under stand for population (3.7)	Communications strategies essential (4.2: 4.7) Communication quality linked to response quality (4.7) Chaotic information flow to staff and public (4.6) Workforce needs accurate, timely information (4.2: 4.7) Communication needs to be in real time and allow feedback to alter practice (4.7) Local stakeholders demand local content (4.7)	Communications is essential and often problematic (5.5) Need for improved and accurate pre deployment information to guide resource prioritisation (5.5) Should be communications with local health providers and other agencies (5.5)
Documentation and reporting	Importance of good documentation (3.5) Distribute premade IDs, chart packs, x-ray, lab slips (3.3) Ensure patients have their medications and notes (3.3) Need a standardized format to assist reporting/research (3.9)	Reporting requirements problematic (4.2)	Documentation needs to be improved and easy to use and reliable (5.5)
Standards	Common language and definitions needed (3.9) Lack of standards and guidance for EDs as to reasonable expectations of their capacity (3.1) Need development of national standards in hospital disaster planning and CBR preparedness (3.1).		Need for evidence based standards and 'indicators of effectiveness (5.4)
Business continuity	The non disaster ⁄ presurge patients must be considered (3.3)	Care of non-flu patients compromised as result of overwork, distraction from core business, difficulties accommodating infectious patients (4.6)	Impact on service delivery of donor health service needs to be considered (5.3)
Security	Co-locate triage and security staff to create surge team(s) and control entry (3.3) Place security at all entry and exit points to ensure access only to patients and properly badged staff (3.3)	Patient and family aggression (4.6)	Security issues addressed including adequate security briefings, evacuation plans and exit strategies (5.2)

	Local / Regional	National - pandemic	International assistance
Control flow	Controlling flow can preserve capacity (3.3) Minimize return of patients to ED – a patient leaves ED with provisional diagnosis and disposition plan (3.3) Pursue appropriate disposition even no clear diagnosis (3.3)		
Coordinate patient movement	Importance of tracking, and coordination patient movement (3.5) Use disaster patient tracking system and a dedicated staff member to keep updated (3.3)		
Standards of service	Consider change in standard of service, rather than standard of care (3.3) Announce surge-induced goals of care and investigation and treatment processes (3.3)		
Benefits			Deployment felt to benefit affected community (5.6) Less felt there was a benefit for own community (5.6)
STAFF			
Staffing model	Decide if/how ED must modify its staffing model (3.3) Allocate roles & distribute appropriate action cards (3.3) Determine meeting points for new staff to arrive and staff updates to occur (3.3) Request surgical/ critical care liaison points in ED (3.3) Engage nonclinical staff as runners, scribes, and patient transporters (3.3) Ensure adequate staff if alternative sites used (3.5) Access staff trained in patient care during transport (3.5) Re-positioning of staff with aide memoires to assist (3.4)	Staff will be redeployed (4.5) Organizational change to enable rapid deployment of alternative sites care (4.6)	Process for team selection needed (5.6) Role definition needed so actual role matches intended role and clinical background suited to task (5.6) Teams need to be familiar with each other (5.3; 5.6) There should be role recognition on return (5.6) Most enjoy experience and would volunteer again (5.6)

	Local / Regional	National - pandemic	International assistance
Staff health	Staff at risk if not supplied with appropriate PPE (3.1)	Staff will also become ill (4.5) - Staff illness with ILI 37% - 56.6% staff absent least 1 d - mean days absent 3.73 Health workers unlikely to comply with advice to stay home if sick (4.3) - Of staff who became ill, many still come to work (4.5)	Only those in good health should deploy (physical and psychological) (5.1) Physical health checks and vaccination prior (5.1) Psychological screen prior (5.1) Medical and psychological support available for team members while away (5.2) Physical and mental health review post return (5.1)
Staff welfare	Staff will also have family commitments with local disasters (3.5)	Majority population have sufficient supplies to cope with isolation for 3 days (4.4) Fewer have reserves if isolated with interruption in utility services (4.4) Health workers less likely to be prepared for short term isolation (4.4) Staff also have family commitments (4.5; 4.6) Absenteeism associated with care-giver roles, school closures, concern about own and family health (4.6) Heightened stress related to increased workloads and lower levels of staffing (4.6)	Team performance can be affected by concern for own health and family (5.2) Period of operations needs to be supported by planning and provision of rest cycles, food, accommodation and rest areas for staff (5.2) Minimise personal hardship by being able to communicate with home and keeping family adequately informed of whereabouts and health status (5.2)
Training	Staff need training which may need funding support (3.1) Need to prepare and protect staff (3.1; 3.5) Model framework for disaster health education may provide an infrastructure around which future educational programs in disaster health can be based (3.8)		Teams needed to be adequately trained (5.3) There should be a specific training program (5.3) Leadership training essential for commanders (5.3) Specific training on cultural awareness (5.3) Specific communications training and communications equipment (5.3) Specific training using self sufficiency equipment including water (5.3) Specific training on ability to erect tents / shelters (5.3) Should train as team (5.3)

	Local / Regional	National - pandemic	International assistance
HR issues		Staff exposed to ILI often develop illness but not tested 87% = implications for disease spread and insurance re occupational exposure (4.5)	Adequate indemnity, insurance and pay issues, organised in advance (5.6) Staff preferences considered in rostering to minimize fatigue, ensure staff welfare and effectiveness care (5.6) - on call option of one month - notice to deploy 6-24 hours - deployment of 14-21 days - shift length of 12 hours
SPACE			
Design and fit out	EDs face increased demand, reducing surge capacity (3.2) Call for extra trolleys and chairs so every patient has a place to lie or sit (3.3)	EDs need better design to cope with infectious patients (4.2; 4.6)	Habitat may be needed as shelter for team (5.2) All team members able to erect tents / facilities (5.3)
Divert	Clear waiting room of all patients fit for disposition to alternative providers (3.3) Notify EMS to arrange bypass of individual patients unrelated to the surge event (3.3)		
Decant	Clear ED of admitted patients with cooperation of inpatient units / hospital executive (3.3) Send admitted patients to predetermined holding area to allow immediate decant, with inpatient units to pick up (3.3)		
Expand	Planning should consider alternative care sites (3.3; 3.5) Set up extra-ED diversion area for stable, ambulatory, nonemergency patients (3.3)	Plan alternative sources care in advance (4.2; 4.5; 4.6)	

	Local / Regional	National - pandemic	International assistance
Absorb	Maximize cohort care and minimize one to one care (3.3) Identify intra-ED expansible areas for care of stretcher and sitting patients (3.3)		
SUPPLIES			
Logistics	Team member dedicated to restocking supplies allowing staff maintain clinical role (3.3) Create at least one portable disaster trolley appropriate for each area. Stock with items such as fluids, dressings, IVs, analgesia, antibiotics (3.3)		Importance of dedicated logistics support (5.5) Equipment should be able to be moved easily around site with safe container weights (20 - 40 kg) (5.5), Equipment clearly labelled to aid identification (5.5)
Transport	Consider access to transport platforms (3.5)		Transport options to site may be problematic (5.5)
Medical supplies	Ensure adequate medication, oxygen, equipment (3.5) Call for extra portable suction, ventilators, monitors (3.3)	Access to antivirals and consistent prescribing (4.6)	Medical supplies should include the provision of a dedicated team member medical cache (5.2)
PPE	EDs have limited equipment including PPE and decontamination for specific CBR risks (3.1)	Staff access to PPE and vaccinations (4.2; 4.6) Staff discomfort with prolonged wearing PPE (4.6)	Uniforms should clearly identify team (5.6) Uniforms appropriate for the environment (5.2) Adequate PPE (5.2)
Self sufficiency			Basic self sufficiency essential (5.5) Need to be self sufficient for minimum of 72 hours (5.5) Adequate water / food (5.2) Adequate toilet facilities, hand washing, personal hygiene, showers (5.2)
Personal items			Need minimum suggested personal equipment list, including suitable clothes, toiletries, phone, insect repellent, camera (5.2) Personal survival kit is recommended (5.2)
Investigations	Consider use of ultrasound to aid early disposition (3.3) Limit contrast studies (3.3)		

The conceptual model is then expanded in Figure 6.2, which articulates the relationships between these elements. Review of disaster types should enable identification of generic issues consistent with the ‘all hazards’ approach as well as any hazard specific issues that need special consideration. Surge management strategies can then be developed to assist with preparedness across the domains of space, staff, supplies and systems. Addressing the generic issues initially, followed by consideration of any hazard, best approaches this. This should also be scalable to achieve maximum surge capability. The initial response will be at a local level, which in most situations will provide most of the response effort using available resources and local surge capability. Regional neighbours will usually be next to offer assistance and augment the local response. This practice is both sensible and efficient – neighbours will have less distance to travel minimising response time and more likely to have similar health system characteristics, language and culture. Depending on whether the imbalance between supply and demand can be met, there may be a need for national or international assistance. This concept is displayed in Figure 6.3. This figure illustrates the separate domains of the surge paradigm (space, staff, supplies, system) with the impact of the disaster represented as a series of concentric rings spreading from local to regional, national and international involvement. This can be thought of both as a ripple effect spreading out but also in reverse as the waves of assistance coming in from further afield.

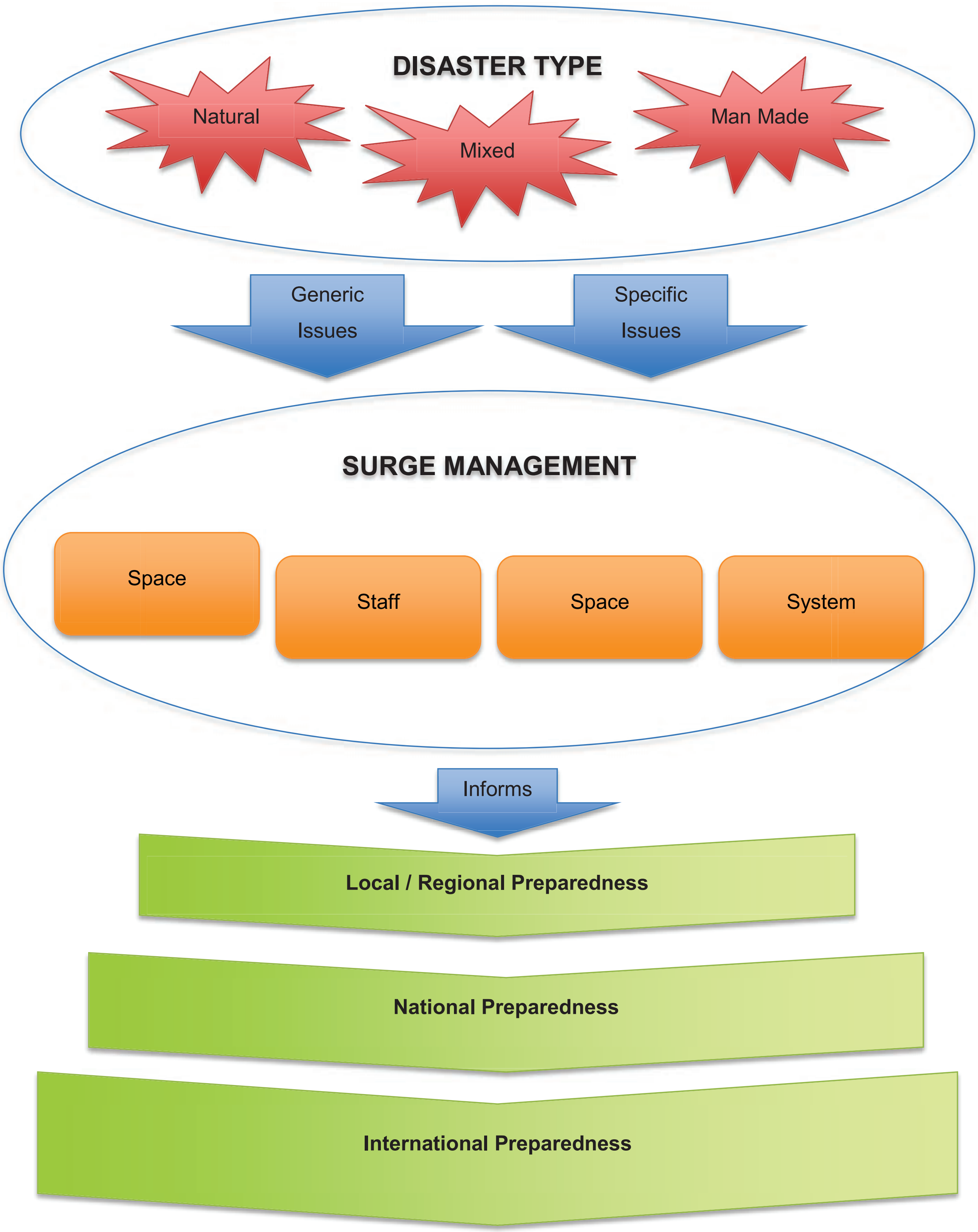
DISASTER TYPE
Natural
Mixed
Man Made
Generic Issues
Specific Issues
SURGE MANAGEMENT
Space
Staff
Space
System
Informs
Local / Regional Preparedness
National Preparedness
International Preparedness

Figure 6.2: Conceptual summary expanded

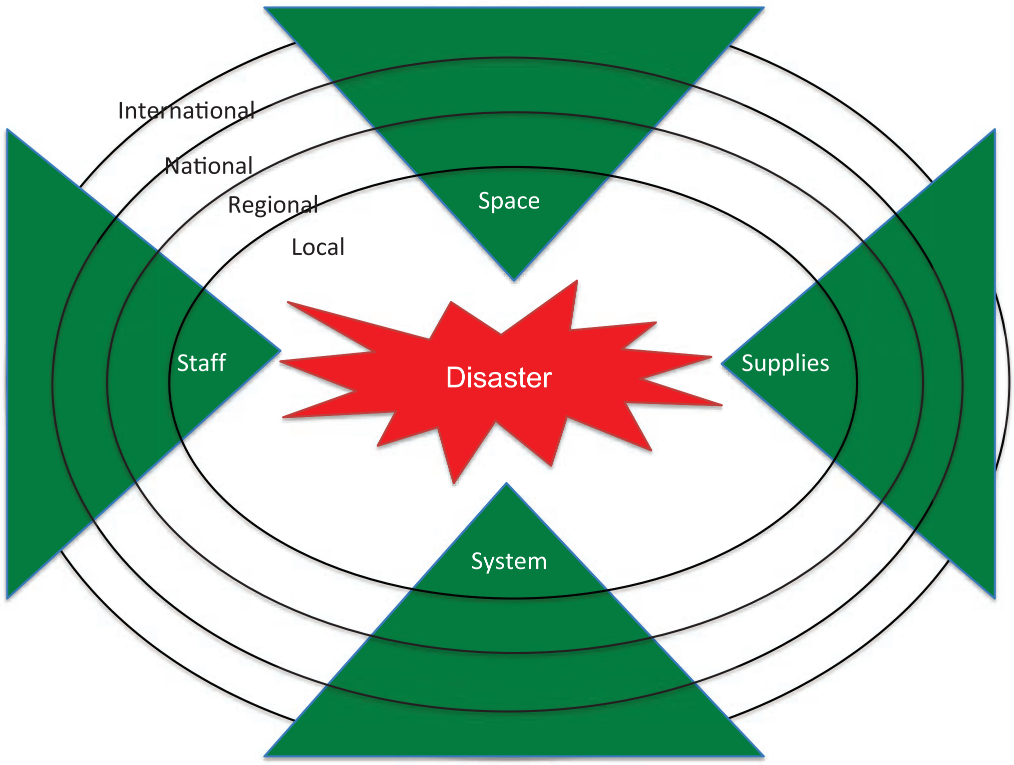

Figure 6.3: Scalable Surge Systems

The findings of the thesis are then presented in the format of the expanded conceptual model and displayed in Figure 6.4. For this scalable approach to work there needs to be consistency of both operational practice and preparedness. The concept of inter-operability is essential as staff must have consistent and similar levels of training, equipment should be the same or be able to be used together and most importantly systems are integrated.

DISASTER TYPE	
Generic Issues	Specific Issues
Plans need to be realistic (3.1) and planning assumptions evidence based (3.1; 3.7)	Disaster plans 'all hazards' but consider specific aspects of preparedness such as CBR arrangements (3.1), evacuation (3.5) establishment of alternate facilities (3.5) Injury patterns predicted to guide planning (3.4; 3.7;

Informs

SURGE MANAGEMENT			
Space	Staff	Supplies	System
ED design to consider infectious patients (4.2; 4.6) intra-ED expansible areas, holding areas (3.3) Plan alternative areas for care in advance (3.3; 3.5; 4.2; 4.5; 4.6; 5.2) Coordinated approaches to maximising space should include bypass and clearance of ED (3.3)	Defined team roles and reporting (3.3; 5.4; 5.6) Changes likely (3.3) and include redeployment (4.5), alternative areas (3.5; 4.6), non ED staff (3.3), specific skills (3.5) Base surge activity on normal activity (3.2) and ensure clinical background suitable (5.6) non clinical staff as runners, scribes, patient transporters (3.3) Action cards, aide memoires assist (3.3; 3.4) Teams need to be familiar with each other (5.3; 5.6) Staff will get ill (4.5) and still come to work (4.3; 4.5) Ensure physical health of staff (5.1; 5.2) vaccinations (4.2; 4.6), testing (4.5) Ensure psychological well being of staff (5.1; 5.2) Staff family commitments (3.5; 4.5; 4.6) affect performance (5.2) or absenteeism (4.6) as less likely prepared for short term isolation (4.4) Heightened stress due workload, staffing, concern own health (4.6; 5.2)	PPE (3.1; 4.2; 4.6; 5.2) Adequate medical supplies (3.3; 3.5; 4.6; 5.2) Dedicated logistic support role so staff can maintain clinical roles (3.3; 5.5) Equipment clearly labelled and able to be easily moved (3.3; 5.5) Consider access to appropriate transport platforms (3.5; 5.5) Ensure non medical supplies - extra patient trolleys and premade IDs, chart packs, x-ray, lab slips (3.3) Uniforms should identify team (5.6) and role (5.4) and be appropriate for the environment (5.2) Basic self sufficiency is essential (5.2; 5.5) with training in use (5.3)	Consider behaviour in plans (3.2; 4.1; 4.3), e.g. diversion strategies (3.2), border control (4.1; 4.3), social distancing (4.2) Awareness plans (4.2; 4.6) Plans realistic and evidence based (3.1; 3.7) Clear command structure and leaders (3.5; 5.4) Team leaders trained (5.3), clearly identified (5.4) and focus on decision making (3.3; 3.5) Communication strategies vital (3.5; 4.2; 4.7; 5.5) Redundancy in communications (3.3; 3.5) with staff trained (5.3) Single information source (4.2; 4.6; 4.7) Communications targeted, bi-directional and include local health (5.5) local content (4.7) and sub-populations identified (4.2) Standardized format assist reporting (3.9; 4.2) Documentation (3.3; 3.5; 5.5) Common language and definitions, evidence based standards, 'indicators of

	Support staff with rest cycles, food, rest areas, accommodation, personal equipment, ability to keep family supported, informed of health (3.5; 4.4; 5.2) Staff adequately trained (3.1; 3.5; 5.3) and specific training required (3.8; 5.3) Adequate indemnity, pay, insurance - organised in advance (4.5; 5.6) Staff rostering preferences minimise fatigue (5.6)		effectiveness to guide preparedness and response (3.1; 5.4) Care of non disaster patients (3.3; 4.6; 5.3) Security to control access, maintain patient flow and protect staff (3.3; 4.6; 5.2) Controlling flow preserves capacity (3.1; 3.3) Coordination of patient movement (3.3; 3.5) Change in standard of service, rather than standard of care (3.3)

Informs

Local / Regional	National	International
Integrated planning including jurisdictional plans (3.5; 4.1; 4.2)		

Figure 6.4: Thesis Findings Presented in Expanded Conceptual Model

6.4 Linkages with other Models

6.4.1 Haddon's Matrix

It is also important to remember the relationship between the components of the comprehensive approach. While the focus of this thesis is improving preparedness this remains inextricably linked to response and recovery. Adequate preparedness before a disaster helps ensure an effective response, while an adequate review afterwards as part of the recovery process ensures an ongoing cycle of improvement in preparedness. This pre-event, event, post event structure aligns well with Haddon's Matrix.

Haddon's Matrix (see Table 6.2) was initially used to describe an approach to injury prevention and can be used to identify public health interventions able to be taken pre-event, during the event and post-event to reduce the likelihood of injury. These actions can be taken across a number of different domains including human elements, structural elements, physical elements and social or economic factors. Each cell of the matrix represents a distinct locus for identifying strategies to prevent, respond to, or mitigate injuries or other public health challenges (Runyan 1998).

Table 6.2: Haddon's Matrix

	Human	Structural	Physical	Social
Pre Event				
Event				
Post Event				

Noji (1987) first described the use of Haddons Matrix in natural disasters. Other authors have used this approach to consider actions in other disaster types such as bus and road crashes (Albertsson, Bkornstig & Falkmer 2003), chemical terrorism using a sarin example (Varney et al. 2006) and SARS and 'dirty bomb' scenarios (Barnett et al. 2005).

In

Table 6.3 the time elements of Haddons Matrix (pre-event, event, post-event) are matched with components of the comprehensive approach while the domains of human, structural, physical and social are matched with the elements of the surge paradigm (staff, space, supplies and system respectively). This inter-relationship will also be used to map the outcomes of the thesis. This is then completed in Table 6.4 using the summarised findings from Chapters 3 to 5 (Table 6.1). This is the first description, to the author's knowledge, of the inter-relationships between these three key models of emergency preparedness: Haddons Matrix, the Comprehensive Approach (PPRR) and the Surge Management Paradigm.

Table 6.3: Linkages between Haddon's Matrix, the Comprehensive Approach and Surge Management

HADDON	**HADDON DOMAIN**	HUMAN	STRUCTURE	PHYSICAL	SOCIAL & ECONOMIC
HADDON PHASE	**SURGE MANAGEMENT** **COMPREHENSIVE APPROACH**	STAFF	SPACE	SUPPLIES	SYSTEM
PRE EVENT	PREVENTION PREPAREDNESS				
EVENT	RESPONSE				

POST EVENT	RECOVERY				

Table 6.4: Thesis Findings Incorporated into Haddon's Matrix

HADDON	**HADDON DOMAIN**	HUMAN	STRUCTURE	PHYSICAL	SOCIAL & ECONOMIC
HADDON PHASE	**SURGE MANAGEMENT** **COMPREHENSIVE APPROACH**	STAFF	SPACE	SUPPLIES	SYSTEM
PRE EVENT	PREVENTION PREPAREDNESS	Education Training Health screen Vaccination Adequate pay and indemnity Define roles based on normal activity	ED design Identify and prepare extra / alternate areas	Pre-positioning Adequate supply - medical - non medical Label and pack Training in use Redundancy in communications	Realistic plans Planning based on evidence Standards Integrated planning
EVENT	RESPONSE	Support staff stressors Family support Staff illness Support staff redeployed	Bypass ED Clear ED Control access Control flow	Logistics support Restock location PPE Uniforms Rationing Access	Clear command Communication strategies Single source information Change service standards
POST EVENT	RECOVERY	Health care Psychological health support	Review design, flow and plans	Restocking and review	Review process (all areas)

The merging of these three models offers the benefits of all in a simple format. Most importantly it also helps promote consistency of language across public health, clinical medicine and emergency management – the three domains of disaster medicine as described by Bradt et al. (2003).

As described by Barnett et al. (2005), Haddon's Matrix provides a framework for understanding an incident in a temporal context, including its preevent, event (crisis), and postevent (consequence) phases; allows users to dissect these temporal phases into their contributing factors and can aid an agency's vulnerability assessment of its preparedness and response capacities. While theoretically attractive, its use has been mostly restricted to the public health workforce. The Comprehensive Approach (PPRR) is part of the standard language of all emergency managers, while the surge management paradigm is mainly restricted to use by ED staff as a tool to guide preparedness in the face of increased overcrowding and congestion. The combination of these three models helps each user group understand the language of the other groups and potentially assist improvements in not just preparedness but integration of plans and arrangements.

The scalability of this arrangement can be reflected by the vertical alignment of cells for local, regional, national and international response. For those with visual thought processes, this may be thought of as a 'tower of power' or a 'cube of control', where each element is built upon but also is related to each other. The key element in this is that no single element stands alone. Just as there is consideration of preparedness, response and recovery arrangements across staff, space, supplies and the system, there is scalability between the levels of response. The cube is not complete with all cells being considered. This reflects the need for a truly integrated approach if disaster management is to be successful.

This approach is also consistent with work examining best outcomes in out of hospital cardiac arrest. The 'chain of survival' recognizes that all elements are essential to achieve not just survival but best outcomes (Cummins et al. 1991). Disasters are no different. Outcomes are often dictated by the weakest link (de Boer 1999) and if any of the elements of space, staff, supplies or the system is deficient, the quality of the response will be less. Simple examples include well-supplied teams with no space to care for patients; no staff to actually provide the care; staff with no equipment or a disjointed system with sufficient space, staff and supplies but no communication resulting in task omission or duplication.

6.4.2 Input. Throughput, Output Model

Another model identified as being of importance to ED staff is the 'Input, Throughput, Output' model (Asplin 2003), which describes the flow of patients through an ED. The abbreviated findings of the thesis are also presented in terms of this model given the increasing issues with over crowding and congestion faced by ED internationally. This can be expanded for specific disasters such as pandemic response and linked directly to ED processes. This is shown in Table 6.5.

Table 6.5: Thesis Findings Incorporated into Input, Throughput, Output Model

Input	Throughput	Output
Consider diversion strategies Consider community behaviours – ED use likely to persist in disasters EMS bypass of new patients Divert to GPs Divert to alternative care facilities (e.g. flu clinics) Conrtrol entry to ED Remember non disaster patients	Command structure Clear roles Communication strategies Logisdtic support to free up clinical staff Adequate equipment to maintain care Maintain staff health and welfare to preserve efficacy and workforce Control flow Patient tracking and documentation Change standards of service	Decant ED with assistance inpatient units and hospital administration Pursue disposition with no clear diagnosis Patients leave ED with plan and not return Control exit points

6.5 Summary of research findings translation into practice

The thesis has multiple direct links to policy and practice, with a number of findings from the thesis already translated into practice or used to inform system development.

At a local and state level the findings of the thesis have helped inform:

- Local Townsville Hospital disaster and pandemic planning
- Qld Health disaster and mass casualty planning
- Innovations such as the development of 'survey monkey' as a tool for real time improvement are now used in many facilities in Qld (4.7)
- The Cairns evacuation has already contributed to local, state and national planning with the evaluation of this directly influencing changes in practice two years later during the Bundaberg Hospital evacuation (3.5).

At a national level:

- The Surge Card has been distributed to ACEM Fellows and is available on line with further copies requested by the Victorian Department of Human Services. (3.3).
- Development of the first post graduate Disaster Health education program for health professionals in Australia

- Influencing policy and planning – Paper 4.6 was distributed by the Chief Medical Officer of Australia to all members of the AHPPC to inform preparedness and the review of the AHMPPI.
- Informed AUSMAT planning and development nationally
- The DMAT literature review (2.4) initially helped inform the development of the Western Australia model for disaster medical assistance teams.
- The updated literature review and preliminary survey results (2.4; 5.1 – 5.6) were reported to PHERP and subsequently to DoHA and the AHPC (now AHPPC). This has informed the development of the national AUSMAT structure and the ongoing work of the National Health Emergency Medical Sub-Committee (NHEMS) AUSMAT Work Group.
- The findings have also helped subsequently guide the development of the Queensland deployable team capability;
- The literature review (2.4) and research papers from the DMAT survey (5.1 - 5.6) have been used as key references in a number of education programs:
    - The National Critical Care and Trauma Response Centre (NCCTRC) national AUSMAT Team Leader and Team Member courses and accompanying AUSMAT Team Member manual;
    - The JCU Disaster Health post graduate education program;
    - The QUT Disaster Health post graduate education program;
    - The Major Incident Medical Management and Support (MIMMS) courses in Australia.
- The national education framework (3.8) has been used to guide the development of new disaster health programs at QUT.
- The CONFIDE guidelines (3.9) have been used to prepare case reports for publication in Emergency Medicine Australasia and been acknowledged in a recent international meeting held at Stavanger in Norway, looking at developing consistent international reporting frameworks'

At international level:

- First paper to show evidence of morbidity and mortality of heatwaves in acclimatised populations (3.6)
- The findings, with the approval of the AHPPC, were also made available and reported to the New Zealand Department of Health to inform their preparedness program (2.1; 5.1 – 5.6)

- Contributed to development of WHO deployable teams classification and standards (2.1; 5.1 – 5.6)

6.6 Recommendations

The following is a summary of recommendations:

- Health system preparedness for disasters is multidimensional
- Need to consider disaster types and level of response (local, national or international) suggesting scalable models
- Basing preparedness on surge management principles helps address all aspects and is consistent with existing models (Haddon's matrix) that recognise multiple domains of activity
- Need to have a prepared system
    - Common language; awareness of common and specific local risks; integrated planning with valid assumptions of behaviour and epidemiology of disasters; standards; consistent information and communication
- Need to have prepared staff
    - Prepared, trained, protected, supported (physical and psychological health) staff with family welfare considered and communication channels enhanced
- Need to have prepared space
    - Additional and alternate areas identified and planned for
- Need to have prepared supplies
    - Access to stores; pre-positioning; redundancy; communications
- Needs to be supported by evidence & research to inform plans & policy
- Frameworks support scalable preparedness
    - Based on epidemiology of injury
    - Supported by an educational and training framework
    - Assisted by standardized reporting arrangements

These recommendations are also presented in a number of formats below. Use of models may help dissect a problem into its dimensions of time and contributing factors can be used as a planning tool to help understand, prepare for, and respond to a broad range of public health emergencies (Runyan 2003).

- **Surge Management Paradigm**
    - Table 6.6 describes more detail of these recommendations across all elements of the surge management paradigm. Bold font represents recommendations consistent across two areas of local, national or international while italic font represents recommendations that occur in separate papers but in the one area (local, national, international).
- **Conceptual Model of the Thesis**
    - Figure 6.5 also describes the summarised findings of the expanded conceptual model of the thesis itself.
- **Haddons Matrix**
    - The integration of the comprehensive approach and the surge management paradigm into Haddons Matrix has been displayed in Table 6.3 and is the first description of the combination of these three models into one.
- **Input: Throughput: Output Model**
    - The integration of the thesis findings into the Input, Throughput, Output Model also allows process mapping for EDs and has been displayed in Table 6.4.

Table 6.6: Summary of Recommendations Across Domains of Surge Paradigm

SYSTEM
Need for better integration of planning including jurisdictional support plans (3.5; 4.1; 4.2)
Need to consider anticipated behaviour in planning (3.2; 4.1; 4.3), including the effectiveness of diversion strategies (3.2), border control (4.1; 4.3), social distancing (4.2)
Disaster plans should be 'all hazards' but also consider specific aspects of preparedness such as CBR arrangements (3.1), evacuation (3.5) and establishment of alternate facilities (3.5)
Ensure awareness of plans (4.2; 4,6)
Plans need to be realistic (3.1) and planning assumptions evidence based (3.1; 3.7)
Injury patterns can be predicted to guide planning (3.4; 3.7; 3.8)
Need a clear command structure and decision makers (3.5, 5.4)
Team leaders should be trained (5.3), able to be clearly identified (5.4) and able to focus on decision making rather than direct operational activities (3.3; 3.5)
Communications strategies are essential (3.5; 4.2; 4.7; 5.5)
Redundancy in communications strategies (3.3; 3.5) with staff trained in use (5.3)
Single authoritative information source with accurate, timely information (4.2; 4.6; 4.7)
Communications targeted and bi-directional and include local health providers (5.5) with local content (4.7) and sub-populations identified for public health messages (4.2)
Need for a standardized format to assist reporting (3.9; 4.2)
Importance of good documentation (3.3; 3.5; 5.5)
Need for common language and definitions, evidence based standards and 'indicators of effectiveness to guide preparedness and response (3.1; 5.4)
The care of non disaster patients need to be planned for and provided (3.3; 4.6; 5.3)
Security is essential to control access, maintain patient flow and protect staff (3.3; 4.6; 5.2)
Controlling flow can preserve capacity (3.1; 3.3)
Importance of patient tracking, and coordination of patient movement (3.3; 3.5)
Consider a change in standard of service, rather than a change in standard of care with surge-induced goals of care and investigation and treatment processes (3.3)
STAFF
Clearly defined team roles and reporting structures (3.3; 5.4; 5.6)
Changes in staffing models likely to occur (3.3) and may include redeployment (4.5), non ED staff assisting (3.3) and specific skill sets such as transport (3.5)
Base surge activity on normal activity (3.2) and ensure clinical background suitable (5.6) including nonclinical staff as runners, scribes, and patient transporters (3.3)
Action cards and aide memoires may assist (3.3; 3.4)
Enable deployment of alternative sources of care (4.6) with adequate staffing (3.5)
Process for team selection needed (5.6) and teams need to be familiar with each other (5.3; 5.6)
Staff will also become ill (4.5) and many will still come to work (4.3; 4.5)
The physical health of staff should be ensured (5.1; 5.2) including vaccinations (4.2; 4.6) and testing (4.5)
The psychological well being of staff should be ensured (5.1; 5.2)
Staff will have family commitments (3.5; 4.5; 4.6) which may impact on performance (5.2) or cause absenteeism (4.6) as also less likely to be prepared for short term isolation (4.4)
Heightened stress related to workloads, levels of staffing and concern for own health (4.6; 5.2)

Support staff with rest cycles, food, accommodation, rest areas, personal equipment and ability to keep family supported and informed of whereabouts and health status (3.5; 4.4; 5.2) **Staff need to be adequately trained (3.1; 3.5; 5.3) and specific training is required (3.8; 5.3)** **Adequate indemnity, insurance and pay issues and organised in advance (4.5; 5.6)** *Staff preferences in rostering to minimise fatigue and ensure staff welfare / effectiveness of care (5.6)*
SPACE
ED design needs to consider infectious patients (4.2; 4.6) ability to use intra-ED expansible areas (3.3) and pre-determined holding areas (3.3) **Plan alternative sources care in advance (3.3; 3.5; 4.2; 4.5; 4.6; 5.2)** *Coordinated approaches to maximising space should include bypass and clearance of ED (3.3)*
SUPPLIES
There should be adequate PPE (3.1; 4.2; 4.6; 5.2) **Ensure adequate key medical supplies (3.3; 3.5; 4.6; 5.2)** **A dedicated logistic support role is essential so staff can maintain clinical roles (3.3; 5.5)** **Equipment should be clearly labelled and able to be easily moved (3.3; 5.5)** **Consider access to appropriate transport platforms (3.5; 5.5)** *Ensure non medical supplies - extra patient trolleys and premade IDs, chart packs, x-ray, lab slips (3.3)* *Uniforms should identify team (5.6) and role (5.4) and be appropriate for the environment (5.2)* *Basic self sufficiency is essential (5.2; 5.5) including training in use (5.3)*

DISASTER TYPE	
Generic Issues	**Specific Issues**
Plans need to be realistic Planning assumptions evidence based	Disaster plans ‘all hazards’ Specific arrangements for CBR, evacuation and establishment of alternate facilities Injury patterns predicted to guide planning

Informs

SURGE MANAGEMENT			
Space	Staff	Supplies	System
ED design consider - infectious patients - expansile areas, - holding areas Plan alternative care areas in advance Plans include bypass and clearance of ED	Defined roles Base surge activity on normal activity Ensure staff role appropriate to background Remember non clinical staff Defined reporting Changes are likely Action cards Staff illness process Ensure physical health of staff Ensure psychological well being of staff Recognise staff family commitments Recognise stress and support staff Staff trained Adequate indemnity, pay, insurance	Dedicated logistic support Adequate supplies Non medical supplies - extra patient trolleys - premade IDs, - chart packs, - x-ray, lab slips PPE Uniforms identify and protect staff Equipment labelled and easily moved Access to transport Basic self sufficiency Training in use of all equipment	Consider behaviour Awareness plans Clear command Team leaders trained Communication strategies Redundancy in communications Single information source Standard reporting Documentation Common definitions Evidence based standards Remember non disaster patients Secure access Control flow and track movement Change standard of service

Informs

Local / Regional	**National**	**International**
Integrated planning		

Figure 6.5: Summarised Findings Presented in Expanded Conceptual Model

6.7 Future Directions Based on the Research

This work has just begun. Work has already commenced on projects either developed from the thesis or related to it. These include:

- Characteristics of ED surge and strategies to address this
- Epidemiology of disaster demand in cyclones and system impacts
- Hospital evacuation parameters and strategies
- Heatwave morbidity, predictors and warning tools
- Classification and minimum standards for Foreign Medical Teams including use and effectiveness of these

It is likely that additional future developments will include work on the following:

- Increased Professionalisation of Disaster Response
  - Standards of care (and altered standards of care)
  - Accountability and credentialing of disaster health care providers, teams and managers
  - Improved integration of health care 'normal business' & 'disaster response'
  - Improved integration of health care into the disaster 'system' and vica versa – and how to best achieve this,
- Increased use of technology
  - Improved communications including visibility and sharing of information and integration with other agencies
  - The use of technology including patient tracking and use of field images
- Effectiveness of disaster health interventions (clinical & system) related to:
  - The implications of an aging population on disaster response.
  - The implications of global warming on vector borne disease and exposure of disease naive populations
- Growth of research and refinement of research methods in disaster health
- Recognition of disaster health as an area of specific knowledge and training
- Validation of the utility of the conceptual models proposed in this thesis.

6.8 How the DrPH objectives have been met

The objectives of the program of study are repeated below with specific comments about how these have been achieved.

1. To identify general factors involved in the preparedness for disaster response
    - This is addressed initially in Chapter 2, the Literature Review, and built upon in each chapter before conclusions are made in this Chapter.
2. To identify specific factors involved in the preparedness of Emergency Departments (ED) in Australia to respond to local disasters
    - This is specifically addressed in Chapter 3 (Local and Regional) based on the preliminary work of the Literature Review (Chapter 2) with additional detail emerging from Chapter 4 (National) and Chapter 5 (International) before conclusions are made in this Chapter.
3. To identify specific factors involved in the preparedness for larger scale disasters
    - This is specifically addressed in Chapter 4 (National) based on the preliminary work of the Literature Review (Chapter 2) with additional detail emerging from Chapter 3 (Local and Regional) and Chapter 5 (International) before conclusions are made in this Chapter.
4. To identify specific factors involved in the preparedness for international disaster response
    - This is specifically addressed in Chapter 5 (International) based on the preliminary work of the Literature Review (Chapter 2) with additional detail emerging from Chapter 3 (Local and Regional) and Chapter 4 (National) before conclusions are made in this Chapter.
5. To compare factors involved in preparedness for local, national and international disaster response, and to different types of disasters, to identify major areas of focus
    - This is specifically addressed in this Chapter, which draws together the findings of Chapter 3 (Local and Regional), Chapter 4 (National) and Chapter 5 (International).
6. To identify future directions for disaster health preparedness
    - This is specifically addressed in this Chapter following analysis of factors involved in preparedness for local, national and international disaster response.

Meeting the objectives of the thesis has also helped ensure the ability to:

- Meet the aim of this thesis:

“To identify factors that can be subsequently targeted to improve preparedness for disaster response”.

- Address the main research question of the thesis:
  “Are there factors able to be identified, both general and specific to disaster types that influence disaster preparedness?”

6.9 Outcomes by publication and presentation

The outcomes of this program of study can also be assessed in terms of academic outputs such as published papers and presentations at national and international meetings.

The thesis has presented 26 papers in total, which include two editorials, three monographs, one textbook chapter and 20 peer reviewed research papers. These are included in Annex 1. This is however only a sample of the work that has been undertaken with a further 20 papers published or currently undergoing peer review that have not been included and approximately 50 presentations at national and international conferences including keynote and plenary sessions.

6.10 Conclusions

Disasters are of special significance to all those who work in Emergency Departments. As the front door of the hospital, ED staff need to be aware of local risk profiles, prepare their department and ensure they become involved in a ‘whole of hospital’ and ‘whole of community’ approach to disaster planning. Emergency Physicians and ED nurses are well suited to acute humanitarian roles with their broad skill mix and familiarity with uncertainty. These personnel do however; need additional training across public health, safety and security to be most effective as aid workers.

Increasingly, disaster medicine is moving from good intentions to good practice, with growth as a professional discipline in its own right. There has been a recent growth in research, development of standards and indicators of effectiveness and moves to not just improved education and training of responders, but credentialing as well. One of the challenges for the future, with the high likelihood of future disasters, is to build on this so that lessons identified are put into practice to become lessons actually learned and that these innovations are formally assessed to determine effectiveness and whether outcomes are improved.

As described in Section 6.5, this thesis has multiple direct links to policy and practice, with a number of findings from the thesis already translated into practice or used to inform system development. This has occurred across local, state, national and international preparedness. It is hoped that the findings of this thesis, and its associated outputs, will continue to help inform future emergency preparedness and contribute to further improvements in the care provided to the victims of disasters.

The doctoral program has also had a profound effect on both my understanding of, and ability to conduct research as well as develop skills in project proposals, funding applications and disaster management. The thesis has contributed to the development of my profile in the disaster health community and led to invitations to participate in other roles and committees which further help translation of the thesis into practice. My personal development is shown below which compares my roles and responsibilities pre thesis to those at the time of thesis submission.

Summary Table of Personal Development Pre and Post Doctorate

Professional Role: Pre-Doctorate	**Professional Role: On submission of Doctorate**
Employed role Staff Specialist, Emergency Department, The Townsville Hospital	*Employed role* Medical Director, Aeromedical Retrieval and Disaster Management Branch, Queensland Health
Other positions – state, national and international No disaster or research related positions	*Other positions – state, national and international (examples)* Multiple committees and roles such as: - State level planning for G20, Commonwealth Games and Queensland Health Ebola Preparedness. - National positions with ACEM, St John Ambulance Australia, Department of Health and the Emergency Medicine Foundation - International roles with WADEM, IFEM and the WHO.
Academic Senior Lecturer JCU	*Academic* Associate Professor JCU Adjunct Professor QUT
Peer review journals and Editorial Roles None	*Peer review journals and Editorial Roles* Peer review for 12 different journals and board three journals
Grant review panels None	*Grant review panels* Member of panels for QEMRF, ACEM, NHMRC and Health Services Research Fund (HHSRF) and Hong Kong Government.
Overall publications = 5	*Overall publications >80*
Overall conference presentations = 12	*Overall conference presentations > 100*

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Appendix

Appendix 1 Personal Contributions to each Paper

Paper		Type	Concept	Design	Data	Analysis	Writing	Contribution %
2.1	**Aitken, P** & Leggat, P 2012, ‘Considerations in mass casualty and disaster management’, in M Blaivas (ed.), *Emergency medicine – an international perspective*, Intech, Croatia, pp. 143-82.	Chapter			N/A	N/A		90%
2.2	Toloo, S, FitzGerald, G, **Aitken, P,** Ting, J, Tippett, V & Chu, K 2011, *Emergency health services: Demand and service delivery models. Monograph 1: Literature review and activity trends,* Queensland University of Technology, Brisbane, Queensland.	Monograph						20%
2.3	FitzGerald, GJ, Patrick, JR, Fielding, E, Shaban, R, Arbon, P, **Aitken, P**, Considine, J, Clark, M, Finucane, J, McCarthy, S, Cloughessy, L & Holzhauser, K 2010, *H_1N_1 influenza 2009 outbreak in Australia: Impact on emergency departments,* Queensland University of Technology, Brisbane, Queensland.	Monograph						20%
2.4	**Aitken, P**, Canyon, D, Hodge, J, Leggat, P & Speare, R 2006, *Disaster medical assistance teams – a literature review*. Health Monograph Series, Health Protection Group, Perth, Western Australia.	Monograph	N/A					80%
3.1	Edwards, NA, Caldicott, DGE, **Aitken, P,** Lee, CC & Eliseo, T 2008, ‘Terror Australis 2004: preparedness of Australian hospitals for disasters and incidents involving chemical, biological and radiological agents’, *Critical Care and Resuscitation,* vol. 10, no. 2, pp. 125-36.,<	Research						25%
3.2	FitzGerald, G, Toloo, S, Rego, J, Ting, J, **Aitken, P** & Tippett, V 2012, ‘Demand for public hospital emergency department services in Australia: 2000-2001 to 2009-2010’, *Emergency Medicine Australasia*, vol. 24, no. 1, pp. 72-78, doi:10.1111/j.1742-6723.2011.01492.x	Research						20%
3.3	Bradt, DA, **Aitken, P,** Fitzgerald, G, Swift, R, O’Reilly, G & Bartley, B 2009, ‘Emergency department surge capacity: Recommendations of the Australasian Surge Strategy Working Group’, *Academic Emergency Medicine*, vol. 16, no. 12, pp. 1350-58, doi:10.1111/j.1553-2712.2009.00501.x	Research						30%

3.4	Rotheray, KR, **Aitken, P**, Goggins, WB, Rainer, TH & Graham, CA 2012, ‘Epidemiology of injuries due to tropical cyclones in Hong Kong: A retrospective observational study’, *Injury,* vol. 43, no. 12, pp. 2055-59, doi:10.1016/j.injury.2011.10.033	Research						20%
3.5	Little, M, Stone, T, Stone, R, Burns, J, Reeves, J, Cullen, P, Humble, I, Finn, E, **Aitken, P**, Elcock, M & Gillard, N 2012, ‘The evacuation of Cairns hospitals due to severe Tropical Cyclone Yasi’, *Academic Emergency Medicine*, vol. 19, no. 9, pp. 1088-98, doi:10.1111/j.1553-2712.2012.01439.x	Research						30%
3.6	Wang, XY, Barnett, AG, Vaneckova, P, Yu, W, Fitzgerald, G, Wolff, R, Tippett, V, **Aitken, P**, Neville, G, McRae, M, Verall, K & Tong, S 2012, ‘The impact of heatwaves on mortality and emergency hospital admissions in Brisbane, Australia’, *Occupational and Environmental Medicine*, vol. 69, no. 3, pp. 163-69, doi:10.1136/oem.2010.062141	Research						10%
3.7	Vaneckova, P, Neville, G, Tippett, V, **Aitken, P**, FitzGerald, G & Tong, S 2011, ‘Do biometeorological indices improve modeling outcomes of heat-related mortality?’, *Journal of Applied Meteorology and Climatology,* vol. 50, no. 6, pp. 1165-76, doi: http://dx.doi.org/10.1175/2011JAMC2632.1	Research						10%
3.8	Fitzgerald, G, **Aitken, P**, Arbon, P, Archer, F, Cooper, D, Leggat, P, Myers, C, Robertson, A, Tarrant, M & Davis, E 2010, ‘A national framework for disaster health education in Australia’, *Prehospital and Disaster Medicine,* vol. 25, no. 1, pp. 70-77, doi: http://dx.doi.org/10.1017/S1049023X00007585	Research						30%
3.9	Bradt, D & **Aitken, P** 2010, ‘Disaster medicine reporting: The need for new guidelines and the CONFIDE statement’, *Emergency Medicine Australasia,* vol. 22, no. 6,pp. 483-87, doi: 10.1111/j.1742-6723.2010.01342.x	Editorial			N/A	N/A		50%
4.1	Leggat, P, Speare, R & **Aitken, P** 2009, ‘Swine flu and travellers: a view from Australia’, *Journal of Travel Medicine,* vol. 16, no. 6, pp. 373-76, doi:10.1111/j.1708-8305.2009.00372.x	Editorial	N/A					30%
4.2	Brown, L, **Aitken, P,** Leggat, P & Speare, R 2010, ‘Self-reported anticipated compliance with physician advice to stay home during pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey’, *BMC Public Health,* vol. 10, no. 138, pp.1-6, doi:10.1186/1471-2458-10-138	Research						30%

4.3	Leggat, P, Brown, L, **Aitken, P** & Speare, R 2010, 'Level of concern and precaution taking amongst Australians regarding travel during Pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey', *Journal of Travel Medicine,* vol. 17, no. 5, pp. 291-95, doi: 10.1111/j.1708-8305.2010.00445.x	Research						25%
4.4	**Aitken, P**, Brown, L, Leggat, P & Speare, R 2010, 'Preparedness for short term isolation among Queensland residents: Implications for pandemic and disaster planning', *Emergency Medicine Australasia*, vol. 22, no. 5, pp. 435-41, doi: 10.1111/j.1742-6723.2010.01319.x	Research						50%
4.5	Considine, J, Shaban, R, Patrick, J, Holzhauser, K, **Aitken, P**, Clark, M, Fielding, E & FitzGerald, G 2011, 'Pandemic (H1N1) 2009 influenza in Australia: Absenteeism and redeployment of emergency medicine and nursing staff', *Emergency Medicine Australasia,* vol. 23, no. 5, pp. 615-23, doi: 10.1111/j.1742-6723.2011.01461.x	Research						20%
4.6	FitzGerald, G, **Aitken, P**, Shaban, RZ, Patrick, J, Arbon, P, McCarthy, S, Clark, M, Considine, J, Finucane, J, Holzhauser, K & Fielding, E 2012, 'Pandemic (H1N1) 2009 influenza and Australian emergency departments: Implications for policy, practice and pandemic preparedness', *Emergency Medicine Australasia,* vol. 24, no. 2, pp.159 – 65, doi: 10.1111/j.1742-6723.2011.01519.x	Research						30%
4.7	Seidl, I, Johnson, A, Mantel, P & **Aitken, P** 2010, 'A strategy for real time improvement (RTI) in communication during the H1N1 emergency response', *Australian Health Review,* vol. 34, no. 4, pp. 493-98, doi: http://dx.doi.org/10.1071/AH09826	Research						30%
5.1	**Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2009, 'Pre and post deployment health support provided to Australian disaster medical assistance team members: Results of a national survey', *Travel Medicine and Infectious Disease,* vol. 7, no. 5, pp. 305-11, doi:10.1016/j.tmaid.2009.03.001	Research						60%
5.2	**Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2009, 'Health and safety aspects of deployment of Australian disaster medical assistance team members: Results of a national survey', *Travel Medicine and Infectious Disease,* vol. 7, no. 5, pp. 284-90, doi:10.1016/j.tmaid.2009.03.005	Research						60%

5.3	**Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M & Speare, R 2011, 'Education and training requirements for Australian disaster medical assistance team members: Results of a national survey', *Prehospital and Disaster Medicine,* vol. 26, no. 1, pp. 41-48, doi: http://dx.doi.org/10.1017/S1049023X10000087	Research						60%
5.4	**Aitken, P**, Leggat, P, Robertson, A, Harley, H, Leclerq, M and Speare, R 2012, 'Leadership and standards for Australian disaster medical assistance team members: Results of a national survey', *Prehospital and Disaster Medicine,* vol. 27, no. 2, pp. 1-6, doi: http://dx.doi.org/10.1017/S1049023X12000489	Research						60%
5.5	**Aitken, P**, Leggat, P, Harley, H, Speare, R & Leclercq, M 2012, 'Logistic support provided to Australian disaster medical assistance teams: results of a national survey of team members', *Emerging Health Threats,* vol. 5, doi: 10.3402/ehtj.v5i0.9750	Research						60%
5.6	**Aitken, P**, Leggat, P, Harley, H, Speare, R & Leclercq, M 2012, 'Human resources support provided to Australian disaster medical assistance teams: results of a national survey of team members', *Emerging Health Threats*, vol. 5, doi: 10.3402/ehtj.v5i0.18147	Research						60%

ANNEX

Peer-reviewed and published papers presented as components of the thesis.

List of Annexes: Publications

Chapter 2 Annexes

Annex 1: Paper 2.1

Aitken P & Leggat P. Considerations in mass casualty and disaster management. In "Emergency Medicine – An International Perspective" Edited by Michael Blaivas. Intech 2012 Croatia. ISBN 978-953-51-0333-2

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Considerations in Mass Casualty and Disaster Management

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1. Introduction

Disasters have increased in frequency over the past century. A number of high profile disasters have also dominated news headlines in the past decade raising the media and community awareness, of disasters. This has been across the full spectrum of disasters and as illustrated in Table 1 has included terrorist bombings, hurricanes, earthquakes, tsunamis and floods.

The relevance of mass casualty incidents and disaster management to Emergency Medicine is obvious. Emergency Departments are the 'front door' of the hospital component of the health system. The injured or unwell and also often the worried well, will present for care. Emergency Departments (ED) need to be able to respond effectively, which mandates advance planning and preparedness. Most ED already run beyond capacity so the ability to manage an acute influx of patients in a system with potentially damaged infrastructure is a significant challenge requiring fore-thought and an understanding of disasters. Additionally, the broad skill set of Emergency Physicians may see them working in the pre-hospital arena or as part of international disaster response. This requires additional training to maintain the safety of clinicians in often challenging, and hazardous environments.

The aim of this chapter is to:

- Provide an overview of disaster epidemiology and the definitions and principles of practice;
- Outline common problems associated with mass casualty incidents and disaster management;
- Describe the potential roles of emergency physicians in mass casualty incidents, international response and pandemics and the specific issues associated with these;
- Identify emerging issues in mass casualty incidents and disaster management, future developments and research areas.

Year	Location	Disaster	Dead	Broader Impact
2001	New York	World Trade Centre	> 3,000	Broad societal change
2003	Bam, Iran	Earthquake	>25,000	>30,000 injured
2004	South Asia	Tsunami	>230,000	1.6 million homeless
2004	Russia	Beslan school siege	334	Legislative change
2004	Spain	Madrid train bombing	191	Change of government
2005	London	Subway bombings	52	Societal impact UK
2007	New Orleans	Hurricane Katrina	> 1,800	> $80 billion USD
2008	Myanmar	Cyclone Nargis	>140,000	Politics of aid
2008	China	Earthquake	> 65,000	> $140 billion USD
2009	Haiti	Earthquake	>80,000	1.5 million homeless
2010	Pakistan	Floods	>1000	20 million homeless
2011	New Zealand	Earthquake	181	>$20 billion USD
2011	Japan	Earthquake + Tsunami	> 15,000	> $300 billion USD

Table 1. Examples of Major Disasters in the Past Decade.

2. Definitions

A consistent problem in disaster management is a lack of consistency in definitions. This may lead to research problems and difficulty comparing one database with another or problems comparing outcomes when different definitions of injury or restoration of function are used. Most importantly it can lead to an ineffective response if different systems or organisations use different definitions in the same community.

A number of studies have illustrated the differences in disaster definition (Al-Mahari, 2007; Debacker, 2002). While these tend to focus on the role of the organisation and include finance, transport or health for those organisations, which have these as key roles, there remain a number of common elements. These can be described as:

1. An extraordinary event
2. Damage to existing infrastructure
3. A state of disaster / emergency declared
4. A need for external assistance

Definitions, from the World Association of Disaster and Emergency Medicine (WADEM) (Sundnes & Birnbaum, 2002) and Australian Emergency Management Institute (AEMI, 2011) are shown in Figure 1 and highlight these commonalities.

WADEM has made efforts to standardise the language of disasters. The primary purpose of this was to promote consistency of terms in research through development of their Utstein Template (Sundnes & Birnbaum, 2002). However, use of common language in operational phases is just as important. For example one of the key benefits of the Advanced Trauma Life Support (ATLS) has been the development of a common language in the management of trauma. Confusion also often exists between terns such as 'disaster' and 'mass casualty incident'. Generally speaking, a mass casualty incident, while it may involve large numbers of patients, can be managed within the resources of the affected organisation or health facility. A disaster cannot, and will mean the mobilisation of additional resources using external assistance. This is obviously context dependant with different thresholds for

WADEM Disaster Definition	EMA Disaster Definition
"A serious disruption of the functioning of society, causing widespread human, material and environmental losses which exceed the ability of the affected society to cope using only its own resources; the result of a vast ecological breakdown in the relations between man and his environment, a serious and sudden event (or slow as in drought) on such a scale that the stricken community needs extraordinary efforts to cope with it, often with outside help or international aid."	"A serious disruption to community life which threatens or causes death or injury in that community, and damage to property which is beyond the day-to-day capacity of the prescribed statutory authorities and which requires special mobilisation and organisation of resources other than those normally available to those authorities."

Fig. 1. Examples of Disaster Definitions.

external assistance for different systems (e.g. a small rural hospital versus a large inner city tertiary teaching hospital). This also explains why most definitions of disasters do not use numbers of patients in their definition, while this may be included for specific facilities. Of note is that many definitions of 'disaster' used by databases, also specifically exclude war and complex emergencies (CRED, 2000).

3. Epidemiology of disasters

Disasters have always occurred. Our ability to capture an historical record has improved with development of language and writing skills, just as our awareness of disasters in other countries has improved with the growth of telecommunications and the internet. The great flood in the Bible is likely to have been based on a real event and historically coincides with the description of a major flood event in the Mesopotamian Gilgamesh epic. One of the earliest confirmed descriptions of a disaster was that of Pliny the Elder who witnessed the destruction of Pompeii by the volcano Vesuvius in AD 79.

Table 2 describes selected major disasters from world history. Points to note are that the number of deaths does not always reflect the true impact of the disaster or allow full comparison between disasters. While only 6 official deaths were recorded in the Great Fire of London (the poor and homeless were not included), 80% of the buildings were destroyed. Change the context to the London of today and imagine the impact not just on London, but the whole of the country – socially, psychologically and economically. Similarly while 20-40 million died during the Spanish Flu of 1918-1919, the Black Death killed an estimated 100 million people in the 14th century which was approximately one third to one half of Europe's population at the time.

The frequency of disasters has also increased. Data from the CRED database is reproduced in Figure 2 and clearly shows a rise in disaster numbers each decade from the 1950's to end of the 20th century (CRED, 2000). While improved reporting has no doubt played a role, there are many other reasons for this. The world population has increased significantly, and along with that both population density (Drabek, 1986) and spread of population with large cities located in at risk areas (Dynes, 1998). This means an incident is both more likely to affect larger numbers of people in an inhabited region (e.g. inner city) but also affect people in previously unpopulated zones. The growth in technology has also contributed to not just

Year	Location	Disaster	Dead	Broader Impact
79	Pompeii	Volcano (Vesuvius)	30,000	First recorded description
526	Syria	Antioch Earthquake	250,000	
1300's	Europe	Black Death Plague	1,000,000	1/3 -1/2 population die
1666	London	Great Fire	6 officially	80% of buildings destroyed
1883	Indonesia	Volcano (Krakatoa)	40,000	Global temperature effects
1887	China	Flooding	1-2,000,000	1/2 deaths due disease, famine
1912	North Atlantic	Titanic	1517	Shipping safety (lifeboats)
1918-19	World	Spanish Flu pandemic	20-40,000,000	3% world dead, 27% infected
1931	China	Floods	1-2,000,000	Most dead any natural disaster
1970	Bangladesh	Cyclone Bhola	300,000	Most cyclone deaths
1976	China	Tangshan Earthquake	>300,000	International aid refused
1989	England	Hillsborough	91	Stadium safety

Table 2. Major Disasters in World History (prior to 2000).

industrial disasters but also transport disasters (Quarantelli, 1985), which have evolved from horse and cart to the A380 with potentially 500 passengers aboard, or involve carriage of dangerous goods.

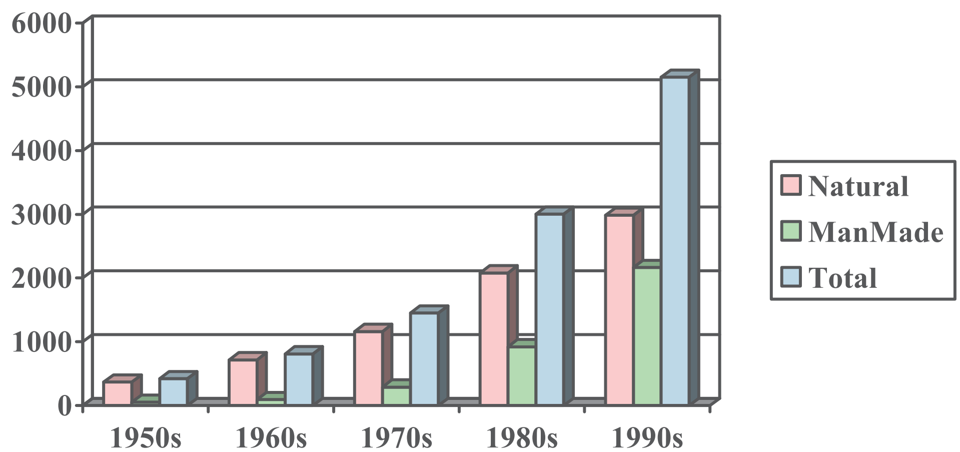

Fig. 2. Frequency of Disasters Each Decade.

There are also many types of disaster evident from this table. The WADEM Utstein Template describes disasters by hazard and separates them into natural disasters, man-made disasters and mixed disasters where both nature and man contribute (Sundnes & Birnbaum, 2002). An abbreviated version is provided in Table 3 describing natural and man-made disasters. Mixed disasters may occur as a result of man's activities influencing desertification processes, flooding due to altered waterways or landslides due to removal of trees.

NATURAL	Seismic	Earthquake
		Volcano
		Tsunami
		Celestial collision
	Climatic	High winds – gales, cyclones, hurricanes, typhoons, tornados
		Precipitation – rain, snow, ice
		Lightening
		Temperature extremes – heat, cold
		Erosion
		Drought
		Desertification
		Floods
		Avalanches
MAN-MADE	Technological	Substance release – chemical, biological, radiological
		Transport
		Structural failure
		Explosions
		Fire
		Environmental interference
	Conflict	Armed conflict – war, civil war, complex emergency, terrorism
		Unarmed conflict – sanctions, embargo

Table 3. Classification of Disasters by Hazard (based on WADEM Utstein template).

Table 4 based on information from the IFRC database shows the frequency of different disaster types by continent (IFRC, 2000). A number of clear messages emerge from this.

- The three most common disaster types are floods, windstorms (including cyclones and hurricanes) and transport disasters. This holds true for all continents except Africa where floods is replaced by drought.
- Disasters are over represented in the developing world, while North America, Europe and Oceania is less affected. This can only partly be explained by population differences. While 90% of disaster related deaths occur in countries with income less than 760 US dollars per year (Haddow & Bullock, 2003), it is not surprising that there are lower levels of disaster preparedness and response capability in those countries. When there is a struggle to put food on the table today, it is difficult to plan for tomorrow. Similarly, some shelter is better than none and some income is better than none. This potentially leads to less developed industrial standards, building codes and response capability of both health and emergency services.

The burden of disasters in developing countries remains one of the major challenges in global emergency medicine and disaster health. There have been efforts to address this through initiatives such as the Decade of Global Disaster Reduction where the focus was on mitigation as the key to addressing natural disasters (Iwan, 1999). Similarly international bodies such as the WHO or Pan American Health Organisation (PAHO) have made efforts to develop cost effective solutions and promote disaster preparedness. The real solution lies in improving local capacity with linkages between development and preparedness, all of which has financial implications.

Disaster Type	Asia	Americas	Africa	Europe	Oceania	Total
Transport	668	233	437	186	11	1535
Floods	362	216	207	153	25	963
Windstorms	322	283	49	71	58	783
Industrial	225	55	37	67	2	386
Misc. accidents	178	45	57	53	5	338
Droughts / Famines	77	39	113	13	11	253
Earthquakes	112	48	10	37	8	215
Avalanche / Landslide	101	40	12	25	5	183
Forest fires	18	55	11	39	9	132
Extreme temperatures	35	30	6	51	4	126
Volcanic eruptions	16	23	3	2	6	50

Table 4. Frequency of Disaster Types by Continent (Based on data from IFRC).

It is also important for Emergency Physicians to remember that health and medical issues are just one component of the damage caused by a disaster. Mortality is a poor indicator of the severity of a disaster. Communities can be affected in many ways, including disruption of transport, education, security, water and sanitation, to name just a few. These have been described as "Basic Societal Functions' by WADEM and are described in Table 6 (Sundnes & Birnbaum, 2002). Health workers need to appreciate that they are simply one part of the disaster effort and that their needs may not be considered the main priority at that particular stage by those responsible for overall coordination of the response. This broad extent of damage may also impact on the health effort. It may affect the ability of staff to report to work, while power and water failures may lead to secondary health hazards that need to be pro-actively planned for and addressed. An example of this broad impact is seen in the effects of Hurricane Mitch on Honduras in 1997. While approximately 9000 people were killed, more than 3 million were displaced with 75% of the Honduran population affected. The damage bill of 8.5 billion US dollars was more than the GDP of Honduras and was estimated to set development back by more than 20 years (Lichtenstein, 2001).

(1) Medical
(2) Public Health
(3) Sanitation / H2O
(4) Shelter / Clothing
(5) Food
(6) Energy Supplies
(7) Search & Rescue
(8) Public Works & Engineering
(9) Environment
(10) Logistics / Transport
(11) Security
(12) Communication
(13) Economy
(14) Education

Table 5. Basic Societal Functions as Defined by WADEM.

4. Major principles of care

Disaster Management is "the aggregate of all measures taken to reduce the likelihood of damage that will occur related to a hazard(s), and to minimise the damage once an event is occurring or has occurred and to direct recovery from the damage" (Sundnes & Birnbaum, 2002). Disaster management, like any profession or health sub-specialty has its own language to describe the components of this. It is important to fully understand these major models, principles of care and key concepts, which are described below.

4.1 Disaster models

A number of models have emerged in recent years. The disaster cycle (Hogan, 2002) describes a series of phases from warning, impact, rescue, recovery and the quiescent phase. While this describes the life cycle of a disaster it should not be interpreted as when activities occur. For example, recovery should begin as early as possible in the response phase and is not simply a transition. A Venn diagram style model developed by Bradt et al (2003), describes the interface between public health, clinical medicine and emergency management as the core focus of disaster medicine. This has since been expanded by WADEM in a model that illustrates the complexity and multi-disciplinary nature of disaster medicine (Archer & Synaeve, 2007).

4.2 Comprehensive approach

The Comprehensive Approach consists of Prevention / Mitigation; Preparation, Response and Recovery (AEMI, 2011). It is important to recognise that these are NOT sequential phases, but simply different areas of emphasis. Recovery, for example, should start early in the response phase rather than after this has finished. Recovery for maximum effect should also address mitigation issues.

4.2.1 Prevention and mitigation

Prevention refers to activities undertaken to stop a disaster happening. This is obviously impossible for many disasters - despite scientific advances we cannot stop an earthquake or a cyclone from occurring. While it may conceivably be easier to stop manmade disasters, there are often hidden costs associated with this that stop it happening. For example we could stop aircraft disasters by banning air flight but the effect on the global economy and world culture would be prohibitive. Mitigation is the usual alternative and refers to activities undertaken to lessen the effects of a disaster. Examples include building codes and town planning with inclusion of flood zones. A definition is the "regulatory and physical measures to ensure that emergencies are prevented, or their effects mitigated" (AEMI, 2011).

4.2.2 Preparedness

Preparedness refers to those activities undertaken beforehand to lessen the impact of the disaster. This consists primarily of planning but examples also include the education, training and exercising of staff and the development of warning systems fro communities. A definition is the "arrangements to ensure that, should a disaster occur, all those resources and services which may be needed to cope with the effects can be rapidly mobilised and deployed" (AEMI, 2011).

4.2.3 Response

Response refers to the actions taken directly following a disaster. Examples include deployment of teams and emergency services, rescue services and acute health care. A definition is the "actions taken in anticipation of, during and immediately after impact to ensure that its effects are minimised and that people are given immediate relief and support" (AEMI, 2011).

4.2.4 Recovery

Recovery refers to the process of restoring the affected community to normal. This includes psychosocial issues, the economy and reconstruction. A definition is "the coordinated process of supporting disaster affected communities in reconstructing their physical infrastructure and restoration of emotional, social, economic and physical well being" (AEMI, 2011).

4.3 All agencies

The All Agencies approach emphasises the multiple agencies that come together in disaster management. Nobody responds alone and preparations should ensure the ability to work together and 'play happily together in the sandpit'. For this to occur, organisations need to come together in advance as part of preparedness. It is not just a common language and interoperability of systems that is important. A common finding in post incident reviews is that the pre-incident development of networks, relationships and trust between individuals is an important determinant of successful outcomes.

4.4 All hazards

The All Hazards principle promotes the concept of planning for a consistent response across disaster types. There can be issues in having a separate plan for every type of disaster, as this can lead to a shelf of plans, which are unlikely to be used. Many elements of a plan are common to each disaster type. These might include for example the activation arrangements, recall of staff, triage, surge arrangements and documentation (AEMI, 2011).

4.5 Prepared community

The prepared community recognises that the initial response will be from those in the affected community. External assistance will take time to arrive and in the meantime local people will have rescued people from the rubble, commenced first aid and initiated treatment as best able. People by nature will turn to local agencies and organisations for assistance. They will present to local facilities, whether they be health or government. Increasing the ability of the local community to respond increases the ability of the community to manage the disaster. This can be defined as "a prepared community is one which has developed effective emergency and disaster management arrangements at the local level, resulting in:

- Alert, informed and active community, which supports its voluntary organisations.
- Active and involved local government.
- Agreed and coordinated arrangement for PPRR" (AEMI, 2011).

4.6 Risk management

The principles of risk management can be described as identification of the risk, analysis of the risk and management of the risk. Risk can be defined as 'the systematic application of management policies, procedures and practices to the tasks of identifying, analysing, evaluating, treating and monitoring risk' (AEMI, 2011)

A key issue in the identification and prioritisation of risks is consideration of the likelihood of an event and the likely impact if it occurs. This can be done as formal risk assessment scoring systems, classic 2 x 2 risk tables (likelihood and impact), knowledge of local disaster history and answering the question "what if?". An example of a 2 x 2 table is shown in Figure 3 with Cell B (high impact and high likelihood) the obvious focus of initial planning. Increasingly organisations are required to perform a formal risk analysis. This should still be supplemented by local knowledge and review of what might happen as a result. Once recognised, risks should be modified - this can either be by prevention or mitigation strategies. Strategies should also be reviewed.

A High Impact Low Likelihood	B High Impact High Likelihood
C Low Impact Low Likelihood	D Low Impact High Likelihood

Fig. 3. Risk Management using Risk Tables.

4.7 Resilience

There has been a major focus in recent years on recognising the importance of resilience (Castleden, 2011). There are many definitions of resilience in use, but simply put it is "the ability of a community to 'bounce back' following a disaster". Factors contributing to community resilience include past experiences, preparedness, and degrees of dependence or independence. Many rural or regional communities are thought to be more resilient than their urban counterparts, although this varies between communities, disaster type and even disaster frequency.

5. Common problems

The analysis of different disasters illustrates a number of common issues. It is important to note that in many reports these are described as 'lessons learned'. This is not true – they have usually only been observed. Lessons have only been learned once strategies have been devised and implemented to successfully address these issues.

A selection of these problems is described below, with examples of research work trying to address these included as potential solutions.

5.1 Communication

Communication is THE most common problem identified in most disaster reviews (Arnold, 2004; Braham, 2001; Chan, 2004; Gerace, 1979; McEntire, 1998). This may occur as a result of problems with the medium, the message and the messenger, all of which may vary depending on the intended target audience. It is also essential to remember that communication is not simply disseminating information but is a two way street and as much care needs to be taken ensuring the ability to receive messages and information as disseminating them. While it may be impossible to avoid all communication problems, these can be minimised with advance preparation and ensuring redundancy of methods.

There may be a failure of the communication medium and having a pre-identified fall back solution is a mandatory part of preparedness. Hospital switchboards may be overwhelmed, phone systems (including mobile or cell networks) may collapse, and email may fail. Reach of the message is also important. Not everyone is able to receive the message using the same medium. This applies just as much to hospitals as communities. The elderly may be less likely to access email than younger groups, some pockets of the population may be geographically isolated, have poor phone or television reception, speak a different language, or not have a fixed abode. Similarly, clinical or operational staff are unlikely to access email regularly, while administrative staff will be able to. Staff work different shifts or in different buildings, on or off campus.

Reliance on one communication method alone is a recipe for disaster, as this may fail, be overloaded or not have sufficient reach. Planning should consider the use of alternatives such as use of runners, Public Address (PA) systems, SMS messaging, and social networks including personal communication and tools such as Facebook and Twitter. When using multiple modes of communication, it is essential that the message is consistent, to avoid confusion. A standard structure, with use of a pre-developed template, helps achieve this. Radios are a commonly used alternative but staff must be trained in proper radio use and a system put in place to ensure radios are charged and accessible when needed.

Community information should remember potentially isolated groups and distribute information in multiple languages (selection of which to be guided by knowledge of local community) as well as use of sign language for television broadcasts. The message structure should be clear and concise while at the same time not causing undue alarm or panic.

Communication planning should also recognise that there is a need to also receive information. Clear contact points and lines of communication should be established with logging of calls and communication. While it is important to be able to be aware of large scale or strategic developments through monitoring of news channels and regular updates from higher-level committees, it is also important to be able to receive information from 'the coalface'. A member of the Incident Management Team walking through operational areas may provide this opportunity in an informal way. Use of electronic media also provides an opportunity if developed properly. An open email account for staff feedback can assist this process. A more formal solution is the use of tools such as 'survey monkey', which allow analysis of feedback patterns, potential prioritisation of issues and recognition of gaps in message coverage. This approach also allows real time improvement, during the life cycle of the disaster, rather than waiting for feedback in the operational debrief and initiating changes in practice for 'next time' (Seidl et al., 2010). It is also possible to learn from other industries by analysis of their management of communication (Seidl et al., 2011).

5.2 Command, control, coordination

Command, control and coordination arrangements became a point of emphasis after the California wildfires in the 1970's. This recognised that there are limited spans of control and a need for clear lines of command within organisations and communication across organisations. Failure to do this may lead to difficulties with an integrated response and either task omission or task duplication. Figure 4 illustrates some of the key elements of Command, Control and Co-ordination.

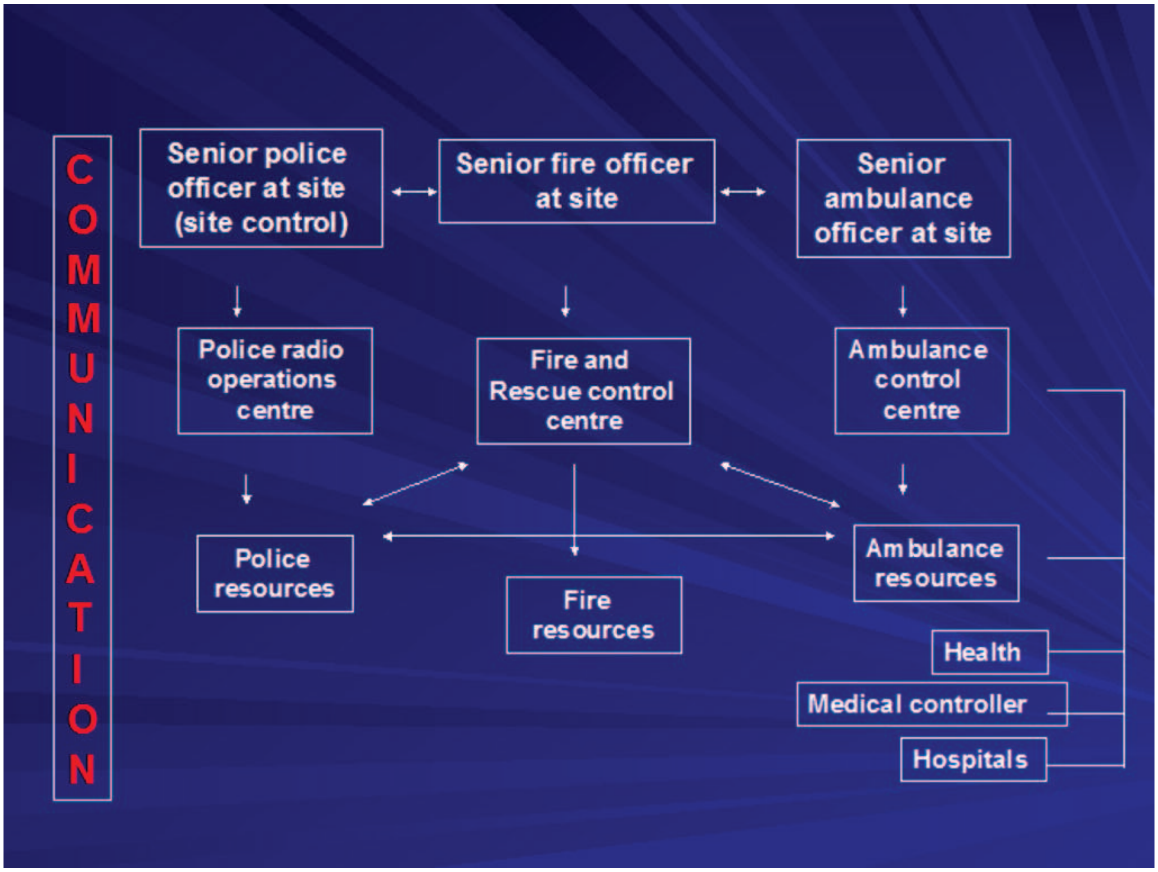

Fig. 4. Command, Control and Coordination.

Command is the direction of members of an organisation in the performance of roles and tasks.

- It operates vertically within an organisation.

Control is the overall direction of emergency management activities in an emergency situation.

- It operates horizontally across organisations.

Coordination bringing together of organisations and elements to ensure an effective response, mainly concerned with systematic acquisition and application of resources in accordance with threat or impact.

- It operates both vertically and horizontally as functions of authority to command and control.

Incident Command Systems or Incident Management Systems have many guises but are all essentially similar (see Figure 5). They have a person in charge and then people supporting them by adopting functions such as "planning" (what might happen?); "operations" (what do we need to do?); "logistics" (how do we make this happen?); "admin / finance" (keeping track of costs) and "media". It is important staff are trained to work in these roles, or they will tend to fall back into their usual role and that there is redundancy for roles in case of either illness or a prolonged response and the need for shifts.

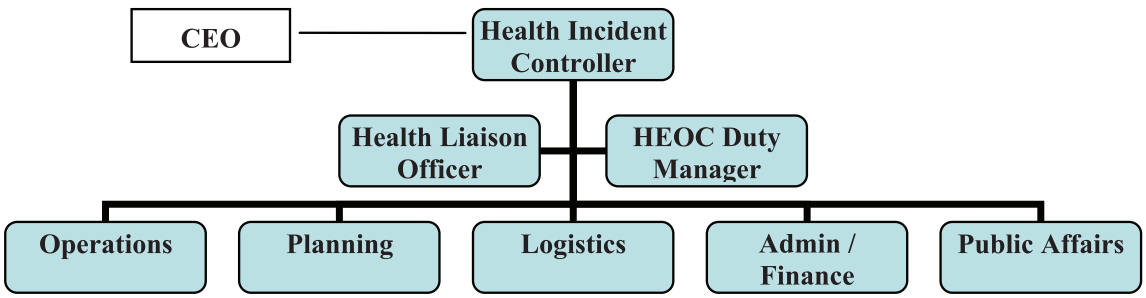

Fig. 5. Typical ICS Structure.

5.3 Activation procedures

Activation procedures need to be clearly defined and able to occur 24 hours a day, seven days a week. Common causes of delays are the failure of staff receiving the information to recognise the need for activation, inability to locate a senior staff member with the authority to activate the plan and difficulties with dissemination of the activation message. Solutions to this include:

- A pre-determined point of contact for notification of disasters, which applies equally to Health Districts, Health Facilities and Clinical Departments.
- Delegation of authority to activate to individuals on site after hours,
- A dedicated phone for calls from other organisations such as ambulance services and / or airport flight control.
- Clear procedures for staff to follow, including notification of senior staff, if they receive a call,
- Visibility of action cards close to phones.
- Cascading activation procedures to expedite spread of the message
- Use of group message systems such as SMS or pagers
- Avoidance of switchboards to avoid congestion and failure of message dissemination

5.4 Surge management

Health systems need to be able to expand their capability as part of disaster response. This can be thought of in terms of "space", "staff", "stuff" and the "system" (Kaji et al., 2006). Table 6 summarises a number of suggested approaches to surge management across this spectrum. Each facility is different however and strategies need to be developed that recognise local issues including barriers and potential solutions. Staff action cards should include some of these tasks as key prompts. Expert working groups have also developed 'surge cards' that summarise key emergency department actions to facilitate surge management both before and during an incident (Bradt et al., 2009).

	Space	**Staff**	**Stuff**	**System / Flow**
ED	Decant patients Divert patients Expand ED Absorb into existing ED space	Reception area "Buddy" non ED staff with regular ED staff Call in lists Group page	Preparation of essential equipment Preparation of functional kits (e.g. crush or burns)	Triage Control entry Cohort areas One way flow
OT	Cancellation Extra theatres	Staggered recall	Preparation of essential equipment	Case selection for early OT Prioritise life saving surgery Delay minor orthopaedic work until after this Damage control surgery
ICU	Discharge as possible Expand bed space	Staggered recall Staff expansion programs	Additional ventilators, monitors, fluid pumps	Case selection re futility and early care
Wards	Discharge Absorb extra patients as 'over-census' Cohort patient group	Staggered recall Prior identification of double skilled staff (e.g. ICU, OT)	Preparation of discharge medications	Cohort area Ward staff coming to get patients from ED or OT
Across Organisation	Alternative care areas for acute patients (expansion) Use of community facilities, outreach or fever clinics Liaison with private facilities Liaison across state borders	Support services Use of students Volunteer system Runners plan Fatigue policy Indemnity	Early identification of resource gaps Resupply routes protected Pre-event stock piles for seasonal risks	Incident Management Team and Emergency Operations Centre established with rapid activation protocols and redundancy

Table 6. Surge Management Strategies.

5.5 Vulnerable groups

While we traditionally think of women, children, the elderly and the disabled the concept of vulnerability is much broader than this. All of us can be vulnerable to disasters. Travel in a different city, particularly overseas, loss of prescription lenses or medications and even minor injuries such as a sprained ankle can increase our personal vulnerability regardless of other factors. Emergency Departments should consider vulnerability from three perspectives.

5.5.1 General community

Women, children, the elderly and the disabled are vulnerable. This list should also include tourists, migrants, the homeless and those in communities easily isolated or in at risk zones. Buildings may be vulnerable also because of their location and / or their occupants. Buildings with at risk occupants include nursing homes, schools, prisons, mental health institutions and hospitals themselves. These facilities should be encouraged to link with local government to ensure adequate arrangements are in place to support occupants during a disaster or be able to evacuate. Evacuation to a hospital is generally only recommended as a last resort to preserve surge capacity and capability to care for the rest of the community.

5.5.2 Vulnerable groups likely to impact on directly on the ED

These are people who are more likely to present to ED for care as a result of a disaster. Common groups include:

5.5.2.1 Those who are dependent on power supplies

Those dependent on power supplies may have the following facilities interrupted:

- Home oxygen (especially use of power dependant oxygen generators)
- Home ventilators
- Other power dependant medical services e.g. suction; electric wheelchairs
- Refrigeration dependant medicines such as insulin

5.5.2.2 Those dependant on home support

Many elderly or disabled in particular are dependant on community organisations to supply meals, assist with showers and bathing dress chronic wounds or deliver medications. The interruption of these due to staff injury or illness, disrupted transport infrastructure (e.g. damage to roads or cars, petrol availability) or destroyed pharmacies may see these patients brought to the ED for care. Alternatively these people may have previously coped with support from family but lose this support when the family home or business is damaged.

5.5.2.3 Those with chronic disease

Many chronic diseases may be exacerbated by the stress of involvement in a disaster. This may include increased presentation rates of patients with ischaemic heart disease or unstable diabetes for example. The other ‘chronic disease’ worth noting is drug use. In the early stages of large disasters there may be increased presentation of patients with acute drug withdrawal as supply lines are interrupted. The logistic supply chains of drug supply are remarkably effective and ingenious however and this phase is usually short lived. It may in fact be replaced by presentations with overdose due to either overly enthusiastic use patterns or the introduction of stronger substances from different suppliers filling the market gap.

5.5.3 Vulnerable staff

Staff vulnerability has the ability to impact on staffing levels and service capability. Staff may not be able to present for work because of disruption to transport (e.g. public transport not working, roads closed), school closure and need to care for children or the effects of the disaster on their own family (illness, injury, damage to dwelling). Staff, also need to be considered during pandemics or work in altered conditions. This may include the ability, or inability, of pregnant staff or those with chronic disease, to work in flu clinics. Arrangements that can be made in advance include the ability to offer a shuttle service for staff transport, accredited child-care arrangements on campus, pre-planning for redundancy of the workforce so that 'essential' positions can be covered.

5.6 Recovery

Emergency Physicians also need to remember the 'long tail' of recovery. The response phase is relatively short lived in comparison to the recovery phase. Recovery can be thought of in terms of reconstruction, emotional or psychosocial, economic and the community. Planning for recovery should start with the early phases of the response. This is important for a number of reasons. Firstly any fund raising is much easier to achieve in the early stages of a disaster with heightened media attention. Part of monies raised or donated should be kept aside for the recovery process. Secondly it is also important for the affected community to see their future recovery needs being planned for and addressed. Recovery planning should ensure that the affected community has a voice and that there is consistent, and on going, communication with community members. Often insurance is one of the major issues. In developing countries, recovery is even harder. The opportunity cost of the disaster means that development may be set back many years.

5.7 Post incident review and debrief

A post incident review and debrief should be conducted after any disaster. This should consist of both a hot and cold debrief as well as a formal report and longer term follow up arrangements of staff.

The 'hot debrief' is important to conduct soon after the disaster. It should focus on operational issues and is best conducted within work units. It is not a time to criticise performance as emotions can run high. The 'cold debrief' occurs later and should allow time for functional, or work, areas to review their own performance before a whole of organisation meeting between department representatives. The focus, again, should be on system improvement rather than blame. A formal report needs to be developed from this to help guide system improvements and satisfy reporting and governance arrangements. The formal report should also provide an objective evaluation of performance against standards and indicators. This is important if we are to improve the delivery of care.

Staff need to be cared for, as well as the community. Forced psychological debriefing, is now thought to be associated with worse outcomes. Instead staff should be made aware of follow up arrangements and provided with contact numbers if needed.

5.8 Planning

Planning is the most important element of preparedness. In many ways it is the planning process that is as important as the plan itself. The planning process should bring a representative group of people and organisations together to develop the plan. This allows relationships to be developed that will support the ability to operationalise the plan later and ensure planning arrangements are valid across agencies. All of this helps prevent the concept of a plan sitting on a shelf because it is not meaningful to the users - the 'paper plan' concept. Other key concepts in planning are to base planning on normal arrangements and build on these rather than starting afresh and plan for both what is likely to happen and what people are likely to do. The diagram below (See Figure 6) describes the sequence of activities for disaster planning based on the Emergency Management Australia guidelines (AEMI, 2011). It is also important to recognise that following review of the plan that the planning objectives are revisited as part of a continuous improvement process.

THE PLANNING PROCESS

Determine Authority to Plan

↓

Establish Planning Committee

↓

Conduct Risk Assessment

↓

Set Planning Objectives

↓

Apply Management Structure

↓

Determine Responsibilities

↓

Analyse Resources

↓

Develop Emergency Management

↓

Arrangements and Systems

↓

Document the System

↓

Test the Plan

↓

Activate the Plan

↓

Review the Plan

Fig. 6. Approach to Planning (based on EMA approach).

5.9 Education, training and exercises

There is widespread agreement on the need for improved education and training in disaster medicine. (Birch, 2005; Birnbaum, 2005; Gaudette, 2002; Marmor, 2005; PAHO, 1999; Russbach, 1990; Sharp, 2001; VanRooyen, 2005.) As Birnbaum has noted, we need to move from the era of the well-intentioned amateur, to that of the well-trained professional (Birnbaum, 2005).

Current training for health staff, with its need to focus on hospital and community care, does not adequately prepare personnel for work in a disaster. Disaster medicine is not just more patients but more patients in a system with damaged infrastructure. In the words of Quarantelli (1988) – 'there are both quantitative and qualitative differences' to normal care.

There are often significant intervals between training and exposure and there may be difficulties in application due to different conditions (Ford, 2000). Also many of those who are involved in disaster response do not experience this again. This means they do not have a chance to pass on the lessons of experience and each responding group consists of novice disaster practitioners (Birnbaum, 2005). The growing need for disaster relief, and time sensitive demands, has led to inexperienced or inadequately trained personnel in the field who may be of limited and decreasing usefulness (Campbell, 2005; Moresky et al., 2001). Key areas are decision making (Frisch, 2005), with trained staff able to make better decisions (Moresky, 2001; VanRooyen, 2001). Teamwork skills also need to be specifically addressed (Ford 2000*)* to improve team efficiency during a crisis (DeVita, 2004).

A number of developments have occurred to improve disaster health education.

- An education framework has been developed by WADEM, which consists of seven levels (Archer & Synaeve, 2007). This has also been adapted so that it is consistent with national qualification frameworks (FitzGerald et al., 2010).
- A model curriculum has been developed by the International Society for Disaster Medicine (ISDM 1993).
- Curricula and frameworks have been inked for national context.
- Competencies have been developed, particularly in public health.
- A number of education programs have been developed, ranging from short courses to post graduate university programs.
- While standard educational approaches are used mainly a number of novel instructional methodologies have been developed and include on line formats, aide memoires and use of case studies to provide vicarious experience with use of video as a substitute for the real environment. If possible immersive learning with use of simulation is ideal but costly and more difficult to organise than for traditional one on one patient care.

Exercises are essential to test the plan, or elements of it, as well as provide the opportunity to both practice and test individual skills. While many different exercise classifications exist, a simple approach is to consider the following:

- Discussion Exercises – These are theoretical 'talk throughs' of the response to a particular scenario and useful as a preliminary activity.
- Tabletop Exercises (with or without props): These have additional information and inputs but are still usually a hypothetical activity.

- Functional Exercises: These test specific elements of a plan such as the activation or call-in procedures.
- Full Field Exercises: These involve mock patients but use real resources including staff, vehicles and other equipment including communications channels.

The first step in development of an exercise is identification of the objectives. This allows selection of the appropriate exercise type (budget issues and time line of need with standing). The design and development of full field exercises in particular needs significant resources

5.10 Research, evidence and standards

There has been a remarkable growth in published disaster medicine literature over the past few decades. Research in disaster health is still an emerging area however, with disaster literature traditionally anecdotal in nature and dominated by case reports. Research during disasters is difficult. It is hard to conduct formal trials and there are ethical concerns with use of personnel to collect data rather than assist with the response. Solutions include use of standard definitions (Sundnes & Birnbaum, 2002), standardised reporting of case studies to allow contextual comparison (Bradt & Aitken, 2010), and improved reporting to allow collation of data, recognition of the value of qualitative and mixed methods research and use of novel methods.

The development of standards allows objective assessment of performance while also guiding evidence based response that assists effective use of resources. The SPHERE guidelines have been one of the first systematic efforts to improve accountability. They provide key indicators across 5 sectors: water supply and sanitation, nutrition, food aid, shelter and site management and health services (Sondorp et al., 2001). They provide clearly defined guidelines and minimum standards (Brennan et al., 2001) and are used by both NGOs and military and may be a common link between them (Dufour et al., 2004).

5.11 Media management

Media will be present in a disaster. There is no point in ignoring them and instead efforts should be made to ensure the media are pro-actively managed. To do this there is a need to understand what the media want, what health needs from the media and how to achieve this. The media will initially focus on the scope of the disaster. Questions will want to determine the numbers killed, numbers injured, types of injuries and special groups involved such as children. The next phase will want human-interest stories with a focus on heroes or tales of sacrifice or despair. International media will be interested in whether any of those affected were from their home country. The next phase will focus on blame and who was or is responsible. The timeline of media interest has also been compressed with the development of 24 hour news channels and the transition may occur much more rapidly.

The media can also assist health facilities by passing on health warnings to the community or advice about what health services are available and how to access them. Staff can also be advised about the need to return to work. To achieve this compromise means managing the media. Ideally this should be done in conjunction with a professional public relations or media advisor. Even if not available a number of basic rules can be used as a guideline. These include:

- Have a designated venue for media statements
- Have a designated media spokesperson so there is a familiar 'talking head'
- Have a scheduled time for media conferences, and keep to it.
- Develop a small number of key messages that you want to convey
- Anticipate problem questions and how to respond to these
- Provide media training for those likely to be used as media spokespeople

Other issues to consider are the use of media images. Having multiple film crews or photographers may be disruptive to operational staff and potentially compromise the privacy of those affected. Most media will be happy to cooperate if it means access to vision. Allowing one cameraman access and asking media to 'pool' images is one option to consider. It is also inevitable that with large disasters there may also be political pressures to manage the media at a high level. While this is helpful in promotion of a consistent message it may lead to delays in ability to use the media to pass information to affected local communities.

6. Mass casualty management

Emergency physicians have an important role in mass casualty management. This extends from the pre-hospital response at the site, to care during transport and once in the Emergency Department. All of this requires planning and it is important that pre-hospital care and hospital based care form part of a continuum so that both the therapeutic vacuum is minimised and the disaster is simply not moved from one site to another.

6.1 Site management

While this does differ in some countries, in most environments the police service has overall responsibility for the disaster site. They will normally establish an outer cordon and restrict access to the area. Health responders need to not only have appropriate personal protective equipment, but should have identification and be clearly identified as health staff. Fire may have responsibility for any central hazardous zone. An example of site structure based is shown in Figure 7.

It is important that structure is established early in the response. While the cordon assists this process, care should be taken in identifying access and egress routes for emergency vehicles, location of a casualty clearing post (if needed) and areas to both hold ambulances and areas to load them. One of the issues can be that failure to establish this early leads to a congested site with difficulties in loading ambulances and transporting patients. Another essential early task is the establishment of a command post so that all agencies responding to the scene can report in, and provide updates and input across their respective areas of expertise.

For health teams deployed to a site a number of helpful mnemonics exist. The MIMMS course (Major Incident Medical Management System) uses the CSCATT mnemonic for tasks at a scene and the (M)ETHANE for the initial report from the site (Advanced Life Support Group, 2005). These are described in Figure 8 and 9.

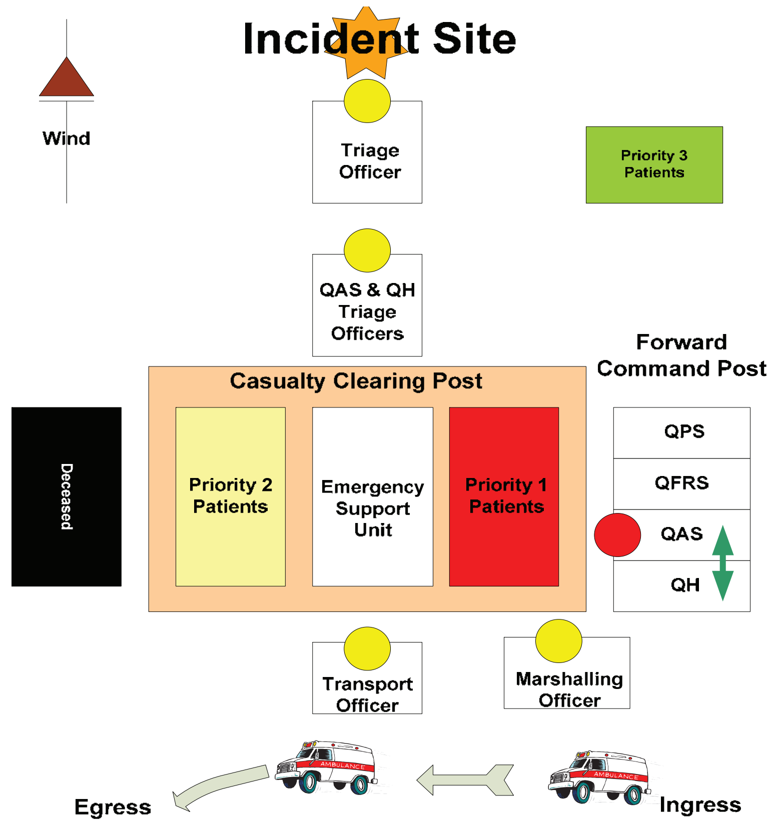

Fig. 7. Site Structure. Legend: QAS = Ambulance; QFRS = Fire and Rescue; QH = Health; QPS = Police (Source: Queensland Health, 2011).

C	Command
S	Safety
C	Communication
A	Assessment
T	Triage
T	Treatment
T	Transport

Fig. 8. CSCATT mnemonic for scene tasks (from MIMMS).

M	Mass casualty incident or not?
E	Exact location
T	Type of incident
H	Hazards present at site
A	Access to site
N	Numbers of casualties (and specific types of injury)
E	Emergency services present and required

Fig. 9. METHANE mnemonic for reports for scenes (from MIMMS).

6.2 Triage

Triage in disasters is based on a priority-based system and colour coded. Most systems use red as the most urgent category, followed by yellow with green as minor injuries or 'walking wounded' and black as dead (see Figure 10). The expectant category, those not expected to survive, is controversial, with some systems using blue tags for this, while others include this in the red group or do not recognise at all. Triage accuracy is also important. Under triage may mean patients with high acuity injuries do not receive timely care while over triage may consume resources which may also delay access of some patients to care. The two main systems in use are "Sieve and Sort" and "Start and Save". Both of these use simple algorithms in the initial component (Sieve or Start) as a screening mechanism, with more complex anatomical and injury score based approaches on subsequent arrival at the Casualty Clearing Post (Sort or Save).

Priority	Treatment	Colour	Comment
Immediate	1	Red	Need immediate care and transport
Urgent	2	Yellow	Need urgent care and transport – usually 6 hours
Delayed	3	Green	Initial separation by ability to walk in sieve / start
Deceased		Black	

Fig. 10. Summary of Triage Systems.

There is no perfect triage tag and many varieties exist. These include single coloured cards, folding cards, cruciform tags, flags and wristbands. Some problems with use of tags include visibility, the ability to record information, waterproofing of cards and ability to change triage category (either inability to change or ability to change by patient).

6.3 Care on site and casualty clearing post

The principles of care on site are aimed at 'doing the most for the most'. This includes simple measures to assist immediate preservation of life, life saving interventions and those that ensure the ability to safely transport to hospital. This is a simplistic view however and needs to be reconciled with degree of resources on scene that are able to provide care (may be surplus or overwhelmed), the availability of transport platforms able to move patients (and provide care en route) and the distances to hospital. Figure 11 summarises the key elements of care on site.

Safety of treatment site and Personal Protective Equipment (PPE)
Simple and restricted clinical procedures
Maintenance of cardiorespiratory functions
Haemorrhage control – prevention of shock
Specific antidotes as indicated or available
Splinting fractures
Dressing wounds/burns
Adequate analgesia

Fig. 11. Elements of care on site.

6.4 Transport

The best transport platform to use is one that is normally used to carry patients. This means staff are familiar with the transport environment and vehicles are configured appropriately with stretchers, equipment, drugs and communications. Care also needs to be provided en route and this provision of care is equally as important as the transport platform.

There may be a need to improvise when there are large numbers of patients and ideally this will have been considered prior to any event. Large numbers of 'walking wounded' may need to be transported by bus or train, with health care worker escort rather than relying on use of ambulances. This not only moves these people away from the scene so they can access health care as required but preserves specialised ambulance resources for those most severely injured.

6.5 Disposition

The disposition of patients from the scene should consider a number of principles. These are principles only though and it may not be possible to keep to them.

- The most severely injured should be transferred first (Triage Category Red)
- Where possible normal policies, such as trauma bypass, should be maintained with major trauma sent to those facilities capable of managing this and smaller facilities receiving those with lesser injuries.
- Those with special injuries should be transferred to specialist units initially (if possible) to avoid secondary transfer and increase passage of these patients in cohorts (e.g. burns, spinal or paediatrics)
- Patients should be distributed between centres so that the disaster is not simply moved from the site to the hospital. This 'carousel' style model should also recognise facility expertise and patient requirements as well as patient volumes.
- Ideally families should be kept together if possible (and if known or recognised)

This needs close liaison between the site and a central control point. This allows: information on bed availability to be conveyed to the site commander (and stops them from either having to make multiple phone calls to ascertain this information or simply sending patients without knowledge of bed availability). It also allows the central control point to have increased knowledge of incoming patients, which assist distribution of information flow, as well as on going planning.

6.6 Care in the emergency department and the hospital

The ED has a key role as the 'front door' to the hospital. Many of the issues described previously, such as communication, surge capacity, planning, education and training apply equally to ED. A number of key messages and myths are presented below. Key activities include the following examples:

- Having a plan!!
- Having defined activation procedures
- Having maintained, and current, staff recall lists
- Having an over flow area for surge capacity (ideally for less injured)

- Having tabards so that key staff roles in ED can be identified
- Having surgical and ICU liaison in ED which helps to prioritise OT cases and also establish futility early in a consensus manner
- Having an ultrasonographer in ED
- Limiting radiological investigations in the initial stages
- Recognising the 'dual wave' phenomenon where minor injuries arrive first, and may fill operating theatres, before pre-hospital personnel evacuate the more seriously injured.

Whole of hospital activities include:

- Having a plan that is linked to site and ED response as well as jurisdiction and national arrangements
- Having defined activation procedures that operate 24 hours a day, 7 days a week
- Being able to empty the ED rapidly to supply immediate surge capacity
- Being able to discharge patients from wards and ICU to create bed capacity
- Being able to create OT capacity
- Ensuring consistent information flow across the facility
- Planning for communications failure so that redundancy measures, such as radio, runners and PA system announcements, are in place
- Establishing a specific centre for family re-union
- Establishing a media centre and providing regular media updates
- Capturing all information flows including tracking and data management systems
- Capturing all costs for possible reimbursement if jurisdiction or national disaster declarations

Myths to be aware of include the following examples:

- The ED will always receive prior notice of incoming patients from a disaster. Patients will self evacuate and will present to hospital either on foot or using any means of transport available. Plan to have no notice.
- Patients will only present to designated hospitals. Patients who self evacuate from a site will present to the closest health facility. This may be a hospital designated for obstetric or cancer services, however regardless of this some patients will present.
- The ED will always receive regular, and accurate, updates from the scene. Communications channels may be interrupted or accurate information may not be available. Plan to
- All patients arriving at ED will have been already triaged. Patients may self present and plan for this to occur with triage tags available on arrival.
- All patients arriving at ED will have been decontaminated following CBR disasters. Again, patients will self-present and may bypass decontamination services. Plan to have to deal with non-decontaminated patients.

6.7 Volunteers

Volunteers may be a useful resource or a minefield of regret if not managed properly. Consideration should be given in advance to how best to manage these arrangements. This can include pre-event credentialing of local medical and nursing practitioners as well as standing arrangements to grant emergency credentialing powers to individuals under and approved process. The reasons for ensuring this occurs includes:

- Avoiding volunteers who may really be media or simply those with a morbid curiosity
- Ability to 'buddy' volunteers with regular staff to (a) maximise their efficiency by providing a system chaperone (b) ensure their safety by being able to log their presence
- Avoid issues with liability for the department, hospital and organisation
- Indemnity of volunteers

It is also important to provide volunteers with identification so they can move around the allocated area without being challenged or not used appropriately. Ideally this should consist of both an ID card and a tabard to aid recognition.

6.8 Predictors of numbers

Having an idea of numbers is important. While communication from the site may provide this information, it does not always hold. The Centers for Disease Control and Prevention (CDC) has developed a 'calculator' based on analysis of a number of disasters (CDC, 2005). For sudden onset urban disasters (this distinction is important) an ED can expect in total, twice the number of patients that present in the hour following the arrival of the first patient. Two axioms should also be remembered - in widespread natural disasters (e.g. tsunamis) the initial estimates are likely to be under while in localised man-made disasters (e.g. transport / industrial) the initial estimates are usually over the actual figure.

6.9 Chemical, Biological or Radiological (CBR) incidents and decontamination

A special consideration is the potential for patients to be involved in chemical, biological or radiological

Incidents (CBR). This may occur as a discrete incident in its own right (e.g. chemical spill, nuclear reactor incident) where the causative agent is easily identified or as part of a more complex scenario involving a 'dirty bomb'. In this scenario biological or radiological material is mixed in with a standard explosive device.

A CBR scenario poses a series of new, and different, concerns. These include:

- The ability to ensure decontamination prior to entry to ED
- Who provides decontamination – is this hospital staff or fire services?
- What happens to any residual run off? Is simple dilution sufficient for all substances?
- The provision of PPE to ED staff – and ensuring they are trained in use of equipment
- The ability to offer antidotes to staff and patients if exposure has occurred

The level of preparedness of most ED, for a CBR event has been questioned (Caldicott et al., 2008).

7. International humanitarian response

Emergency physicians may play a role in international response. Key considerations include:

7.1 International diplomacy and politics

The affected country must, first invite international teams that deploy overseas. Failure to wait for this, despite good intentions, may result in diplomatic incidents and can even considered being invasion. The process for securing diplomatic approval may take days, and while clinical staff may feel frustrated by this delay, failure to do this prior to arrival, may result in teams being refused entry, spend hours or days at airports or ports or even returned home. Similarly, their equipment may not be allowed entry with significant effects on the team's effectiveness.

It is also likely there will be increased calls for disaster medical assistance from developing countries. (McEntire, 1998; Lennquist 2004; Burkle 2001). This is underpinned by the precept that health and security are a basic human right (Judd, 1992; WHO, 2005). There have also been changes in how disasters are viewed by the world community with disaster relief being seen not as a magnanimous gesture but as a humanitarian obligation and claimed as a right by affected countries (Gunn, 2005).

While cost effective mitigation is seen as the key to natural disasters (Iwan, 1999), most governments provide little assistance for mitigation in comparison to response. While disaster aid should be seen as part of long-term development (Gunn, 2005), "silent", long term investments in mitigation are rarely viewed with favour by politicians (Stephenson et al., 2005).

7.2 Epidemiology of aid

The timeline of injury must be understood when planning to deploy teams and the selection of the team should reflect the injuries or illnesses likely to be present. Different disasters produce different injury patterns, which helps estimate needs and timelines (Milsten, 2000; Noji, 2000; Van Rooyen, 2001). There is also at tri-modal distribution of medical issues post sudden onset disasters (Maegele et al., 2005, Taylor et al., 1998). Phase 1 occurs in seconds to minutes and has a high mortality, phase 2 occurs in minutes to hours and consists of medical care with a focus on trauma management, and phase 3 occurs days to weeks afterwards and consist of complications such as sepsis, multi-organ failure and mental health issues; the care of displaced persons and a lack resources and trauma from the clean up and recovery.

Three phases of care have been described for deployment of foreign field hospitals, in a guideline document developed by WHO and PAHO (2003). These are outlined in Table 7 and are based on an appreciation of the following key issues:

- The timeline of survival
- Types of injury can be predicted for different types of disasters
- Chronic disease is often exacerbated by the disaster due to stress, loss of access to usual care (e.g. dialysis or home oxygen) or loss of usual medications
- Women and children still have babies
- Disruption of water and sewage may have significant impact on infectious disease, as may power loss and refrigeration failure
- Vector control may be problematic with disasters caused by flooding or rainfall

Unfortunately international medical assistance teams are rarely on site soon enough to deal with the acutely injured (Judd, 1992; Hsu, 2002; Asari, 2000; Noji, 2000; Redmond, 2005;

Wallace, 2002). Following the Gujarat earthquake, outside help arrived only after local health services had provided emergency assistance and immediate care with specialised field hospitals arriving too late to reduce mortality and morbidity (Bremer, 2003, Roy, 2002). Similarly following the Chi Chi earthquake of the 104 teams that responded, 80% needed more than 24 hours to be able to provide care (Hsu, 2002).

7.3 Type of aid

International assistance is often best supplied by means other than through deployment of an international health team, in fact this should be a provider of last resort. Cash rather than goods, is often more appropriate (Campbell 2005; de Ville de Goyet 2000; Martone 2005; Redmond 2005b). Money is often the most useful resource as it allows:

- Increased local control of resource allocation and how the money is spent.
- Purchase of goods, and personnel locally, which helps stimulate the local disaster affected economy (Martone 2005, Redmond 2005b).
- Purchase of local goods, and use of local personnel, often at a significantly lower cost
- Use of local staff, familiar with local health care standards as well as language and culture

Phase	PHASE 1 EARLY EMERGENCY CARE	PHASE 2 FOLLOW UP TRAUMA AND MEDICAL CARE	PHASE 3 TEMPORARY HEALTH FACILITY
Primary Role	Provide early emergency medical care, including ATLS.	Temporarily fill the gaps in emergency medical assistance during the period when health services are progressively overwhelmed by the need for ongoing secondary care of trauma victims and routine medical care.	To substitute for damaged installations pending repair or reconstruction.
Timeline	Initial 48 hours following the onset of an event.	From day 3 to day 15, and should not exceed 15 days.	From second month to two or more years.
Essential Requirements	Be operational on site within 24 hours of event Be entirely self sufficient Offer similar or higher standards of medical care than were available in the affected country prior to the precipitating event.	Be fully operational within 3-5 days of event Minimal need for support from local communities Basic knowledge of health situation, language and respect for culture Availability of selected specialties. e.g. general surgery, anaesthetics, internal medicine, obstetrics / gynaecology, paediatrics with appropriate paramedic and support staff. Equipment should allow treatment of all patients regardless of age / gender. Sustainability Evaluation of the cost effectiveness and cost benefit associated with use of foreign field hospital	Lack of other cost effective alternatives Appropriate standards for patients and staff Designed for use by final reconstruction Installation and maintenance support provided at no cost to affected country

Table 7. WHO / PAHO Guidelines.

Donated goods may create a problem in their own right. Common problems include:

- Being unusable (Rubin et al 2000) due to expiry dates, (particularly for medications and food) and the language that instructions are written in (particularly for medications or technical equipment)
- The appropriateness of donated goods, such as revealing swim wear to cold climates or Muslim countries
- Consume personnel and space for storage, cataloguing and transport or destruction (Frisch 2005; Noji 2000; Rubin et al 2000).
- Undermining local practice rather than supporting it (Redmond 2005b).
- Technical support, and consumables, for medical equipment. Power sources and plug configuration should also be considered.
- Ability to actually enter the country through posts and customs

The 1988 Armenia Earthquake is an example of this. More than 5000 tons of drugs were donated, which occupied more than 30 warehouses and took 50 people 6 months to sort through. Of these only 30% were relevant and useful with 8% expired. There are also concerns about how donations are used and the risk of corruption with donations of money. This should not prevent donations. Donations should instead be based on assessed needs and the requests of the affected community

7.4 Based on needs

Any assistance offered should be based on the needs of the affected community. As Redmond notes "if aid is to do the most good for the most people it must be targeted" (Redmond, 2005b). Rapid needs assessments have thus become the norm for gathering information about the status of an affected population (Keim et al., 2001; Malilay, 2000; Redmond, 2005 Asari et al., 2000; Chen et al, 2003).

The United Nations use Disaster Assessment and Coordination teams (UNDAC), which are a 2-6 person team drawn from member countries that travels quickly to a disaster scene to report the immediate needs to the international community (Redmond, 2005). Needs assessment is a specialised area of expertise, and without use of personnel with appropriate experience and training multiple problems may occur. These include:

- May be inaccurate (Asari et al, 2000; Birnbaum, 2005; Braham et al., 2001; Malilay, 2000; Maury et al., 2004; McEntire, 1998; 1999; Rubin, 2000).
- May be incomplete (Asari et al., 2000; Mallilay, 2000; Maury et al., 2004).
- May be delayed (Asari et al., 2000; Braham, 2001; Malilay, 2000; Maury, 2004; McEntire, 1998; 1999).
- May be repeated multiple times by different agencies leading to assessment fatigue (Malilay, 2000; Nabarro, 2005; PAHO, 1999; Redmond, 2005).
- Need for a validated tool (Malilay, 2000)
- Need for standardisation of the content (Bradt, 2003; Malilay, 2000).
- Need for timeline to determine what information is needed from assessments at various times post disaster (Malilay, 2000).
- Level of experience of those performing the needs assessment (Redmond, 2005b).
- Assessment may not involve local population (Redmond, 2005b).

7.5 Integration with existing services

Deployed teams need to integrate with local services. It is the local services who will have provided the initial care and it is the local services who will continue to provide care after the deployed team has left. The local population should ideally be involved in all phases of relief operations as it enhances capacity building, empowers local communities and helps regain control over their lives (Brennan et al., 2001; Leus et al., 2001). Failure to do so can lead to mistrust, resentment, lack of cooperation (Brennan et al., 2001) and undermine the capacity of local people to solve their own problems (Judd, 1992). It may also lead to undermining of the local health system or problems with on going care for those treated by deployed teams.

Common problems are:

- Different standards used by deployed team to local health services
  - This may undermine local health services by raising expectations of care to a level that is unable to be continued locally due to resource or funding issues
  - This may leave patients with no adequate follow up post procedure, with risk of complications
- Free care and impact on economic recovery and livelihood of health workers

7.6 Self sufficiency

Deployed teams must be self sufficient (Nabarro, 2005; Redmond, 2005; Roschin, 2002*)* to ensure they do not pose an additional burden on affected communities. This applies not just to medical equipment but also to their ability to support themselves. All teams should have a basic self-sufficiency capability, which should include shelter, sleep gear, food and water at a minimum. Ideally teams should be self-sufficient for the duration of their stay but this will depend on the context of the disaster and the ability to provide re-supply. It may actually provide assistance to the affected community to contribute to the local economy by purchasing local products, including accommodation, if these are not in short supply.

7.7 Language and culture

Communication is a cornerstone of health care unfortunately language barriers are common with international deployment. This may occur between the team and the affected population or between responding teams. Solutions include bilingual staff, language training and interpreters. Use of bilingual staff is the optimal arrangement but difficult to achieve, while few deployments have time to arrange language lessons in time to be more effective than the basics of ‘please’ and ‘thank you’. Interpreters are the most common option for most NGOs (Moresky, 2001). The use of interpreters from the local community may also assist integration with local services, provide local knowledge and local cultural advice and, if paid, stimulate the local economy (Redmond, 1991; McCurdy, 1999). While the most efficient solution is use of interpreters, this needs to be approached with caution. Payment well above local rates may result in loss of staff from local essential functions, including health services. Care also needs to be taken with selection of interpreters that isolation of cultural groups does not inadvertently occur. This may result in other groups not wishing to seek care or perceived favouritism.

Culture is unfortunately often over looked as a potential issue (Moresky, 2001). Cultural factors must be addressed in order to appreciate the context of disasters for a population (Keim et al., 2001). Common problems include dress codes of international responders, especially for women, the ability of men to examine or treat women (Roshchin et al., 2002) and the cultural appropriateness of donated goods. All team members should be aware of cultural issues before deploying as failure to do this may compromise the personal safety of team members and effectiveness of the mission.

7.8 Safety and security

Safety and security is becoming an increasing problem (Brennan, 2001; Burkle, 1995; Holland, 2004; Schull, 2001; VanRooyen, 2001). The major cause of death and injury in the 1970s was MVA (Birch. 2005; Brennan, 2001), while the major cause of death in the 1990s was violent trauma (Brennan, 2001). Sheik (2000) looked at the deaths of 382 aid workers and found 67% were from intentional violence, with the number of deaths from hostile acts increasing. Unfortunately combatants in complex humanitarian emergencies (CHE) increasingly regard medical workers as targets (Bricknell, 2005). Deployed teams need to be cognisant of their own safety and security. All deployed teams should have safety and security training and have considered the elements in Table 8 as a minimum.

Grouping	Details
Vehicle safety and travel	Vehicle inspection Vehicle safety Convoy planning and driving Driver training Basic mechanics Trip planning (routes, access points, petrol, what to carry)
Basic Navigation Skills	Map reading Use of GPS Use of compass
Basic Communications Skills	Use of radios including radio protocols Use of specific team communications equipment
Camp Safety	Perimeters Guards Lighting Curfews Equipment security
Personal Safety	Grab bags Avoiding being out alone (especially after dark) Identification
Team Safety	Buddy strategies and monitor systems Rendezvous points Team musters and regular team meetings
Critical Incident Safety	Actions on Evacuation plans Hostage negotiation Weapons awareness

Table 8. Essential Safety and Security Training.

7.9 Health and welfare of deployed team

The health and welfare of deployed teams is important. Team members becoming ill or injured may compromise the mission by altering the level of care able to be provided. It may also increase the workload for other members as yet one more patient is added to the load, and the morale of team members may be adversely affected. The sponsoring organisation may also be adversely affected either by reputation, or through costs of evacuation, care and rehabilitation of the unwell team member(s), which may be prolonged and even possibly litigation.

The health and welfare of deployed teams involves a systematic approach that recognises the need for pre and post health support; health support during deployment and appropriate team selection, education and training and logistic support (Aitken et al., 2009a; 2009b; 2011).

Processes should be in place to ensure that all team members who deploy:

- Are in good physical health and have had a recent medical and dental check up
- Have access to regular personal medications (if appropriate to deploy with these) and have a spare set of eyeglasses if needed
- Have received appropriate vaccinations prior to deployment and access to any chemoprophylaxis necessary
- Have an appropriate degree of physical fitness
- Ideally have acclimatisation schedules considered, especially for any deployment from temperate to hot environments
- Have access to medical care while deployed, including a team medical kit
- Have access to clean water and safe food supply while deployed
- Have access to uniforms appropriate to both climate and work environment
- Have task appropriate personal protective equipment
- Are protected from vector borne diseases by an appropriate combination of vector control, prophylactic measures and access to treatment
- Have access to post deployment follow up health care, with both physical and mental health issues addressed

7.10 Coordination

Deployed teams should not only integrate with local health services but also coordinate their activities with other deployed teams. This is to ensure that all needs are addressed and that there is appropriate coverage of aid needs to all geographical areas. Otherwise, both task omission and task duplication can easily occur. This is especially important in large-scale disasters where coordination and logistics issues can be immense. As an example consider the problems faced in Haiti. At one stage there were over 1000 NGO on ground, in a country with virtually all infrastructures (including government) destroyed and the native language was different to nearly all deployed teams.

Efforts to improve global coordination of disasters have led to the development of the Cluster approach, which is now an essential component of international humanitarian work. The clusters are open to all contributing agencies with each of the nine clusters (Protection, Camp Coordination and Management, Water Sanitation and Hygiene, Health, Emergency Shelter, Nutrition, Emergency Telecommunications, Logistics, and Early Recovery) led by a designated agency. Two additional clusters, Education and Agriculture, were later added. For the Health Cluster the lead agency is the World Health Organisation. There are also efforts currently to ensure only appropriately trained and prepared teams deploy internationally with development of an international register of accredited teams.

8. Pandemics

The recent experience with Pandemic (H1N1) 2009, while not the severe disease initially expected, has highlighted a number of issues confronting emergency medicine.

8.1 ED design

Emergency Departments, as a rule, are not designed to manage large numbers of patients with infectious disease. Open plan design, which meets the need to maintain the visibility of patients with acute presentations, sacrifices not only privacy but also offers little ability to isolate patients. As FitzGerald et al (2010) note, "curtains make poor barriers to the spread of disease". Few ED have designs well suited to management of infectious patients with ability to isolate from time of presentation to triage and through their ED 'journey'.

8.2 Identification of index cases

This can only happen as a result of raised awareness and heightened suspicion. EDs need to recognise that they are part of the broader health system as well as the front door of the hospital. There should be strong links with local public health and communicable disease networks. This allows ED staff to be aware of communicable disease alerts and have a clear reporting structure if cases are identified.

8.3 Alternative care sites

The use of "flu clinics" is intended to divert patients from Emergency Departments and preserve ED capacity. The establishment of 'flu clinics' needs careful planning for it to be successful:

- It is important to avoid using ED staff for this role or ED capacity may be actually reduced;
- There must be an ability to provide immediate care for those with more severe illness at flu clinics as well as the ability to transfer to higher levels of care
- There must be clear case definitions and protocols in place to ensure standardised and consistent care across the community
- The community must be informed of where to attend to seek care.

8.4 Controlling entry to ED

Patients with flu, or any infectious disease, should not enter EDs and mingle freely with other patients and staff. Pathways should be established so that patients with suspected infectious diseases are diverted to alternative care sites (flu clinics) or if unwell have a clear route to areas capable of isolation or ideally negative pressure rooms.

8.5 Integrated care

It is imperative that EDs have established links with the public health system, primary health care and the full hospital system. Planning needs to ensure that this is a 'whole of health' response. This enables early notice of emerging infectious diseases, clear reporting lines, support for alternative care sites and consistent care pathways with in the hospital for admitted patients to both the ward and Intensive Care. It is also essential that microbiology and laboratory services as well as hospital administration are included in this.

8.6 The workforce

Staff welfare is an essential element of pandemic management. This not only protects the health and safety of health personnel but also ensures the on going ability of the ED to provide care. This needs to include access to PPE, vaccination and antiviral medications. Staff in high-risk groups may also need to be re-deployed from their primary place of employment. While this may differ for specific disease processes, for H1N1 this included pregnancy, immunosuppression and chronic disease. There is a need for clear processes to be in place for sick leave and staff absence as carers during the pandemic (Considine et al., 2011). The latter is particularly important when schools are closed, or staff quarantined as the primary carers of those with confirmed illness.

The willingness of staff to present for work also needs to be considered. Conflicting opinions have been presented, however the severity of the disease and levels of personal risk are probably the best guide. Health workers are altruistic by nature, however personal and family risk may limit this. The personal risk for health workers when caring for patients in an environment similar to the 1918 pandemic (see Figure 12) should not be under estimated.

9. Emerging issues

Disaster health does not stand still. As the world changes and new technology is developed, different threats emerge. Risk assessment is a continuous process and needs to recognise new hazards as they emerge. Some of these are discussed briefly below.

Fig. 12. Patient care during the 1918 Flu Pandemic.

9.1 Climate change

It has been proposed that climate change will bring with it an increased number of severe storms, cyclones and hurricanes. Additionally global warming may cause the endemic regions for vector borne disease to expand. The most serious concern is the spread of malaria while other diseases such as dengue fever are also of concern. The exposure of disease naive populations increases the potential to cause significant morbidity and mortality.

9.2 Heatwave

Heatwaves are generally an under recognised disaster and have caused significant mortality. Most of this occurs in populations in which buildings have been adapted for the cold and keep heat in. Buildings reliant on air conditioning to keep cool, including hospitals, are particularly at risk with power failures. Recent work has identified standard definitions, the influence of biometeorological influences (Vaneckova et al 2011) and population susceptibility (Wang et al 2011). Local temperature, and the variation from this, is one of the most important factors with the elderly and those with chronic disease particularly ischaemic heart disease and diabetes, at risk.

9.3 Pandemics and emerging infectious disease

The advent of cheap global travel and expansion of international trade has its own risks, with the spread of disease able to occur much more readily as a result of this. Emerging infectious diseases have the potential to be spread quickly with transcontinental flight and may not be noticed initially if diseases have a longer incubation period allowing disembarkation before onset of symptoms and negating the effectiveness of pre-flight screening. This is particularly relevant given that the majority of travellers would not postpone their travel, even if they exhibited flu-like symptoms (Leggat et al., 2010). Pandemics occur regularly and while Pandemic (H1N1) 2009 was not the disease initially feared, diseases with higher case fatality rates such as SARS and 'Bird Flu' and emergence of novel viruses associated with animal reservoirs continues to pose concerns. Fortunately, almost everyone reported that they would comply with physician's advice to stay at home for seven days if they were diagnosed with Pandemic (H1N1) 2009 (Brown et al., 2010). Interestingly, most of these people also indicated that they would have sufficient food supplies to cope with isolation for a period of three days, although they would cope less well if there was a disruption in utilities (Aitken et al., 2010).

9.4 Conflict and war

War is not included as a disaster in many databases. However both war and complex health emergencies have accounted for millions of deaths in the past century. This is not just as a result of direct violence but occurs due to disruption of the health system, loss of access to basic food and water, loss of immunisation programs and general loss of infrastructure including transport systems. The crisis in the Democratic Republic of the Congo (DCR) resulted in the deaths of ten million people over a two year period with more than 50% dying as a result of infectious disease. Of the 15% who died from battlefield injuries many of these occurred in inaccessible places away from help (Brennan & Nandy, 2001).

9.5 Information technology

The development of information technology has enhanced our ability to respond and manage disasters (Arnold et al., 2004). However many of our systems, including health systems, are so reliant on computers that a major disruption of the information technology infrastructure may result in complete system failures. This may range from patient data systems, refrigeration and cooling of medical and blood-stocks to digital radiology systems. Indirect effects include the impact on public transport, economic breakdown and other components of critical infrastructure.

9.6 Standards of care

An emerging, and necessary, discussion is the concept of standards of care during a disaster. The modern community has an expectation that care will continue, at the same standard, during a disaster. Depending on both the imbalance between supply and demand and the level of infrastructure damage this may not be possible.

10. The future

The ability to predict the future is in the realm of crystal balls and Nostradamus. Novel disasters will occur, or 'traditional' disasters in less likely locations. However it is likely that future developments will include work on the emerging issues described above with a focus on:

- standards of care (and altered standards of care),
- accountability and credentialing of disaster health care providers and managers,
- the integration of health care into the disaster 'system',
- improved communication with improved visibility of communication and sharing of information,
- the impact of ED overcrowding on surge capacity
- the implications of an aging population on disaster response in the developed world.

11. Conclusion

Disasters are of special significance to Emergency Physicians and all those who work in Emergency Departments. As the front door of the hospital, ED staff need to be aware of local risk profiles, prepare their department and ensure they become involved in a 'whole of hospital' and 'whole of community' approach to disaster planning. Emergency Physicians and ED nurses are well suited to acute humanitarian roles with their broad skill mix and familiarity with uncertainty. These personnel do however; need additional training across public health, safety and security to be most effective as aid workers.

Increasingly, disaster medicine is moving from good intentions to good practice, with growth as a professional discipline in its own right. There has been a recent growth in research, development of standards and indicators of effectiveness and moves to not just improved education and training of responders, but credentialing as well. One of the challenges for the future, with the high likelihood of future disasters, is to build on this so that lessons identified are put into practice to become lessons learned and that these innovations are formally assessed to determine effectiveness and whether outcomes are improved.

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Annex 2: Paper 2.2

Toloo S, FitzGerald G, **Aitken P**, Ting J, Tippett V, Chu K. Emergency Health Services: Demand and Service Delivery Models. Monograph 1: Literature Review and Activity Trends. Queensland University of Technology, 2011. ISBN: 978-1-921897-11-5

Queensland University of Technology

Emergency Health Services:

Demand & Service Delivery Models

Monograph 1

Literature Review & Activity Trends

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Executive Summary

Introduction

The term ‘Emergency Health Services’ (EHS) encompasses hospital Emergency Departments (ED), ambulance services and a range of aero-medical, retrieval, and transfer services that provide integrated medical care to people suffering acute illness and injury. EHS is a significant and high profile component of Australia’s health care system and congestion of these, evidenced by physical overcrowding and prolonged waiting times, is causing considerable community and professional concern. This concern relates not only to Australia’s capacity to manage daily health emergencies but also the ability to respond to major incidents and disasters.

EHS congestion is a result of the combined effects of increased demand for emergency care, increased complexity of acute health care, and blocked access to ongoing care (e.g. inpatient beds). Despite this conceptual understanding there is a lack of robust evidence to explain the factors driving increased demand, or how demand contributes to congestion, and therefore public policy responses have relied upon limited or unsound information.

The Research Program

The Emergency Health Services Queensland (EHSQ) research program proposes to determine the factors influencing the growing demand for emergency health care and to establish options for alternative service provision that may safely meet patient’s needs. The EHSQ study is funded by the Australian Research Council (ARC) through its Linkage Program and is supported financially by the Queensland Ambulance Service (QAS).

The specific objectives of this research program are the:

1. identification, analysis, and evaluation of the factors that influence demand for EHS;
2. identification of drivers for EHS demand;
3. identification of the pattern and scope of services currently provided in Australia;
4. development of predictive models of future EHS demand;
5. identification and evaluation of possible alternative models of service delivery that could satisfactorily meet patient need;
6. provision of evidence on which to base future policy development, as well as design and development of new EHS systems and structures.

This research program comprises four sub-studies:

Study 1: Examination of the literature, and current operational context, to develop a conceptual understanding of the factors influencing growth in demand so as to identify demand trends.

Study 2: Examination of data privately held by both the Queensland Ambulance Service and the Queensland Health Emergency Departments on patient trends, to determine the characteristics of users.

Study 3: Structured interviews with patients to identify quantitatively and qualitatively the factors that they take into consideration in seeking acute medical assistance.

Study 4: Analysis and synthesis of all data to provide a structured predictive model of demand and of the policy options for demand management, in consultation with EHS stakeholders.

This first monograph presents the outcomes of Study 1. Literature was sourced using standard search approaches and a range of databases as well as a selection of articles cited in the reviewed literature. Public sources including the Australian Institute of Health and Welfare (AIHW), the Council of Ambulance Authorities (CAA) Annual Reports, Australian Bureau of Statistics (ABS) and Department of Health and Ageing (DoHA) were examined for trend data across Australia.

Theoretical Framework for the Study of EHS Demand

For the purposes of the current research program, demand for EHS at the individual level is considered a health-seeking behaviour that can be explained by **socio-demographic factors** which are mediated and modified through the **individual's health beliefs and perceptions**, **personal characteristics**, **social environment**, and **illness conditions**. Using theoretical models such as the Health Belief Model, Health Services Utilisation Behaviour, Theory of Planned Behaviour, Decision Making Theory, and Social Support and Social Networks Theory, a conceptual framework has been developed to aid understanding of the relationships between the various factors influencing demand as identified in the literature.

The immediate factors that can affect an individual's decision to seek healthcare are their own perception of the severity, complexity and acuity of the illness, as well as their general health status. The decision to pursue a particular course of action is influenced by an analysis of the associated costs and benefits. Therefore if a condition is considered to be worthy of medical attention, the benefits and barriers of the action (e.g. seeing a GP or visiting an ED instead) are consequently considered. Benefits and barriers are likely to include financial factors, convenience, and (perceived or actual) access to and availability of the health services.

The decision to choose a particular action is a reflection and/or effect of one's beliefs regarding the health system; learnt norms and values about how to act at times of sickness; personality traits such as self-efficacy and belief in one's abilities; previous experience and information such as having a family member who received good treatment at ED; and environmental factors such as peer pressure and support networks. The influence of these factors becomes more evident when patients, with lower acuity problems, seek emergency medical care as a result of a decision by a bystander, or because of a perception that using an ambulance would give them a higher priority and they would be able to 'jump the queue'.

Finally, socio-demographic characteristics can determine or alter how people feel, think, learn and behave in a perceived emergency or when deciding to attend an ED. For example an elderly person living alone and without access to a car or other forms of transport is more likely to call an ambulance. Or, a newly arrived migrant or refugee without a clear and detailed knowledge of the host country's medical system may act the way they did in their previous country. The relationships among these factors are not necessarily linear and one-way (cause-effect) and in many situations new experiences can change old perceptions and lead to a change of behaviour in the future.

Key Findings

Rising Demand for EHS

In 2009-10, Australian public hospital EDs reported nearly 7.4 million occasions of service across the country, equal to 331 services per 1000 population. Utilisation rates ranged from 286 per 1000 in Victoria to 577 per 1000 in the Northern Territory. Queensland was above the national average with 350 per 1000 occasions of service. The per capita demand for EDs grew at an annual rate of 2% in Australia in the period between 1998-99 and 2009-10. Growth varied between the states and territories; the Northern Territory (0.5%), South Australia (0.8%), and Queensland (0.8%) had the lowest annual growth rates while Tasmania had the highest (7.4%) during this period.

In 2009-10, over 3 million ambulance incidents were recorded across Australia, equal to 137 per 1000 population. Rates ranged from 89 per 1000 in Western Australia to 169 per 1000 in Queensland. Per capita demand for ambulance services rose at an average annual rate of 3.7% in the period between 1999-00 to 2009-10. Western Australia (2.1%) recorded the slowest annual growth in ambulance utilisation rates and Tasmania (6%) the highest.

Factors Affecting ED Demand

Factors driving demand for EDs can be grouped broadly into three categories: individual factors; societal factors; and health system factors.

Individual Factors include patient characteristics that are known to affect health service utilisation, such as demographics (age, gender, living arrangements), socio-economic status, health insurance status, health and well-being profile, and health literacy.

The elderly appear to be consistently higher users of ED than most other age groups. However, study results on ED use in younger age groups differ by country and system. Other factors such as socio-economic status, ethnic or indigenous background, and living in deprived areas can increase the rate of ED visits.

Demand for ED care is also associated with actual and/or perceived presence of an illness/injury. Studies that focus on medical criteria argue that high acuity patients are "appropriate" users and should be treated in the ED, while the low acuity group are more appropriately managed as primary care patients. However, studies conducted on patient decision making suggest that it is the patient's perception of the seriousness of their illness which determines where they seek care. In this respect, higher levels of health literacy and possibly increased awareness of health services are also likely to drive demand.

Frequent users have also been blamed for increasing the ED load. However, frequent users are also likely to be “sicker” than infrequent users and likely to use ED intensely within a short period and not at all at other times.

Health System Factors, the way services are organised and funded, also drive demand for EDs. However, much less is known about how these factors impact on ED workloads. Factors such as a hospital’s location, type and size, as well as access to affordable alternative services (e.g. bulk-billing GPs) may have an impact. This later factor has been the subject of much policy attention but the relationship is still very unclear.

Lack of appropriate care for chronic disease in other health settings such as nursing homes may impact on the magnitude of demand for ED care. Some studies have demonstrated that increased access to primary health care services, including general practice and community clinics, reduces demand for ED but others have shown no effect. Many people consider the ED more appropriate as a source of better quality of care and convenience.

Health insurance status has been associated with increased ED use in the United States but the same relationship may not be true for Australia because of the differences in our funding of public health systems. Reduced affordability of alternate health care services however has been related to the rise in demand for emergency department services in the lower acuity spectrum.

Societal Factors have been shown to impact ED demand because of the population’s expectations for equitable and affordable access to specialised health services. However, little evidence exists as to the extent of the impact of these factors. The ageing of the population and the associated increases in chronic disease may prove to be a significant contributor to demand for ED. In Australia, patients aged 65 and over comprised 17.7% of ED presentation in 2007-08 while they form 13.1% of the total population.

Other social phenomena which may have some bearing on utilisation patterns are peer pressure and health related anxiety which occur in some population sub-groups. Additionally, living arrangements affect ED use, particularly for people isolated from social support.

Factors Affecting Ambulance Demand

Reports published to date which examine the drivers of demand for ambulance have generally relied on demographic factors to explain demand increase, although several reports have also speculated about other potential factors such as funding models, limited access to primary healthcare, and the burden of chronic disease.

Both demographic and illness related factors (e.g. perceived threat of illness) are significantly associated with demand for ambulance. Population growth and ageing has been estimated to account for about 20% of demand for ambulance in Queensland and 17% in England. An Australian study found that arrival by ambulance to the ED was 2.9 times higher among patients aged over 65 years. The impact of ethnicity, gender, and time of day are not well known.

International comparisons are further challenged by the variety of funding arrangements and the different skill sets of staff. The impact of price is unclear although often publicly cited as a significant impact factor. Ambulance services may incur no cost to individuals because services are government funded, or they may incur a significant cost to the patient which may or may not be offset by insurance arrangements.

Other population related factors that may place extra pressure on ambulance demand include residents in geographically deprived areas, binge drinkers and those involved in substance abuse, and bystanders to minor car accidents, however the impact of these factors has not been quantified. Similarly the impacts of patient decision making and increasing health literacy have not been canvassed in regard to pre-hospital care.

The operational context may also impact on ambulance demand. Symptoms of system congestion such as prolonged waiting times, ramping, or bypass arrangements may affect the capacity of emergency pre-hospital services to respond to demand in the community. However evidence of the impact of these circumstances for ambulance response has not to date been rigorously examined.

EHS Demand Management

Debate has arisen over the last decade surrounding appropriate and necessary versus inappropriate and unnecessary EHS utilisation. The findings of these studies with regard to their impact on demand pressures are questionable since they often depend on post-hoc validation of the patient's symptoms by medical staff. These studies estimate the proportion of inappropriate or unnecessary ED utilisation at 11% to 50%. Rarely do these studies take into account the patients' reasons for seeking assistance or the paramedics' decision to transport the patient.

Articulating the drivers of demand for Emergency Health Services is a relatively new endeavour. The analysis of this phenomenon will be multifaceted and may present many challenges to established and traditional positions regarding roles and responsibilities of the agencies providing services. Regardless of these challenges, finite public health care resources require cost effective solutions to manage increasing demand. Demand management in the broader health care system, over the last two decades in particular, has engaged policy makers, researchers and other stakeholders in forecasting, planning and policy development; to identify and test new models for health service delivery. This same multidisciplinary approach is required at the entry point to emergency health care.

Over the last decade, nationally and internationally, several interventions aimed at reducing demand for Emergency Health Services have been tested. These include expanding the role of primary health care, expanded decision making roles for paramedics, telephone health advice, public education campaigns, patient education and communication, strategies to reduce re-admissions, patient co-payments, and initiatives such as Hospital in the Nursing Home (HINH) and Hospital in the Home (HIH) programmes. The short- and long-term effectiveness of these interventions in reducing demand varies and is contested.

Conclusions

It is generally accepted that health system congestion arises from several factors; deficiencies in patient flow, limitations to service availability, inappropriate policy development, and the inefficient coordination of services to address growth in demand. Therefore, identifying the factors that affect demand is of significance in developing policies and strategies, to reduce congestion, that do not adversely affect patient outcomes or patient safety. The effects of the strategies applied to date have been mixed. For instance, telephone advisory services have not been shown to reduce demand, whereas programs such as Hospital in the Home and self management of chronic disease seem to reduce EHS demand without threatening the safety of the patients.

It is important to ensure that these initiatives which aim to facilitate reduction in congestion or demand are directed at the real reasons underlying the problem and are supported by evidence. The EHSQ aims to analyse these issues in detail and to propose solutions appropriate for the Australian EHS environment.

Annex 3: Paper 2.3

FitzGerald GJ, Patrick JR, Fielding E, Shaban R, Arbon P, **Aitken P**, Considine J, Clark M, Finucane, J, McCarthy S, Cloughessy L, Holzhauser K. H_1N_1 Influenza 2009 outbreak in Australia: Impact on Emergency Departments. (ISBN: 978-1-74107-322-5) QUT. 2010

H_1N_1 Influenza 09 Outbreak in Australia: Impact on Emergency Departments.

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Executive summary

Objective

The aims of this study were to identify the impact of Pandemic (H_1N_1) 2009 Influenza on Australian Emergency Departments (EDs) and their staff, and to inform planning, preparedness, and response management arrangements for future pandemics, as well as managing infectious patients presenting to EDs in everyday practice.

Methods

This study involved three elements:

1. The first element of the study was an examination of published material including published statistics. Standard literature research methods were used to identify relevant published articles. In addition, data about ED demand was obtained from Australian Government Department of Health and Ageing (DoHA) publications, with several state health departments providing more detailed data.

2. The second element of the study was a survey of Directors of Emergency Medicine identified with the assistance of the Australasian College for Emergency Medicine (ACEM). This survey retrieved data about demand for ED services and elicited qualitative comments on the impact of the pandemic on ED management.

3. The third element of the study was a survey of ED staff. A questionnaire was emailed to members of three professional colleges—the ACEM; the Australian College of Emergency Nursing (ACEN); and the College of Emergency Nursing Australasia (CENA). The overall response rate for the survey was 18.4%, with 618 usable responses from 3355 distributed questionnaires. Topics covered by the survey included ED conditions during the (H_1N_1) 2009 influenza pandemic; information received about Pandemic (H_1N_1) 2009 Influenza; pandemic plans; the impact of the pandemic on ED staff with respect to stress; illness prevention measures; support received from others in work role; staff and other's illness during the pandemic; other factors causing ED staff to miss work during the pandemic; and vaccination against Pandemic (H_1N_1) 2009 Influenza. Both qualitative and quantitative data were collected and analysed.

Results

The results obtained from Directors of Emergency Medicine quantifying the impact of the pandemic were too limited for interpretation. Data sourced from health departments and published sources demonstrated an increase in influenza-like illness (ILI) presentations of between one and a half and three times the normal level of presentations of ILIs. Directors of Emergency Medicine reported a reasonable level of preparation for the pandemic, with most reporting the use of pandemic plans that translated into relatively effective operational infection control responses. Directors reported a highly significant impact on EDs and their staff from the pandemic. Growth in demand and related ED congestion were highly significant factors causing distress within the departments. Most (64%) respondents established a 'flu clinic' either as part of the ED operations or external to it. They did not note a significantly higher rate of sick leave than usual.

Responses relating to the impact on staff were equal between the colleges. Most respondents felt strongly that Pandemic (H_1N_1) 2009 Influenza had a significant impact on demand in their ED, with most patients having low levels of clinical urgency. Most respondents felt that the pandemic had a negative impact on the care of other patients, and 94% revealed some increase in stress due to lack of space for patients, increased demand, and filling staff deficits. Levels of concern about themselves or their family members contracting the illness were less significant than expected. Nurses displayed significantly higher levels of stress overall, particularly in relation to skill-mix requirements, lack of supplies and equipment, and patient and patients' family aggression. More than one-third of respondents became ill with an ILI. Whilst respondents themselves reported taking low levels of sick leave, respondents cited difficulties with replacing absent staff. Ranked from highest to lowest, respondents gained useful support from ED colleagues, ED administration, their hospital occupational health department, hospital administration, professional colleges, state health department, and their unions. Respondents were generally positive about the information they received overall; however, the volume of information was considered excessive and sometimes inconsistent. The media was criticised as scaremongering and sensationalist and as being the cause of many unnecessary presentations to EDs. Of concern to the investigators was that a large proportion (43%) of respondents did not know whether a pandemic plan existed for their department or hospital. A small number of staff reported being redeployed from their usual workplace for personal risk factors or operational reasons. As at the time of survey (29 October –18 December 2009), 26% of ED staff reported being vaccinated against Pandemic (H_1N_1) 2009 Influenza. Of those not vaccinated, half indicated they would 'definitely' or 'probably' not get vaccinated, with the main reasons being the vaccine was 'rushed into production', 'not properly tested', 'came out too late', or not needed due to prior infection or exposure, or due to the mildness of the disease.

Conclusion

Pandemic (H_1N_1) 2009 Influenza had a significant impact on Australian Emergency Departments. The pandemic exposed problems in existing plans, particularly a lack of guidelines, general information overload, and confusion due to the lack of a single authoritative information source. Of concern was the high proportion of respondents who did not know if their hospital or department had a pandemic plan. Nationally, the pandemic communication strategy needs a detailed review, with more engagement with media networks to encourage responsible and consistent reporting. Also of concern was the low level of immunisation, and the low level of intention to accept vaccination. This is a problem seen in many previous studies relating to seasonal influenza and health care workers. The design of EDs needs to be addressed to better manage infectious patients. Significant workforce issues were confronted in this pandemic, including maintaining appropriate staffing levels; staff exposure to illness; access to, and appropriate use of, personal protective equipment (PPE); and the difficulties associated with working in PPE for prolonged periods. An administrative issue of note was the reporting requirement, which created considerable additional stress for staff within EDs. Peer and local support strategies helped ensure staff felt their needs were provided for, creating resilience, dependability, and stability in the ED workforce. Policies regarding the establishment of flu clinics need to be established. The ability to create surge capacity within EDs by considering staffing, equipment, physical space, and stores is of primary importance for future pandemics.

Annex 4: Paper 2.4

Aitken P, Canyon D, Hodge J, Leggat P, Speare R. “Disaster Medical Assistance Teams – A Literature Review”. Health Monograph Series. Health Protection Group WA May 2006

Chapter 3 Annexes

Annex 5: Paper 3.1

Edwards NA, Caldicott DGE, **Aitken P,** Lee CC, Eliseo T. Terror Australis 2004: preparedness of Australian hospitals for disasters and incidents involving chemical, biological and radiological agents. Critical Care and Resuscitation 2008. 10(2): 125-136.

Terror Australis 2004: preparedness of Australian hospitals for disasters and incidents involving chemical, biological and radiological agents

Nicholas A Edwards, David G E Caldicott,
Peter Aitken, Christine C Lee and Tony Eliseo

ABSTRACT

Objective: To assess the level of preparedness of Australian hospitals, as perceived by senior emergency department physicians, for chemical, biological and radiological (CBR) incidents, as well as the resources and training available to their departments.

Methods: Detailed questionnaires were mailed to the directors of the 86 hospital emergency departments (EDs) in Australia accredited by the Australasian College for Emergency Medicine. Questions covered hospital planning, available resources and training, and perceived preparedness.

Results: Responses were received from 76 departments (88%): 73 reported that their ED had a disaster plan, with 60 (79%) having a contingency plan for chemical, 57 (75%) for biological, and 53 (70%) for radiological incidents. Specific staff training for managing patients from a conventional mass casualty incident was given in 83% of EDs, falling to 66% for a CBR incident. Forty-three per cent reported that their plan involved staff managing contaminated patients, but availability of personal protective equipment and decontamination facilities varied widely. Although 41% believed their ED could cope with a maximum of 20 patients in the first 2 hours after a conventional incident, this increased to 71% for a CBR incident. Staff training was considered the main funding priority (59%).

Conclusions: This survey raises significant questions about the level of preparedness of Australian EDs for dealing with patients from both conventional and CBR incidents. Hospitals need to review their plans and functionality openly and objectively to ensure that their perceived preparedness is consistent with reality. In addition, they urgently require guidance as to reasonable expectations of their capacity. To that end, we recommend further development of national standards in hospital disaster planning and preparedness.

Crit Care Resusc 2008; 10: 125–136

Every year, if not every day, we have to wager our salvation upon some prophecy based upon imperfect knowledge.

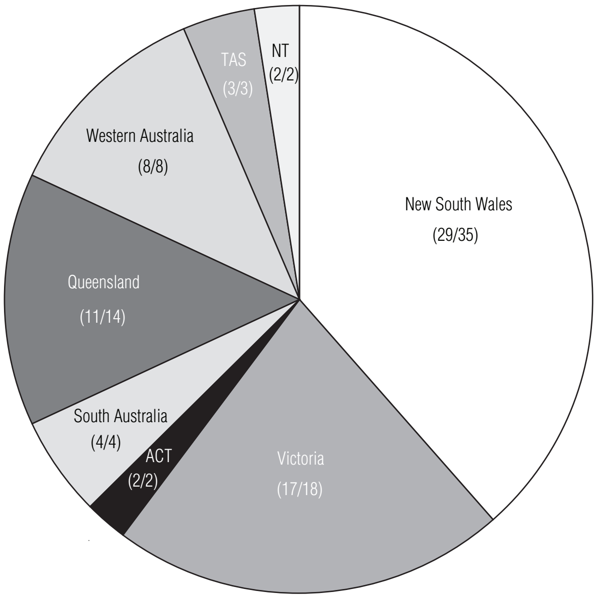
Oliver Wendell Holmes Jr,
United States jurist (1841–1935)

The health care system, including hospitals, will clearly play a pivotal role in the response to a mass casualty incident from any cause. Incidents involving chemical, biological or radiological (CBR) agents differ significantly from conventional incidents in that they have the potential to contaminate both the people and the environment exposed. Hospitals therefore need to develop CBR annexures to their major incident plans that address issues such as decontamination, antidotes, and the avoidance of secondary contamination of the hospital, staff and decontaminated patients. If hospital staff are exposed to the agent while attending contaminated patients, they too may become casualties, further compounding the disaster.[1-4] If security is breached, the ability of the hospital to function may also be severely impaired, and may force its closure.[5,6]

There is little literature on hospital preparedness for CBR incidents, particularly in Australia. In 2001, Treat et al examined hospital preparedness for incidents involving weapons of mass destruction (WMD) in a region of the United States.[7] They concluded that "hospitals in this sample do not appear to be prepared to handle WMD events, especially in areas such as mass decontamination, mass medical response, awareness among health care professionals, health communications, and facility security". Similar surveys of 21 hospitals in a major US city in 1996 and 2000 concluded that these hospitals were poorly prepared to manage chemical emergency incidents, including terrorism.[8]

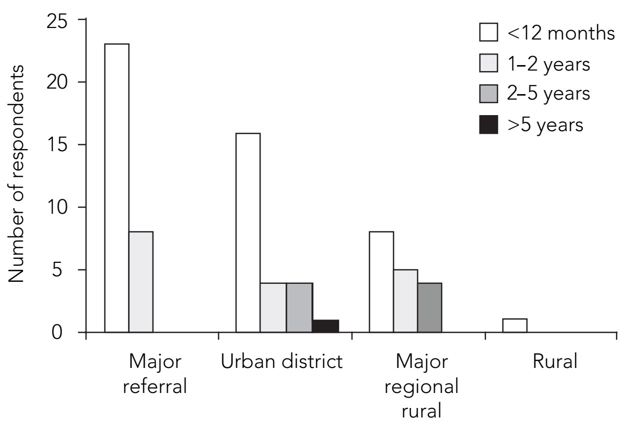
The threat and potential consequences of a mass casualty incident have now reached the point that claims of preparedness need to be supported by evidence. We believe that detailed information needs to be gathered on the training, conduct of exercises and resources available to hospitals, and realistic conclusions developed about their respective capacities to deal with large numbers of patients, both from conventional and CBR incidents. As recently suggested by Auf der Heide, disaster planning is only as good as the assumptions on which it is based.[9]

Figure 1. Distribution of respondents by state*



*Figures in parentheses are the number of respondents as a fraction of the number of emergency departments to which the survey was sent in each State. (ACT = Australian Capital Territory. NT = Northern Territory. TAS = Tasmania.)

Figure 2. Time since the major incident plan was last revised, by hospital classification (*n* = 76*)



* Two respondents did not answer the question.

It is not only impossible to prepare completely for all potential scenarios, but also difficult to define the extent to which hospitals should be expected to prepare. Issues such as whether all hospitals in a given geographical area require specific CBR annexures to their major incident plans, how many casualties they should be able to decontaminate, whether hospital staff should have access to, and be trained in the use of, high-level personal protective equipment (PPE), and how frequently plans should be exercised, remain unclear. In addition, there is little coordinated collection or record of individual hospital capabilities in Australia, at either a state or national level.

Table 1. Plans for dealing with internal incidents, and whether tested (*n* = 76)

Incident	Plan: Tested	Plan: Not tested	No plan	Don't know	No answer
Department evacuation	11 (14%)	55 (72%)	4 (5%)	4 (5%)	2 (3%)
Loss of power supply	28 (37%)	40 (53%)	3 (4%)	3 (4%)	2 (3%)
Loss of water supply	9 (12%)	39 (51%)	8 (11%)	16 (21%)	4 (5%)
Extended operations*	8 (11%)	44 (58%)	14 (18%)	5 (7%)	5 (7%)

* > 1 shift.

Methods

A questionnaire was mailed in December 2003 to the directors of the 86 emergency departments in Australia that are accredited for training by the Australasian College for Emergency Medicine (ACEM), representing a mixture of adult and combined adult and paediatric units. The questionnaire was sent again to centres that did not respond within 6 weeks.

The data collected were descriptive and quantitative, with most questions having set answering options. Data were entered into an SPSS database. A strict process of de-identification ensured that the authors remained blinded to the identity of each respondent's hospital, and respondents were assured in a covering letter that no specific hospital would be identifiable by its responses. The study was approved by the Royal Adelaide Hospital Research Ethics Committee.

Results

Demographics

Responses were received from 76 (88%) of the 86 emergency departments. ACEM classifications of the hospitals that responded were major referral, 31 (41%); urban district, 26 (34%); major regional rural, 18 (24%); and rural, 1 (1%). The distribution of respondents by state is shown in Figure 1; the disproportionate number of non-respondents from New South Wales did not reach statistical significance. Annual emergency department attendance was reported as less than 20 000 by two departments (3%), 20 000–40 000 by 43 (57%), and more than 40 000 by 31 (41%).

Table 2. Plans for dealing with patients from chemical, biological or radiological incidents at individual hospitals, by ACEM classification (*n* = 76*)

	Chemical			Biological			Radiological		
ACEM classification	Yes	No	Don't know	Yes	No	Don't know	Yes	No	Don't know
Major referral	28 (37%)	3 (4%)	0	28 (37%)	3 (4%)	0	27 (36%)	4 (5%)	0
Urban district	19 (25%)	5 (7%)	1 (1%)	18 (24%)	6 (8%)	1 (1%)	15 (20%)	8 (11%)	2 (3%)
Major regional rural or rural†	13 (17%)	5 (7%)	0	11 (14%)	7 (9%)	0	11 (14%)	7 (9%)	0
Total	**60 (79%)**	**13 (17%)**	**1 (1%)**	**57 (75%)**	**16 (21%)**	**1 (1%)**	**53 (70%)**	**19 (25%)**	**2 (3%)**

ACEM = Australasian College for Emergency Medicine. * Two respondents (3%) did not answer the question.
† Major regional rural and rural ACEM categories were combined to ensure the single rural respondent was de-identified.

Table 3. Frequency of disaster training for hospital staff (*n* = 76)

Type of staff	Never	> 5-yearly	2–5-yearly	2-yearly	1-yearly	< 1-yearly	Don't know	No answer
Medical	7 (9%)	2 (3%)	11 (15%)	13 (17%)	23 (30%)	15 (20%)	2 (3%)	3 (4%)
Nursing	5 (7%)	0	9 (12%)	10 (13%)	26 (34%)	18 (24%)	6 (8%)	2 (3%)
Administration	9 (12%)	0	9 (12%)	10 (13%)	7 (9%)	7 (9%)	19 (25%)	15 (20%)

Planning

Seventy-three of the 76 respondents (96%) reported that their department had a major incident or disaster plan in place, with a further two having a plan in development. Forty-four (60%) of these had a local risk assessment performed during the development of that plan (with a further eight being unsure); at least 18 of these assessments (41%) were undertaken by a professional body (with a further 12 [27%] being unsure). Sixty-five per cent (48/74) of hospitals with a major incident plan had revised it in the previous 12 months (including the two sites developing plans), with a further 17 (23%) having revised it 1–2 years previously, eight (11%), 2–5 years previously, and one (1%), over 5 years previously (Figure 2).

All plans were reported to contain a clearly defined command structure, with the vast majority addressing the issues of security (95%), a media centre (95%), and an information centre for relatives (89%). Backup communication equipment was available in 79% of departments, with 42% reporting training in its use. Seventy-five per cent reported ready access to specialist CBR advice, from sources such as poisons information centres (46%), Emergency Management Australia (30%), the Internet (28%), fire services (11%) and local specialists (3%).

Eighty-three per cent (63/74) of respondents reported that their department had action cards for use in a major incident, with 92% (56/61) of these describing ready access to them. Fifty-four per cent (41/74) had tested their department's method for activating extra staff. In case of an internal incident, most had plans for evacuation of the emergency department, loss of power or water supply, and extended operations, although substantially fewer had tested these plans (Table 1).

Sixty (79% overall) described their major incident plan as containing a contingency for dealing with patients from a chemical incident, 57 (75%) from a biological incident, and 53 (70%) from a radiological incident (Table 2). Fifteen (20%) reported that their major incident plan had been activated once in the past 12 months, six (8%) twice, and one on three occasions. Occasions included chemical releases, two "white powder" incidents, an outbreak of food poisoning, and a "nuclear facility leak". Eleven of these departments reviewed their major incident plan afterwards.

Twelve directors (16%) reported that their hospital had been involved in incidents when they considered the major incident plan should have been activated, but was not. Half of these were at major referral centres, three at urban district hospitals, and three at major regional rural hospitals. The incidents included chemical incidents, fires, transport crashes, power failures, a storm and "extreme workload". Three incidents involved eight patients presenting to the hospital, with other single episodes of 10 and 25 patients.

Resources, education and training

Eighty-three per cent of respondents reported that their department conducted specific staff training for managing the response to a conventional mass casualty incident, which fell to 66% for one involving a CBR agent. The frequency of training is shown in Table 3.

Table 4. Equipment available at hospitals (*n* = 76)

Specific equipment	Yes	Don't know	No answer
PPE			
Helmet	58 (76%)	1 (1%)	1 (1%)
Boots	53 (70%)	0	1 (1%)
Chemical-resistant gloves	54 (71%)	3 (4%)	2 (3%)
Highest level of PPE*		4 (5%)	4 (5%)
Level A	5 (7%)		
Level B	11 (14%)		
Level C	34 (45%)		
Level D	18 (24%)		
Decontamination facility		0	1 (1%)
No facility	8 (11%)		
Outdoor hose	18 (24%)		
Indoor	21 (28%)		
Single outdoor	25 (33%)		
Erectable outdoor	22 (29%)		
2 or more fixed outdoor	16 (21%)		
Characteristics of facility			
Privacy screens	47 (62%)	0	5 (7%)
Separate sexes	13 (17%)	3 (4%)	4 (5%)
Water runoff control for decontamination facility		7 (9%)	0
None	52 (68%)		
Stormwater containment	5 (7%)		
Underground tank	8 (11%)		
Deployable tanking	5 (7%)		

PPE = personal protective equipment.
* A = fully encapsulated suit with self-contained breathing apparatus (SCBA).
B = chemical protective or charcoal suit with SCBA or airline.
C = chemical protective or charcoal suit with air-purifying respirator.
D = work clothes (uniforms or overalls).

Table 5. Responsibility for performing decontamination at the hospital (*n* = 76)

	Initial response	Continued response
Hospital staff	32 (42%)	17 (22%)
Police	0	0
Fire	50 (66%)	61 (80%)
Ambulance service	1 (1%)	1 (1%)
Health department	0	1 (1%)
Other	1 (1%)	1 (1%)
No answer	2 (3%)	2 (3%)

Table 6. Previous time hospitals were involved in a mass casualty exercise

Type of exercise	Never	No. of years previously > 5	2–5	1–2	< 1
Non-CBR					
Tabletop	7 (9%)	2 (3%)	8 (11%)	10 (13%)	49 (65%)
Field	8 (11%)	14 (18%)	13 (17%)	12 (16%)	29 (38%)
CBR					
Tabletop	10 (13%)	23 (30%)	4 (5%)	14 (18%)	25 (33%)
Field	13 (17%)	37 (49%)	3 (4%)	10 (13%)	13 (17%)

CBR = chemical, biological or radiological.

There was wide variation in the type of decontamination facility available to the emergency departments. Eight (11%) had no facility, three (4%) relied solely on a simple outdoor hose, and a further five (7%) only had an indoor shower. Only 16 (21%) hospitals had two or more fixed outdoor showers, while 30% had an erectable outdoor shower, although its size and capacity were not queried. While privacy screens were relatively common (62%), separate sex decontamination facilities were not (17%), perhaps consistent with the lower percentage of hospitals with multiple showers. Fifty-two (68%) had no facility to control the runoff of water used in the decontamination process (Table 4).

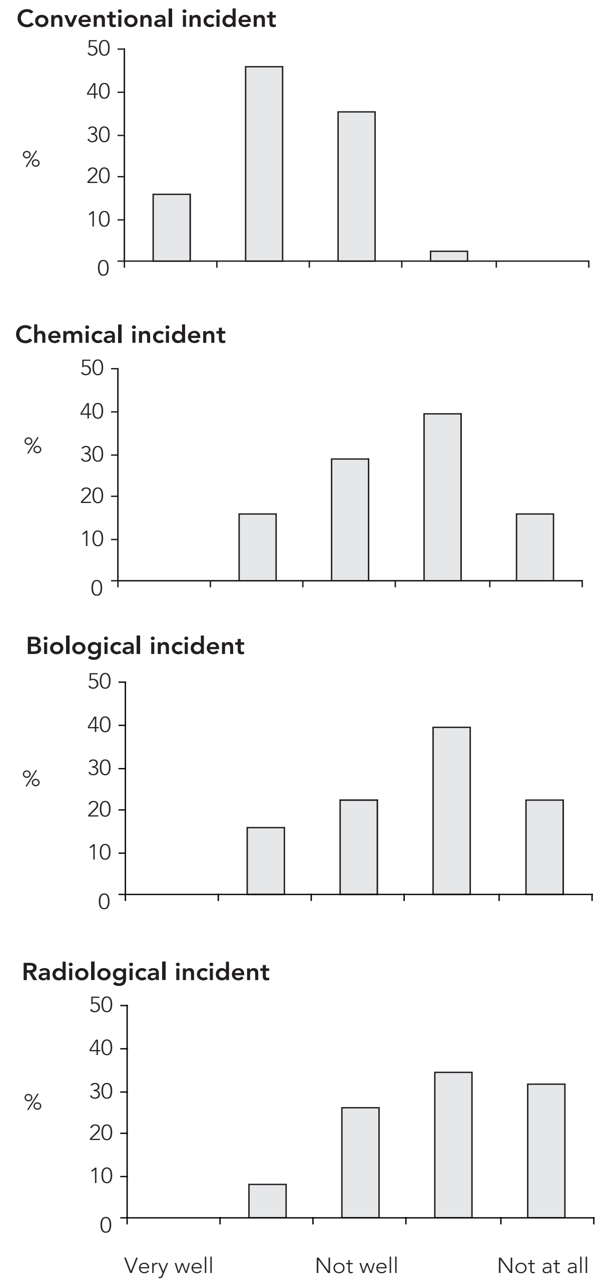
Thirty-three directors (43%) reported that their department's plan involved sending hospital staff outside to manage potentially contaminated patients. If more than 20 patients presented to their hospital after a CBR incident, respondents were asked who would be responsible for commencing their decontamination. Responses included the fire services alone (55%), hospital staff alone (32%), both of these (9%), or a combination of the fire and ambulance services and hospital staff (1%). One believed that decontamination was usually done before hospital, and two did not answer (Table 5). This survey did not examine whether formal arrangements, such as memoranda of understanding, had been developed with other agencies to provide this function.

Most emergency departments had supplies of general PPE, such as helmets, boots and gloves, but were less likely to have more sophisticated equipment (Table 4). The highest level of PPE to which they would have access was reported as Level A by five (7%), Level B by 11 (14%), Level C by 34 (45%), and Level D by 18 (24%). Four (5%) respondents did not know what was available to their staff, and a further four (5%) did not answer the question. It is worth noting that these levels were defined in the survey to

Table 7. "Significant difficulties" reported in conducting exercises ($n = 76$; more than one response permitted)

Difficulty	Tabletop exercise	Field exercise
Expense	20 (26%)	51 (67%)
Time	54 (71%)	60 (79%)
Staffing	43 (57%)	65 (86%)
Interference with normal patient care	33 (43%)	60 (79%)
Interagency collaboration problems	21 (28%)	27 (36%)
Exercise not required	0	0
Other	1 (1%)	1 (1%)

Figure 3. Respondents' perception of how well their emergency department would cope with a mass casualty incident ($n = 76$)



avoid confusion and to maximise accuracy of responses. Fewer than half the departments with access to Level C PPE or higher (22; 44%) reported a formal process of accreditation of training for staff in use of this equipment, with four (8%) being unsure. Although 38 (76%) of departments with these levels of PPE had practiced donning it (another four did not answer), 15 (30%) reported that this practice occurs less than once a year, with a further eight (16%) never practicing. Only four (8%) practiced at least every 6 months.

Sixty-nine (91%) respondents reported that their hospital had been involved in an exercise to test their major incident plan. Standard multicasualty exercises were more likely to have been conducted in the previous 2 years than CBR exercises, with tabletop exercises more likely than field type exercises in both groups (Table 6). Thirty-three per cent of hospitals reported having a CBR tabletop exercise in the past year, with 17% having a CBR field exercise. Notably, 43% reported that their hospital had not been involved in a CBR tabletop exercise in the past 5 years, which increased to 66% for a CBR field exercise. The most common difficulties in conducting exercises were reported to be those related to the impact on service delivery — time, available staff and direct effect on patient care. Cost was also raised as a significant issue, particularly for field exercises (Table 7).

Sixteen per cent of respondents reported that their department stockpiled antibiotics, 42% atropine, and 32% oximes, specifically for a CBR incident.

Only 30% of emergency departments had direct funding for disaster preparedness, with most of this for PPE (91%) or decontamination facilities (48%). Further training in CBR and specific funding for CBR preparedness were both thought to be needed by 91%. The single main priority for further funding was identified as being for training (59%), followed by PPE (16%) and decontamination facilities (10%). Despite requesting only the main priority, 10 (14%) listed multiple options, including the only respondent to nominate stockpiling.

Preparedness

Respondents were asked to grade how well they believed their department would cope with different types of mass casualty incident, on a 5-point visual analogue scale (Figure

Table 8. Maximum number of patients with which emergency departments could cope in the first 2 hours after an incident* ($n = 76$)

Type of incident	Maximum number of patients < 10	10–20	21–50	51–100	> 100
Conventional	9 (12%)	22 (29%)	33 (43%)	10 (13%)	2 (3%)
CBR	33 (43%)	22 (29%)	13 (17%)	5 (7%)	3 (4%)

CBR = chemical, biological or radiological.
* Assuming one significant injury for every five "walking wounded".

3). Most respondents believed their department would cope "well" or "very well" with patients from a conventional mass casualty incident. However, the reverse was true for a CBR incident, with 16% believing they would cope "not at all" with a chemical incident, increasing to 22% for a biological, and 32% for a radiological incident. Regarding how well they believed they would personally cope with the response to such an incident, 23 (30%) believed they would cope well or very well with a chemical incident, compared with 16 (21%) for a biological and 15 (20%) for a radiological incident. However, 21 (28%) believed they would cope from "not well" to "not at all" with a chemical incident, increasing to 29 (38%) for a biological, and 35 (46%) for a radiological incident.

Respondents were then asked what they considered the maximum number of patients with which their department and hospital could cope in the first 2 hours after an incident (assuming one significant injury for every five "walking wounded") (Table 8). Forty-one per cent believed they would be able to cope with 20 patients or fewer after a conventional incident, which increased to 72% for a CBR incident. Eight of the 76 respondents considered that their hospital could cope with over 50 patients from a CBR incident in the first 2 hours.

Discussion

The high response rate to this survey probably reflected the increased interest in terrorism and WMD when it was conducted in 2003. Although we recognised that such a survey carries significant potential for reporting bias, we considered it the only way at present to readily obtain such data. The surveys were addressed to the directors of the emergency departments, as it was envisaged that they would either know or have access to information on the resources and capabilities of their departments.

Nearly all the hospitals surveyed appear to have a major incident plan, with most having some type of CBR annexure to that plan. These figures are similar to those found by surveys of Australian hospitals in 2002.[10,11] However, nearly one in six respondents believed their hospital had been involved in incidents in which their plan should have been activated, but had not been. We did not ask the reasons, but they potentially include inadequate staff education, poorly defined criteria for activation, and concern over the political implications of activation of a major incident plan and the subsequent response.

Most respondents believed their emergency department would not cope well with an influx of patients from such an incident, with 15%–30% believing that it would not cope at all, depending on the type of agent. Of more concern was the proportion (41% for a conventional incident, and 72% for a CBR incident) who believed that their department could not cope with more than 20 patients in the first 2 hours after the incident. It is difficult to accurately predict the number of patients that a hospital could reasonably manage in a mass casualty incident, particularly as Australia has been relatively spared such events. However, this underlines the importance of conducting realistic exercises designed to reveal the strengths, weaknesses and capacity of hospital plans.[5] Previous surveys of hospital personnel have raised concerns that perceived preparedness of their institutions may be higher than actual preparedness.[10-12] Notably, of the five hospitals reported to be able to manage 51–100 patients after a CBR incident, all planned to send hospital staff outside, despite one having only Level D PPE, and a further three having fewer than 10 suits of Level C or higher (Table 9). Two had not been involved in a field exercise in the previous 5 years. Three respondents believed their hospitals could manage over 100 patients, although one hospital had not been involved in a field exercise in the previous 5 years.

Respondents generally perceived that they personally and their departments would cope better with a conventional major incident than with a CBR incident. They appeared more confident about dealing with contaminated patients

Table 9. Highest level of personal protective equipment (PPE) available to hospital staff at their institution

PPE level	Current study ($n = 76$)	Aitken (2002)[11] ($n = 61$)
Level A	5 (7%)	6 (10%)
Level B	11 (15%)	7 (12%)
Level C	34 (45%)	20 (33%)
Level D	18 (24%)	20 (33%)
Don't know	4 (5%)	5 (8%)
No answer	0	3 (4%)

from a chemical than a biological exposure, and less confident again for a radiological incident. This may reflect the perceived respective likelihood of an incident with each of these agents, and therefore the focus of any training or education that may have been conducted. It may also reflect prior experience with chemical (eg, industrial) and biological (eg, severe acute respiratory syndrome and "white powder") exposures, but little with radiological incidents.

Previous major incidents have repeatedly demonstrated that most people exposed to a chemical, biological or explosive attack bypass control measures such as triage and decontamination at the scene and self-present to hospitals.[13-16] Despite this, it is suggested that state disaster plans ensure that the more severely injured patients are directed to trauma centres by helicopter and ambulance, and the less injured be corralled or transferred by bus to smaller hospitals.[17] However, previous experience suggests that most of those injured leave the scene quickly, arriving at local hospitals by means other than ambulance, largely in the first 6 hours.[9] The US Centers for Disease Control and Prevention have warned that, in the event of an urban disaster, half of all casualties will arrive at hospital seeking medical care over a 1-hour period.[18] Two separate open-air terrorist bombings in Istanbul, Turkey, in November 2003 resulted in 33 deaths and injury to an estimated 450. One hundred and eighty-four patients presented to one hospital, all in the first hour after the incident, of whom 96 (52%) self-presented.[19] In the subway sarin attacks in Tokyo in 1995, fewer than 11% of those affected were transported by ambulance.[13] Studies of numerous disasters have also shown that most casualties are transported, by a variety of means, to the closest or most familiar hospitals, despite prior planning to distribute the patient load between centres.[14] Accordingly, hospitals cannot afford to rely on the controlled, orderly delivery of decontaminated patients from the scene by emergency services.[5,14] They also cannot assume that other emergency services or the military will be able to deploy resources to assist them, unless they have developed formal memoranda of understanding with them.

The vast majority of hospitals reported having a major incident plan, with most having a CBR annexure to that plan. However, it is naive to believe that a plan fulfils its function merely because it exists.[9] The optimum method of exercising major incident plans remains debated, and is influenced by the objectives of the particular exercise. A study by Johns Hopkins University was unable to provide a definitive statement favouring either field or tabletop exercises.[20] Our study found that at least 28% of hospitals had not been involved in either a field or tabletop CBR exercise in the previous 5 years, with a further 20% not answering at least one of these questions. Nearly half had not been involved in a tabletop CBR exercise in the previous 5 years, which increased to two-thirds of hospitals for a CBR field exercise. An essential component of education and exercises is interagency cooperation,[21-23] which reflects the multidisciplinary skill-mix and integrated approach needed in disaster management.[24] It is important to note that ambulance, fire, police and state emergency services were involved in a significant proportion of the exercises with hospitals, although the survey did not assess the nature or degree of this involvement for each.

There are significant difficulties in conducting exercises at hospitals, particularly field exercises. These include time constraints, cost and impact on service delivery, which are likely to be compounded by access block and emergency department overcrowding.[25,26] A Japanese study found that 73% of public hospitals stated it would be impossible to conduct exercises.[27] These difficulties may partly explain why Australian hospitals have not been more involved in local or multijurisdictional exercises, but it seems that many valuable opportunities have been lost.[28] Large-scale exercises have been held in a number of centres, addressing issues such as smallpox,[29] bioterrorism[30] and influenza.[31] In 2003, the largest Australian hospital-based field exercise involving contaminated patients — Exercise Supreme Truth — was conducted in South Australia. Despite extensive planning, interagency meetings, and additional funding for resources, such as a permanent mass decontamination facility, a number of significant deficiencies were revealed which had not been evident even in tabletop exercises held beforehand. We believe this further emphasises the integral role of exercises in the ongoing cycle of improvement in disaster planning. A number of recommendations were made, some of which have been implemented.[5]

There has been much debate as to whether hospital staff should be equipped with PPE to allow them to venture safely outside the hospital to assist with functions such as crowd control, decontamination, triage and initial treatment. In our survey, 43% reported that hospital staff would be expected to manage contaminated patients outside the hospital. This represents a significant increase from the 14% reported in a 2002 study,[10] and coincides with only a small increase in the number of departments with access to Level C or more sophisticated PPE from the level reported by Aitken in 2002[11] (Table 9). Forty-five per cent of hospitals reported that the highest level of PPE to which their staff had access was Level C, which is likely to reflect the provision of 180 Level C kits to each Australian state in 2003, which were then distributed between emergency service agencies and hospitals. In addition, it is likely that some hospitals reporting access to Level A or B also had access to Level C. However, according to Emergency Management Australia, Level C is appropriate only under specific conditions, as outlined in Table 10.[32] This information will not immediately be available to hospitals receiving contaminated patients, if at all. Although the Emergency Management Australia guidelines were developed for personnel operating within the zone of release of an agent, and not for persons outside that zone managing contaminated patients, no other Australian guidelines or standards have been established for the latter.

Hick et al have suggested that Level C PPE is appropriate for hospital staff, although recognising that the US Occupational Safety and Health Authority and other major regulatory bodies in that country have declined to specify what they consider to be an appropriate level for the health care sector.[33] In comparison, Garner et al questioned the assumption that patients presenting to emergency departments will be minimally contaminated, and recommended that medical personnel have access to Level B PPE.[34] If Level C PPE is considered to provide inadequate protection for hospital staff in such an environment, only 21% of Australian hospitals surveyed appear to have access to a more appropriate level.

The level of PPE available to hospital staff is only one of the issues. It is questionable whether adequate numbers of hospital staff could be trained (and maintain proficiency) to a level at which they could safely operate in a contaminated environment. Fewer than half the departments with access to Level C or higher PPE reported a formal process of accreditation of training for staff in the use of this equipment. In addition, over half reported that staff practice donning PPE less often than once a year, or never. Sending hospital staff into a contaminated environment, with little understanding of HAZMAT (hazardous material) principles, wearing PPE they have donned perhaps once or twice previously, is an enormous occupational health and safety issue. In the United Kingdom, chemical PPE and a training package (Structured Approach to Chemical Casualties) were distributed to hospitals in 2001. Nevertheless, two subsequent exercises with simulated casualties contaminated with a chemical agent found substantial problems with the donning of PPE by staff, equipment failure, leakage of suits, efficacy of patient decontamination, staff decontamination and manual handling.[35] If Level C PPE is deemed appropriate in this context, there needs to be an absolute commitment to a rigorous and sustainable training and maintenance program. The US Occupational Safety and Health Standard on Personal Protective Equipment (Standard 29 CFR 1910.132) states that "the proper use of PPE requires considerable training by a competent person", and that "wearing PPE without proper training can be extremely dangerous and potentially fatal". "Medical personnel who will decontaminate victims must be trained to the First Responder Operations Level with emphasis on the use of PPE and decontamination procedures (29 CFR 1910.120(q)(6)). The employer must certify that personnel are trained to safely perform their job duties and responsibilities".[36] It has been suggested that such certification be linked to specialty training, board examination, hospital privileges, and continuing medical education requirements.[37] Of note, during the Gulf War, 6.5 million gas masks were distributed to the population in Israel, with at least 13 deaths caused by simple misuse of these masks.[38]

Only a third of emergency departments had ready access to stockpiles of antidotes. This is likely to be of more concern in the response to a chemical exposure, when treatments are likely to be required much faster than after a biological release. The location of stockpiles remains controversial, with debate on ready clinical availability versus cost, security and strategic positioning. In the US, strategic approaches, such as "chempack" (containing nerve agent antidotes), aim to supplement local supplies, which still need to be maintained. These Strategic National Stockpile

Table 10. Levels of personal protective equipment (PPE)[32]

Level	Option 1	Option 2	Notes
A	Fully encapsulated suit with SCBA	–	Unknown levels, or known level mandates
B	SCBA and chemical protective suit or charcoal suit	Airline and chemical protective suit or charcoal suit	Known level, or risk assessment performed if level not measurable Positive pressure system
C1	Powered air-purifying respirator and chemical protective suit	Powered air-purifying respirator and charcoal suit	Known level of risk, or risk assessment performed if level not measurable Positive pressure system
C2	Air-purifying respirator and chemical protective suit	Air-purifying respirator and charcoal suit	Known and measurable level Negative pressure system
D	Work clothes (uniforms or overalls)	–	No hazard present or detected May require access to PPE at short notice if near "warm zone"

SCBA = self-contained breathing apparatus.

assets are delivered to the site within 12 hours of a federal decision to deploy, so are unlikely to be immediately available.[39] In Australia, the National Emergency Medicines Stockpile was established in 2002 and includes antidotes, antibiotics, PPE and ventilators. Antidotes to chemical agents that form part of this stockpile need to be stored at hospitals to allow treating clinicians to have ready and rapid access if they are to be used to any effect. Our survey did not formally address the size of individual hospital stockpiles, but it is likely to be a significant issue.

Further concerns are evident on examining some of the functional and logistic components of CBR planning at some hospitals. The level of PPE available to staff often did not correlate with the expectation that they would manage contaminated patients outside the hospital. Of the 33 emergency departments that planned to send staff outside, five had Level D PPE only, which appears inadequate by any standards, potentially putting staff at significant risk. A further two respondents were unaware of the level of PPE available at their institution. In addition, seven of these hospitals had not conducted any exercises in the previous 5 years. Five hospitals reported that they would be able to manage between 50 and 100 patients in the first 2 hours after a CBR incident, but one had access only to Level D PPE, and the other four each had fewer than 10 protective suits (although of a higher level). Two had not been involved in a field exercise in the previous 5 years. Three hospitals believed they would be able to cope with over 100 patients in the same time frame, although one had fewer than 10 PPE suits, and one had not had a field exercise in the previous 5 years.

These data raises significant doubt as to whether some hospitals' resources and training would allow them to achieve their perceived capability. Of the 12 respondents who believed their department would cope "well" in a CBR disaster, two had Level D PPE only, with no CBR exercise in the previous 5 years. Accordingly, we strongly encourage hospitals to look at the feasibility of conducting realistic field exercises that are designed to reveal their strengths and weaknesses. It is only by truly testing our plans that we can more realistically appreciate what is likely to work in a major incident, and what issues and modifications need to be considered. To claim preparedness without doing so appears naive.

Most respondents considered staff training to be their department's main funding priority, whereas funding already provided was most likely to have been for PPE or decontamination equipment. A single funding strategy for the provision of equipment to hospitals is relatively simple, but needs to be followed with ongoing commitment to maintenance and training as, without this, equipment is likely to be of little value.[40] Training of hospital staff needs to be urgently addressed, with a firm commitment from governments to support, resource and finance appropriate training programs. It has recently been suggested that the Australian health care system consider including a mandatory component of disaster management training for all health care workers, medical students and student nurses.[20] Similar calls have been made internationally,[41] including calls for the development of integrated multidisciplinary curricula based on core competencies.[42,43]

We believe our data highlight the need to further develop national standards in disaster planning and preparedness. The Australian Council on Healthcare Standards found that the emergency management systems in 26% of facilities surveyed in 2003 and 2004 required attention to ensure they adequately protected staff and patients.[44] The US Joint Commission on Accreditation of Healthcare Organisations (JCAHO) requires hospitals that offer emergency services to be involved in two exercises per year, at least one of which includes an influx of volunteer or simulated individuals. They must also participate in at least one community-wide practice drill annually, relevant to the priority emergencies identified by the organisation's hazard vulnerability analysis, which assesses communication, coordination and effectiveness of the organisation's and community's command structures.[45] In the UK, the chief executive of each healthcare trust is required to ensure that arrangements are in place to enable adequate training, planning, exercising and testing of emergency planning arrangements. The National Health Service Emergency Planning Guidance (2005.40) states that each trust is required to undertake a minimum of a live field exercise every 3 years, a tabletop exercise every year, and a test of communication cascades every 6 months. There are no such stringent regulations in Australia.

Criteria have been proposed for minimum preparedness for hospital emergency departments to evaluate and treat victims of a biological or chemical agent.[46] At present in Australia, there are no minimum standards of preparedness of hospitals for dealing with mass casualties from a terrorist incident involving either conventional or CBR weapons. The Australian Standard *Planning for emergencies — health care facilities* was approved by the Council of Standards Australia in 1997,[47] but has not been updated. It provides an overview of aspects of preparedness, particularly to internal emergencies, but little specific detail, and at no point refers to acts of terrorism or CBR incidents. The Australian Council on Healthcare Standards has developed a series of accreditation standards for health care facilities, one component of which looks at emergency management systems. It states that each organisation "needs to identify potential emergency situations that may arise either internally or externally in terms of consequence, exposure, probability and preventative actions and develop and imple-

Table 11. Suggested minimum standards for hospitals reasonably expected to receive and manage patients after a chemical, biological or radiological incident[50]

- Written policies on the evaluation and treatment of patients involved in a chemical, biological or radiological incident.
- Written memoranda of understanding with external agencies that, as part of their plan, are expected to provide support to the hospital in a CBR incident.
- Ability to decontaminate at least 10 ambulant and five stretcher patients per hour.
- An accredited program of training for staff in the use of an appropriate level of personal protective equipment if they are expected to manage contaminated patients as part of their hospital's plan. This needs to be supported by an ongoing process of regular credentialling.
- At least 25% of emergency department staff (medical and nursing) must have completed an accredited training course recognised by their state's department of health as being appropriate.
- All new full-time medical and nursing appointees to the emergency department must have completed an accredited training course recognised by their state's department of health as being appropriate, within the first 12 months of that appointment.
- All hospital administrators who may reasonably be expected to perform a significant role in their hospital's response to a mass casualty incident must have completed an accredited training course recognised by their state's department of health as being appropriate.
- Two exercises within each 2-year period, at least one of which includes an influx of volunteers or simulated individuals. Written reports from each must be provided to that state's department of health.

ment an appropriate emergency response system in consultation with relevant external emergency response organisations".[48] Again, it provides minimal practical detail, although it notes that it was released in 2002, with a new edition due in 2007.

Detailed standards need to be developed to enable hospitals to assess their levels of preparedness more accurately and to provide guidance on improvement. However, a 1996 study analysing the major incident plans of 142 hospitals in the UK found that only 4% actually complied fully with National Health Service guidelines.[49] Accordingly, we believe that these need to be linked to a formal process of hospital accreditation tailored to the likely role a given hospital would play in the response to a mass casualty incident. A key component would be the development of an accredited training program for hospital staff, which is relevant to their particular roles and environment and could train significant numbers annually. This needs to include hospital administrators, who may be expected to provide leadership and coordination in a mass casualty incident.[28] The standards should also include statements on decontamination facilities, PPE (including training of staff expected to manage contaminated patients) and exercises (such as those used by the JCAHO[45]).

In our survey, 72% of respondents believed their hospital would not be able to cope with more than 20 patients in the first 2 hours after a CBR event. We, as clinicians, administrators and community members, need to decide whether this is acceptable, while also considering the likelihood of such an event, potential outcomes and competing demands for funding. In line with this, we propose a set of standards for hospitals that could reasonably be expected to receive patients after a CBR incident (Table 11).[50] We recognise that different standards may need to be devised for different hospitals, depending on their likely role in any response. Once developed, the standards would need to be administered and enforced by a body such as the Australian Council on Healthcare Standards.

Limitations of this study include the self-reporting of data, with its inherent bias, and an inability to fully review functional aspects of the plans. There are a large number of aspects to disaster preparedness, and it was impossible to cover all in the detail we would have liked. The survey therefore concentrated on hospital planning and resourcing for mass casualty incidents, and the acute response to an incident involving the presentation of contaminated patients. We did not specifically assess the surge capacity of Australian hospitals, although a recent study has raised significant concerns in that area, and found that Australian hospitals did not meet US Department of Health and Human Services benchmarks for mass casualty incidents.[51,52] We also did not examine broader issues, such as the longer-term capability to manage patients, particularly after a biological exposure, and its related public health issues. We also did not assess the resources (eg, Geiger counters) available for managing patients exposed to a radiological incident, such as a "dirty bomb"; this needs to be further examined. In addition, it is likely that the capabilities of some hospitals have changed significantly since the survey was conducted. For example, erectable mass decontamination facilities (TVI Corporation, Md, USA) and ventilators have subsequently been distributed to a number of Australian hospitals. However, it is too easy to claim that our data are not representative of a particular state or hospital, or that they are outdated. If that is believed to be the case, then the onus should be on that body, and indeed the Federal Government, to openly and transparently prove it to be so. The potential ramifications of inadequate planning and preparedness, or that based on false assumptions, must not be underestimated.

Conclusions

The Royal Australasian College of Surgeons has warned that "as long as we continue to tackle planning response and recovery from disaster in an ad hoc fashion the greater the chances will be of bigger and more catastrophic outcomes. If there are massive casualties, our hospitals would easily be overwhelmed and swamped".[53] Hospitals will almost certainly play a significant role in the response to a mass casualty incident. It is clear that, at least in the initial stages after such an event, they will need to be largely self-sufficient. We believe that some of the results presented here raise concerns about the level of response that Australian hospitals would be able to provide. Accordingly, we need accurate information about the capacity of our hospitals to manage patients from mass casualty incidents.

A superficial assessment of CBR plans may give a false sense of preparedness, and a detailed and critical review is needed to truly determine the functionality of these plans. We found that the vast majority of Australian emergency departments considered further funding to be needed to improve CBR disaster preparedness, with training regarded as the major funding priority. A set of agreed national standards would help remove uncertainty over what can reasonably be expected of hospitals, and allow more appropriate and efficient planning, training and allocation of resources. An open process with honest debate among all interested groups is needed for this to move forward.

Our findings should not be regarded as criticism of the efforts of individuals and departments to improve disaster preparedness in Australia, but rather as an aid to recognising current strengths and deficiencies, and a guide for future strategies. Just as administrators need to support this process, clinicians need to be involved in the development of plans and guidelines, and to be aware of their role in a system-based approach to preparedness. Without this, not only our patients, but also the health care system and its staff, may suffer when a mass casualty incident occurs.

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Annex 6: Paper 3.2

FitzGerald G, Toloo S, Rego J, Ting J, **Aitken P**, Tippett V. Demand for public hospital emergency department services in Australia: 2000-2001 to 2009-2010.
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ORIGINAL RESEARCH

Demand for public hospital emergency department services in Australia: 2000–2001 to 2009–2010

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Abstract

Objective: Hospital EDs are a significant and high-profile component of Australia's health-care system, which in recent years have experienced considerable crowding. This crowding is caused by the combination of increasing demand, throughput and output factors. The aim of the present article is to clarify trends in the use of public ED services across Australia with a view to providing an evidence basis for future policy analysis and discussion.

Methods: The data for the present article have been extracted, compiled and analysed from publicly available sources for a 10 year period between 2000–2001 and 2009–2010.

Results: Demand for public ED care increased by 37% over the decade, an average annual increase of 1.8% in the utilization rate per 1000 persons. There were significant differences in utilization rates and in trends in growth among states and territories that do not easily relate to general population trends alone.

Conclusions: This growth in demand exceeds general population growth, and the variability between states both in utilization rates and overall trends defies immediate explanation. The growth in demand for ED services is a partial contributor to the crowding being experienced in EDs across Australia. There is a need for more detailed study, including qualitative analysis of patient motivations in order to identify the factors driving this growth in demand.

Key words: *Australia, demand, emergency department, public hospital, utilization trend.*

Introduction

Hospital EDs are a significant and high-profile component of Australia's emergency health-care system. The crowding of EDs has been extensively described[1,2] and linked principally to Access Block and bed shortages.[3–5] The causes of ED crowding are complex and caused by a combination of input (demand), throughput (e.g. patient processing) and output (e.g. access block) factors.[6] The focus of the present paper is to quantify the increasing demand for ED care over the past decade in Australia and explore possible explanations for this increase.

In recent years, increasing ED presentations have been reported by various government agencies.[7,8] This

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Table 1. Gross number of ED occasions of service in Australian public hospitals: 2000–2001 to 2009–2010

Year	Unit	NSW	Vic.	Qld	WA	SA	Tas.	ACT	NT	Australia
2000–2001	'000	1771	1144	1168	566	476	92	93	97	5407
2001–2002	'000	2003	1210	1220	561	469	101	95	95	5755
2002–2003	'000	1982	1261	1223	571	472	97	96	94	5796
2003–2004	'000	1986	1289	1248	580	461	101	97	102	5864
2004–2005	'000	2007	1318	1282	593	474	122	94	104	5993
2005–2006	'000	2137	1409	1304	629	496	134	100	120	6328
2006–2007	'000	2304	1468	1382	727	516	125	96	123	6741
2007–2008	'000	2418	1523	1471	778	544	143	98	125	7101
2008–2009	'000	2417	1538	1525	783	532	146	102	129	7172
2009–2010	'000	2443	1592	1578	823	555	159	107	133	7390
Total growth	%	37.9	39.1	35.1	45.5	16.6	73.3	14.8	36.7	36.7
Annual growth	%	3.7	3.8	3.4	4.4	1.8	6.6	1.6	3.6	3.6

ACT, Australian Capital Territory; NSW, New South Wales; NT, Northern Territory; Qld, Queensland; SA, South Australia; Tas., Tasmania; Vic., Victoria; WA, Western Australia.

is not unique to Australia but reflects similar trends in other countries in the western world, most notably the UK[9], the USA[10,11] and Canada.[12] However, the reported trends have not been successfully analysed for significance or meaning, nor have the factors influencing those trends been fully distilled so as to form a common platform for rational policy development.

This is the first report of a suite of investigations being conducted as the Emergency Health Services Queensland study. The overall intent of this project is to identify the factors underlying increasing utilization by analysing in detail the characteristics of users and their reasons for using EDs. These analyses will form the evidentiary platform on which to propose alternative service delivery models that might appropriately and safely manage future demand. The aim of the present article is to provide a clear basis for that further research by describing and analysing current trends in utilization.

Methods

The data for the present article have been extracted and compiled from publicly available sources for a 10 year period between 2000–2001 and 2009–2010. Ethics approval for the research was granted by the Queensland University of Technology Human Research Ethics Committee.

Data for public hospital EDs were extracted from the Australian Institute of Health and Welfare hospital statistics.[7] The hospital ED statistics are sourced from National Public Hospital Establishment Database, which contains summary data on 'Accident and Emergency Occasions of Service' for 'almost all' public hospitals since 1995–1996.[13] We have used the data for the period of 2000–2001 to 2009–2010 to analyse time trends in ED presentations for the purposes of the present paper.

Census data and estimates published by the Australian Bureau of Statistics (ABS)[14–17] were used to adjust the overall ED presentation numbers to population-based presentations (presentations per 1000 persons) for each state, and for explaining the patterns in ED presentations.

For the analysis, we used SPSS 18 (SPSS, Chicago, IL, USA) and MS-Excel 2007 (Microsoft, Redmond, WA, USA). Descriptive statistics were used to analyse the ED presentations and growth rates over the study period. We then calculated Spearman correlation to test the strength of yearly increase in ED presentations. In order to adjust for population growth, we analysed relative rate ratios (RRR) and 95% confidence intervals (CI) based on a Poisson regression model. This is a more powerful test to ascertain the variations in ED presentations per 1000 persons in each year relative to 2009–2010 (reference category). It also establishes whether ED presentation rates followed a statistically significant pattern in each state or territory throughout the decade.

Results

Increasing emergency department presentations

Australian public hospital EDs provided nearly 7.4 million occasions of service to patients in 2009–2010 compared with 5.4 million in 2000–2001 (Table 1). The

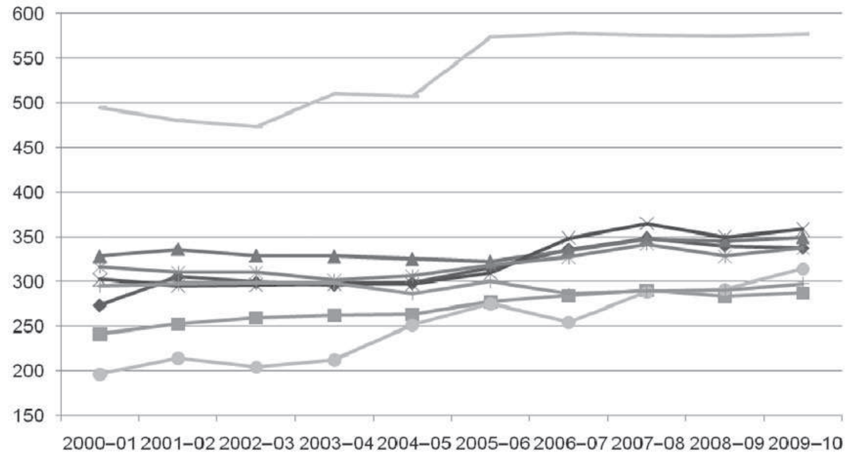

Figure 1. ED presentations per 1000 persons in Australian public hospitals: 2000–2001 to 2009–2010. (-◆-) New South Wales, (-■-) Victoria, (-▲-) Queensland, (-✕-) Western Australia, (-✱-) South Australia, (-●-) Tasmania, (-+-) Australian Capital Territory, (—) Northern Territory.

Table 2. Growth in ED presentations per 1000 persons in Australian public hospitals: 2000–2001 to 2009–2010

	NSW	Vic.	Qld	WA	SA	Tas.	ACT	NT	Australia
Total growth (%)	23.6	19.1	6.6	18.7	6.8	60.3	0.9	16.6	17.3
Annual growth (%)	2.5	2.0	0.7	2.0	0.8	5.7	0.1	1.8	1.8
Spearman correlation	0.84**	0.94**	0.56	0.84**	0.74*	0.95**	–0.14	0.85**	0.91**

*P < *0.05*, **P < *0.01. ACT, Australian Capital Territory; NSW, New South Wales; NT, Northern Territory; Qld, Queensland; SA, South Australia; Tas., Tasmania; Vic., Victoria; WA, Western Australia.*

total growth during this period was about 37% and the average growth was 3.6% per annum. The highest growth occurred in Tasmania (73%), whereas South Australia (SA) and the Australian Capital Territory (ACT) recorded the lowest increases (16% and 14%, respectively). Other jurisdictions had growth rates between 35% and 45%.

The impact of population growth alone is adjusted by examining the utilization rate per 1000 persons. The overall ED presentations increased from 282 to 331 per 1000 persons during the study period in Australia showing an average annual increase of 1.8% (Fig. 1). The rates were consistently highest in the Northern Territory (NT) and lowest in Tasmania, Victoria and the ACT.

Table 2 shows the growth rates in ED presentations per 1000 persons. Despite having consistently lowest ED presentation rates, Tasmania showed a surprisingly high growth rate during the study period particularly from 2004–2005, which might be partly due to the inclusion of data from Mersey Community Hospital, Latrobe, Tasmania, Australia. The ED data for this hospital were reported as a private hospital up to 2003–2004 and as a public hospital from 2004–2005 onwards. Similarly, Western Australia (WA) showed a spike in 2005–2006 onwards, which might partly be due to the inclusion of two new reporting public health units in 2004–2005 (p. 6).[18] Other states and territories have also experienced similar reporting arrangements to varying degrees in different years. The growths in the ACT and Queensland were not statistically significant.

Trends and patterns

The increase in ED presentation rates did not follow similar patterns (see Spearman correlations in Table 2). Tasmania, Victoria, NT, NSW and WA experienced strongly positive linear patterns; Queensland and SA followed non-linear (polynomial) trends, whereas the ACT's ED usage rate did not change significantly. A closer examination of the data (Fig. 1) shows that the ED usage rate reduced to a greater or lesser extent in most parts of the country in the years between 2001–2002 and 2004–2005 and again in 2008–2009. The ACT experienced statistically insignificant negative growth over the decade, whereas Tasmania, NSW, Victoria and NT recorded significant increases in ED presentation rates. Queensland maintained the highest presentation rate among the larger states, but it appears that the other large states are catching up.

The regression results also confirm the patterns described above (Table 3). Accordingly, Tasmania's ED presentations per 1000 persons in 2000–2001 were 38% fewer than 2009–2010 (RRR = 0.623, CI 0.618–0.628). This pattern remained fairly constant until 2004–2005, but increased and continued to grow thereafter. On the contrary, the 2000–2001 ED presentation rates were very close to 2009–2010 in the ACT (RRR = 0.978, CI 0.970–0.987), SA (RRR = 0.933, CI 0.929–0.937) and Queensland (RRR = 0.921, CI 0.919–0.923) throughout the study period with little fluctuations. The 2000–2001 ED presentation rates in other locations were around 20% lower than 2009–2010, but increased gradually through the period. Overall, the presentation rates fluctuated between 2002–2003 and 2005–2006 in all areas except Victoria, which had a steady increase throughout the decade.

Discussion

The present article describes the growth and trends in the usage of public hospital EDs in Australia. The demand has been consistently increasing over the last decade in all locations except the ACT and should form the basis for future planning. The ED utilization rate in Australia, which is currently 331 per 1000 persons, has been growing at an average of 1.8% per annum over the past decade. Not only do the rates vary between the various states and territories of Australia, but also the growth in the utilization rate varies. This increased utilization rate requires understanding so as to better map future trends to population and social change.

The so-called 'inappropriate users' or 'GP' (general practice) patients have been commonly blamed for the increasing demand for ED services,[19,20] and to some extent this is added to by clinicians who often take a professional perspective that ignores the patient view. Many studies use a combination of the triage categories 4–5 and non-admitted as an indicator of low-acuity patients who can be cared for outside the ED. However, the Australian Institute of Health and Welfare reports showed that the proportion in the Australasian Triage Scale (ATS) 1–5 have remained 'fairly stable' at around 1%, 7%, 31%, 47% and 13% of total presentations, respectively, between 2001–2002 and 2008–2009.[7] Similarly, the admission rates have also remained unchanged at around 79%, 61%, 40% 16% and 5% within triage categories 1–5, respectively.[7] It is recognized that there are significant issues in the consistency of the application of the ATS and variations in data consistency, which limit the interpretation of the significance of these changes. The ATS is also an imprecise estimate of appropriateness, imprecision drawn not only from the variability in its application but also from the nature of urgency and its relationships to other concepts, such as severity or appropriateness. Furthermore, admission rates can reflect something of the severity of the patient. However, admission rates are also impacted on by hospital policies and by other societal influences. Although it is not reasonable to extract from this information judgements about the appropriateness of ED attendances, it is at the very least possible to state that there is no evidence that increased demand or utilization is due to overuse by lower-acuity patients or 'inappropriate use' based on retrospective clinical judgements.[21,22]

The explanation for changes in ED presentations might also be attributable to the changes in demography. Australia has experienced population growth at an average of 1.6% per annum for the 10 years to June 2010.[16] This growth in population has been most prominent in inner city areas, outer suburbs, urban infill areas and along the coast. Areas that have seen population decline include inland, rural areas and mining areas. Inner city and outer metropolitan growth rates (where most hospitals are) have ranged from 3% to 8% per annum.[14,15,17] Thus, urbanization can explain some of the variance if there are different utilization rates between urban and rural areas. Such data on these variations are not readily available.

A small change in the median age of a population can have dramatic effects on public health services. The Australian population is also ageing. The median age of the Australian population has increased by 4.8 years over the last two decades. Tasmania experienced the largest increase in median age over the last 20 years, increasing by 7.8 years from 32.1 years in 1990 to 39.9 years in 2010.[14,16,17] Calculations based on ABS reports show that the population aged 65–84 increased at an average annual rate of 2.03% and 85-year-olds and over increased at 4.66% annually over the past decade.[16] It is assumed that the elderly are more likely to require health services, including emergency health services, than younger people.[23] However, the ageing might not necessarily explain the whole trend of increasing ED usage. For instance, although the ACT had the highest

Table 3. Relative rate ratios of ED presentations per 1000 persons in Australian public hospitals: 2000–2001 to 2009–2010

	Relative rate ratio (95% confidence interval)							
	NSW	Vic.	Qld	WA	SA	Tas.	ACT	NT
2000–2001	0.798 (0.797–0.800)	0.830 (0.828–0.832)	0.921 (0.919–0.923)	0.831 (0.828–0.833)	0.933 (0.929–0.937)	0.623 (0.618–0.628)	0.978 (0.970–0.987)	0.847 (0.840–0.854)
2001–2002	0.895 (0.894–0.897)	0.867 (0.865–0.869)	0.940 (0.938–0.942)	0.813 (0.810–0.815)	0.914 (0.910–0.917)	0.682 (0.677–0.688)	0.987 (0.978–0.995)	0.826 (0.819–0.832)
2002–2003	0.880 (0.878–0.882)	0.893 (0.891–0.895)	0.919 (0.917–0.921)	0.816 (0.813–0.818)	0.914 (0.910–0.917)	0.648 (0.643–0.654)	0.988 (0.979–0.997)	0.813 (0.806–0.820)
2003–2004	0.877 (0.876–0.879)	0.902 (0.900–0.904)	0.916 (0.913–0.918)	0.816 (0.813–0.819)	0.887 (0.884–0.891)	0.668 (0.663–0.673)	0.995‡ (0.987–1.004)	0.873 (0.866–0.880)
2004–2005	0.880 (0.879–0.882)	0.910 (0.908–0.912)	0.918 (0.916–0.921)	0.820 (0.817–0.823)	0.905 (0.901–0.908)	0.802 (0.796–0.808)	0.956 (0.947–0.964)	0.873 (0.866–0.880)
2005–2006	0.929 (0.927–0.931)	0.958 (0.956–0.960)	0.912 (0.910–0.914)	0.852 (0.849–0.855)	0.938 (0.934–0.941)	0.874 (0.867–0.880)	1.005‡ (0.996–1.013)	0.984 (0.876–0.891)
2006–2007	0.989 (0.987–0.991)	0.980 (0.978–0.982)	0.943 (0.940–0.945)	0.960 (0.957–0.963)	0.964 (0.961–0.968)	0.810 (0.804–0.816)	0.945 (0.936–0.953)	0.989 (0.982–0.997)
2007–2008	1.021 (1.020–1.023)	0.996 (0.994–0.999)	0.977 (0.975–0.979)	0.997‡ (0.994–1.00)	1.005 (1.001–1.009)	0.917 (0.911–0.924)	0.950 (0.942–0.959)	0.978 (0.971–0.986)
2008–2009	1.004 (1.002–1.006)	0.985 (0.983–0.987)	0.986 (0.984–0.988)	0.973 (0.970–0.976)	0.971 (0.967–0.975)	0.927 (0.921–0.934)	0.972 (0.964–0.981)	0.987 (0.980–0.995)
2009–2010†	1	1	1	1	1	1	1	1

†2009–2010 denotes reference year; ‡Not statistically significant; All others, $P < 0.01$. *ACT, Australian Capital Territory; NSW, New South Wales; NT, Northern Territory; Qld, Queensland; SA, South Australia; Tas., Tasmania; Vic., Victoria; WA, Western Australia.*

growth of 7.65% in the number of persons aged 85 and over, its ED presentation rates did not change significantly. Also, in a separate analysis of ED presentations at Queensland public hospitals, we found that the presentations per 1000 persons decreased for the over 60 age group in the 5 years between 2003–2004 and 2008–2009, but increased among the 0- to 14-year-old group.[24]

There might be a multiplying effect of changing community attitudes to elderly people (wanting to do more) and declining general practitioner availability or involvement in after hours care.[25] Population projections suggest increases in the proportion of the population over the age of 65, and this increased proportion is likely to have an ongoing impact on ED demand. Hence the ongoing efforts by various investigators to keep these patients out of hospital by increasing levels of support for homes or nursing homes.[25,26]

The drivers for this growth are likely to be multifactorial and encompass the factors that influence an individual's decisions to access EDs, broader population level socioeconomic factors, and health system funding, service provision arrangements, and availability, accessibility and affordability of alternative care. A recent comprehensive literature review detailed the collection of factors.[27] However, it is currently unknown how these factors contribute to the individual's decision to access these services. The relative impact of these factors on the observed variations in utilization rates, particularly in explaining interstate variances in Australia and the increases in utilization over time, is also unclear. Additional studies are needed to determine the profile of ED users and their reasons for the utilization of the services. The Emergency Health Services Queensland study is pursuing analyses of the effect of different factors on emergency health services utilization, including qualitative studies, using patient surveys.

Study limitations

The data presented for the above analysis were derived from publicly available sources. Variations in definitions, types of activities reported for ED occasions of services across jurisdictions, and the varying number of reporting hospitals across the time present significant challenges to comparing and interpreting the data from the major databases available.

Population data from the ABS are estimates for most years and vary from publication to publication. As such, our analyses might present a somewhat different picture to other reports that use a different source.

The presented utilization trends in the present article exclude data from private hospitals as they do not report to central data sources, and therefore a full picture of EDs' utilization is difficult to achieve. However, because the existing reporting arrangements are as accurate as possible and as they present whole population data, the relative impact of data inaccuracies and definitions is likely to be minimal.

Conclusions

The growth in demand for public hospital ED services in Australia results from a complex interaction of multiple factors. A greater understanding of these factors and their impact on ED demand is necessary to inform public policy in emergency health and in particular to inform strategies designed to manage the growth in demand.

Further research should most notably include and consider patients and carers as influential 'social actors' who actively make a decision to seek emergency health care. Although studies abound on health service utilization, health-seeking and decision-making behaviours in other aspects of health care,[28] such research has scarcely been applied in the context of using ED services.[29]

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Author contributions

GF and VT conceived the study. GF and ST prepared the first draft. ST and JR performed the statistical analyses and submitted the ethics application. PA, JT and VT critically reviewed all the drafts and analyses. All authors contributed to and approved the final manuscript.

Competing interests

None declared.

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Annex 7: Paper 3.3

Bradt DA, **Aitken P**, Fitzgerald G, Swift R, O'Reilly G, Bartley B. Emergency department surge capacity: Recommendations of the Australasian Surge Strategy Working Group. Academic Emergency Medicine, 16: 1350-1358

Emergency Department Surge Capacity: Recommendations of the Australasian Surge Strategy Working Group

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Abstract

For more than a decade, emergency medicine (EM) organizations have produced guidelines, training, and leadership for disaster management. However, to date there have been limited guidelines for emergency physicians (EPs) needing to provide a rapid response to a surge in demand. The aim of this project was to identify strategies that may guide surge management in the emergency department (ED). A working group of individuals experienced in disaster medicine from the Australasian College for Emergency Medicine Disaster Medicine Subcommittee (the Australasian Surge Strategy Working Group) was established to undertake this work. The Working Group used a modified Delphi technique to examine response actions in surge situations and identified underlying assumptions from disaster epidemiology and clinical practice. The group then characterized surge strategies from their corpus of experience; examined them through available relevant published literature; and collated these within domains of space, staff, supplies, and system operations. These recommendations detail 22 potential actions available to an EP working in the context of surge, along with detailed guidance on surge recognition, triage, patient flow through the ED, and clinical goals and practices. The article also identifies areas that merit future research, including the measurement of surge capacity, constraints to strategy implementation, validation of surge strategies, and measurement of strategy impacts on throughput, cost, and quality of care.

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Keywords: emergency medicine; disaster management; surge capacity

By the early 1990s, the World Health Organization, hospital associations, and other health bodies began to promulgate disaster management guidelines for hospitals.[1–4] Since 1995, emergency medicine (EM) specialty societies have contributed to this effort, and EM concerns are now common in the literature.[5–9] However, difficulties encountered in assessing the impact on EM have led to international calls for the development of standardized tools.[10] Guidance on prehospital management of mass casualties has been incorporated into standardized training curricula for over a decade in the United Kingdom and more recently in the United States.[11,12] In Australasia, a strategic plan for disaster medicine was published by emergency physicians (EPs) in 2003 with recommendations on developing standards for supply, equipment, and nomenclature relating to disasters.[13]

Critical to the management of mass casualties in emergency departments (EDs) is the ability to rapidly expand capacity to accommodate a sudden increase in demand.[14] Surge capacity has been defined and considered for selected hazards[15] with various models developed to predict the hazard-specific case load.[16,17] Guidelines have been published on hospital capacity to

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manage critical care patients from selected hazards.[18] A conceptual framework has emerged in the EM literature.[19] Generic recommendations have been published in relation to department staffing and hospital beds.[15] Altered standards of clinical care under disaster conditions have also been considered.[20] By 2006, a ''Science of Surge'' consensus conference in the United States, sponsored by *Academic Emergency Medicine* and the National Center for the Study of Preparedness and Catastrophic Event Response, differentiated between daily and extraordinary surge requirements and made further calls for the setting of benchmarks to trigger surge actions.[21,22] The American Medical Association and the American Public Health Association produced a consensus report from a leadership summit with eight generic recommendations on health system surge capacity. The report ultimately called for the establishment of common terminology and definitions and appealed to authoritative groups such as the Institute of Medicine to address health system surge capability.[23]

However, EM at present lacks agreed-upon strategies for tactical management of volume overload. A concise, authoritative, and practical set of management strategies is required. Such strategies become increasingly important in health systems that run at, or near, full capacity with access block, overcrowding, inpatient boarding, fully occupied beds, and ambulance diversion common.

The Australasian Surge Strategy Working Group (Working Group) was convened with the express purpose of producing a set of practical, scalable response strategies for EPs confronted with sudden excess demand arising either from a single mass casualty incident (MCI) or from the overwhelming demand of a ''bad day.'' This article offers recommendations for clinical management of these situations, as well as for future operations research.

WORKING GROUP METHODS

The Working Group consists of Australasian EPs drawn from the Australasian College for Emergency Medicine (ACEM) Disaster Subcommittee. ACEM appointed 12 members to the disaster subcommittee based upon individual disaster expertise, experience, and interest. Six subcommittee members self-selected to form the writers' group. Subcommittee members at large constituted the reviewers' group. Members come from all states in Australia and New Zealand. The members have diverse clinical, management, and academic backgrounds, with professional practice experience in a variety of hospital settings including academic, nonacademic, urban, and rural hospitals. The subcommittee corpus of disaster field experience includes relief operations in 21 countries and territories working for governmental, nongovernmental, Red Cross, and United Nations organizations, as well as clinical management of focal MCIs with dozens of injured survivors.

The Working Group undertook a modified Delphi technique[24,25] to examine response actions in surge situations. Core issues were explored in the biomedical literature using Medline from 1966 to 2007 implementing the key words ''disaster,'' ''surge,'' and ''surge capacity.'' Members of the group independently identified epidemiological and operational assumptions that underpinned EM surge situations. The assumptions were collated and then redistributed to the group. Once agreement was reached on the assumptions, the next round identified response actions—work practices under the control of the EP independent of prehospital and in-hospital constraints. These response actions were compiled within the domains of ''space, staffing, supplies, and health system.''[26] The overall strategy was collated into a draft written framework and collectively reviewed in February 2008. Unsettled issues led to further independent electronic review and framework revision until consensus emerged. All Working Group members supported the final recommendations.

PLANNING AND OPERATIONAL ASSUMPTIONS

In developing its strategies, the Working Group identified and agreed on a number of assumptions, both epidemiologic and operational, that underlie the approach to the management of major incidents.

Epidemiologic Assumptions

- Natural and transportation hazards are the most likely cause of disasters.[27]
- Daily variations in demand, without a single event, are the most likely cause of surge in EDs.[28]
- In the event of terrorist attacks, explosions using conventional weapons remain the most common cause,[29] with one-third of patients deemed critical, and two-thirds of patients treated and released from an ED.[30]
- Hazard-specific death rates will be low as even bomb blasts have been found to inflict a fatality rate of less than 5% on its victims.[29] Hence, almost all disaster-affected persons must be considered as potential survivors.
- Events may attract department visitors (media, VIPs, hospital staff, concerned families, etc.) far in excess of patients generated by the events.[31]
- The majority of patients will be ambulatory.[32] More specifically:
- The vast majority of casualties in a disaster will leave the scene spontaneously.[33] These patients are typically not triaged, treated, or transported by an emergency medical services (EMS) system, and they commonly arrive at the nearest hospital before the most injured patients.[34]
- Major events may yield patients with psychiatric symptoms far in excess of patients with organic symptoms. For example, in the Tokyo Sarin nerve agent attack, the ratio of psychiatric to organically ill patients was 4:1.[35]

Operational Assumptions

- EDs operate at full capacity at almost all times.[32,36–38]
- There will be little or no advance warning.[29,33]
- As most patients presenting as part of the surge following an incident will not have been transported by

EMS, they may have had no triage, decontamination, or treatment provided before arrival.[29]

- Approximately 50%–80% of the acute mass casualties in a disaster will arrive at the closest medical facilities, generally within 90 minutes following an event.[16] Other hospitals outside the area may receive few, if any, casualties.[34]
- There will be limited options in surge for patient diversion or transfer to another facility. Under standard operating procedures of local control, an ED may have the option to go on EMS diversion (bypass) during a typical busy day. However, an out-of-hospital MCI is considered likely to exclude that option. Moreover, under those circumstances, the EMS role in interfacility transfer of patients remains speculative, beyond control of the ED, and not considered an option.
- Preventing the physical entry into the hospital of persons seeking emergency care is not considered an option during surge. While the concept is theoretically relevant to selected chemical, biologic, or radiation hazards,[39] its rarity in clinical practice, its ethical challenges,[40] and its bureaucratic dependence on the hospital executives put it beyond the scope of this article.
- External deployable medical teams, portable hospitals, or portable decontamination units are not an immediately available response option for an affected hospital.[32]
- All attempts will be made to maintain normal standards of care.

FINDINGS

Findings of the Working Group are presented as an ED response framework in Tables 1 and 2. Table 1 identifies actions to be considered before the surge (preevent). Table 2 lists actions to be considered during the surge (event). The tables prioritize actions within categories of space, staffing, supplies, and systems. Key actions that differ markedly from routine work practices are considered in detail in the discussion. Actions with an asterisk apply particularly to the management of surge associated with a busy day unrelated to an MCI and are collectively considered at the end of the discussion.

DISCUSSION

The Working Group has identified several key principles that appear critical to the effective management of surge.

1. Recognizing Surge

Recognizing surge is the key to a prompt response. ED surge is a significant increase in the demands placed on an ED, given the normal capacity within which an ED can reasonably maintain standards of care. The surge may be reflected in rate of patient presentations, waiting times, patients queued, and ambulance diversions. A discrete, sudden mass casualty event makes activation relatively straightforward; however, a surge may occur without such declaration or in the absence of a discrete event. The

Table 1
Working Group Recommendations for Surge Management Preevent Priority Actions

SPACE
Clear the ED of all admitted patients with cooperation of inpatient units as feasible and the hospital executive as needed.*
Identify intra-ED expansible areas—corridors, transit lounge, short stay, fast track—for care of stretcher and sitting patients who can be cohorted.*
Identify and set up an extra-ED diversion area for stable, ambulatory, nonemergency patients.
Clear the waiting room of all patients fit for disposition to alternative providers.
Send admitted patients to a predetermined holding area (e.g., outpatients, short stay unit) to allow immediate decant, and have inpatient units pick patients up rather than ED staff perform transfer.
STAFFING
Allocate roles and distribute appropriate job action cards.
Determine meeting points for new staff to arrive and staff updates to occur.
Decide if or how the ED must modify its staffing model.*
SUPPLIES AND EQUIPMENT
Distribute premade ''disaster'' IDs, chart packs, x-ray, and lab slips.
Distribute tools for redundant communications—cell (mobile) phones, two-way radios, white boards, runners.
Call for extra patient trolleys and chairs so every patient has a place to lie or sit.*
Call for extra portable suction, ventilators, monitors.
Create at least one portable disaster trolley appropriate for each cohort area. Stock with items such as fluids, dressings, IVs, analgesia, antibiotics.
SYSTEM OPERATIONS (FLOW)
Notify EMS to arrange bypass of individual patients unrelated to the surge event.*
Co-locate triage and security staff to create triage-security surge team(s).
Preposition a surge team to the waiting room entrance.
Call rounds or make rounds to force clinical decision-making on remaining ED patients.*
Announce surge-induced goals of care and investigation and treatment processes.*
Place security at all entry and exit points to ensure access exclusively to patients and properly badged staff.
Announce intent to delegate extensively to free up the senior clinician(s) for decision-making purposes.*
Bring in early use of disaster patient tracking system and have a dedicated staff member keep this updated.
If recognized by the local system, invoke preestablished methods of utilizing alternative sites for patient disposition.

*Applies particularly to the management of surge associated with a busy day unrelated to a mass casualty incident.

Table 2
Working Group Recommendations for Surge Management Event Priority Actions

SPACE
- Maximize cohort care and minimize one-on-one care.*

STAFF
- Request surgical and critical care liaison points in ED
- Engage nonclinical staff (e.g., medical students) as runners, scribes, and patient transporters.*

SUPPLIES AND EQUIPMENT
- Have a team member dedicated to restocking supplies in main cohort areas, allowing staff in these areas to maintain clinical roles.*

SYSTEM OPERATIONS (FLOW)
- Delegate extensively. Your job is to make decisions, not gather data.*
- Make frequent rounds to geographic areas of cohort care.*
- Pursue an appropriate disposition even without a clear diagnosis.*
- Consider the use of Focused Assessment with Sonogram in Trauma (FAST) to assist early disposition.
- Limit contrast studies. ED staff read films, but insist on real-time reporting of studies as driven by patient instability or provider uncertainty.
- Minimize return of patients to the ED. A patient sent out of the ED for a special study goes with a provisional diagnosis and a disposition plan.

*Applies particularly to the management of surge associated with a busy day unrelated to a mass casualty incident.

Working Group focused its efforts on problems managing daily surge as well as single event surge from traumatic MCIs. The Working Group believes its recommendations provide a starting point for an EP managing a generic surge situation. In an "all-hazards" environment, the Working Group also acknowledges that prehospital hazards from chemical, biologic, and radiologic sources may require hazard-specific modification to the generic surge guidance provided here.

An understanding of the patterns of surge, including the previously listed epidemiologic assumptions, is critical to its identification and management. In these contexts, a hospital ED is more likely to be burdened by self-presenting patients and their families than by ambulance patients. Nevertheless, current literature emphasizes the numbers of available operating rooms (ORs) and critical care beds as major factors in determining a hospital's capacity to care for critically injured casualties.[30]

Planning for surge has led to numerous types of quantitative triggers. These include absolute numbers of patients dead or affected, overflow beds required as a percent of hospital baseline,[41] and numbers of patients per million of the host population.[42] The Working Group believes the simple metrics of numbers of presenting patients will be most familiar to EPs. Further specifics are detailed in Section 5 below.

2. Initiating Action

The Working Group believes that initial strategies must be initiated from the ED. While a "whole of institution" disaster plan activation may ultimately be necessary, the Working Group believes that properly timed surge strategies can prevent a surge situation from overwhelming an ED and escalating into a facilitywide disaster. The Working Group recognizes that different EDs under the stress of surge may use a separate capacity enlargement plan or activate components of their disaster plan, depending on local policy. Unfortunately, the Working Group also recognizes reluctance of EPs to initiate volume-triggered surge strategies—particularly for daily surge. As a result, "business as usual" commonly prevails.

3. Maintaining Patient Flow

There is a need to ensure unidirectional flow through the system and to avoid bottlenecks where possible.[43] The Working Group recommends that an EP consider a range of disposition options for patients in surge. An ED schematic with loci of application of different strategies is presented in Figure 1, which provides several functional insights into the scope of oversight of the attending physician. The convergence of staff and equipment in surge can impair free movement within the department and amplify problems of decontamination should breaches occur. Arrows in the figure convey how hospital spaces outside the ED may receive decanted or diverted patients as part of a surge strategy.

- Diverting inbound EMS patients is a well-recognized option, although it may require EMS resources beyond the control of the EP.
- Decanting ED patients—sending the "walking wounded" to another supervised part of the acute care area—may decompress the treatment area without incurring EMTALA liabilities. Ambulatory surge patients who appear well at triage may be escorted away from a chaotic waiting room and observed by appropriate staff pending detailed examination by a treating physician. Particular care needs to be taken, however, with the detailed examination of ambulatory patients following terrorist bombings, to ensure occult shrapnel injuries are not missed.[44]
- Discharge nonsurge, nonsick patients to community providers.

Overall, the working area of the ED enlarges with surge. Staff and crowd control must reach beyond the confines of the department's treatment areas. Reallocating resources specifically permits the department to preposition key functions of security and triage, as discussed below.

4. Setting Clinical Goals

Notification of a surge in demand should prompt immediate review of staff work practices in anticipation of increased workloads. At issue is not that they work faster or harder than normal, but that they work to a different goal. In these circumstances the clinical goal shifts from individual patient satisfaction to doing "the most for the most." This does not obligate a change in the standard of care, but does imply a change in the standard of service. Standards of service encompass amenities of care that become unsustainable in surge situations and frank disasters.[19,45] These changes are

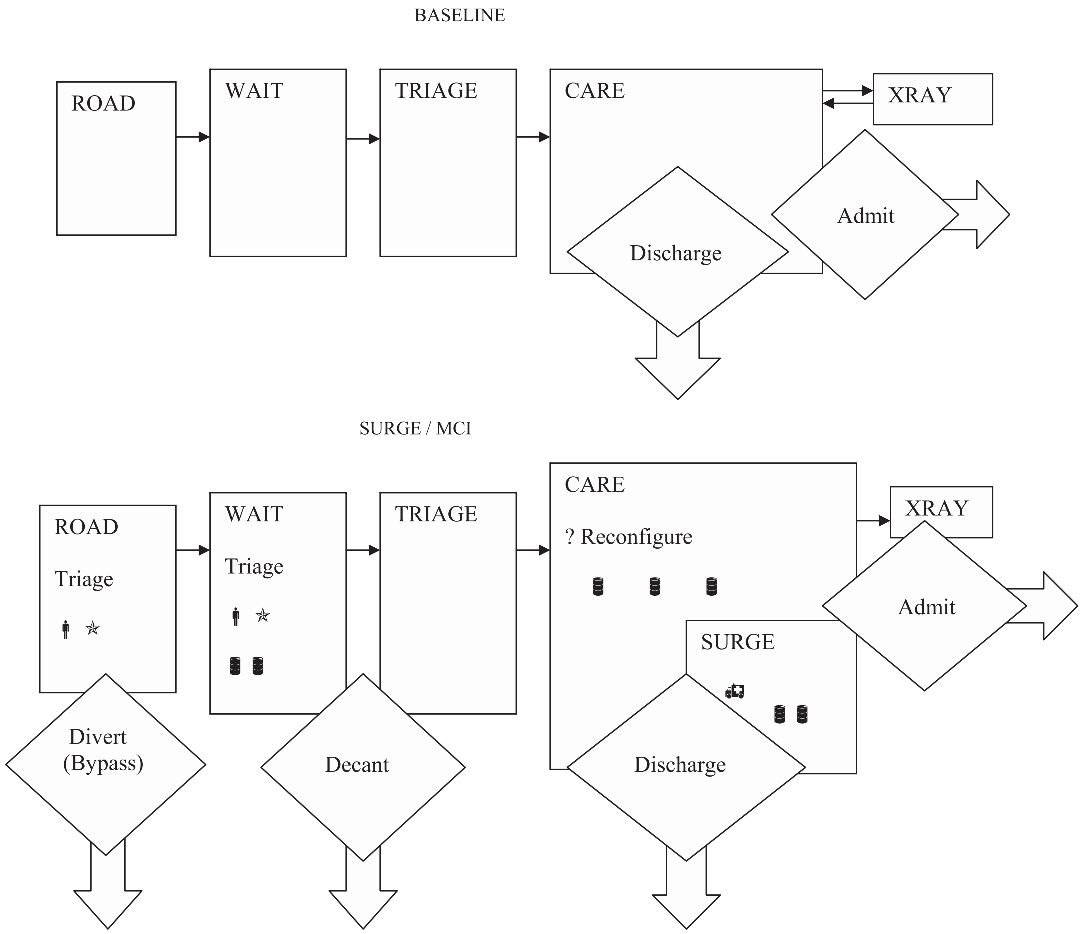

Figure 1. Priorities in surge augmentation. Physical spaces/places are depicted with capitals; recommended priorities for the ED supervising consultant and senior colleagues are depicted in lower case. ''CARE'' = patient care area/treatment cubicles and resuscitation areas; ''ROAD'' = roadside; ''SURGE'' = surge areas (e.g., short stay unit, fast track area, corridor); ''TRIAGE'' = triage area; ''Triage'' = advance triage; ''WAIT'' = waiting room; ''XRAY'' = radiology department; = redeployed senior ED staff member; = Security personnel; = extra trolleys/stretchers; = medical supplies and equipment; → = usual patient flow; ''Action'' = action to reduce ED patient number/workload; reconfigure = reorganize staff and cohort patients.

Table 3
Working Group Recommendations for Patient Priorities in Surge Settings

Patient Priority
1. Life threat
2. Limb threat
3. Other urgent bedside procedures (analgesia, splinting, dressings, etc.)
4. Disposition decision
5. Diagnosis decision
6. Patient comfort (access to stretcher, blankets, pillows, newspapers)
7. Visual and auditory privacy

listed in Table 3, for which a notional rank order is proposed. Senior staff members have the responsibility of articulating these practice changes to their junior staff and delegating appropriate tasks. Changes in the standard of care occurring through depletion of critical supplies or exhaustion of staff are beyond the scope of this paper.

5. Deploying a Surge Team for Advance Triage

Triage is fundamental to the efficient and effective management of multiple patients. Routine triage may be maladapted to ED needs in times of surge. Passive reception of patients at triage denies the ED the opportunity to control patient flow before it converges on the waiting room, invites contamination of the premises from patients with transported hazards, and delays initial clinical decision-making. Loss of crowd control in surge has been known to swamp a hospital within minutes.[46]

Triage and security are the lynchpins of the initial management of surge in the ED. Triage and security protect the ED from chaos and contamination and should also facilitate clinical care. In that context, triage and security must co-locate and work as a surge team. This may be as simple as one security officer and one triage nurse creating a surge team, or the team may enlarge with administrative and clinical staff.

The principal responsibilities of the surge team are to 1) ensure that the work environment stays safe from contamination, 2) divert nonclinical visitors to an appropriate non-ED destination, and 3) decant ambulatory patients (''walking wounded'') to a designated reception area. To these ends, the surge team must preposition itself ahead of the customary triage location. The numbers used in the graphic are illustrative and may differ between EDs dependent on staffing levels, bed capacity, and existing workload and occupancy. The key is to recognize the changes in practice associated with differing levels of demand and to maintain control of both patient entry to the ED and patient flow.

- With the anticipated arrival of fewer than 10 additional patients, the surge team prepositions itself at the entrance to the waiting room.
- If the waiting room is overloaded, or triage anticipates an imminent arrival of 10 or more additional patients, the surge team prepositions itself at the vehicle/ambulance entrance on the street.
- If a patient load far in excess of 10 patients is anticipated, then the surge team should consider curbside triage and close the street to through traffic.

The data set for decision-making by surge teams is visual. There is no documentation. Patients are directed to the decontamination area as needed, decanted to the designated ambulatory reception areas, or passed through to the routine triage desk. The Working Group believes that the most senior clinicians (whether doctors or triage nurses) best perform this role, and most naturally project the gravitas needed for crowd control.

This model may be seen as controversial and appear resource-intensive, especially to small departments. However, the Working Group believes that advanced triage is critical to the effective management of surges in demand in the ED. This is particularly so when multiple civilian vehicles converge on the ED or when mass transport of minor casualties to the hospital has occurred. The need for these prepositioned staff is generally short-lived, and the consequences of mismanagement are chaos and/or contamination of the department. The value of this approach was exemplified in the London bombings, where critical mortality was reduced by repeated effective triage, implementation of a hospitalwide damage control philosophy, minimal clinical investigations, and rapid transfer to definitive care.[47]

Decanting stable, ambulatory patients to an appropriate treatment area is a key task that contributes to both efficient patient care and crowd control. This concept is well recognized in basic disaster training,[12] but is uncommonly applied in ED settings. The Working Group believes that the near-simultaneous arrival of more than 10 ambulatory patients should prompt consideration of diversion to an in-ED ''fast track'' area or to an extra-ED ambulatory treatment area. To facilitate the movement of these ''green'' triage patients, we recommend a preestablished protocol with a dedicated hospital escort to assist with patient movement. One option is placing wide green adhesive tape (5 cm/2 inches wide) on the hospital floor to mark the path from the ED triage area to the decant area receiving ambulatory patients.

6. Providing Clinical Care

Emergency physicians typically focus on finding the pathology, but the demands of surge force the ED to find the ''unmade'' decision. Surge in demand should prompt clinical rounds of the ED to expose unmade decisions. In a small ED, this is easily organized, but in the large ED, taking all clinicians from their clinical duties to attend these rounds may be counterproductive, and different approaches may be necessary. Senior staff should regularly review patients under their care to ensure that timely decisions are made.

The Working Group recommends consideration of designated teams (one to two staff) for specific ED tasks—resuscitation, cohort care, bedside procedures, fluid and medication review, etc. A patient who is seriously ill or injured may require the attention of a resuscitation team. A patient not seriously ill or injured may be managed in a designated area of the ED by one of the dedicated teams. Allocation of individuals to specific tasks such as analgesia has been shown to be effective.[48]

One group of patients merits particular attention—the nondisaster/presurge patients. These patients may be easily marginalized by the demands of an incoming surge and its associated drama. Some of these patients may harbor serious pathology, but all of them call for clinical decision-making. For example, an ED with 50,000 visits/year may have 25 beds in geographically scattered domains—resuscitation, acute care, fast track, procedure room, etc. At any time, many of these beds may hold patients who have been triaged, assessed by a nurse, and are waiting for a doctor. The Working Group recommends that a senior clinician make quick bedside rounds on these patients to advance the decision process. Individual Working Group members have undertaken this action in concert with a charge nurse. They gather *all* the unseen patients' charts, lab reports, etc., and then proceed to bedside round on the waiting patients. After a brief explanation of circumstances to the patient, they sort out the chief complaint, perform a focused inspection, and order necessary studies. The process takes approximately 1 minute per patient. In the 25-bed ED hypothesized above, even where recent turnover places new patients in half the beds, the clinical team will substantively sight all the department's new patients in perhaps 12 minutes. Occasionally this process leads to immediate consultation and acceptance by an inpatient service—particularly for referred patients. After patients have been initially seen, nurses can play a major role in subsequent clinical decision-making by sharing clinical data with the treating physician as new data become available. The Working Group finds particular value in work practices that optimize information sharing in brief clinical encounters. Selected illustrative practices are listed in Table 4.

Within the ED, disposition to inpatient locations should also be enhanced. Early investigations and early selection of patients suitable for transfer to the OR and intensive care unit aid faster patient transit and preservation of both ED space and staff capacity. This also allows critically ill patients to spend minimal time in the ED and to access definitive care earlier.

The Working Group recommends that a patient needing hospital admission be so admitted on determination of that need and after stabilization of the patient's condition. By contrast, completion of a data

Table 4
Working Group Recommendations for Clinical Work Practices in Surge Settings

Do not interrupt the expression of the chief complaint
Chart as you listen
Order laboratory investigations necessary to make a disposition, not necessarily to make a diagnosis
Limit imaging, particularly contrast imaging, as much as possible
Put selected patients with a clear diagnosis and limited care needs (IV fluid, analgesia, antibiotics) under the care of a junior doctor
Make a disposition plan with a key family member present to optimize understanding and minimize redundant conversations

set, particularly involving laboratory or radiologic studies, considered routine in nonsurge settings, becomes counterproductive in times of surge. Successful implementation of this approach will require preexisting agreements with affected inpatient services.

7. Using External and Ancillary Personnel

The Working Group notes that surge in the ED from an MCI is likely to last only several hours. With the exception of small EDs, the call-in of additional clinical staff is often too slow to affect the immediate situation. While call-in lists should be pre-prepared and updated regularly, the Working Group finds staff shortage is rarely an issue. Surge situations are characterized more by resource maldistribution than by absence. In those circumstances, planning should include a ''corral point'' for arriving staff, and a buddy system that partners non-ED staff (medical, nursing, clerical) to work with existing ED staff or supervisors. Medical and nursing students are a source of additional workforce and may assist with minor interventions (IVs, pathology specimen delivery) or serve as message bearers or scribes.[44] Similarly, allied health staff are often neglected in surge planning, but may be able to fill a variety of valuable roles.[49]

8. Managing Surge Due to Variations in Daily Demand

The most common surge confronting EDs is the overwhelming demand of a very busy day aggravated by access block. The resultant crowding has been shown to be associated with adverse patient outcomes.[50–52] Selected actions in Tables 1 and 2 are marked by asterisks for their applicability to these situations in the ED. In effect, surge management on a busy day amounts to a simplification of the options available in an MCI. The key is forthright recognition of the problem and willingness to activate an appropriate response.

Some actions, such as ambulance bypass, are commonly undertaken. Other actions, such as clearing the department of admitted patients, may be precluded by access block and effectively may yield little in terms of new ED bed space. The Working Group focused on those particular work practices under the control of the EP—independent of prehospital and in-hospital constraints.

Depending on local conditions, various options may be most applicable in given circumstances. Not all options suggested in this paper may be available to all departments at all times. It is also recognized that many of the recommendations are generic and will need to be adapted to suit both local practices and resource constraints. Nonetheless, the Working Group believes that an EP with a ready list of options is best equipped to serve his or her patients in a surge situation.

FUTURE STEPS

The Working Group recognizes that these recommendations are simply the start of what needs to be a long-term effort to validate and optimize surge management strategies in EDs. Surge management is but one aspect of disaster management, and it will require the commitment of health and government leaders. The Working Group embraces the busy ED as a center for hospital clinical excellence and an opportunity for clinical education and operations research. To those ends, particular areas meriting future attention include:

- A more complete understanding of factors limiting ED surge capacity is needed to enable development of appropriate response strategies.
- How much surge capacity a hospital or health system should be expected to produce a priori remains unclear. Surge capacity benchmarks have been described in terms of percentage of usual bed capacity in Israel,[41] population ratio in the United States,[42] and absolute numbers of patient beds in other settings. Improved measures of population risk, agreement on performance indicators, and data transparency enabling assessment of preparedness are all future landmarks in the science of surge.
- Operational research into the kinetics of patient flow merits future attention. Researchers will likely adopt tools commonly used in lean systems such as bar coding, provider ID card readers, and software enabling full department schematic display. Metrics of interest include patient volumes in areas of surge, elapsed times associated with the patient flow in Figure 1, and outcomes of care.
- The effect of surge on quality of care also needs more study. Pioneering work in Australasia clearly shows excess mortality in patients presenting during periods of high ED occupancy.[51] While competence in medicine is case-related, volume overload in EM remains linked to patient outcomes. Surge strategies appear destined to become integral to the achievement of standards of care in overburdened health facilities. Clearer understanding of consequences of surge management will guide future efforts to refine the strategies.

SUMMARY

The Working Group believes that the identification of ''surge strategies'' for EDs can lead to quantifiable measures of disaster preparedness. This will facilitate measurement of progress by individual departments and allow comparison between departments in pursuit of improved patient outcomes.

The Working Group thanks the staff of the ACEM for their support in coordinating the meetings of the group.

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Surge Strategy Working Group Recommendations
Event Priority Actions

SPACE

- Maximize cohort care and minimize one-on-one care

SUPPLIES & EQUIPMENT

- Have a team member dedicated to restocking supplies in main cohort areas allowing staff in these areas to maintain clinical roles.

STAFFING

- Request surgical and critical care liaison points in ED
- Engage non-clinical staff (e.g. medical students) as runners, scribes, and patient transporters.

SYSTEM OPERATIONS (Flow)

- Delegate extensively. Your job is to make decisions, not gather data.
- Make frequent rounds to geographic areas of cohort care.
- Pursue an appropriate disposition even without a clear diagnosis.
- Consider the use of Focused Abdominal Sonogram in Trauma(FAST) to assist early disposition
- Limit contrast studies. ED staff read films but insist on real time reporting of studies as driven by patient instability or provider uncertainty.
- Minimize return of patients to the ED. A patient sent out of the ED for a special study goes with a provisional diagnosis and a disposition plan.

Adapted from: Bradt DA, Aitken P, Fitzgerald G, Swift R, O'Reilly G, Bartley B. Augmentation of hospital emergency department surge capacity: recommendations of the Australasian Surge Strategy Working Group. *Acad Emerg Med 2009; 16:1350-8.* Used with permission of John Wiley & Sons.

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Surge Strategy Working Group Recommendations
Pre-Event Priority Actions

SPACE

- Clear the ED of all admitted patients with cooperation of inpatient units as feasible and the hospital executive as needed.
- Send admitted patients without a bed to a pre determined holding area (e.g. outpatients, short stay unit) to allow immediate decant and have inpatient units pick patients up rather than ED staff perform transfer.
- Identify intra-ED expansible areas—corridors, transit lounge, short stay, fast track—for care of stretcher and sitting patients who can be cohorted.
- Identify and set up an extra-ED diversion area for stable, ambulatory, non-emergency patients.
- Clear the waiting room of all patients fit for disposition to alternative providers.

SUPPLIES & EQUIPMENT

- Distribute pre-made "disaster" IDs, chart packs, X-ray and lab slips.
- Distribute tools for redundant communications—cell (mobile) phones, 2 way radios, white boards, runners.
- Call for extra trolleys and chairs so every patient has a place to lie or sit.
- Call for extra portable suction, ventilators, monitors.
- Create at least one portable disaster trolley appropriate for each cohort area. Stock with items such as fluids, dressings, IVs, analgesia, antibiotics.

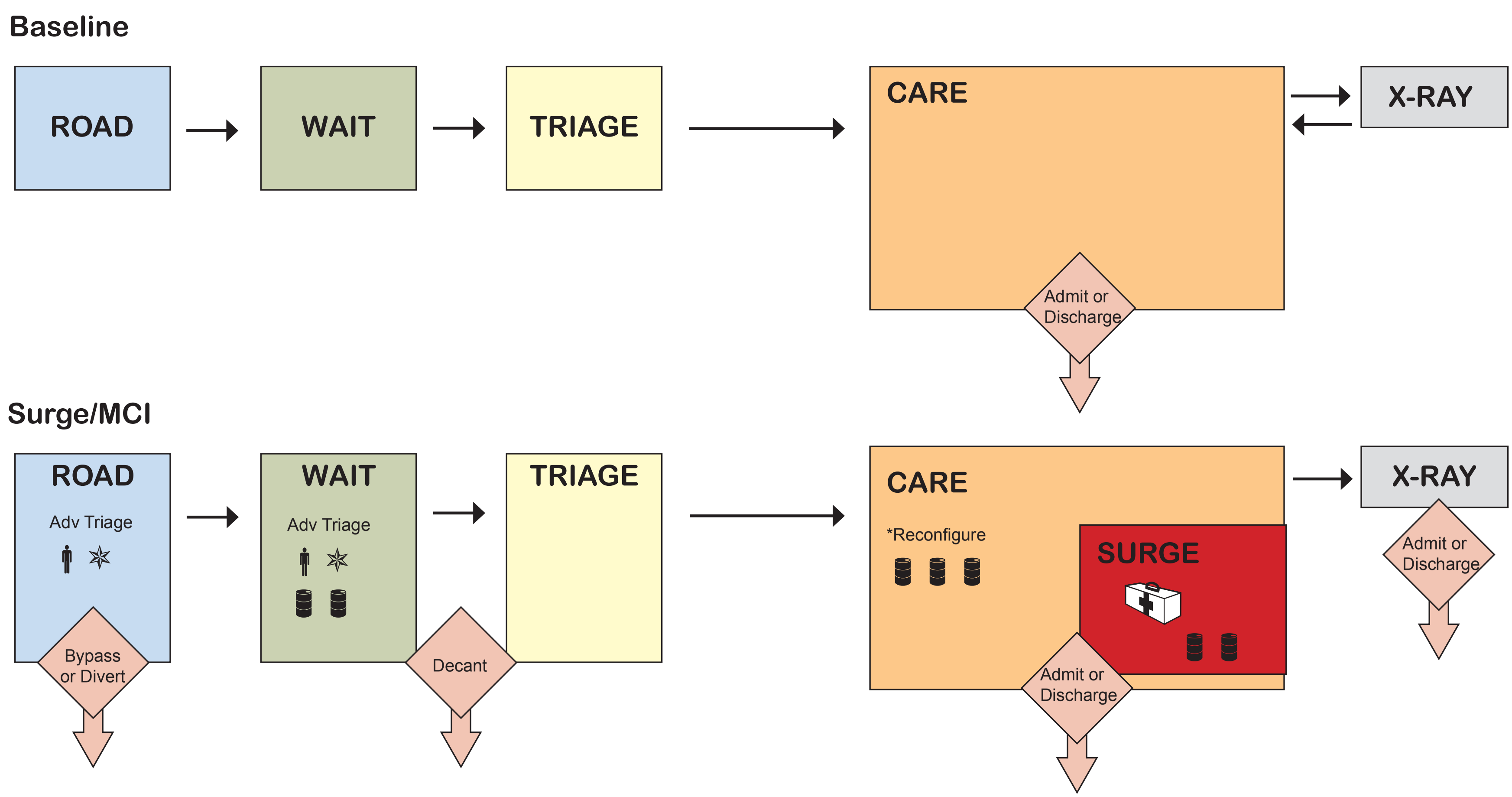
STAFFING

- Allocate roles and distribute appropriate job action cards.
- Determine meeting points for new staff to arrive and staff updates to occur.
- Decide if/how the ED must modify its staffing model.

SYSTEM OPERATIONS (Flow)

- Notify EMS to arrange bypass of individual patients unrelated to the surge event.
- Co-locate triage and security staff to create triage-security surge team(s).
- Preposition a surge team to the waiting room entrance.
- Use rounds to force clinical decision-making.
- Announce surge induced goals of care with truncated investigation and treatment processes.
- Place security at all entry and exit points to ensure access exclusively to patients and properly badged staff
- Announce intent to delegate extensively to free up the senior clinician(s) for decision-making purposes.
- Bring in early use of disaster patient tracking system and have a dedicated staff member keep this updated.
- If recognized by the local system, invoke pre-established methods of utilizing alternative sites for patient disposition.

PRIORITIES IN SURGE AUGMENTATION



Physical spaces/places are depicted with CAPITALS.
Recommended priorities for the ED supervising consultant and senior colleagues are depicted in lower case.
CARE = patient care area/treatment cubicles and resuscitation areas
ROAD = Roadside
SURGE = surge areas (eg. Short stay unit, fast track area, corridor)
TRIAGE = triage area
Adv Triage = advance triage
WAIT = waiting room
X-RAY = radiology services

= Re-deployed senior ED staff member
= Security personnel
= Extra trolleys/stretchers
= Medical supplies and equipment
= Usual patient flow
*Reconfigure = Re-organise staff and cohort patients

Annex 8: Paper 3.4

Rotheray KR, **Aitken P**, Goggins WB, Rainer TH, Graham CA. Epidemiology of injuries due to tropical cyclones in Hong Kong: A retrospective observational study. Injury 2012; 43 (12): 2055-2059.

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Epidemiology of injuries due to tropical cyclones in Hong Kong: A retrospective observational study

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ABSTRACT

Background: Tropical cyclones are huge circulating masses of wind which form over tropical and sub-tropical waters. They affect an average of 78 million people each year. Hong Kong is a large urban centre with a population of just over 7 million which is frequently affected by tropical cyclones. We aimed to describe the numbers and types of injuries due to tropical cyclones in Hong Kong, as well as their relation to tropical cyclone characteristics.

Methods: The records of all patients presenting to Hong Kong's public hospital emergency departments from 1st January 2004 to 31st December 2009 with tropical cyclone related injuries were reviewed and information regarding patient and injury characteristics was collected. Meteorological records for the relevant periods were examined and data on wind speed, rainfall and timing of landfall and warning signals was recorded and compared with the timing of tropical cyclone related injuries.

Results: A total of 460 tropical cyclone related injuries and one fatality across 15 emergency departments were identified during the study period. The mean age of those injured was 48 years and 48% were female. 25.4% of injuries were work related. The head (33.5%) and upper limb (32.5%) were the most commonly injured regions, with contusions (48.6%) and lacerations (30.2%) being the most common injury types. Falls (42.6%) were the most common mechanism of injury, followed by being hit by a falling or flying object (22.0%). In univariable analysis the relative risk of injury increased with mean hourly wind speed and hourly maximum gust. Multivariable analysis, however, showed that relative risk of injury increased with maximum gust but not average wind speed, with relative risk of injury rising sharply above maximum gusts of greater than 20m/s. Moderate wind speed with high gust (rather than high average and high gust) appears to be the most risky situation for injuries. Relative risk of injury was not associated with rainfall. The majority of injuries (56%) occurred in the 3 h before and after a tropical cyclone's closest proximity to Hong Kong, with relative risk of injury being highest mid-morning.

Conclusions: In tropical cyclone related injuries in Hong Kong the head and upper limb are the most commonly affected sites with falls and being hit by a falling or flying object being the most common mechanisms of injury. Hourly maximum gust appears to be more important that mean hourly wind speed in determining risk of injury. These findings have implications for injury prevention measures and emergency planning in Hong Kong and other regions effected by tropical cyclones.

Background

Tropical cyclones are "areas of very low atmospheric pressure over tropical and sub-tropical waters which build up into a huge, circulating mass of wind and thunderstorms up to hundreds of kilometres across".[1] They are also known as hurricanes, typhoons and cyclones in different areas of the world. Tropical cyclones caused 251,384 deaths between 1980 and 2000, and affect an average of 78 million people each year.[2]

Despite the huge burden of morbidity and mortality due to tropical cyclones, there is relatively little in the published literature on tropical cyclone related injuries. There is also considerable variation in the results of different studies describing the epidemiology of tropical cyclone related injuries. Several studies report crush injury from building collapse,[3–5] drowning[4–6] and fires[5–7] as important causes of morbidity and mortality. The majority of deaths and injuries have been reported as occurring

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during the impact phase,[4,6] whilst other studies indicate that more injuries occur during clean-up.[8,9] These apparent differences may be due in part to differences in methodology, but also due to differences such as quality of housing and early warning systems. There have been no previous studies looking at tropical cyclone related injuries in Hong Kong.

According to the United Nations Development Programme report on disaster risk, relative mortality risk from tropical cyclones is approximately 200 times higher in low-income countries than in wealthy industrialised nations.[2] Hong Kong is a densely populated urban centre in Asia which has seen rapid development during the past few decades and now has comprehensive and sophisticated systems for tropical cyclone warning, rescue and medical treatment. In the past tropical cyclones caused great loss of life as well as homelessness and loss of livelihood in Hong Kong. Over the past century, however, Hong Kong has been highly successful in reducing mortality from tropical cyclones. In the first half of the twentieth century there were two tropical cyclones which caused over 10,000 deaths each,[10] however, there have been only 503 deaths due to tropical cyclones in Hong Kong in the past fifty years, with only 71 of these occurring in the past 30 years.[11]

This was a retrospective observational study describing the epidemiology of tropical cyclone related injuries in the Hong Kong population and the relationship of these injuries to tropical cyclone characteristics.

Methods

Within Hong Kong most emergency care is provided in the public sector. Hong Kong now has 16 public hospitals which have Emergency Departments (EDs), with a mean average of 2,034,466 attendances per year.[12] When a tropical cyclone warning signal is raised in Hong Kong all EDs are alerted and activate the disaster module. Following this the ED triage nurse will enter any patient who has a tropical cyclone related injury into a database. This system has been in place since 2003.

A list of all patients presenting to any of the 16 public hospital EDs in Hong Kong with tropical cyclone related injuries was generated. The time period reviewed was from 1st January 2004 to 31st December 2009. These patients' records were then retrieved from the computerised medical system. The patients ED notes, inpatient and outpatient notes were reviewed and data recorded in an Excel® spreadsheet (Microsoft Corporation, WA, USA, 2007).

Data recorded were as follows: patient ED identification number, age, time and date of injury (where available), time of ED attendance, triage category, mechanism of injury, hospital, procedures/investigations performed, hospital admission, length of stay if admitted, occupation (where available), whether or not injury was work related, number of days off work recommended and any follow up or sequelae. Time of ED registration was used as a proxy for time of injury when analysing incidence of injury in relation to tropical cyclone characteristics.

Injury sites were recorded as head/face/neck; shoulder/arm/hand; chest/abdomen/back or hip/leg/foot. Types of injury were grouped as: contusion/abrasion; open wound (laceration/cut/stab/pierce); sprain; fracture; tendon laceration/rupture; nerve injury; intra-cranial haemorrhage; crush and amputation were grouped together as all the amputations seen were partial finger amputations due to crush injuries.

Data concerning the characteristics of each tropical cyclone affecting Hong Kong was obtained from the Hong Kong Observatory. Information on 60 min mean wind speed, maximum peak gust hour by hour, hourly rainfall and proximity to Hong Kong, as well as timing of issue and cancellation of typhoon signals 1, 3, 8, 9 and 10[13] were entered into an Excel® spreadsheet.

Statistics

All data was entered into Excel® spreadsheets. Descriptive statistics on numbers, types, mechanisms and timing of injuries were produced. Data on the characteristics and timing of each tropical cyclone was linked with patient injury data to show timing of injury in relation to tropical cyclone average hourly wind speed, maximum gust, rainfall, time of closest proximity to Hong Kong and timing of typhoon signals being issued. Poisson Generalized Additive Models were used to examine the relationship between tropical cyclone characteristics and risk of injury in order to take into account non-linearity and check the independent associations of closely correlated variables such as hourly average wind speed and hourly maximum gust. The R packages mgcv and dlnm were used for the modelling. Rainfall was square root transformed to reduce the influence of outliers. Smooth terms with maximum 4 degrees of freedom each were used to model the effects of mean wind speed, maximum hourly gust, and total hourly rainfall, whilst smooth terms with maximum 8 degrees of freedom were used for time of day and hours before/after landfall. The mgcv package then chooses the appropriate degree of freedom for each variable using cross-validation.

Results

The total number of attendances at public hospital EDs in Hong Kong from mid-2003 to mid-2009 was 12,206,797. During the study period there were injuries reported for 12 of the 29 tropical cyclones which affected Hong Kong[11] and a total of 460 people sustained tropical cyclone related injuries. The mean age was 48 years, with 221 (48%) of patients being female. Only eight injuries were reported in children under the age of 12, with those in the 40–49 year age group being most commonly injured ($n = 108$; 23.5%). 25.4% of injuries (117) were work related. Occupation was reported in 120 (26.0%) cases with the most common being security guards (21), drivers (15) and cleaners (12). No injuries were reported for ambulance crews or fire service workers, 5 police officers and 5 medical staff reported injuries.

The majority of injuries were minor, with 70.0% (322) being triaged as category 4 or 5, 27.2% (125) as category 3, and 2.8% (13) as category 1 or 2. There were 99 patients (21.5%) who required admission to hospital, with total hospital bed days being 930. One death was identified from hospital data, however, official figures report 10 deaths due to tropical cyclones during this period[11] which includes those declared dead on the scene. Time of injury was recorded for 156 patients (33.9%), with median time from injury to presentation being 55 min.

Injuries to the head (201, 33.5%) were the most common followed by upper limb injuries (195, 32.5%). The most common type of injury was contusion or abrasion (273, 48.6%) followed by laceration (170, 30.2%). Fractures accounted for 13.2% (74) of injuries. Falling due to slipping over, or being blown over by the wind was the most common mechanism of injury (196, 42.6%). Other common mechanisms of injury included being hit by a falling or flying object (101, 22.0%) and crush injuries caused by doors and windows (55, 11.9%).

In univariable analyses relative risk of injury was significantly related to average hourly wind speed, maximum gust speed, tropical cyclone landfall or closest proximity to Hong Kong and time of day but not to rainfall (Fig. 1). When multivariable analysis was used to assess the independent contribution of these factors the relative risk of injury increased with maximum gust but not average hourly wind speed (Fig. 2), with relative risk of injury rising sharply above maximum gusts of greater than 20 m/s. The adjusted relative risk for injury for an hour with maximum gust of 25 m/s vs. an hour with a maximum of 12 m/s (the study average)

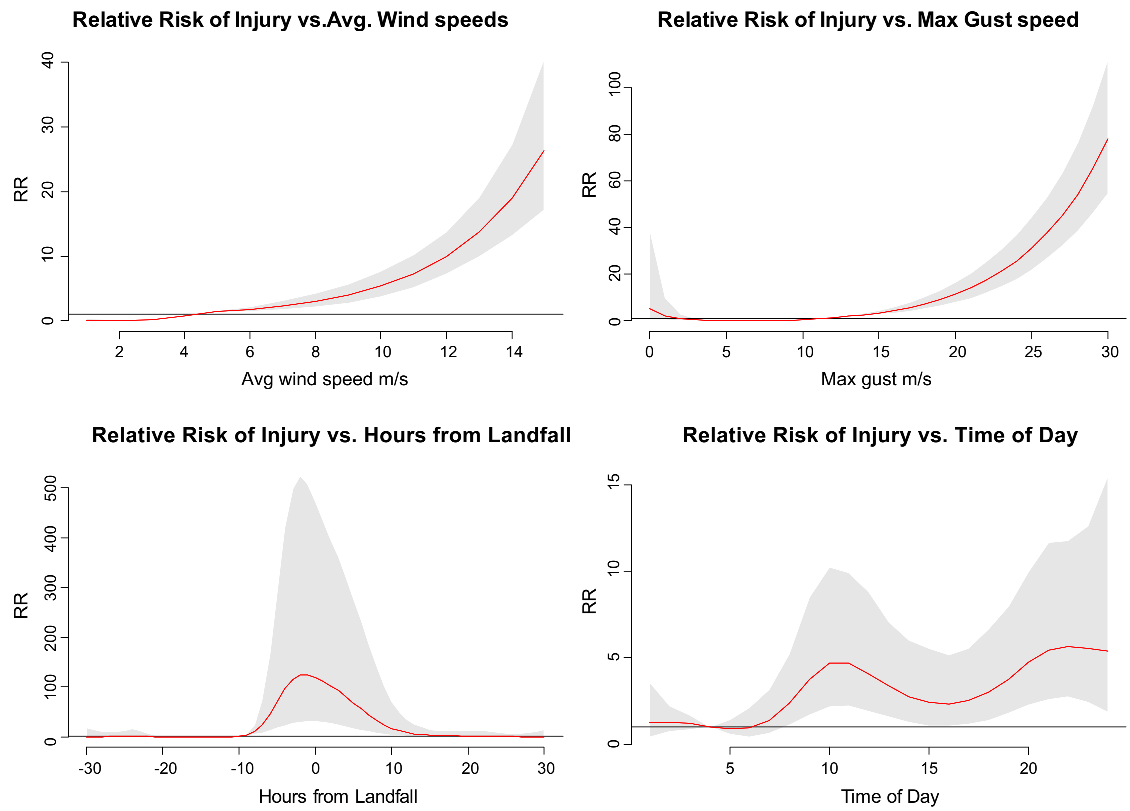

Fig. 1. Unadjusted GAM analysis for relative risk of injury and tropical cyclone characteristics.

was 23.8 (95% CI = 14.9, 39.0). Moderate wind speed with high gust (rather than high average and high gust) appears to be the most risky situation for injuries. The residuals from the multivariable model showed no autocorrelation. The relation of injury timing to both average 60 min wind speed and maximum gust is particularly well illustrated for Typhoon Nuri (Fig. 3), where a drop in number of injuries is seen in line with the drop in wind speeds when the eye of the typhoon passed over Hong Kong Injury.

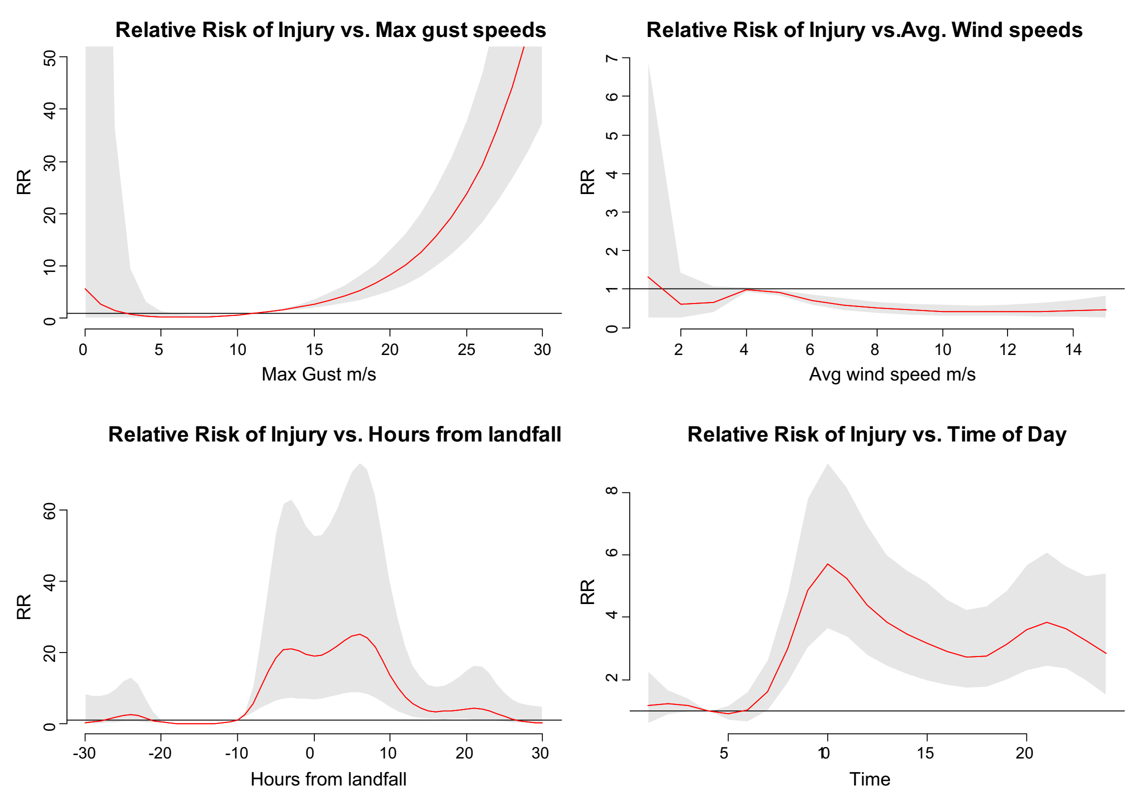

Fig. 2. Adjusted GAM analysis for relative risk of injury and tropical cyclone characteristics. (The reference time for time of day was 4 and for hours from landfall was −10. These were based on the times with the smallest number of injuries.)

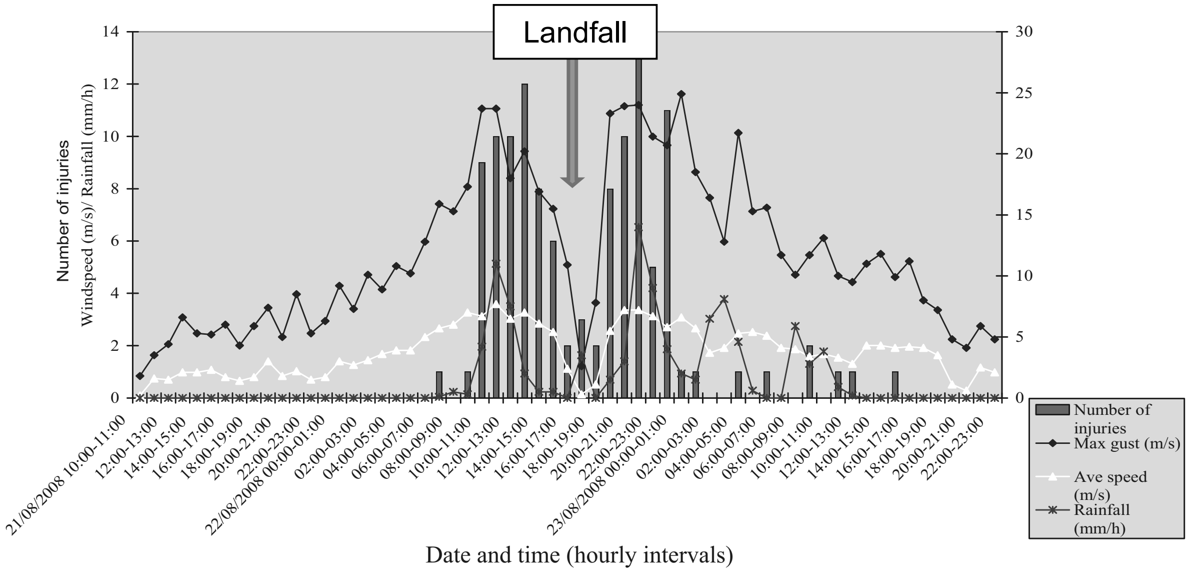

Fig. 3. Typhoon Nuri 17–23 August 2008.

Relative risk of injury was higher close to tropical cyclone landfall or closest proximity to Hong Kong (Fig. 2); 387/460 (84.1%) of injuries occurred within 6 h of the time of closest proximity to Hong Kong, 258/460 (56.1%) within 3 h and 112/460 (24.3%) within 1 h. The highest relative risk of injury was during the morning around 9 am–11 am with lowest risk during the early hours of the morning (2 am–6 am) (Fig. 2). The reference time for time of day was 4 and for hours from landfall was −10. These were based on the times with the smallest number of injuries.

Discussion

This is the first study of tropical cyclone related injuries in Hong Kong, and the first to study injuries in multiple tropical cyclones over a period of years. The number of tropical cyclone related injuries in Hong Kong is relatively low considering the high level of exposure to tropical cyclones.

The 40–59 year age group had the highest incidence of injuries, with very few injuries seen in children. These findings are similar to those in studies in Mainland China and Hawaii[3,7,14] but differ from some of the studies from the mainland United States where the age of peak incidence of injury was younger.[9,15]

A quarter of injuries were work related, which may indicate the need for review of arrangements for work attendance during tropical cyclones, as well as improved safety training and procedures for those who are required to work in all weather conditions (such as security guards). Given the large number of head injuries (33.5%) perhaps those who work during tropical cyclones should be required to wear helmets. No injuries were reported amongst either ambulance crews or fire service workers, and relatively few injuries (10) were reported amongst police officers and medical staff. This may be due to the strict safety procedures which are in place.

The admission rate in this study was 21.5%, much higher than that seen in other studies from the US (4%) [15] or Hawaii (2.9%).[7] This may be due to the large numbers of head injuries which might require observation prior to being sent home or different admission definitions and criteria.

In terms of mechanism of injury, the most common was falling (either due to slipping over or being blown over 42.6%), followed by being hit by a falling or flying object (22.0%), being crushed by a door or window (11.9%) and being cut by glass or a sharp object (10.0%). Future tropical cyclone warnings might include specific advice on securing objects on high buildings and on closing windows early during tropical cyclones. There is little consistency between studies as to the most common mechanisms of injury, part of which is due to differences in classifying mechanisms of injury. In mainland China, Gong et al.[3] report that being injured by flying debris and traffic accidents were the most common mechanisms whilst Shen et al.[14] found that 55% of injuries were caused by being cut or stabbed by a sharp object and that 40% of injuries occurred whilst shutting a door or window. In Hawaii, Hendrickson et al.[7] found that being cut or pierced by a sharp object accounted for 41.5% of all injuries. Traffic accidents accounted for only 5% of tropical cyclone related injuries in Hong Kong, in comparison with 18% and 23% in studies from the United States[15] and Mainland China,[14] respectively. The relatively high incidence of falls and relatively low incidence of traffic accidents may reflect patterns of motor vehicle ownership and use. Many people in Hong Kong commute using public transport and will travel home when a tropical cyclone warning is issued, with low rates of car ownership.[16] A prospective study which included detailed information on the exact mechanism of injury would enable more effective injury prevention strategies to be developed.

The majority of injuries (56%) occurred in the 3 h before and after the tropical cyclone was at its closest proximity to Hong Kong. This is similar to the findings of studies in mainland China.[3,14] Highest relative risk of injury was mid-morning around 9 am–11 am and lowest risk during the night and early hours of the morning (2 am–6 am) probably represent the numbers of people going outside during these periods. Tropical cyclone warnings focusing on encouraging people not to set out in the morning and encouraging employers to clearly notify employees when they are not required to attend work might help to reduce risk of injuries.

Relative risk of injury increased with mean 60 min wind speed and hourly maximum gust wind speed, but not with rainfall. This is consistent with findings from other studies.[3,14] The finding that times of moderate average wind speeds but high maximum gusts are the most risky may indicate that people are more likely to go outside at moderate average wind speeds not recognising the risk of injury from sudden high gusts. The finding that relative risk of injury rises sharply with maximum gust speeds of more than 20 m/s may enable adaptation of tropical cyclone warning systems to place more emphasis on maximum gust rather than average wind speed.

Limitations

This study will not have included those patients who did not come to a public ED for treatment, however the vast majority of emergency care in Hong Kong is provided within the public sector, and many private clinics close during tropical cyclones, so the study will have picked up the majority of patients with tropical cyclone related injuries.

It was up to each triage nurse to decide what constituted a tropical cyclone related injury, which may have led to inconsistencies in reporting. This study also describes the epidemiology of tropical cyclone related injuries and does not address any changes in non-injury based attendances during tropical cyclones. This may well be increased as a result of exacerbation of chronic illness, shortage of medication or limited access to other health care providers. Time of attendance at ED is used as a proxy for time of injury which may lead to some inaccuracies; however the median time from injury to presentation for those patients for whom time of injury was recorded was 55 min, suggesting that it is a reasonable surrogate for time of injury.

Conclusion

This is the first study looking at tropical cyclone related injuries in Hong Kong, and the first study to look at injuries from a series of cyclones affecting the same area over several years. In tropical cyclone related injuries in Hong Kong the head and upper limb are the most commonly affected sites with falls and being hit by a falling or flying object being the most common mechanisms of injury. Hourly maximum gust appears to be more important that mean hourly wind speed in determining risk of injury with moderate wind speed with high gust (rather than high average and high gust) appearing to be the most risky situation for injuries.

There was also increased relative risk of injury in the hours just before tropical cyclone landfall and during mid-morning time. Similar prospective studies would enable clarification of types and mechanisms of injury so aiding injury prevention strategies and future emergency planning in tropical cyclone prone regions.

Conflict of interest statement

None.

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Annex 9: Paper 3.5

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SPECIAL CONTRIBUTION

The Evacuation of Cairns Hospitals Due to Severe Tropical Cyclone Yasi

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Abstract

On February 2, 2011, Tropical Cyclone Yasi, the largest cyclone to cross the Australian coast and a system the size of Hurricane Katrina, threatened the city of Cairns. As a result, the Cairns Base Hospital (CBH) and Cairns Private Hospital (CPH) were both evacuated, the hospitals were closed, and an alternate emergency medical center was established in a sports stadium 15 km from the Cairns central business district.

This article describes the events around the evacuation of 356 patients, staff, and relatives to Brisbane (approximately 1,700 km away by road), closure of the hospitals, and the provision of a temporary emergency medical center for 28 hours during the height of the cyclone.

Our experience highlights the need for adequate and exercised hospital evacuation plans; the need for clear command and control with identified decision-makers; early decision-making on when to evacuate; having good communication systems with redundancy; ensuring that patients are adequately identified and tracked and have their medications and notes; ensuring adequate staff, medications, and oxygen for holding patients; and planning in detail the alternate medical facility safety and its role, function, and equipment.

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La Evacuación de los Hospitales de Cairns Durante al Devastador Ciclón Tropical Yasi

Resumen

El 2 de febrero de 2,011, el ciclón tropical Yasi, el mayor ciclón que ha cruzado la costa de Australia y del mismo tamaño del huracán Katrina, amenazó la ciudad de Cairns. Como resultado, tanto el hospital base como el hospital privado de Cairns fueron evacuados. Los hospitales cerraron y un centro de urgencias alternativo se estableció en un estadio deportivo a 15 km del distrito central de negocios de Cairns. Este artículo describe cómo transcurrió la evacuación de los 356 pacientes, el personal y los familiares a Brisbane (aproximadamente a 1.700 km por carretera), el cierre de los hospitales y la provisión de un centro médico temporal de urgencias durante las 28 horas del ciclón. Nuestra experiencia pone de manifiesto la necesidad de planes de evacuación hospitalarios adecuados y ensayados; la necesidad de control y órdenes claras con identificación de la persona responsable; la necesidad de una toma de decisión rápida de cuándo evacuar; de tener buenos sistemas de comunicación; de asegurar que los pacientes están adecuadamente identificados, localizados y que tienen sus medicaciones e historias clínicas; de asegurar un adecuado personal, las medicaciones y el oxígeno para asistir a los pacientes; y de planificar con detalle una alternativa médica segura y su papel, función y equipamiento.

There is increasing focus, being led by the World Health Organization (WHO), around disaster risk reduction, especially when it involves health facilities, in an attempt to reduce the loss of health care in disasters.[1] The literature suggests that hospital evacuations occur globally; however, there is a paucity of published data on policy,[2] and policies are often developed only after an event.[3–5] A recent report highlights the dangers of evacuating hospitals, even in developed countries, with more than 50 patients dying during or just after the evacuation in Japan after the Tsunami in 2011.[6] In Australia there are little, if any, published data on hospitals being evacuated, although in the Queensland floods of 2010 and 2011, five small (<50-bed) country hospitals had been evacuated and an additional four in 2011 and 2012.

On January 31, 2011, Severe Tropical Cyclone Yasi formed off Fiji. This developed into the largest cyclone to ever cross the Australian coast, with an eye more than 100 km wide and a storm size of 600 to 800 km diameter. The Australian Bureau of Meteorology predicted on February 1 that the cyclone would cross the Australian coast at Cairns, Queensland (NE Australia), at approximately 22:00 hours on February 2, coinciding with a high tide. It was also predicted that the associated storm surge could be as high as 7 m above the normal tide. Cairns Base Hospital (CBH) is located on the waterfront and was regarded as being at particular risk from storm surge. The Cairns Private Hospital (CPH) is 100 m from CBH. As a consequence of this, at 09:30 hours on February 1, the Premier of Queensland, Anna Bligh, announced a State Disaster Management Group meeting decision that CBH and CPH in Cairns would be evacuated. All patients not able to be discharged would be transported by air to Brisbane, approximately 1,700 km south. A full timeline of events is displayed in Table 1. A comparison to the United States of the distances involved, size of the cyclone, and the likely course of the cyclone when the decision was made is shown in Figures 1A through 1C.[7–9] Townsville (350 km south), as the closest major facility, was not considered, both to maintain surge capacity in North Queensland and to allow the concurrent evacuation of approximately 200 patients from waterfront Townsville nursing homes, also likely to be affected by the storm surge.

At 23:54 hours on February 2, this Category 5 cyclone with a central pressure of 930 hPa and gusts up to 285 km/hour crossed the coast at Mission Beach, approximately140 km south of Cairns (Figure 1D[10]). Cairns (latitude 16° South) is a city of approximately 151,000[11] in NE tropical Australia, situated 1,700 km north of the state capital Brisbane. The city has two hospitals, the public hospital, CBH (~300 beds), and the private hospital, CPH (~150 beds). They are situated 100 m apart and are separate organizations. CBH has the only emergency department (ED), with an annual census of 50,000 presentations, which includes pediatrics and adults. CBH has all services excluding cardiothoracics, neurosurgery, and urology. CBH is 50 m from the waterfront, and CPH 100 m, both on the flood plain. CBH has two blocks dating from the 1970s. Concerns have been recently raised about the structural integrity of parts of the older block (windows and window frames) with a category 4 cyclone. The ED is in the newest block, built in the 1990s, with a wind load rating for a category 4 cyclone for all structures, although there is no window protection present.

The Australian Bureau of Meteorology uses the Australian tropical cyclone intensity scale, which describes tropical cyclones ranging from 1 (weakest) to 5 (strongest) relative to the maximum wind speed, strongest gusts, and central pressure (Table 2).[12] This differs from the Saffir/Simpson Scale used in the United States, in that estimated 10-minute maximum wind gusts are used rather than 1-minute average sustained wind. A comparison of the two systems is shown in Figure 2.

Being in tropical Australia, Cairns experiences a cyclone every 2 to 3 years, and the region has experienced two Category 5 cyclones in the past 6 years.

Table 1
Timeline of Events Around the Evacuation of Cairns Hospitals

Day	Time	Event
January 31, 2011		Cyclone Yasi forms off Fijian coast
February 2, 2011	09:30	Premier Bligh announces plans to evacuate CBH and CPH
	10:30	ED starts planning and moving department to first floor
	14:00	Evacuation commenced
	14:00	Careflight air ambulance arrived to take one ventilated neonatal patient
	15:00	Royal Flying Doctor Service (RFDS) Townsville arrived to take two ventilated patients
	15:00	HEOC decision made to close entire CBH 07:00 February 2, 2011, and establish alternative care facility operational at 08:00 February 2, 2011
	16:00	RFDS Rockhampton arrived to take two critical care (one ventilated patient)
	17:30	Careflight Air Ambulance Lear jet arrived to take two ventilated adult patients
	18:00	RFDS Cairns departed with two ICU patients (one ventilated)
	18:30	RFDS Rockhampton arrived to take one ventilated ICU patient
	19:00	First patients moved from wards to ED staging post
	20:30	RFDS Brisbane to take four SCBU patients
	21:30	Arrival of RAAF aircraft two C-17s, two C-130s
	22:00	QANTAS chartered flight—parents, hemodialysis patients, mental health patients, medical escorts VIRGIN charter SCBU mothers
	22:25	RFDS Brisbane arrived to take three (two ventilated) SCBU patients
	23:30	Security authorized to review wards and closure once patients transferred
	00:40	Government jet to take nine obstetric patients
	03:20	RFDS Cairns departed with four neonates
	03:30	Careflight air ambulance arrived for five neonatal SCBU patients
	05:00	CBH cleared of all patients
	06:30	Last ADF flight departs
	08:00	Alternative care facility operational at Fretwell Park
	08:00	Last of 11 palliative patients transferred from airport to Atherton Hospital, inland ~100 km from Cairns
	09:00	RFDS Brisbane departed with four neonatal patients
	23:54	Cyclone Yasi core crosses coast
February 3, 2011	12:00	CBH ED reopens

ADF = Australian Defense Force; CBH = Cairns Base Hospital; CPH = Cairns Private Hospital; HEOC = Health Emergency Operations Centre; ICU = intensive care unit; SCBU = special care baby unit.

Emergency equipment is checked (generators, communications), and extra stores and resources are stockpiled at the beginning of each cyclone season (November through March). The hospital has a well-exercised process when a cyclone is likely to strike the region within 48 hours.

The hospitals' standard practice has been to discharge home all patients who can be and then shelter in place. Staff are rostered above the usual staffing levels, with the understanding that staff may be isolated in the hospital for up to 24 hours. Others are identified to be on call and to return to the hospital when able. Although there are plans to evacuate the hospital, the plans mainly revolve around evacuating wards or a wing of the hospital. There is a plan to evacuate the entire hospital, but only to a nearby congregation point. There were no plans to evacuate patients to Brisbane, close the hospital, and establish an alternate health facility.

In Queensland, the disaster management system is a legislated response.[13] The local government has the local disaster management group. This organization is responsible for the preparation for and management of a disaster. A number of local government regions are then collected together into districts based on police district boundaries. The local disaster management groups are supported within each district by a district disaster management group, which provides whole-of-government planning and coordination capacity to support local governments in disaster operations. This feeds to the state disaster management group, which is at a state government level. The state disaster group is the peak disaster management policy and decision-making body in Queensland, and it provides strategic direction and advice to the government. Membership of the state group is composed of representatives from government and nongovernment agencies at the senior officer level who have a significant role in disaster management. The federal government then supports the state disaster management group.[13]

The health disaster management system runs parallel to this with liaison at each level. Local health facilities feed into the local disaster management group with health service districts (and often larger referral hospitals) linking into the district group. A health incident controller (HIC) is responsible for the local health response and is supported by a Health Emergency Operations Centre (HEOC). The HIC reports to the state health coordinator who is supported by the State Health Emergency Coordination Center (SHECC), which also liaises with the state disaster management group.

METHODS

Data were sourced from postaction reports written by various departments and key individuals involved in

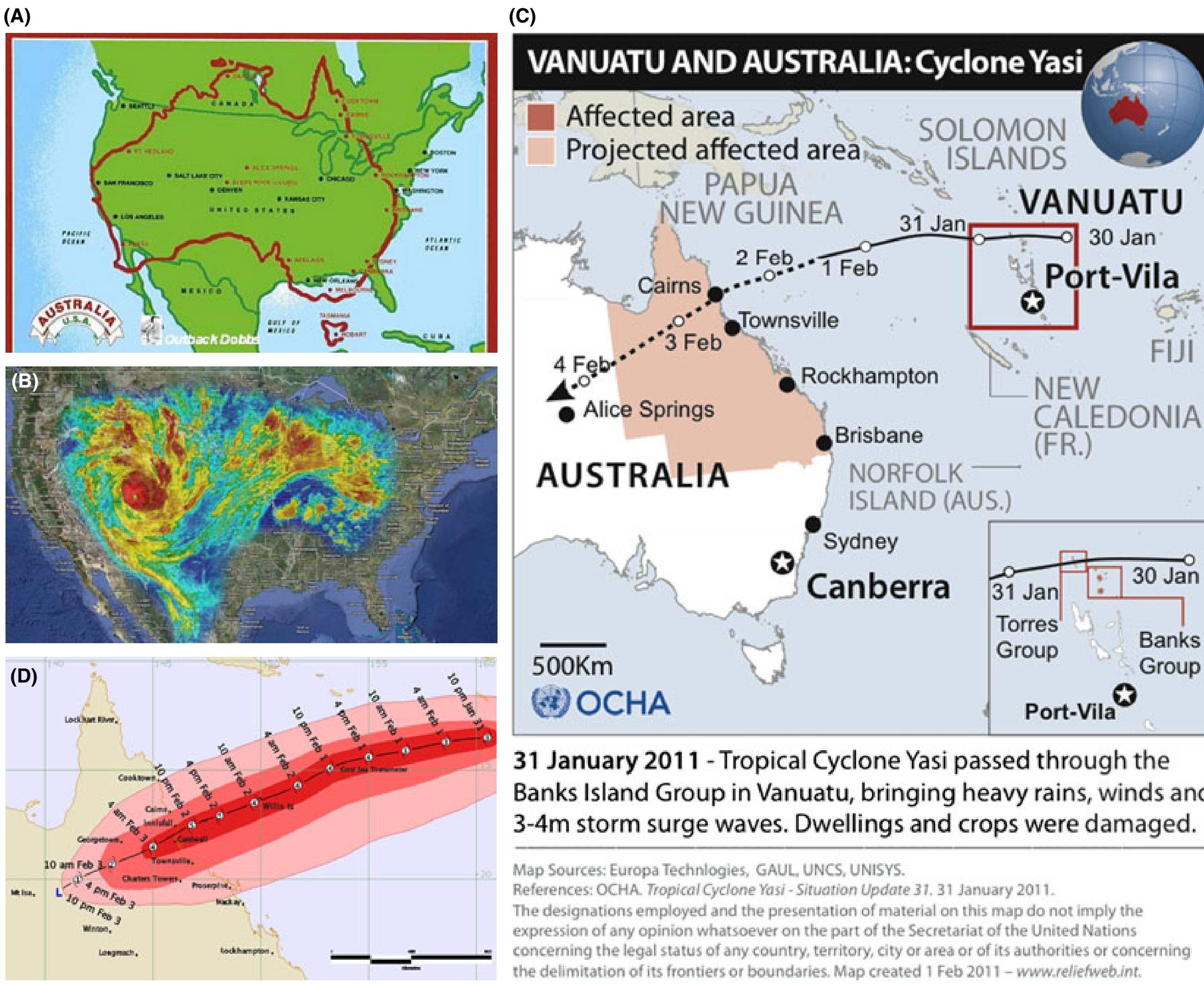

Figure 1. (A) Size of Australia compared to the United States.[7] (B) Size of Cyclone Yasi compared to the United States.[8] (C) Map of Australia and likely route of cyclone Yasi when the decision was made to evacuate Cairns' hospitals.[9] (D) The actual track of Severe Tropical Cyclone Yasi, from the Australian Bureau of Meteorology.[10]

Table 2
Australian Bureau of Meteorology Tropical Cyclone Intensity Scale[12]

Category	Maximum Mean Wind (km/hour)	Typical Strongest Gust (km/hour)	Central Pressure (hPa)	Typical Effects
1	63–88	<125	>985	Negligible house damage. Damage to some crops, trees, and caravans. Craft may drag moorings.
2	89–117	125–164	985–970	Minor house damage. Significant damage to signs, trees, and caravans. Heavy damage to some crops. Risk of power failure. Small craft may break moorings.
3	118–159	165–224	970–955	Some roof and structural damage. Some caravans destroyed. Power failures likely. (e.g., *Winifred*)
4	160–199	225–279	<930	Significant roofing loss and structural damage. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures. (e.g., *Tracy*, *Olivia*)
5	>200	>279	<930	Extremely dangerous with widespread destruction. (e.g., *Vance*)

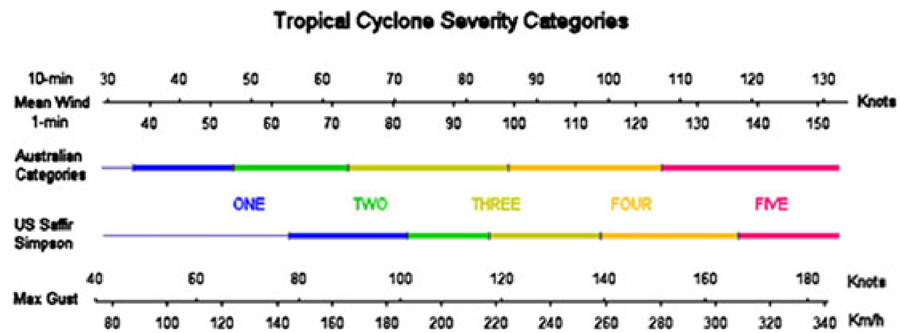

Figure 2. Comparison between the Australian and the U.S. tropical cyclone severity scales.[12]

Cairns and elsewhere in Queensland. The CBH ED staff summarized their experience and the reports and minutes from the department debrief were also accessed. CBH held a formal debrief, involving many staff at all levels of the organization, and these reports were also accessed. Authors on this paper, representing various agencies involved with the entire incident, provided summaries of their departments' debriefs. Lessons observed were derived from all debriefs. Data were also obtained from the Queensland government's media releases and media reports.

Using a standardized approach, all reports were reviewed and summarized by one author (ML) and reviewed by another (PA). This summary was sent to all other authors and comments were then added to the document. A search of the medical literature was also performed examining worldwide reports of evacuating hospitals, as well as policy documents from leading national and international organizations.

RESULTS

Evacuation

Cairns Response. Following the decision to evacuate, staff were notified by line managers, with other key personnel off campus also contacted by telephone and planning for evacuation commenced. The CBH cyclone and disaster plans had already been activated prior to this announcement, and the HEOC was established with the Deputy District Executive Director of Medical Services (also an emergency physician) appointed as HIC. All patients were assessed by their respective inpatient teams to identify 1) who was able to be discharged, 2) who was able to be transferred commercially, 3) who needed to be transferred on a stretcher, and 4) who needed to be transferred on a stretcher with a high level of care. High-risk community patients, such as home dialysis and advanced pregnancy, were also identified by treating teams and included in the evacuation plans.[14] Eleven patients with terminal conditions (mainly severe dementia or palliative care patients with metastatic disease) and not expected to survive for more than 72 hours were transferred by road to Atherton Hospital. Figures 3 and 4 describe the distribution of patients following the evacuation of Cairns Hospitals.

Each patient had a one-page summary of his or her condition, most recent investigations, medications, and a set of observations summarized. Each patient was identified with two patient labels. All patients were fed and given simple analgesia and preflight antiemetics. During this day there were 99 presentations to the ED. Three patients who presented, or who developed potentially life-threatening complications during the evacuation, were added to the list. They required intervention and management and the decision to transfer despite the potential risks. The three patients were: 1) a female in the labor ward with a postpartum hemorrhage requiring blood transfusion, with a hemoglobin level 66 g/L; 2) a female with a stable ectopic pregnancy, diagnosed in ED; and 3) an intubated male patient with an undifferentiated head injury post assault who was retrieved from Atherton (100 km from Cairns) to Cairns International Airport for transfer to Brisbane.

In addition to the coordination of the ongoing general primary health, community, public, and mental health services response to the disaster event, the SHECC was tasked with the coordination of the emergency evacuation of the Cairns Hospitals and transport of inpatients to Brisbane hospitals, where there was collective capacity to absorb the patients. This particular coordination activity was required to be planned, resourced, and completed within a 10-hour fixed time line.

The SHECC coordination components were assembled on the announcement of the evacuation and involved:

- Constant real-time communication between the Cairns Hospital, the SHECC, and the State Disaster Coordination Centre.
- A specialist clinical assessment team to assess and allocate mode of transport categories.
- A specialist air desk logistic cell headed by Retrieval Services Queensland, including Queensland Ambulance Service (QAS), Australian Defence Force (ADF), and commercial airline procurement capability to manage the various air medical and air transport missions. Retrieval Services Queensland coordinates approximately 18,000 air medical transfers per year across the state and had previous experience evacuating a number of smaller hospitals, including five in the previous month, but none were larger than 50 beds.
- A specialist patient flow planning team to place Cairns patients in appropriate accommodation in Brisbane hospitals.

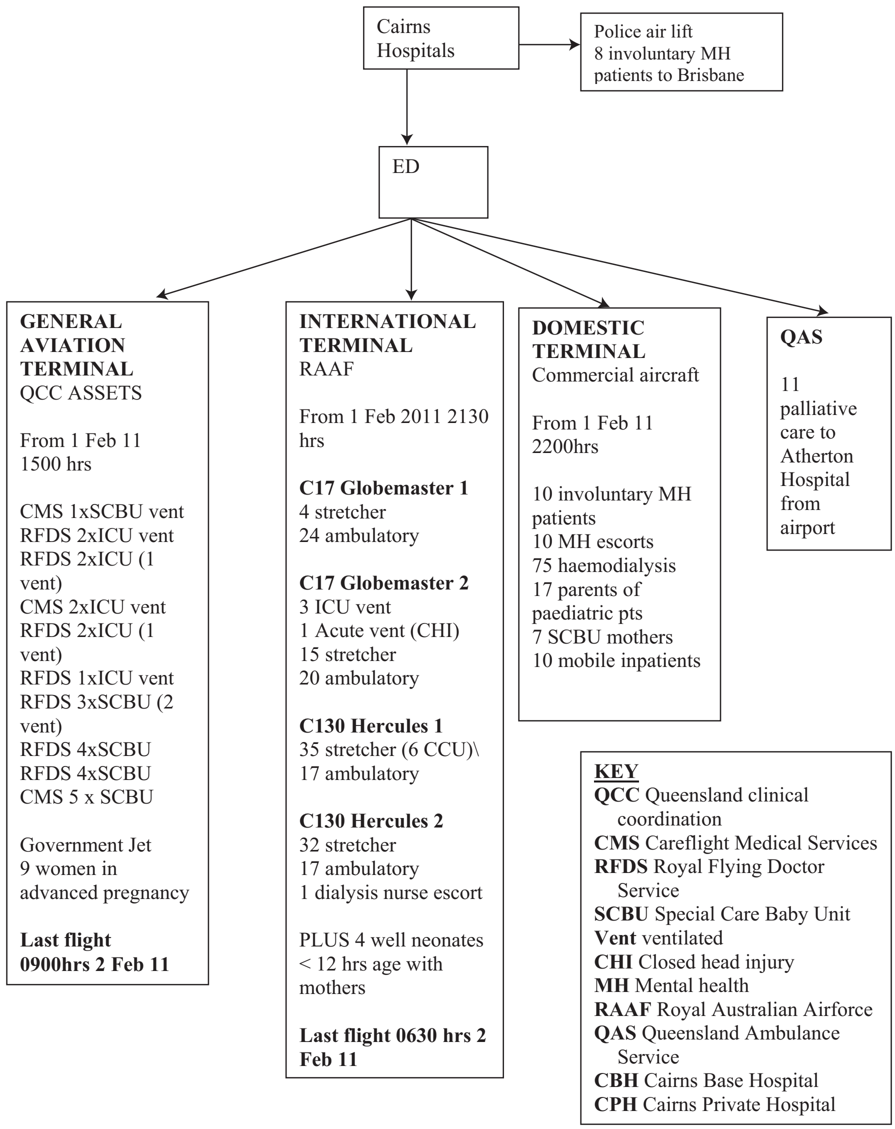

Figure 3. Disposition of patients: 26 from CPH rest from CBH.

- A patient repatriation planning team to manage the progressive return of patients to Cairns Hospitals during the recovery phase of the disaster event (over 6 weeks).

A Code Brown (an Australian disaster category signifying an external emergency) was declared in a number of South East Queensland hospitals. The two tertiary hospitals in Brisbane (The Royal Brisbane and Women's Hospital with 1,000 beds and The Princess Alexandra Hospital with 700 beds) were planned to accommodate approximately 100 patients each by enacting internal disaster plans. Nine hospitals, both private and public, were organized to receive (and did receive) patients from Cairns.

Evacuation Process

Patient manifests were developed electronically by CBH and CPH and sent to SHECC. This indicated the number of patients. The Royal Australian Air Force (RAAF) had paper manifests of all patients travelling on the military aircraft and this was given to the Tactical Medical Facility medical commander on arrival in Brisbane.

Patients and relatives being evacuated were brought from the wards to the ED, which was used as a staging facility. Here the patients were confirmed and then moved to the airport (~3 km away) using bus or ambulance. Patients were moved from the hospitals to link in with the planned departure of the aircraft. This commenced at approximately 19:00 hours and proved to be a difficult undertaking. It required close liaison with QAS in regard to the urgency of transfer and timing of aircraft departure. This was especially so in the early morning when there were still a significant number of patients requiring transfer from both hospitals, and some of the aircraft (both ADF and civilian) had departed.

Thirteen aircraft were used in the transport of 356 patients, staff, and relatives to Brisbane. These involved commercial aircraft, Royal Flying Doctor Service (RFDS) aircraft, Careflight Queensland Air Ambulance, the Queensland government jet, and four RAAF aircraft

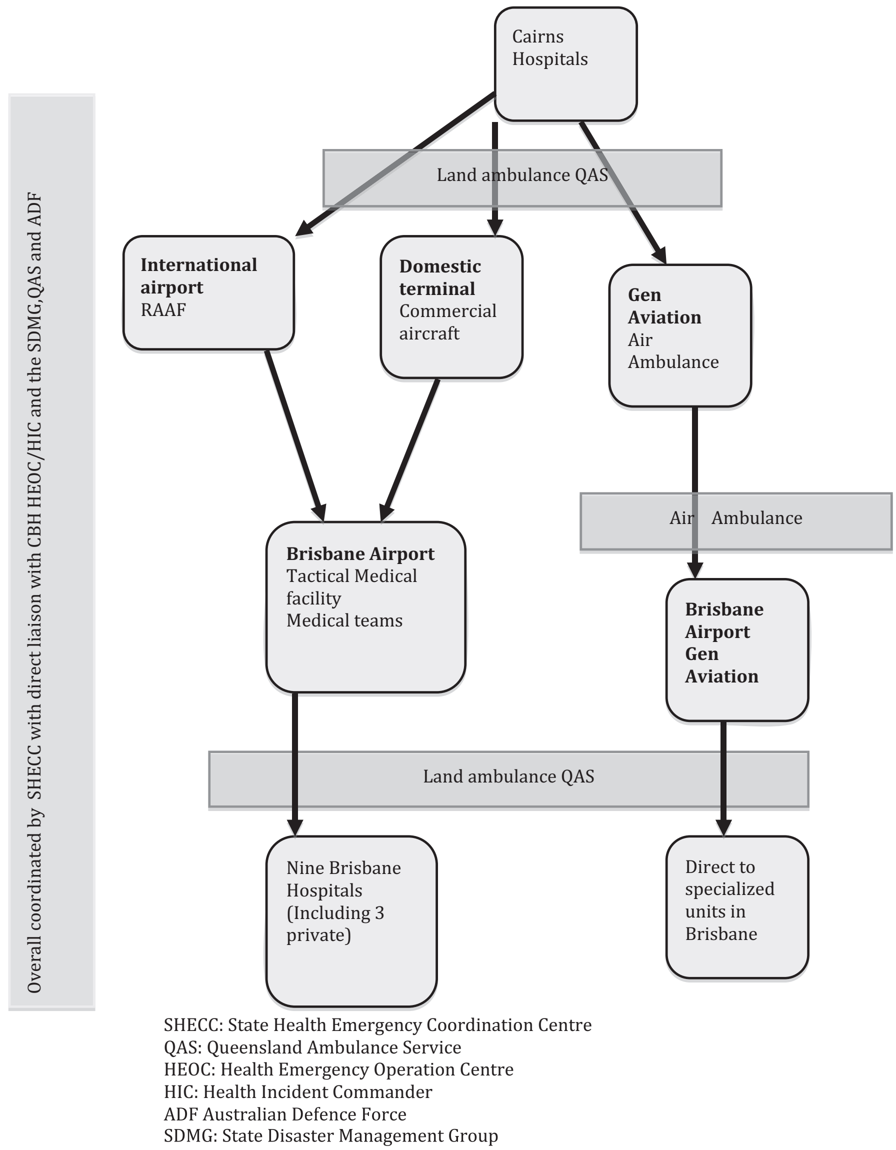

Figure 4. Flow of patients.

(two C-17 Globemasters and two C-130 Hercules). Figure 3 describes the case mix and numbers transported by various aircraft used in the evacuation.

Departure Points

Patients departing Cairns by commercial aircraft left from the domestic terminal, patients using smaller aircraft (RFDS, government jet, Careflight jet, police air wing) used the general aviation terminal, and the RAAF used the international terminal. This meant that there needed to be staff coordinating at three different locations. Medical and nursing staff were located at the domestic and international terminals, and medical escorts were with all patients transferred to the general aviation terminal. At the international terminal, there were approximately 50 QAS paramedics available.[15]

Domestic Terminal. The domestic terminal was a scene of chaos, with patients mixing with domestic passengers desperate to purchase tickets to self-evacuate from Cairns. There was some confusion with commercial airline staff, where the security and ticketing requirement for full identification, including escort names and date of birth (DOB), was an imperative. The commercial airline staff would also not issue tickets unless prepaid by Queensland Health. This was somewhat frustrating, especially for those mothers separated from their sick babies and children. After urgent liaison with SHECC, giving them the names and DOB of these passengers, tickets were issued. The last domestic flight left just after midnight.

General Aviation Terminal. This part of the evacuation ran smoothly as this is the normal process and terminal used, for patients transferring by RFDS or similar air ambulances. A total of 26 critical care Intensive Care Unit and Special Care Baby Unit patients were moved via Queensland's air medical emergency medical system assets, as well as the government jet.

International Terminal. There were no international flights due that evening, so the International Airport check-in lounge, with the permission of the Cairns Airport Authority, was used to stage patients waiting for arrival of aircraft. It provided shelter and limited toilets and seating. Further equipment, drinking water, medications, and dressings were sent from the hospital as required. There was a limited oxygen supply, mainly cylinders supplied by the QAS. Problems included the lack of food for patients; the temperature inside the lounge, as the air conditioning was initially turned off with no flights expected; limitations on the number of power points to charge monitoring equipment; and limited patient trolleys. QAS ambulances cycled between the hospitals and airport, bringing extra staff with the patients and a number of trolleys from the ED.[15]

Once the RAAF arrived, the patients were reviewed by the RAAF Senior Medical Officer and the CBH Medical Commander, who fortunately had a preexisting working relationship, being involved in Australian Medical Assistance Team training courses and the Pakistan floods deployment in 2010.[16] Once patient identification, destination, and condition were confirmed, the patient was moved to one of four aircraft. During this entire process there was excellent cooperation between the ADF, QAS, State Emergency Services, Airport Fire Service, employees of the Cairns Airport, and medical and nursing staff from both the CBH and the CPH.

The RAAF aircraft were staffed with military medical personnel (mainly RAAF evacuation teams) and staff from the RFDS Brisbane and a Brisbane ED. The aircraft were configured for medical evacuation, although they did not have as much oxygen as was required for transfer. There was limited food, but all patients had been fed prior to leaving the hospital.

We were fortunate that the mobile phone network and Internet remained operational throughout the evacuation and use of radios was not needed. The lead in each of the areas (CBH, the ED, and the international airport) had a liaison person assigned. The Internet remained operational and allowed for direct written communication to SHECC in Brisbane.

The last RAAF flight left at 06:30 hours and the last RFDS flight out of Cairns was 09:00 hours. This was the last aircraft to leave Cairns before the airport was closed. The cyclone crossed the coast at 23:54 hours on February 2, 2011.

Reception of Patients in Brisbane

In close liaison with QAS, a tactical medical facility was established at Brisbane Airport to provide a staging post for stretcher patients while awaiting loading into QAS road ambulances. All patients arriving by the RAAF or commercial flights were retriaged by medical teams and liaised with SHECC who had preidentified to which hospital each patient would be transferred. Coordinated movement of patients by QAS road ambulance and buses was facilitated by the State Disaster Coordination Centre and local emergency services, transporting patients to their allocated destination hospitals in the southeast corner. Patients were transferred to nine hospitals, both private and public. All patients survived the flight and were not subject to any reported complications.

Ongoing Provision of Care to the Cairns Community

1. The ED. Planning for movement of patients and assessment of staff commenced following the announcement of Code Brown at 10:00 hours. This complex situation involved an initial assessment of the department activity, initial plan for relocation of ED to the first floor, the movement of current patients, and staff availability for the next 36 hrs.

Contact was made with all staff, either directly or by phone. Most staff found the decision difficult, balancing the needs of their own families with that of the community. This was especially so with the media and public advice from the State Disaster Management Group to leave Cairns.

During the afternoon of February 1, the ED was relocated to the recovery area on the first floor (on level above the ground floor). At 15:00 hours the decision was made by the CBH HEOC to close the hospital to all patients and to set up an alternative off-site emergency medical center to provide basic emergency care to the community. This decision was based on the risk of storm surge with associated power failure and inability of the community to access the facility due to flooding and road closures. The ground floor and temporary first floor ED were both closed on February 2 at 07:00, and all emergency care to the city of Cairns was provided by the emergency medical center at Edmonton, approximately 10 km south of the hospital. CBH ED reopened at midday on February 4. No patients were transferred from CBH ED to the emergency medical center when the CBH ED closed.

2. Emergency Medical Center. A sporting complex in Edmonton was previously identified by the Heath Service District as a potential additional facility to be used for health purposes in the event of a natural disaster. This was based on the size of the facility, its close proximity to key communication and prehospital resources, distance from identified storm surge areas, and location within the main population density of the city. However, it was never anticipated, neither were any plans made, to utilize the facility as an alternative hospital.

The anticipated function of the emergency center was ill-defined, and preparations and logistical planning were necessarily rushed and ad hoc. Equipment and medical supplies were transported by trucks from CBH, with many essential items delayed until late on February 2. Staffing relied on the goodwill of mainly junior medical and nursing staff. Clinical staff were supported by engineering and maintenance staff in the initial setup of clinical areas within the sports complex.

After the emergency center setup was complete, there were concerns raised by Queensland Fire and Rescue Service about the safety of the building in the event of category 5 wind gusts. Modifications such as covering all windows with boards, provision of three-phase power backup, and the supply of a commercial generator were made.

The emergency center was operational for 28 hours, and for this period of time was the only facility providing health care to the Cairns community. Seventy-six patients were treated during this time, with problems including snakebite, acute coronary syndrome, asthma, croup, and fractures. Of particular note, there were three normal deliveries and one complex and prolonged breech labor. A child was treated for a severe respiratory illness complicated by respiratory arrest. There were no documented adverse patient outcomes.

Transition to Normal Practice and Return of Patients to Cairns

Cairns Base Hospital ED reopened at midday on February 3, with the closure of the emergency center in Edmonton. It took several hours for the ED to return to full function due to delays in transporting essential equipment, as well as staffing limitations, given that many had moved south and were unable to return to Cairns rapidly. Five patients were moved back to CBH. The first 24 hours back in the ED were exceptionally busy, with 181 patients seen on February 4 (21% above the daily average of 150 patients). As such, the hospital rapidly filled with patients, which had implications for patient repatriation from Brisbane and affected Brisbane hospital function. An RAAF C-130 Hercules returned 35 patients 1 week after the cyclone, and there were daily air ambulance transfers of two to four patients from Brisbane for approximately 3 weeks. There were also difficulties in tracking patients and their outcomes in the south east Queensland hospitals.

DISCUSSION

This was the largest evacuation of a hospital in Australia, moving 356 patients, staff, and relatives over 1,700 km by air medical transfer to the state capital, Brisbane. There was no loss of life, nor any adverse health events for those transferred. This was all done under the threat of the largest cyclone to hit the Australian coast. The hospital was closed, and an alternative medical facility was established in a sporting complex that provided health care to the community for 28 hours and treated 76 patients in this time.

The evacuation of a hospital is a rare event. There are limited published data around hospital evacuation.[1] In one paper, 275 hospital evacuations were reported in the United States from 1971 to 1999, with only six before 1980.[17] A recent report from Japan highlighted the risks of evacuating hospitals. It detailed the deaths of more than 50 patients who were evacuated after the tsunami in March 2011. Patients were not escorted the 100 km they were transferred and died due to dehydration, hypothermia, and worsening of their medical conditions.[6] The report discussed how there were no prior plans to evacuate the hospital.

The experiences and lessons observed by other facilities involved in evacuating their hospitals are similar to ours.[2,3,18,19] These include having identified key personnel to command and coordinate the evacuation, the establishment of a command center, deciding to evacuate early, the need for good communication, good documentation of patients being transferred, and the use of battery-powered medical equipment and the issues associated.[2,18,19] The evacuation of a hospital has such significant implications, especially in the developing world, that the WHO in combination with the Pan American Health Organization, The World Bank, and the International Strategy for Disaster Reduction has since 2008/2009 developed the global campaign ''Hospitals safe from disasters: reduce risk, protect health facilities and save lives.''[1] The program emphasizes the need for making hospitals safe from disaster (risk reduction). Planning documents from the United Kingdom[20] and the U.S. Government Accountability Office reports[4,5] both highlighted the need for better organization and process around evacuations of hospitals. Both reports were as a result of hospital evacuations, being evacuation of five London Hospitals due to fires (in 2008/2009)[3] and Hurricane Katrina (United States).[4,5]

In the five London hospital fires, two hospitals (The Royal Marsden, a 240-bed cancer center; and The Chase Farm Hospital, a medium secure psychiatric unit) were completely evacuated, while another three (University College Hospital, Great Osmond St. Hospital, and Northwick Park Hospital) were partial evacuations. In the summary report, the National Health Service identified seven ''key lessons learned'' areas.[3] These are summarized in Table 3. Many of these issues were similar to our experience and were also similar to those reported by others in the American evacuating hospitals.[18,19]

We were extremely fortunate to have access to a number of RAAF aircraft and personnel to assist in the evacuation. The ADF are normally extremely busy[21] and

Table 3
Summary of Lessons From the Evacuation of Five London hospitals Due to Fire[14]

Key Lessons from London Hospital Fires	Issues Raised
1. Planning	Developed evacuation plans Available site maps Adequate insurance cover
2. Command and control	Clear command and control Tabards identifying key staff Designate who are the decision makers Availability of alternative control rooms Recovery team planning
3. Communication	Alternate communication devices, communication with external agencies early Patient notes with patients Mechanism to track patients Triage of patients at leaving facility so patient goes to correct location Ensure adequate ambulance support Off site shelter for initial patient holding Detailed planning for critical care, mental health, immunosuppressed, and other special patient groups Patient medication supply
4. Staff	Ensure staff safety and all staff safe Support staff
5. Media	Manage the media Have a media strategy Dedicated spokesperson
6. Post event	Predetermined recovery plan Debriefing plan Event report essential
7. Training and exercise	Regular staff training Regular evacuation drills

have limited aviation assets that were fortunately in Australia at the time of this evacuation. If these assets were not available, it would have made this evacuation more challenging and is an area that needs further planning.

Lessons Observed

Although a successful evacuation, there were many lessons that we observed.

1. Patient issues

a. Patient manifest. We struggled to have a timely available manifest of all patients being transferred from both the public and the private hospitals. We believe that a standardized list needs to available. This would include patient demographics including name, DOB, allergies, weight, and oxygen requirements.

b. Tracking system. We did not have a good system to track patients through their whole journey from leaving our hospital to arriving at the destination hospital in SE Queensland. We used a paper system at each location, but a centralized electronic system would have been better.

2. Equipment

a. Medications. Patients sent to the airport for evacuation did not have their regular medications. Many had complex medical issues. We believe that all patients should have had on them at least 24 hours of their usual medication.

b. Oxygen. There were many patients transferred who required oxygen with limited oxygen available for the transfer and at the airport. We needed to better identify and coordinate oxygen requirements, especially when dealing with the ADF or other outside agencies.

c. Transport monitoring. There were a number of unwell patients (critical care unit/high dependency unit) who required monitoring, both at the airport and during transport. There was limited monitoring available, and we needed to better identify this requirement.

d. Battery power. Most portable medical equipment is battery-powered, and in the airport there were limited power sources. This needs to be planned for.

e. Communication. We were very fortunate that the mobile phone network and Internet were working. Due to the nature of the evacuation, communication was essential and planning should ensure that backup systems are available.

3. Staffing

a. Coordination of response. The early establishment of the hospital HEOC and SHECC, as well as the appointment of key experienced personnel to coordinate the evacuation, was essential in the successful evacuation of the Cairns hospitals.

b. Disaster staffing requirements. This is a difficult issue. During the evacuation, the state disaster management authorities were advising Cairns residents to leave the city. This presents significant challenges for all staff, in preparing their own homes and families for the impending cyclone, as well as preparing the patients for transfer and the temporary medical facility

c. Colocation. At the airport it was difficult with the three locations coordinating the transfer of patients. It would have been easier to have a central point to receive all patients and subsequently transfer from.

d. Experience. We found that having staff who were experienced in disaster response and air medical retrieval was extremely beneficial. This was both in Cairns and in the coordination centers in Brisbane. The value of established relationships was also significant, as many of these staff had worked together previously and were able to rapidly develop a working system.

e. Liaison between health facilities/outpatient care centers. There was excellent cooperation between all health facilities both in the Cairns region and in SE Queensland. There was some difficulty getting an accurate picture of the number of patients to be transferred from the private hospital, and the need to have closer disasters arrangements between private and public hospitals is an area that is being addressed.

f. Provision of suitably located, staffed, and equipped casualty clearing post. With the large number of patients in the airport, we should have set up a formal casualty clearing post to care for the patients awaiting transfer. Ideally this should be staffed by personnel from elsewhere to preserve Cairns capacity. It is suggested that in future events an aircraft should be sent early with a forward team to assist with liaison and establishment of the casualty clearing post, with a full team sent on the first evacuation flight to staff the clearing post.

g. Matching of neonates and mothers in Brisbane. We needed to have a better system so we could match the mothers and neonates once in Brisbane.

4. Emergency medical facility

a. Need for a structured plan for the establishment of an alternate facility. We did not have a plan to establish such a facility. This plan (which is now being finalized) needs to include a number of buildings (e.g., university, schools) that we could use and a process on how we would activate it, staff the facility, and equip it. Of note, the state government is also fast-tracking a plan to build an alternate health facility to be used as a day surgery/primary health care facility (away from the hospital) that could be used as an alternate medical facility if this event occurred again.

LIMITATIONS

This study's data are qualitative. We have not been able to test our observations to see that if we improved on our "lessons" we would improve the way we evacuated our hospital. We do note that many of our lessons have been previously reported by other organizations involved in hospital evacuations.[2,3,5,17,19,20]

CONCLUSIONS

This was the largest evacuation of a hospital in Australia. We were able to successfully transfer 356 patients, staff, and relatives approximately 1,700 km, to Brisbane, within 22 hours of being notified of the need to evacuate. All patients survived their flights and were not subject to any reported complications.

Following this experience we have been able to identify many things that worked well, but also a number of areas where further improvement is needed. All health facilities need to have plans for evacuation of their facility and establishment of alternative care facilities. Health facilities that are geographically isolated need to consider long-distance evacuation in their planning arrangements, while jurisdictions should have pre-standing arrangements to manage the evacuation of these facilities and reception of patients elsewhere. As we have done, hospitals also need to identify facilities that may be used as a temporary medical facility, if the major facility is closed.

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Annex 10: Paper 3.6

Wang XY, Barnett AG, Vaneckova P, Yu W, Fitzgerald G, Wolff R, Tippett V, **Aitken P**, Neville G, McRae M, Verall K, Tong S. The impact of heatwaves on mortality and emergency hospital admissions in Brisbane, Australia. Occupational and Environmental Medicine 2012; 69(3): 163-169.

ORIGINAL ARTICLE

The impact of heatwaves on mortality and emergency hospital admissions from non-external causes in Brisbane, Australia

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ABSTRACT

Objectives Heatwaves can have significant health consequences resulting in increased mortality and morbidity. However, their impact on people living in tropical/subtropical regions remains largely unknown. This study assessed the impact of heatwaves on mortality and emergency hospital admissions (EHAs) from non-external causes (NEC) in Brisbane, a subtropical city in Australia.

Methods We acquired daily data on weather, air pollution and EHAs for patients aged 15 years and over in Brisbane between January 1996 and December 2005, and on mortality between January 1996 and November 2004. A locally derived definition of heatwave (daily maximum ≥37°C for 2 or more consecutive days) was adopted. Case–crossover analyses were used to assess the impact of heatwaves on cause-specific mortality and EHAs.

Results During heatwaves, there was a statistically significant increase in NEC mortality (OR 1.46; 95% CI 1.21 to 1.77), cardiovascular mortality (OR 1.89; 95% CI 1.44 to 2.48), diabetes mortality in those aged 75+ (OR 9.96; 95% CI 1.02 to 96.85), NEC EHAs (OR 1.15; 95% CI 1.07 to 1.23) and EHAs from renal diseases (OR 1.41; 95% CI 1.09 to 1.83). The elderly were found to be particularly vulnerable to heatwaves (eg, for NEC EHAs, OR 1.24 for 65–74-year-olds and 1.39 for those aged 75+).

Conclusions Significant increases in NEC mortality and EHAs were observed during heatwaves in Brisbane where people are well accustomed to hot summer weather. The most vulnerable were the elderly and people with cardiovascular, renal or diabetic disease.

What this paper adds

- Although heatwaves can have significant health consequences, there is no global definition of heatwaves because local regional variability influences the impact of extreme heat, and it also remains largely unknown whether heatwaves have any impact on people who are well accustomed to warm weather.
- This study investigated the impacts of heatwaves on both cause-specific mortality and emergency hospital admissions from non-external causes using a locally-defined definition in Brisbane during 1996–2005.
- We found that heatwaves had significant effects on mortality and emergency hospital admissions in a subtropical city where residents are well accustomed to hot summers.

INTRODUCTION

As climate change continues, the frequency, intensity and duration of heatwaves are likely to increase.[1] Heatwaves, especially severe ones like the 2003 European heatwave, can have significant health consequences resulting in increased mortality and morbidity, particularly among the elderly, young children, people with chronic illnesses and in socially and economically disadvantaged groups.[2–9] Exposure to thermal stress has a significant impact on human health, and is responsible for a quantifiable burden of mortality and morbidity.[10–19]

It is difficult to create a uniform heatwave definition because regional variability plays a large role in determining heat-related impacts. Recent studies have found that heatwave-related mortality and morbidity depend on the acclimatisation of the population.[1 9–11 20 21] Populations in warmer climates tend to have more access to air conditioning and swimming pools, as well as more experience in dealing with heat. What would be described as a heatwave in a temperate region may be considered a normal day in a subtropical region.

In a previous study we assessed heat-related health outcomes using different heatwave definitions.[10] Based on those results, we defined a heatwave in Brisbane as a daily maximum temperature of at least 37°C for two or more consecutive days. According to this definition, three heatwaves occurred between 1996 and 2005 (20–21 January 2000, 24–26 December 2001 and 21–22 February 2004). This study extended our previous work by investigating the impacts of heatwaves on both cause-specific mortality and emergency hospital admissions (EHAs) from non-external causes (NEC) using daily data collected in Brisbane.

METHODS

Brisbane is the capital city of Queensland. It is located in the south-east corner of the state (27°29'S, 153°8'E) and has a subtropical climate. It is Australia's third largest city (after Sydney and Melbourne), covering an urban area of 1326.8 km^2

with a population of 991 260 on 30 June 2006.[22] At that time, 18% of the population were aged 0–14, 71% were aged 15–64 and 11% were aged 65+. We chose Brisbane as the study site because it has the highest population density in subtropical Australia. Therefore, an assessment of heat-related health effects has significant public health implications in relation to the mitigation and prevention of the impact of heatwaves. The data used in this study were 10-year time series of climate, air pollution and EHA data from 1 January 1996 to 31 December 2005. Mortality data were only obtainable up to November 2004 due to the time lag between deaths and their registration by state authorities.

Climate and air pollution data

Daily climate data from five monitoring stations in Brisbane were obtained from the Australian Bureau of Meteorology. The daily arithmetic average values of maximum temperature and relative humidity were computed using the data collected from these stations. Maximum temperature was the highest temperature measured in 24 h after 09:00 h. Relative humidity is the amount of water in the air relative to the maximum amount of water that the air can hold at a given temperature (expressed as a percentage). Air temperatures and relative humidity were measured every 3 h. We used the maximum temperature in this study, because the highest air temperature often occurred around noon to afternoon, a time during which relatively more people may be outside.

Air pollution data were provided by the Queensland Department of Environment and Resource Management (formerly the Queensland Environmental Protection Agency), and included ambient 24 h average concentrations of particulate matter with diameter less than 10 μm (PM_{10}), daily maximum 1 h average nitrogen dioxide (NO_2) and ozone (O_3). For each day, average air pollution concentrations were averaged across 17 available monitoring stations in Brisbane. Approximately 5% of values were missing. When data were missing for a particular monitoring station on a given day, the observations recorded from the other monitoring stations were used to calculate the daily average values.

Mortality and EHA data

Mortality data were provided by the Office of Economic and Statistical Research of the Queensland Treasury. The data included date of death, sex, age, statistical local area of residence and cause of death. Daily data on EHAs were provided by the Health Information Centre of Queensland Health. The data were admission counts by date, principal diagnosis, age group and the number of admitted patient episodes of care. Stratified analysis by gender was not possible since the release of this information from the EHA datasets was considered a potential breach of confidentiality. Cause-specific mortality and EHAs were categorised according to the International Classification of Diseases (revisions 9 and 10) and defined as cardiovascular (ICD-9, 390-459; ICD-10, I00–I99), diabetes (ICD-9, 250; ICD-10, E10–E14), ischaemic stroke (ICD-9, 433-435; ICD-10, I63, I65–I66), mental health (ICD-9, 290-319; ICD-10, F00–F99), renal (ICD-9, 580-629; ICD-10, N00–N39), respiratory diseases (ICD-9, 460-519; ICD-10, J00–J99) and non-external causes (ICD-9, <800; and all ICD-10 codes excluding S00–U99 for external causes).

Data analysis

Statistical analyses were conducted using daily data on climate, air pollution and health outcomes. Case–crossover analyses were used to assess the relationship between heatwaves and health outcomes. The case–crossover approach is useful because it controls for trends and seasonal patterns in the dependent and independent variables by design.[23 24] We used the time-stratified case–crossover with a stratum length of 28 days, and matched control days to case days using day of the week (this gives 3 control days per case day). Lagged effects (lag 1, lag 2 and lags 0–2) of heat on mortality and EHAs (NEC) were also assessed using the same method. Three heatwaves (7 heatwave days) were identified using the local heatwave definition during the study period. Therefore, data for three 28-day strata (84 days) were used in the case–crossover analysis. The main independent variable was heatwave day (yes/no). The dependent variable was the daily number of deaths or EHAs by age group (15–64, 65–74, 75+ years and all ages). We also adjusted for linear effects of humidity and air pollutants (PM_{10}, NO_2 and O_3). Humidity and air pollutants were included with same-day concentrations. However, when the lagged effects of heat on NEC mortality and EHAs were assessed, lagged concentrations of humidity and air pollution were also used. A conditional logistic regression model was used in the final multivariable analyses. All case–crossover analyses were conducted using SAS statistical software.[25]

RESULTS

Three heatwaves were identified during the study period, which were all short (ie, 2 or 3 days each). Table 1 presents summary statistics of the daily climate, air pollutants and health outcomes for Brisbane for the 7 heatwave days and 21 control days. The average maximum temperature during heatwave days was much higher (by 8.5°C) than for the control days; however, the average relative humidity was lower. The average concentrations of PM_{10}, NO_2 and O_3 during heatwave days were higher than those during control days, but the average levels of these concentrations (PM_{10}, NO_2 and O_3) both on heatwave days and on control days were lower than the National Air Quality Standards in Australia (50 μg/m^3, 120 ppb and 100 ppb, respectively). There were a daily average of 23 deaths and 161 EHAs during heatwave days, compared to 15 deaths and 138 EHAs during control days. Table 2 shows the daily average of cause-specific deaths and EHAs during the three heatwaves (7 case days and 21 control days).

Table 1 Summary of daily climate and air pollutants for NEC deaths and EHAs for Brisbane, 1996–2005

Variable	Mean	SD	Min	25%	Median	75%	Max
Heatwave days							
Tmax (°C)	39.1	1.3	37.9	38	38.7	39.8	41.5
Humidity (%)	60.3	6.5	51.1	51.4	62.9	64.6	67.4
PM_{10} (μg/m^3)	27.2	5.5	20.5	23	26.6	32.4	36.1
NO_2 (ppb)	18.4	4.2	13.7	15.5	17	19.9	26.8
O_3 (ppb)	49.8	8.8	40.8	43	49.2	51.8	67.8
Deaths (162)	23	11	12	14	20	35	42
EHAs (1124)	161	35	113	121	165	196	202
Control days							
Tmax (°C)	30.6	3	26.1	28.8	29.9	32.3	37.2
Humidity (%)	71.2	7.7	53.8	65.3	71.9	76.7	86.3
PM_{10} (μg/m^3)	19.1	6	11	14.2	18.2	22.9	32.9
NO_2 (ppb)	13.8	3.6	8.2	11.1	12.9	17.3	19.7
O_3 (ppb)	33.4	9.8	17	26.8	32	39.6	55.7
Deaths (317)	15	4	10	13	15	17	25
EHAs (2888)	138	14	103	133	140	147	160

EHAs, emergency hospital admissions; NEC, non-external causes; PM_{10}, particulate matter with diameter less than 10 μm; Tmax, maximum temperature.

Table 2 Daily average cause-specific deaths and emergency hospital admissions (EHAs) during heatwaves in Brisbane, 1996–2005

Disease	Deaths		EHAs	
	Case days	Control days	Case days	Control days
Cardiovascular	12.6	6.3	24.3	23.0
Diabetes	0.6	0.2	2.3	1.9
Ischaemic stroke	0.3	0.1	1.0	1.5
Mental health	0.4	0.4	15.3	17.6
Renal	0.6	0.5	12.3	8.2
Respiratory	2.1	1.4	19.9	16.7

Spearman correlations between climate variables and air pollutants show that only the correlation between NO_2 and O_3 was statistically significant during both heatwave days ($r=0.78$, $p<0.05$) and control days ($r=0.58$, $p<0.01$). There were positive correlations (although not statistically significant) between humidity and air pollutants during heatwave days ($r=0.54$ to 0.63) but inverse correlations (including a statistically significant one) during control days ($r=-0.15$ to -0.68). There were moderate to high correlations between maximum temperature and air pollutants on control days ($r=0.59$ to 0.77, $p<0.01$).

Figure 1 shows that maximum temperature was positively associated with daily deaths and EHAs in the three 28-day strata which were used in case–crossover analysis. There was an increase in NEC mortality and EHAs during the first and third heatwave periods compared to non-heatwave periods.

Table 3 shows the estimated ORs of cause-specific mortality by age group during heatwave versus non-heatwave days. During heatwaves there was a statistically significant increase in the ORs for total mortality and mortality in the 75+ age group, total cardiovascular mortality and cardiovascular mortality in the 65–74 and 75+ age groups, and also for diabetes deaths in people aged 75+ after adjusting for the confounders humidity, PM_{10}, NO_2 and O_3. There was a striking, but not statistically significant, increase in respiratory mortality in the 15–64 age group. However, there was no statistically significant increase in the other mortality subgroups, even though the risk for most categories of deaths increased during heatwave periods.

Table 4 shows the estimated ORs for EHAs during heatwave versus non-heatwave days. The results for all cause EHAs were slightly different to those for mortality. During heatwaves there was a significant increase in total EHAs and in EHAs in those aged 65–74 and 75+, and also in total renal disease EHAs and renal disease EHAs in those aged 64–75, but no statistically significant increase in other age groups or for other diseases.

There were no real differences in the ORs between the different models (adjustment for humidity and O_3, adjustment for humidity and PM_{10}, adjustment for humidity and NO_2, and adjustment for humidity, PM_{10}, NO_2 and O_3) in both tables 3 and 4. We also evaluated the lagged effects (lag 1, lag 2 and lags 0–2 days) of heat on both mortality and EHAs from NEC (table 5). The lagged effects of heatwaves on mortality and EHAs were similar to those on the current day.

DISCUSSION

Three heatwaves (20–21 January 2000, 24–26 December 2001 and 21–22 February 2004) were identified between 1996 and 2005 in Brisbane, Australia. This study specifically investigated the heatwave–health relationship using information on temperature and cause-specific mortality and EHAs from NEC. People in Brisbane are acclimatised to hot summers which may reduce excess mortality and morbidity. However, our results show consistent and significantly increased risks of death and EHAs during heatwaves.

We used a time-stratified case–crossover analysis with a stratum length of 28 days. The main reason for using the case–crossover method was to control for seasonal confounders and secular trends. As there were only three heatwaves with a total of 7 case days and 21 control days, only 28 days were used in the final analysis (table 1). This did reduce the statistical power and meant that the CIs for some findings were wide (tables 3 and 4). Although a time series method would have used all the data, the time-stratified case–crossover and time series approaches are comparable.[26 27] Examination of heatwave versus non-heatwave days may mean estimates contain a combination of heat and heatwave effects. Hajat *et al*[7] discussed the concept of an added heatwave effect and evaluated whether heatwave days affected mortality risk differently than non-consecutive individual days of high temperatures. The additional effects of heatwaves have recently been estimated by first controlling for the general effects of heat and then estimating the extra burden of heatwaves.[14 15] This issue will be examined in our further research.

Total mortality and cardiovascular mortality significantly increased during heatwaves in Brisbane. This finding is consistent with most previous studies.[14 28] For example, Anderson and Bell[14] investigated the health impact of heatwaves in 43 US cities (1987–2005) and found higher mortality risk during heatwaves. Baccini *et al*[28] reported that high ambient temperatures have an important impact on European population health. This impact is likely to increase in the future, given the projected increase in mean temperatures and in the frequency, intensity and duration of heatwaves. However, we found a quite strong

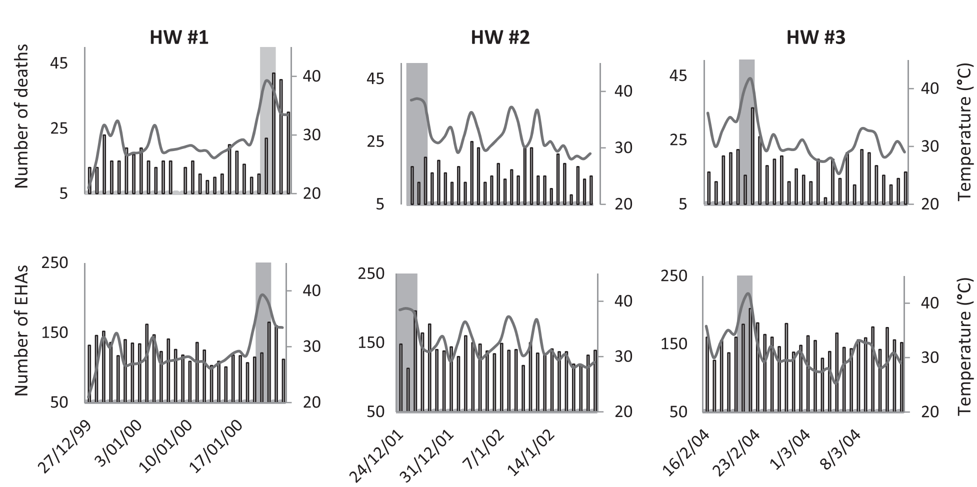

Figure 1 Maximum temperature associated with daily number of deaths and emergency hospital admissions (EHAs) from non-external causes during the three heatwaves by 28-day strata in Brisbane, Australia (the red curves represent maximum temperature, the bars denote deaths/EHAs on that day and the shaded bars represent heatwave periods). HW, heat wave.

Table 3 ORs of mortality during heatwaves in Brisbane

Deaths	Model I* OR (95% CI)	Model II† OR (95% CI)	Model III‡ OR (95% CI)	Model IV§ OR (95% CI)
NEC				
Aged 15–64	1.35 (0.80 to 2.26)	1.42 (0.84 to 2.38)	1.40 (0.83 to 2.35)	1.35 (0.80 to 2.27)
Aged 65–74	1.46 (0.89 to 2.39)	1.52 (0.92 to 2.48)	1.49 (0.91 to 2.43)	1.46 (0.89 to 2.39)
Aged 75+	**1.52 (1.21 to 1.91)**	**1.56 (1.24 to 1.95)**	**1.56 (1.24 to 1.95)**	**1.51 (1.20 to 1.90)**
Total	**1.47 (1.22 to 1.78)**	**1.52 (1.25 to 1.83)**	**1.51 (1.25 to 1.83)**	**1.46 (1.21 to 1.77)**
Cardiovascular				
Aged 15–64	1.61 (0.64 to 4.05)	1.69 (0.67 to 4.24)	1.67 (0.66 to 4.19)	1.63 (0.65 to 4.09)
Aged 65–74	**2.78 (1.20 to 6.45)**	**2.95 (1.28 to 6.83)**	**2.88 (1.25 to 6.66)**	**2.81 (1.21 to 6.51)**
Aged 75+	**1.86 (1.37 to 2.51)**	**1.88 (1.39 to 2.54)**	**1.88 (1.39 to 2.55)**	**1.83 (1.35 to 2.48)**
Total	**1.91 (1.46 to 2.50)**	**1.95 (1.49 to 2.56)**	**1.95 (1.49 to 2.55)**	**1.89 (1.44 to 2.48)**
Diabetes				
Aged 15–64	–¶	–	–	–
Aged 65–74	1.37 (0.12 to 15.40)	1.62 (0.15 to 18.10)	1.56 (0.14 to 17.36)	1.45 (0.13 to 16.44)
Aged 75+	9.49 (0.98 to 91.80)	**9.90 (1.02 to 95.68)**	**10.10 (1.04 to 97.95)**	**9.96 (1.02 to 96.85)**
Total	2.84 (0.71 to 11.45)	3.12 (0.78 to 12.52)	3.06 (0.76 to 12.31)	2.88 (0.71 to 11.62)
Ischaemic stroke				
Aged 15–64	–	–	–	–
Aged 65–74	–	–	–	–
Aged 75+	1.83 (0.30 to 11.05)	1.86 (0.31 to 11.20)	1.94 (0.32 to 11.68)	1.80 (0.30 to 10.89)
Total	1.85 (0.31 to 11.16)	1.92 (0.32 to 11.51)	1.98 (0.33 to 11.87)	1.83 (0.30 to 11.05)
Mental health				
Aged 15–64	–	–	–	–
Aged 65–74	–	–	–	–
Aged 75+	1.05 (0.27 to 4.10)	1.33 (0.34 to 5.16)	1.21 (0.31 to 4.72)	1.08 (0.27 to 4.23)
Total	0.80 (0.21 to 2.98)	1.04 (0.28 to 3.86)	0.92 (0.25 to 3.42)	0.82 (0.22 to 3.06)
Renal				
Aged 15–64	–	–	–	–
Aged 65–74	–	–	–	–
Aged 75+	0.87 (0.24 to 3.19)	0.90 (0.25 to 3.29)	0.85 (0.23 to 3.10)	0.86 (0.23 to 3.15)
Total	1.19 (0.37 to 3.82)	1.20 (0.38 to 3.84)	1.13 (0.35 to 3.63)	1.17 (0.37 to 3.78)
Respiratory				
Aged 15–64	7.72 (0.80 to 74.93)	8.63 (0.89 to 83.52)	8.87 (0.92 to 85.91)	8.25 (0.84 to 80.67)
Aged 65–74	2.69 (0.53 to 13.56)	2.84 (0.57 to 14.20)	3.04 (0.61 to 15.22)	2.78 (0.55 to 14.05)
Aged 75+	1.05 (0.49 to 2.25)	1.04 (0.49 to 2.24)	1.10 (0.51 to 2.35)	1.04 (0.48 to 2.23)
Total	1.47 (0.78 to 2.75)	1.49 (0.80 to 2.78)	1.55 (0.83 to 2.90)	1.45 (0.78 to 2.72)

*Adjusted for humidity and O_3.
†Adjusted for humidity and PM_{10}.
‡Adjusted for humidity and NO_2.
§Adjusted for humidity, PM_{10}, NO_2 and O_3.
¶Insufficient data.
NEC, non-external causes.

positive association between heatwave and respiratory mortality in younger people in this study (aged 15–64 years), although this did not reach statistical significance. This result is in contrast to previous research. For instance, D'Ippoliti *et al*[3] recently reported that the greatest effect of heatwaves was observed for elderly respiratory diseases in nine European cities. The reasons for the different results from this study and other reports are unclear. It may be because outdoor workers (eg, building and road construction) usually continue to work during heatwave periods in Brisbane, and can get sick or die from exposure to heat and high air pollution. However, this is only speculation, and no literature is available on this issue. We also found a higher mortality risk for elderly people (aged 75+ years) with diabetes, but we did not find similar results in other research and the underlying biological mechanism is not clear. The total number of deaths (64) during the first heatwave (20–21 January 2000) was greater than that for the other two heatwaves (49 in both the 2001 and 2004 heatwaves), although the maximum temperatures were not as high as during the latter two periods. This may be because the population was less prepared for the impact of the first heatwave or because the two more recent heatwaves occurred during a holiday season and at a weekend. Potential reasons include gradual improvements in housing, and the increased use of air conditioning and home insulation over recent years. For example, in 2008 about 50% of Queensland houses had insulation, up from 30% in 1994.[29]

NEC EHAs and those for renal disease increased during the heatwaves. As many statistical tests were conducted (tables 4 and 5), possible spurious significance from multiple testing for renal diseases cannot be ruled out. However, a number of studies have also investigated the impacts of heatwaves on cause-specific EHAs or emergency department visits, and our findings are generally consistent with those of other studies. For example, a study of EHAs in London[8] found an increase in respiratory and renal diseases among children under 5 years of age and in respiratory disease among people aged 75+, but failed to find statistically significant increases in total EHAs during extreme heat. Hansen *et al*[17] reported that there was a 10% increase in hospital admissions for all renal disease during heatwave periods in Adelaide, Australia, compared with non-heatwave periods in 2004. Age-specific analysis showed increases in renal hospital admissions across different age and sex groups, especially for

Table 4 ORs of emergency hospital admissions (EHAs) during heatwaves in Brisbane

EHAs	Model I* OR (95% CI)	Model II† OR (95% CI)	Model III‡ OR (95% CI)	Model IV§ OR (95% CI)
NEC				
Aged 15–64	0.97 (0.88 to 1.08)	0.98 (0.88 to 1.09)	0.99 (0.89 to 1.09)	0.97 (0.88 to 1.08)
Aged 65–74	**1.24 (1.02 to 1.51)**	**1.25 (1.03 to 1.52)**	**1.25 (1.03 to 1.52)**	**1.24 (1.02 to 1.50)**
Aged 75+	**1.40 (1.24 to 1.59)**	**1.43 (1.26 to 1.61)**	**1.43 (1.26 to 1.62)**	**1.39 (1.23 to 1.58)**
Total	**1.16 (1.08 to 1.24)**	**1.16 (1.09 to 1.25)**	**1.17 (1.10 to 1.26)**	**1.15 (1.07 to 1.23)**
Cardiovascular				
Aged 15–64	0.78 (0.55 to 109)	0.80 (0.57 to 1.12)	0.79 (0.56 to 1.11)	0.78 (0.55 to 1.09)
Aged 65–74	1.25 (0.86 to 1.83)	1.26 (0.86 to 1.84)	1.25 (0.86 to 1.83)	1.25 (0.86 to 1.83)
Aged 75+	1.14 (0.89 to 1.46)	1.17 (0.91 to 1.49)	1.16 (0.91 to 1.48)	1.14 (0.89 to 1.45)
Total	1.04 (0.87 to 1.24)	1.06 (0.89 to 1.26)	1.05 (0.88 to 1.25)	1.04 (0.87 to 1.23)
Diabetes				
Aged 15–64	1.04 (0.44 to 2.45)	0.98 (0.41 to 2.30)	1.00 (0.43 to 2.36)	1.03 (0.44 to 2.43)
Aged 65–74	1.37 (0.25 to 7.55)	1.43 (0.26 to 7.83)	1.50 (0.27 to 8.22)	1.35 (0.25 to 7.46)
Aged 75+	1.25 (0.48 to 3.28)	1.28 (0.49 to 3.34)	1.33 (0.51 to 3.46)	1.23 (0.47 to 3.22)
Total	1.21 (0.67 to 2.16)	1.18 (0.66 to 2.10)	1.21 (0.67 to 2.16)	1.20 (0.67 to 2.15)
Ischaemic stroke				
Aged 15–64	1.64 (0.30 to 9.06)	1.46 (0.27 to 7.98)	1.46 (0.27 to 7.99)	1.59 (0.29 to 8.80)
Aged 65–74	1.04 (0.21 to 5.17)	1.03 (0.21 to 5.11)	1.04 (0.21 to 5.14)	1.03 (0.21 to 5.10)
Aged 75+	0.41 (0.12 to 1.38)	0.40 (0.12 to 1.34)	0.41 (0.12 to 1.37)	0.41 (0.12 to 1.36)
Total	0.67 (0.30 to 1.52)	0.65 (0.29 to 1.47)	0.66 (0.29 to 1.49)	0.66 (0.29 to 1.50)
Mental health				
Aged 15–64	0.88 (0.71 to 1.11)	0.88 (0.70 to 1.10)	0.90 (0.72 to 1.12)	0.88 (0.71 to 1.11)
Aged 65–74	1.50 (0.45 to 4.99)	1.53 (0.46 to 5.08)	1.52 (0.46 to 5.05)	1.49 (0.45 to 4.98)
Aged 75+	0.60 (0.20 to 1.75)	0.59 (0.20 to 1.74)	0.60 (0.20 to 1.75)	0.59 (0.20 to 1.73)
Total	0.87 (0.70 to 1.08)	0.86 (0.70 to 1.07)	0.88 (0.71 to 1.09)	0.86 (0.70 to 1.07)
Renal				
Aged 15–64	1.17 (0.78 to 1.75)	1.17 (0.78 to 1.75)	1.20 (0.80 to 1.80)	1.16 (0.77 to 1.74)
Aged 65–74	**2.27 (1.06 to 4.86)**	**2.27 (1.06 to 4.86)**	**2.30 (1.07 to 4.93)**	**2.25 (1.05 to 4.83)**
Aged 75+	1.32 (0.86 to 2.04)	1.36 (0.88 to 2.08)	1.37 (0.89 to 2.10)	1.31 (0.85 to 2.02)
Total	**1.42 (1.09 to 1.84)**	**1.44 (1.11 to 1.86)**	**1.46 (1.13 to 1.89)**	**1.41 (1.09 to 1.83)**
Respiratory				
Aged 15–64	1.17 (0.82 to 1.67)	1.19 (0.83 to 1.69)	1.18 (0.83 to 1.69)	1.17 (0.82 to 1.67)
Aged 65–74	1.02 (0.60 to 1.75)	1.04 (0.61 to 1.78)	1.03 (0.60 to 1.77)	1.01 (0.59 to 1.74)
Aged 75+	1.33 (0.92 to 1.93)	1.37 (0.95 to 1.98)	1.39 (0.96 to 2.00)	1.33 (0.92 to 1.92)
Total	1.15 (0.95 to 1.40)	1.17 (0.96 to 1.43)	1.18 (0.97 to 1.43)	1.15 (0.94 to 1.40)

*Adjusted for humidity and O_3.
†Adjusted for humidity and PM_{10}.
‡Adjusted for humidity and NO_2.
§Adjusted for humidity, PM_{10}, NO_2 and O_3.
EHAs, emergency hospital admissions; NEC, non-external causes.

Table 5 ORs of mortality and EHAs during heatwaves in Brisbane for three different lags (days)

	Lag 1* OR (95% CI)	Lag 2* OR (95% CI)	Lags 0–2* OR (95% CI)
Deaths			
NEC	**1.48 (1.23 to 1.79)**	**1.51 (1.25 to 1.83)**	**1.46 (1.21 to 1.77)**
Cardiovascular	**2.01 (1.53 to 2.64)**	**2.06 (1.57 to 2.71)**	**1.89 (1.44 to 2.47)**
Diabetes	2.55 (0.63 to 10.26)	2.78 (0.69 to 11.19)	2.62 (0.65 to 10.59)
Ischaemic stroke	1.90 (0.32 to 11.49)	2.01 (0.33 to 12.07)	1.88 (0.31 to 11.34)
Mental health	1.16 (0.30 to 4.40)	1.13 (0.30 to 4.28)	0.92 (0.24 to 3.42)
Renal	1.12 (0.35 to 3.59)	1.17 (0.36 to 3.74)	1.14 (0.35 to 3.68)
Respiratory	1.47 (0.78 to 2.75)	1.48 (0.79 to 2.76)	1.44 (0.77 to 2.70)
EHAs			
NEC	**1.16 (1.08 to 1.24)**	**1.16 (1.09 to 1.25)**	**1.15 (1.08 to 1.24)**
Cardiovascular	1.04 (0.87 to 1.24)	1.03 (0.87 to 1.23)	1.05 (0.88 to 1.25)
Diabetes	1.13 (0.63 to 2.01)	1.11 (0.62 to 1.98)	1.17 (0.65 to 2.09)
Ischaemic stroke	0.64 (0.28 to 1.44)	0.62 (0.28 to 1.40)	0.67 (0.30 to 1.53)
Mental health	0.85 (0.69 to 1.06)	0.86 (0.70 to 1.07)	0.87 (0.70 to 1.08)
Renal	**1.45 (1.12 to 1.88)**	**1.46 (1.12 to 1.89)**	**1.40 (1.08 to 1.82)**
Respiratory	1.19 (0.98 to 1.45)	1.20 (0.99 to 1.47)	1.14 (0.93 to 1.38)

*Adjusted for humidity, PM_{10}, NO_2 and O_3.
EHAs, emergency hospital admissions; NEC, non-external causes.

elderly women. Another study[18] found that the 2006 California heatwave had a significant impact on morbidity, including in regions with relatively modest temperatures. The authors suggested that population acclimatisation and adaptive capacity influenced risk. Through better understanding of these impacts and population vulnerabilities, local communities can improve heatwave preparedness to cope with a warmer future.

Recent publications using different heatwave definitions have reported inconsistent results regarding heat-related mortality. For example, the study by Anderson and Bell[13] reported that comparison of the 99th and 90th percentile temperatures for cities in the USA showed that heat-related mortality was mostly associated with a shorter lag (average of same day and previous day), with an average increase of 3.0% in mortality risk (95% posterior interval: 2.4% to 3.6%). Hajat *et al*[7] observed the impact of high temperatures on mortality in three European cities. They used a combination of intensity and duration to define heatwave periods and found that heatwave effects were apparent in simple time-series models but were small when compared with the overall summertime mortality burden of heat. However, another study[21] used 3 or more consecutive days with a daily maximum temperature above 35°C as a heatwave definition and found no excess mortality during heatwaves in Adelaide, Australia (located at 34°52′S, 138°30′E).

Our previous study indicates that even a small change in the heatwave definition had an appreciable effect on the estimated health impact.[10] In order to conduct a sensitivity analysis, we used some less stringent definitions of heatwave to estimate the effects on both mortality and EHAs from NEC in the same study period (1996–2005). Thirty-six heatwaves (95 days) and nine heatwaves (20 days) were identified by the definitions of heatwave as a daily maximum temperature of at least 33°C or 35°C for two or more consecutive days, respectively. The longest heatwave periods were 5 days in January 2000 and February 2004 (33°C for 2 or more consecutive days). There were statistically significant increases in NEC mortality (ORs 1.11 and 1.26) and for those aged 75+ (ORs 1.11 and 1.29) by these two different definitions (33°C or 35°C for 2 or more consecutive days). Similar results were also found for EHAs. It appears that the more stringent the definitions of heatwave, the greater the estimates of its effects.

We found that elderly people were most vulnerable to developing, and dying from, heat-related illnesses during a heatwave, which is consistent with previous studies, and is likely to be related to overload of the thermoregulatory system in older people.[9 30 31] A recent study[30] revealed the effects of the ageing process on thermoregulatory responses and outlined the symptoms of heat exhaustion and heatstroke among the elderly. Another study[31] observed that the elderly had poor thermoregulatory responses to high temperatures because of hormonal changes with age.

In order to determine if there were any short-term delays between heatwave and health outcomes, the effects of lags 1, 2 and 0–2 days were examined after adjusting for humidity, PM_{10}, NO_2 and O_3. The results show that statistically significant lagged effects of heatwave were found for total mortality and EHAs (NEC), cardiovascular mortality and renal EHAs (table 5).

This study has three major strengths: (1) this is the first study to broadly examine heat-related health effects including cause-specific mortality and EHAs in a subtropical setting; (2) the dataset used in this study was comprehensive; and (3) importantly, we were able to adjust for the possible confounding effects of air pollution and humidity.

This study has some limitations. First, it focused on only one city. However, the finding of consistent patterns of mortality and EHAs during heatwaves may inspire further research in other locations. Second, we only considered the effect of heatwaves on mortality and EHAs using aggregated data. Individual exposure and outcome data would give a more accurate estimate of the dangers of heat, but these detailed data were not available. Finally, as we focused on extreme heatwave events we had a greatly reduced dataset and hence statistical power. However, many statistically significant associations were found in this study, which suggest the areas for more attention when preparing for heatwave response.

CONCLUSION

A significant increase in mortality and EHAs from NEC was observed during three short-lasting heatwaves in Brisbane, a subtropical city where people are well accustomed to warm weather. The elderly and those with cardiovascular, renal or diabetic disease appeared to be particularly vulnerable. The findings from this study have implications for understanding heat-related health effects and contribute to the development of an evidence base for public health intervention strategies to prevent and mitigate the impact of heatwaves. Based on this study, more specific intervention strategies appear warranted such as targeting the elderly (aged ≥75 years) and those with cardiovascular, renal or diabetic disease. Brisbane does not have a formal public health prevention plan for heatwaves. Therefore it is important for local governments to develop appropriate response plans to cope with the increasing threat from heatwaves.

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Annex 11: Paper 3.7

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Do Biometeorological Indices Improve Modeling Outcomes of Heat-Related Mortality?

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ABSTRACT

Various biometeorological indices and temperature measures have been used to assess heat-related health risks. Composite indices are expected to assess human comfort more accurately than do temperature measures alone. The performances of several common biometeorological indices and temperature measures in evaluating the heat-related mortality in Brisbane, Australia—a city with a subtropical climate—were compared. Daily counts of deaths from organic causes [International Statistical Classification of Diseases and Related Health Problems, 9th Revision, (ICD9) codes 001–799 and ICD, 10th Revision, (ICD10) codes A00–R99] during the period from 1 January 1996 to 30 November 2004 were used. Several composite biometeorological indices were considered, such as apparent temperature, relative strain index, Thom discomfort index, the humidex, and wet-bulb globe temperature. Hot days were defined as those days falling into the 95th percentile of each thermal stress indicator. Case-crossover analysis was applied to estimate the relationship between exposure to heat and mortality. The performances of various biometeorological indices and temperature measures were compared using the jackknife resampling method. The results show that more deaths were likely to occur on hot days than on other (i.e., control) days regardless of the temperature measure or biometeorological index that is considered. The magnitude of the odds ratios varied with temperature indicators, between 1.08 [95% confidence interval (CI): 1.02–1.14] and 1.41 (95% CI: 1.22–1.64) after adjusting for air pollutants (particulate matter with aerodynamic diameter less than 10 μm and ozone). Average temperature performed similarly to the composite indices, but minimum and maximum temperatures performed relatively poorer. Thus, average temperature may be suitable for the development of weather–health warning systems if the findings presented herein are confirmed in different locations.

1. Introduction

Heat stress is a significant health concern and has been previously associated with substantial excess mortality (e.g., Fouillet et al. 2006; Smargiassi et al. 2009), as has

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been documented during heat waves in Europe, the United States, and Australia (e.g., Semenza et al. 1996; Fouillet et al. 2006; Tong et al. 2010). Previous studies have used a variety of heat stress measures (e.g., maximum and minimum temperatures, apparent temperature, and biometeorological and human comfort indices) to assess the vulnerability of populations to heat stress (e.g., Höppe 1999; Spagnolo and de Dear 2003; Nicholls et al. 2008; Barnett et al. 2010).

An essential requirement for normal body function is that the human body constantly regulates its internal temperature with the surrounding environment through several mechanisms of heat exchange. When the body reaches thermal equilibrium with the surrounding environment, thermal comfort occurs (Kerslake 1972). According to the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE 2004), thermal comfort is ‘‘that condition of mind which expresses satisfaction with the thermal environment.'' The perception of thermal comfort (or thermal stress) is complex and results from synergistic effects of environmental, physiological, and behavioral variables such as temperature, humidity, air movement, solar radiation, metabolic rate, age, physical activity, and clothing (Budd 2008). Accounting for all of these elements is hardly manageable because of the complexity of the measures, the limited availability of the input variables, and, in some cases, the invasiveness of such techniques. Therefore, for the purpose of modeling the impact of heat stress in epidemiological studies, simplified measures of thermal stress are generally used.

Although a large number of measures to estimate thermal stress have been developed, a single temperature measure (such as average or maximum temperature) continues to be the most common proxy for thermal discomfort in epidemiological research. Previous studies have also used indices (such as apparent temperature) that combine temperature and humidity because this has been suggested to approximate better how the temperature actually affects the body (O'Neill et al. 2003; Watts and Kalkstein 2004; Budd 2008). More complex indices based on wind component, solar radiation, and atmospheric pressure have also been employed (Kalkstein et al. 1996; Höppe 1999; Sheridan and Kalkstein 2004).

Rarely is more than one measure of thermal stress used in a study; thus, the predictive ability of various measures and their suitability to a specific geographic location are not yet well understood (e.g., Conti et al. 2007; Zanobetti and Schwartz 2008; Anderson and Bell 2009). Metzger et al. (2010) recently compared several heat-stress measures in New York for the period between 1997 and 2006 and found similar results regardless of the measure used. Barnett et al. (2010) compared several temperature measures in many U.S. cities for the period between 1987 and 2000. Although they found large differences in the best temperature measures across different regions, age groups, and seasons, overall none of the measures was deemed superior. They also observed that these temperature measures had similar predictive ability as a result of their strong correlation. They proposed that the best temperature measure for new studies can be chosen based on practical concerns, such as minimizing the amount of missing data. In a similar way, Hajat et al. (2010) used four different approaches to define heat-dangerous days in four cities with various climates. Little agreement on the selection of heat-oppressive days was found among these approaches, and the selected days were not systematically associated with a higher number of deaths. Another study found differences in the impacts of several temperature measures on health (Nicholls et al. 2008). More research is needed to clarify this issue.

During extremely hot days, higher concentrations of air pollutants, such as ozone (O_3) and particulate matter with diameter of less than 10 μm (PM_{10}), have been previously documented (e.g., Roberts 2004; Papanastasiou et al. 2010). Meteorological conditions on such days can foster the formation of photoreactive pollutants, such as ozone (Hart et al. 2006). In addition, PM_{10} can occur in higher concentrations because of increased production of secondary aerosols during days with high ambient temperatures (Morawska et al. 2002). Air pollution is known to have adverse effects on human health and can confound/modify the heat–mortality relationship (Ren et al. 2008; Stafoggia et al. 2008). Therefore regional assessments of the role of air pollutants during hot weather conditions are important. Previous studies that compared the performances of several biometeorological indices rarely adjusted for the presence of air pollutants (e.g., Barnett et al. 2010; Metzger et al. 2010).

To date, systematic assessments of the efficiency of several indices and temperature measures, as well as comparisons of their ability to predict heat-related deaths on a specific population, have rarely been conducted. The aim of our study is to compare the performances of several relatively simple and frequently used biometeorological indices and three measures of temperature in evaluating heat-related health impact after adjusting for air pollution.

In the next section we present the datasets and indices that we used in this study. We also describe the statistical methods used, and then the results. Next, we discuss our results in the context of international and local relevance, and suggest future research directions.

2. Materials and methods

a. Data sources

The Office of Economic and Statistical Research of the Queensland Treasury provided daily mortality counts for the Brisbane, Australia, local governmental area (LGA) for the period between 1 January 1996 and 30 November 2004. The cause of death was classified according to the International Statistical Classification of Diseases and Related Health Problems 9th and 10th Revisions (ICD9 and ICD10) codes. Only organic causes of death (excluding deaths due to injury, ICD9 codes 001–799 and ICD10 codes A00–R99) were considered in this study.

The Australian Bureau of Meteorology (BOM) provided the meteorological variables for the study period. These included daily measurements of air temperature (°C), water vapor pressure (hPa), wind speed at an elevation of 10 m (m s^{-1}), and relative humidity (%). The Archerfield Airport meteorological station (World Meteorological Organization index number 94575; BOM station number 40211) is located southwest of the Brisbane central business district (CBD; 27.5°S, 153.0°E). This is a high-quality station and contains a more complete record than do other stations within the region. It is also assumed to provide a better approximation to the temperature exposure of the population than the other high-quality station available, the Brisbane Airport station, located on the coast and therefore farther from the most populated areas and subject to frequent sea breezes. The temperature records at the Brisbane Airport station would likely underestimate the summer conditions in some locations around Brisbane.

Daily data on 24-h concentrations of O_3 and PM_{10} were obtained from the Queensland Department of Environment and Resource Management (DERM). The air pollution data were measured at the Brisbane CBD station, which is located on the Queensland University of Technology campus in a commercial business area (DERM 2010). Because of its elevated position, this monitoring site is less biased toward any source of particulate matter emissions than are other stations nearby that are not elevated and are often located close to major roads (because their goal is to measure the local emissions). The Brisbane CBD station consequently provides a better measure of the PM_{10} levels to which the majority of the population of the Brisbane LGA is exposed. The O_3 distribution across Brisbane is fairly homogeneous, and therefore any station could be used for measuring the exposure to O_3 (Morawska et al. 2002). Both meteorological and air-pollutant stations were chosen as being representative for the Brisbane LGA.

b. Biometeorological indices

We used daily measurements of maximum, minimum, and average temperature and several biometeorological indices. All three types of temperature measurement have been previously used in heat-related research, and there is currently no evidence of any one measure being superior to the others (Barnett et al. 2010), although average and maximum temperatures are more frequently used than is minimum temperature. The three temperature measurements are usually highly correlated, but also measure slightly different daily exposure experiences. We therefore evaluated the performances of all three temperature measures.

Several biometeorological indices were constructed from commonly available meteorological variables. These indices included the wet-bulb globe temperature (WBGT), apparent temperature (including and excluding the wind component: ATW and AT, respectively), Thom discomfort index (DI), relative strain index (RSI), and ''humidex.'' Most of the indices are a combination of temperature and some measurement of humidity; one index (ATW) also includes the wind component. All indices aim at reflecting the subjective ''perceived temperature.'' A more detailed description of these indices is available in Table 1.

1) WBGT

WBGT is a composite temperature index developed more than 50 years ago to monitor and prevent heat illness in training camps of the U.S. Army and Marine Corps (Yaglou and Minard 1957). This index has since been adopted by many governments and workplaces to estimate the heat stress/comfort of workers. It is often used in occupational health and safety guidelines for work in hot environments and for use in sports that are characterized by continuous exertion (e.g., marathons) (Budd 2008). It generally incorporates measurements of air temperature, wet-bulb temperature, and black-globe temperature. It has a good correlation with sweat rate, but the estimation gets poorer under low-humidity conditions.

2) AT

The concept of ''apparent temperature'' was developed in the 1970s by Steadman (1979a) as an index of ''sultriness'' and included numerous environmental and physiological variables, such as temperature, clothing cover, physical activity level, solar and terrestrial radiation, internal or core temperature, and other variables (Steadman 1979b, 1984). The index was originally developed for indoor conditions but was modified in the 1980s to include sun and wind to extend it to outdoor

TABLE 1. Summary of the physiological indices used in the study.

Index name	Index abbreviation	Equation	Variables used	Source
Wet-bulb globe temperature	WBGT	$\mathrm{WBGT} = 0.567T + 0.393e + 3.94$	T = dry-bulb temperature (°C) and e = water vapor pressure (hPa)	BOM (2010)
Apparent temperature excluding wind	AT	$\mathrm{AT} = -2.653 + 0.994T_a + 0.368(\mathrm{dew})^2$	T_a = air temperature (°C) and dew = dewpoint temperature (°C)	Kalkstein and Valimont (1986)
Apparent temperature including wind	ATW	$\mathrm{ATW} = T + 0.33e - 0.70(\mathrm{ws}) - 4.00$	T = dry-bulb temp (°C), e = water vapor pressure (hPa), and ws = wind speed (m s^{-1}) at an elev of 10 m	BOM (2010)
Relative strain index	RSI	$\mathrm{RSI} = [10.7 + 0.74(T_a - 35)]/(44 - e_x)$	T_a = air temperature (°C) and e_x = partial water pressure of the atmosphere (mm of mercury)	de Garín and Bejarán (2003)
Thom discomfort index	DI	$\mathrm{DI} = T_a - 0.55[1 - 0.01(\mathrm{RH})](T_a - 14.5)$	T_a = air temperature (°C) and RH = relative humidity (%)	Thom (1959)
Humidex		$\mathrm{Humidex} = T_a + 0.5555(e - 10)$	T_a = air temperature (°C) and e = water vapor pressure (hPa)	Environment Canada (2010)

conditions. The definition of the outdoor AT is based on a mathematical model of an adult walking outdoors in the shade and includes parameterizations for factors such as heat generation and loss, fabric resistance, vapor pressure, wind speed, solar radiation, terrestrial radiation, proportion of body clothed, and other factors (Steadman 1984; Davis et al. 2006). In this study, we used two versions of the AT equation: one including and one excluding the wind speed component (ATW and AT, respectively) (Kalkstein and Valimont 1986; BOM 2010).

3) DI

The Thom discomfort index (Thom 1959) was developed at the U.S. Weather Bureau (currently the National Weather Service) and has been widely used during the past 40 years to assess heat discomfort (Epstein and Moran 2006).

4) HUMIDEX

Humidex (Environment Canada 2010) is a Canadian index that also aims at estimating the perceived temperature based on temperature and humidity. It is equivalent to the heat index that is commonly employed in the United States but uses dewpoint temperature rather than relative humidity. Because the heat index is limited to a predefined range of values of humidity and temperature (i.e., 26.7°C and 40% relative humidity), we decided to use humidex. The Canadian Centre for Occupational Health and Safety provides daily values of humidex intended for the general public. Under certain workplace conditions, humidex can be used to assess thermal comfort of occupational workers, and two sets of index threshold values can be differentiated by the level of acclimatization of workers (i.e., higher threshold values for heat-acclimatized workers) (CCOHS 2010).

5) RSI

RSI calculates the ratio of sweat evaporation needed for comfort to the amount of evaporation possible given ambient atmospheric conditions. At low temperatures the humidity is relatively independent of the temperature, whereas at high strain levels both temperature and humidity are significantly correlated (Driscoll 1985). Using a set of predefined parameters such as a person dressed in a light business suit walking at a speed of 1 m s^{-1} with wind speed of 0.5 m s^{-1}, the equation of the RSI requires only air temperature and partial water vapor pressure as inputs (de Garín and Bejarán 2003). The RSI threshold for thermal strain may be set so that the RSI values can be calculated for any combination of air temperature, humidity, air movement, activity, radiation load, clothing insulation, and age (Lee 1980). For example, the thresholds are 0.50 and 0.30 for young and elderly people, respectively. We computed RSI with the method of de Garín and Bejarán (2003).

c. *Statistical analysis*

We calculated daily values and obtained the probability distribution of each index and temperature indicator. We identified hot days as those that fell into the highest 5%, 4%, 3%, 2%, 1%, and 0.5% of each

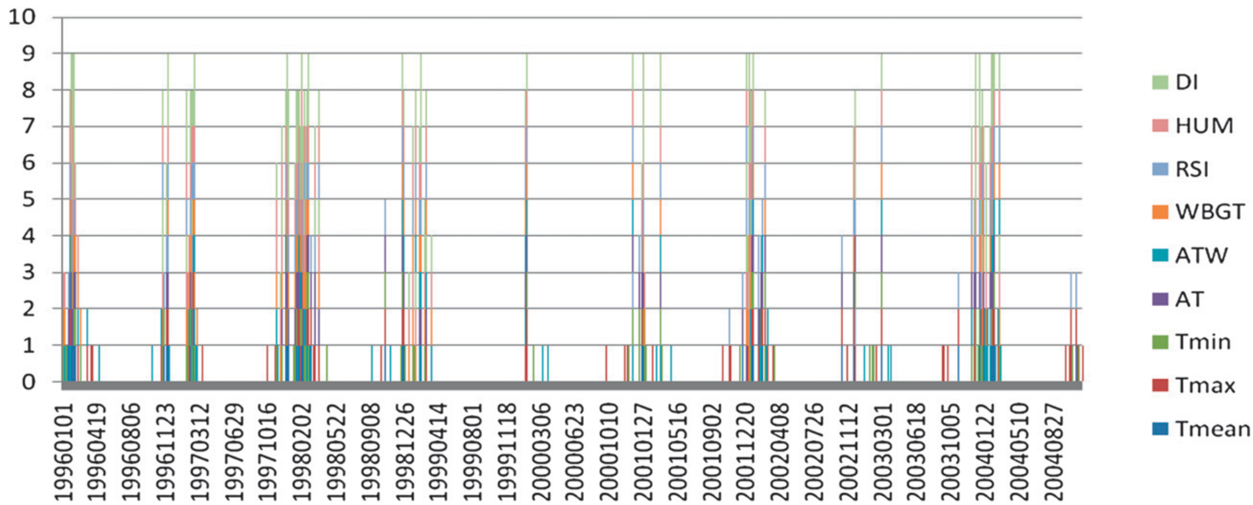

FIG. 1. Time series of the number of indices that selected each day as hot (above the 95th percentile threshold).

index or indicator. We then applied the time-stratified case-crossover method (e.g., Bell et al. 2008). A case-crossover study design compares ''case'' days with nearby ''control'' days to identify the difference in exposure (here the difference in the level of temperature), which may explain the differences in the number of cases (i.e., here a number of daily deaths). By matching a case day with nearby control days, we are comparing only recent changes in the exposure; therefore, long-term and seasonal trends can be eliminated. The time-stratified method divides the whole study period into equally sized nonoverlapping sections (i.e., strata); each case day within a stratum is compared only with the control days within that same stratum. The length of the strata is chosen so that it is short enough to remove the seasonal trend but not too short that the case and control days become correlated.

In our study we used a stratum length of 28 days. Within each stratum we only considered the control days that matched a case day by day of week (e.g., if a case day fell on a Monday, it was matched with the 2–3 Monday control days within the 28-day stratum). We then used the conditional logistic regression to calculate the odds ratio (OR) for cases in comparison with controls. The dependent variable was the daily count of mortality; the independent variables included the indices and temperature measures (each fitted separately) and two air pollutants (O_3 and PM_{10}). Daily measurements of both air pollutants were added as linear independent variables, first separately and then jointly, in the model. Mortality 1 and 2 days after the exposure (lag 1 and lag 2) and mortality on two consecutive hot days were also analyzed.

To compare the ability of all indices to detect excess-mortality days, we used a common data-resampling method, the jackknife procedure (Quenouille 1949). The jackknife method attains statistical parameters such as the estimate and its standard error by resampling the existing dataset repeatedly, excluding a single data value during each iteration. It calculates the effect of each data value on the estimate. The advantage of using this technique is that, even if the original estimate of variance is slightly biased, the jackknife method will often eliminate the bias and produce consistent estimates of standard errors (Wonnacott and Wonnacott 1984). In our study, each stratum (28 days) was repeatedly removed from the case-crossover analysis and new estimates were recalculated. The objective of using this method was to determine the reliability of the ORs and the confidence intervals, and to decrease the potential biases. The newly recalculated estimates were then compared. If the range of the estimates for a predictor did not overlap with others, this predictor was assumed to be significantly different.

3. Results

There were 3258 days in the study period. Ten percent of those days ($n = 331$) were selected as hot days by at least one discomfort measure (Fig. 1). Almost all of the selected hot days ($n = 320$) occurred within the six warmer months in the Southern Hemisphere (i.e., October–March). Only maximum and minimum temperatures (Tmax and Tmin, respectively) selected the remaining 11 days in the generally cooler months of September and April.

We observed some differences in the way the various indices selected a hot day, suggesting that each index modeled slightly dissimilar comfort criteria (Fig. 1). All

TABLE 2. Average of temperature, humidity, and air pollutants on days that were above the 95th percentile for each indicator.

	Avg temperature (°C)		RH (%)		O_3 (ppb)		PM_{10} (μg m^{-3})	
	Case	Control	Case	Control	Case	Control	Case	Control
Avg temperature	27.5	19.4	70.9	71.9	14.5	11.1	20.8	16.4
Max temperature	26.8	19.5	68.3	72.0	15.8	11.1	22.7	16.3
Min temperature	26.9	19.5	74.9	71.7	11.9	11.3	17.7	16.5
Apparent temperature excluding wind	27.5	19.5	71.7	71.8	14.5	11.1	20.1	16.4
Apparent temperature including wind	26.5	19.6	75.6	71.7	14.0	11.2	17.2	16.6
Wet-bulb globe temperature	27.3	19.5	76.1	71.6	13.1	11.2	17.7	16.5
Humidex	27.3	19.5	75.6	71.6	13.4	11.2	17.8	16.5
Thom discomfort index	27.4	19.5	74.4	71.7	13.8	11.2	18.6	16.5
Relative strain index	27.6	19.5	70.6	71.9	14.5	11.1	21.5	16.3

indices selected case days that had on average a higher daily mean temperature (Tmean) than the control days (Table 2). Tmean, RSI, and AT selected days with the highest average temperatures, whereas Tmax and ATW selected days with the lowest average temperatures. Fewer clear patterns occurred in terms of the humidity levels: some indices selected case days that had higher humidity than the control days (Tmin, ATW, WBGT, DI, and humidex) and some did not (Tmean, Tmax, AT, and RSI). The level of both air pollutants was generally higher on the case days in comparison with the control days (Table 2).

Several indices and temperature measures were highly correlated (Table 3). The highest correlation was between Tmean, AT, and DI and also between WBGT and humidex. Least correlated were all indices/temperatures and relative humidity.

The ORs associated with different indices (Table 4) reveal that people were significantly more likely to die on hot (case) days than on neighboring (control) days, with mortality ORs ranging from 1.08 to 1.48 [with associated 95% confidence intervals (CIs) from 1.02 to 1.14 and from 1.30 to 1.68, respectively]. In general, we found that the higher the discomfort level on the case days (95th–99.5th percentiles) was, the higher was the probability of death. Adjusting for air pollutants lowered the ORs slightly for all indices, with the lowest ORs when both O_3 and PM_{10} were included in the model (Table 4). These ORs still remained significant for most of the indices/temperature indicators across the 95th–99.5th-percentile range, however. Only ORs for ATW at the 99th and 99.5th percentiles and for Tmin at the 99.5th percentile were not significant when both air pollutants were included in the model.

The OR estimates and the 95th-percentile CIs, acquired from the case-crossover analysis for case days that fall into the highest 5%, 4%, 3%, 2%, 1%, and 0.5% of each index, did not reveal any significant differences among most of the indices (Table 4). After recalculating the OR estimates using the jacknife resampling, the case days that fall into the highest 5% of each index revealed some significant differences between indices and temperature measures (Fig. 2). The estimates of Tmax and Tmin were significantly lower than those of AT and some other indices (ATW, DI, humidex, and WBGT), with the difference ranging between 0.040 and 0.065 of an OR.

Additional analyses were performed to test whether the mortality on lag-1 or lag-2 days significantly increased. The ORs on a lag-1 day were still statistically significant but were lower than the ORs on the same day (results not shown) for all temperatures/indices except for Tmin, which showed a slight increase of OR (i.e., 0.01). ORs on lag-2 days were not statistically significant for all measures. When two consecutive days of each indicator were tested, the ORs were lower than when individual days (consisting of individually occurring hot days and consecutive days considered individually) were used; when higher percentiles of two consecutive days

TABLE 3. Pearson correlation coefficients of daily measurements of all indices, temperatures, and RH in Brisbane between 1 January 1996 and 30 November 2004.

	Tmean	Tmax	Tmin	RH	AT	ATW	WBGT	Humidex	RSI	DI
Tmean	1.00	0.90	0.92	0.07	1.00	0.74	0.97	0.98	0.95	1.00
Tmax	—	1.00	0.70	−0.09	0.89	0.73	0.83	0.84	0.88	0.88
Tmin	—	—	1.00	0.24	0.93	0.65	0.94	0.94	0.87	0.93
RH	—	—	—	1.00	0.09	0.35	0.29	0.27	0.03	0.14
AT	—	—	—	—	1.00	0.75	0.98	0.98	0.95	1.00

were considered, the ORs became frequently insignificant (results not shown).

4. Discussion

Our assessment of various composite indices and temperature measures in the subtropical city of Brisbane showed that all indices and temperature measures can predict heat-related deaths to some extent. We found some differences in performance among these measures. As an indicator of heat stress, average temperature performed similarly to the more complex indices and could be used interchangeably with them. The performance of maximum and minimum temperatures was poorer than the performance of some indices.

Simple temperature measures have been previously used and advocated as a sufficient measure of heat stress (e.g., Curriero et al. 2002; Nicholls et al. 2008; Vaneckova et al. 2008). Nicholls et al. (2008) investigated the performance of several temperature measures to model heat stress between 1979 and 2001 in Melbourne, Australia. They found thresholds of average and minimum temperatures above which mortality increased, and they advocated the use of a simple temperature measure as being sufficient for setting up a warning system. Our study showed that the use of average temperature was comparable in its performance to more complex biometeorological indices, thus supporting their hypothesis.

Maximum temperature has been used as a variable that models heat-related mortality well (Fouillet et al. 2006; Conti et al. 2007). In our study, maximum and minimum temperatures produced poorer results than did average temperature. This could be due to a sudden change in maximum temperature within a 24-h period, when the temperature peaks during the day but is followed by a sudden drop due to changes in meteorological conditions. As a result, the population is not exposed to high temperatures for periods of time long enough to cause discomfort. Minimum temperature has been documented to be high during heat-wave periods (Semenza et al. 1996; Le Tertre et al. 2006) but has been rarely modeled as a variable alone; it is usually combined with other variables (e.g., Rey et al. 2007; Nicholls et al. 2008). When modeling the days that fell into the 99th percentile in our study, both average and minimum temperatures were comparable to the performance of the composite indices. Given that this occurred only at the 99th percentile, we argue that average temperature is a more stable indicator of heat stress on the Brisbane population than is minimum temperature. Combinations of both minimum and maximum temperatures are more likely to be used in heat-related research, to capture the effect of warm nights that impede the body's recovery after a hot day. Average temperature may be a better indicator because it is more likely to represent the temperature level across the whole 24 h.

The role of humidity on thermal comfort is complex. It is intuitive to assume that simple temperature measures without consideration of the level of humidity may not be sufficient in assessing thermal stress. Apparent temperature combines temperature and humidity and is one of the most used thermal indices in biometeorological studies to predict the impact of heat stress on the local population (e.g., Zanobetti and Schwartz 2008; Baccini et al. 2009). On days when high levels of humidity occur, the human thermoregulatory system may be under additional stress because evaporation, the major mechanism of heat loss, is limited (Kerslake 1972). For the purpose of modeling heat stress, humidity is often combined with a temperature measure. Although all composite indices in our study incorporated some measure of humidity, the role of humidity on the mortality during hot days in Brisbane was not clear and did not seem to make a difference in the final results. Although most indices in our study displayed a linear relationship with average temperature, no obvious relationship was found with relative humidity (data not shown). Thus, the value of each index did not clearly increase with increasing levels of humidity. Some indices selected case days that were more humid than the control day, but overall these indices did not perform differently from those that selected case days with lower humidity than the control days. Brisbane is located in a subtropical climate with summer days that are characterized by high levels of humidity. Sea breeze, which increases humidity, is present on most days. Occasionally hot winds blow from the west and northwest inland regions and result in hot and drier conditions; those days are rare, however. The local population may be well adjusted physiologically to the higher levels of humidity, but it may still be affected by relatively higher temperatures.

Populations in warmer climates are assumed to be well adjusted to the local high temperature as a result of their physiological, behavioral, and technological adaptation. Higher prevalence of air conditioners in regions where high daily temperatures are common during most of the year has been put forward as a protective measure (Davis et al. 2003). Warmer climates also typically show relatively small daily temperature variations in comparison with temperate climates, and heat effects tend to be smaller than those in the temperate locations (Anderson and Bell 2009). Our results and other recent findings have shown, however, that even in warmer climates the population demonstrates an elevated risk of mortality during unusually hot days and that a relative

TABLE 4. Odds ratios of daily deaths during hot days in Brisbane, 1996–2004. Here N is number of days.

		Nonadjusted			Adjusted for O_3			Adjusted for O_3 and PM_{10}		
	N	OR	95% CI		OR	95% CI		OR	95% CI	
Avg temperature (by percentiles)										
95th	164	1.14	1.09, 1.20	<0.0001	1.15	1.10, 1.22	<0.0001	1.12	1.06, 1.18	<0.0001
96th	130	1.13	1.07, 1.19	<0.0001	1.14	1.08, 1.21	<0.0001	1.10	1.03, 1.17	<0.0001
97th	97	1.20	1.12, 1.27	<0.0001	1.20	1.13, 1.28	<0.0001	1.16	1.08, 1.24	<0.0001
98th	64	1.23	1.14, 1.32	<0.0001	1.22	1.13, 1.31	<0.0001	1.17	1.08, 1.27	<0.0001
99th	34	1.30	1.19, 1.43	<0.0001	1.29	1.18, 1.42	<0.0001	1.28	1.15, 1.42	<0.0001
99.5th	16	1.47	1.29, 1.67	<0.0001	1.46	1.28, 1.66	<0.0001	1.40	1.21, 1.62	<0.0001
Max temperature (by percentiles)										
95th	164	1.10	1.05, 1.16	<0.0001	1.11	1.06, 1.17	<0.0001	1.09	1.04, 1.15	0.0009
96th	132	1.13	1.07, 1.19	<0.0001	1.14	1.08, 1.20	<0.0001	1.11	1.05, 1.17	0.0004
97th	100	1.15	1.08, 1.22	<0.0001	1.15	1.08, 1.22	<0.0001	1.13	1.06, 1.20	0.0003
98th	67	1.18	1.10, 1.27	<0.0001	1.18	1.10, 1.27	<0.0001	1.15	1.06, 1.24	0.0007
99th	33	1.18	1.07, 1.30	0.0002	1.17	1.06, 1.29	0.0020	1.12	1.00, 1.24	0.0442
99.5th	15	1.30	1.13, 1.50	<0.0001	1.29	1.13, 1.49	0.0003	1.21	1.04, 1.41	0.0162
Min temperature (by percentiles)										
95th	164	1.11	1.05, 1.16	0.0001	1.11	1.06, 1.17	<0.0001	1.08	1.02, 1.14	0.0051
96th	127	1.15	1.08, 1.21	<0.0001	1.15	1.08, 1.21	<0.0001	1.11	1.05, 1.18	0.0006
97th	95	1.14	1.07, 1.22	<0.0001	1.15	1.08, 1.22	<0.0001	1.11	1.03, 1.19	0.0035
98th	69	1.20	1.12, 1.29	<0.0001	1.21	1.12, 1.30	<0.0001	1.18	1.09, 1.28	<0.0001
99th	31	1.30	1.18, 1.43	<0.0001	1.29	1.17, 1.42	<0.0001	1.27	1.13, 1.42	<0.0001
99.5th	18	1.23	1.08, 1.40	0.0016	1.22	1.07, 1.39	0.0023	1.17	1.00, 1.36	0.0470
Apparent temperature (excluding wind; by percentiles)										
95th	162	1.15	1.10, 1.21	<0.0001	1.16	1.10, 1.23	<0.0001	1.13	1.06, 1.19	<0.0001
96th	129	1.17	1.10, 1.23	<0.0001	1.18	1.11, 1.24	<0.0001	1.14	1.07, 1.21	<0.0001
97th	97	1.19	1.12, 1.26	<0.0001	1.19	1.12, 1.27	<0.0001	1.15	1.08, 1.24	<0.0001
98th	64	1.25	1.17, 1.35	<0.0001	1.25	1.16, 1.34	<0.0001	1.20	1.11, 1.30	<0.0001
99th	32	1.31	1.19, 1.44	<0.0001	1.30	1.18, 1.43	<0.0001	1.29	1.16, 1.44	<0.0001
99.5th	16	1.48	1.30, 1.68	<0.0001	1.46	1.28, 1.67	<0.0001	1.41	1.22, 1.64	<0.0001
Apparent temperature (including wind; by percentiles)										
95th	136	1.16	1.10, 1.22	<0.0001	1.17	1.10, 1.23	<0.0001	1.14	1.08, 1.21	<0.0001
96th	107	1.18	1.11, 1.25	<0.0001	1.19	1.12, 1.26	<0.0001	1.14	1.07, 1.22	<0.0001
97th	80	1.17	1.10, 1.25	<0.0001	1.18	1.10, 1.26	<0.0001	1.14	1.06, 1.22	0.0005
98th	59	1.18	1.10, 1.27	<0.0001	1.19	1.10, 1.28	<0.0001	1.14	1.05, 1.24	0.0021
99th	32	1.14	1.03, 1.26	0.0108	1.15	1.03, 1.27	0.0096	1.11	0.99, 1.23	0.0795
99.5th	19	1.23	1.08, 1.40	0.0016	1.22	1.07, 1.39	0.0026	1.16	1.00, 1.34	0.0521
Wet-bulb globe temperature (by percentiles)										
95th	162	1.16	1.11, 1.23	<0.0001	1.17	1.11, 1.24	<0.0001	1.14	1.08, 1.21	<0.0001
96th	129	1.18	1.11, 1.25	<0.0001	1.19	1.12, 1.26	<0.0001	1.15	1.08, 1.22	<0.0001
97th	97	1.20	1.17, 1.28	<0.0001	1.21	1.13, 1.29	<0.0001	1.16	1.09, 1.25	<0.0001
98th	64	1.26	1.17, 1.35	<0.0001	1.26	1.17, 1.36	<0.0001	1.22	1.13, 1.32	<0.0001
99th	32	1.28	1.16, 1.41	<0.0001	1.29	1.17, 1.43	<0.0001	1.28	1.14, 1.43	<0.0001
99.5th	16	1.28	1.12, 1.46	0.0003	1.27	1.11, 1.45	0.0005	1.21	1.04, 1.40	0.0162
Relative strain index (by percentiles)										
95th	162	1.14	1.09, 1.20	<0.0001	1.15	1.09, 1.21	<0.0001	1.11	1.05, 1.18	0.0001
96th	129	1.14	1.08, 1.20	<0.0001	1.14	1.08, 1.21	<0.0001	1.10	1.03, 1.17	0.0024
97th	97	1.20	1.12, 1.27	<0.0001	1.20	1.13, 1.28	<0.0001	1.17	1.09, 1.25	<0.0001
98th	64	1.23	1.14, 1.32	<0.0001	1.22	1.14, 1.32	<0.0001	1.17	1.08, 1.26	0.0001
99th	32	1.30	1.19, 1.43	<0.0001	1.29	1.18, 1.42	<0.0001	1.28	1.15, 1.42	<0.0001
99.5th	16	1.48	1.30, 1.68	<0.0001	1.46	1.28, 1.67	<0.0001	1.41	1.22, 1.64	<0.0001
Humidex (by percentiles)										
95th	162	1.16	1.10, 1.22	<0.0001	1.17	1.11, 1.24	<0.0001	1.14	1.08, 1.21	<0.0001
96th	129	1.18	1.11, 1.25	<0.0001	1.19	1.12, 1.26	<0.0001	1.15	1.08, 1.22	<0.0001
97th	97	1.20	1.13, 1.28	<0.0001	1.21	1.13, 1.29	<0.0001	1.17	1.09, 1.25	<0.0001
98th	64	1.24	1.15, 1.33	<0.0001	1.25	1.16, 1.35	<0.0001	1.21	1.12, 1.31	<0.0001
99th	32	1.28	1.16, 1.41	<0.0001	1.29	1.17, 1.43	<0.0001	1.28	1.14, 1.43	<0.0001
99.5th	16	1.34	1.19, 1.54	<0.0001	1.34	1.18, 1.53	<0.0001	1.30	1.12, 1.50	0.0006

TABLE 4. (*Continued*)

		Nonadjusted			Adjusted for O_3			Adjusted for O_3 and PM_{10}		
	N	OR	95% CI		OR	95% CI		OR	95% CI	
Thom discomfort index (by percentiles)										
95th	162	1.16	1.10, 1.22	<0.0001	1.15	1.10, 1.21	<0.0001	1.14	1.08, 1.21	<0.0001
96th	130	1.18	1.12, 1.25	<0.0001	1.20	1.13, 1.27	<0.0001	1.16	1.09, 1.23	<0.0001
97th	97	1.19	1.11, 1.26	<0.0001	1.19	1.12, 1.27	<0.0001	1.15	1.07, 1.23	<0.0001
98th	65	1.27	1.18, 1.36	<0.0001	1.28	1.19, 1.38	<0.0001	1.23	1.14, 1.34	<0.0001
99th	32	1.33	1.21, 1.46	<0.0001	1.32	1.20, 1.46	<0.0001	1.31	1.17, 1.46	<0.0001
99.5th	16	1.37	1.21, 1.56	<0.0001	1.36	1.19, 1.55	<0.0001	1.32	1.14, 1.53	0.0003

measure seems to be a better predictor of the heat-related vulnerability than an absolute measure (Gouveia et al. 2003; Anderson and Bell 2009; Chau et al. 2009; Tong et al. 2010; Yu et al. 2010).

Even though several measures of thermal stress were used in previous studies (Basu et al. 2008; Zanobetti and Schwartz 2008; Papanastasiou et al. 2010), a systematic assessment of the performances of these indices at a single location has rarely been conducted. Davis et al. (2006) compared the performances of various biometeorological indices and the spatial synoptic classification index, an airmass-based categorical classification of meteorological conditions. They found a very small difference in performance among the indices. A more recent study of several U.S. cities also found that various indices and temperature measures have similar ability to predict the weather–mortality relationship (Barnett et al. 2010). Our findings support these results.

In our study, all indices selected days on which mortality was significantly higher; the values of the indices on these high-mortality days suggested conditions that should have only resulted in moderate discomfort in the population of Brisbane, however. Even during the 2004 heat wave that resulted in 75 excess deaths (Tong et al. 2010), the ranges of all indices in our study indicated that people experienced only slight discomfort during those days. For example, the RSI thresholds for risk category for young and older population groups are 0.5 and 0.3, respectively. In Brisbane, the hot days that fell into the highest 5 percentile had an RSI value of 0.24, and yet the population had 14% higher probability of dying on these days. In the case of DI, the highest 5 percentile of the index selected days with a value of 25.6, which increased to 27.3 at the 99th percentile but never reached the critical value of 28 associated with the onset of physical and cognitive deterioration. Values of humidex between the 95th and 99.5th percentiles also fell within the "moderate discomfort" category, and the values of apparent temperature (without wind) did not even reach the light discomfort level. The general thresholds marking the onset of discomfort for a specific index may need to be adjusted according to the vulnerability of the local population.

Previous studies have considered the impact of lags and several consecutive days of extreme temperatures on health (e.g., Anderson and Bell 2009). In our study, ORs for lag 1, lag 2, and two consecutive hot days were lower than those on the individual days of exposure. The effect of extreme hot weather on the population of Brisbane was rather immediate, with the largest number of excess deaths on the same day of exposure to hot weather (i.e., lag 0). Mortality displacement could be a possible explanation for acute increases in the number of deaths; those who are in fragile condition and would die regardless of weather in a short period of time could make up a larger proportion of the heat-related deaths. Further study considering the years of life lost rather than numbers of deaths during hot days would help to build a better picture of the impacts of hot weather on public health and to assess whether they could be avoided with proper intervention.

Unlike some of the previous studies comparing the performance of several measures of heat stress, our study also incorporated the potential effect of air pollutants

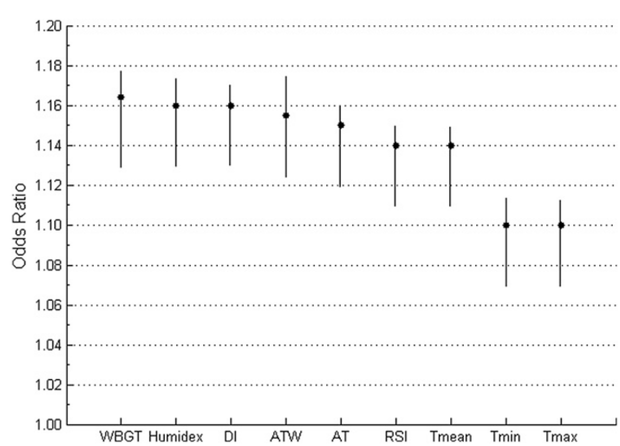

FIG. 2. The range of estimates by the jackknife method of ORs for each index. Vertical bars denote the range values between the 25th and 75th percentiles.

on excess mortality during hot days. Air pollution can account for up to 38% of deaths on such days (Stedman 2004). Both O_3 and PM_{10} had previously been associated with increased mortality in Brisbane (Morawska et al. 2002; Simpson et al. 2005; Ren et al. 2008). Our study found that both air pollutants contributed to mortality to some degree, confirming results from other studies (e.g., Stedman 2004; Stafoggia et al. 2008). A new type of index could incorporate information about air pollution. This would provide an integrated warning message for the public, avoiding the possibility of contradictory messages arising from the use of two independent indices (i.e., air pollution monitoring and heat-warning index).

In general, the concentrations of air pollutants vary spatially within a city. Previous study in Brisbane found that the O_3 measurements did not vary spatially; therefore, any station within the city could be used as representative of the O_3 exposure. In the case of PM_{10}, the concentrations were heterogeneously distributed: more localized and usually higher in close proximity to its sources (Morawska et al. 2002). The main source of PM_{10} in Brisbane is car traffic, with some minor contributions from local industry and occasionally high levels that are due to controlled or wild bushfires (DERM 2010). It can be argued that our results could somehow be affected by our choice of PM_{10} monitoring station. By selecting only one station, the resulting mortality ORs could be biased by the spatially varying levels of PM_{10}. As mentioned before, the station selected is located at an elevated position and therefore is less subject to local fluctuations in levels of PM_{10}. We therefore believe that the inclusion of data from other available stations that are in some cases designed to measure localized levels of PM_{10} would not improve our results. Temperature is also presumed to vary spatially within the LGA boundaries, but we could not account for this in our study because of the limited spatial data on both exposure and outcomes.

We have identified some limitations in our study. First, it was conducted at one location only, which limits the generalization of the results. A subsequent study is under way to compare various indices at climatically different locations. Second, we did not explore the effect of heat on the elderly and by specific cause of mortality. The elderly are considered to be the most vulnerable age group. Most daily deaths normally fall into the older portion of the population, however, and therefore our results are probably correlated with those expected for the elderly group. Cardiovascular and respiratory diseases have been commonly found to be a major cause of death during hot days (e.g., Rey et al. 2007). Mortality from a wide variety of other causes also increases during hot days (e.g., Kalkstein and Davis 1989; Conti et al. 2007). In this study we considered total organic cause of death to include all causes of death that were potentially heat related. A next step will consist of studying different age groups and various specific causes of death. It also would be beneficial to investigate the performance of the indices using nonfatal outcomes. Under extremely hot environmental temperatures, increases in nonfatal health impacts are to be expected. This should be analyzed to verify whether the small differences we observed in the indices and the average temperature hold for nonfatal outcomes as well and to decide whether this framework could be utilized for the development of early-warning systems to particularly vulnerable groups.

5. Conclusions

There was no significant difference in the performance of composite indices and the simple average temperature on the extremely hot days in Brisbane during 1996–2004. Over the years more emphasis has been put on the academic accuracy of indices at the expense of their practicality (Epstein and Moran 2006). A warning system based on a simple temperature measure has been previously established (e.g., Pascal et al. 2006), and those based on more complex methods have not been proven to be superior (Hajat et al. 2010). If a simple measure like average temperature performs well at some location, this would be important for emergency planners, because it offers a measure without extra complexities and associated error risks. For the nonscientific population it offers an easy-to-understand risk measure to approximate heat stress, and it would therefore help with the development of public-health intervention strategies. More research is warranted to confirm if average temperature could be the basis of an inexpensive weather–health warning system across different places.

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Annex 12: Paper 3.8

Fitzgerald G**, Aitken P,** Arbon P, Archer F, Cooper D, Leggat P, Myers C, Robertson A, Tarrant M, Davis E. A National Framework for Disaster Health Education in Australia. Prehospital and Disaster Medicine 2010; 25(1): 70-77

A National Framework for Disaster Health Education in Australia

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Keywords: Australia; awareness; disaster health; education; framework

Abbreviations:
EMA = Emergency Management Australia
WADEM = World Association for Disaster and Emergency Medicine
WHO = World Health Organization

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Abstract

Introduction: Recent events have heightened awareness of disaster health issues and the need to prepare the health workforce to plan for and respond to major incidents. This has been reinforced at an international level by the World Association for Disaster and Emergency Medicine, which has proposed an international educational framework.
Objective: The aim of this paper is to outline the development of a national educational framework for disaster health in Australia.
Methods: The framework was developed on the basis of the literature and the previous experience of members of a National Collaborative for Disaster Health Education and Research. The Collaborative was brought together in a series of workshops and teleconferences, utilizing a modified Delphi technique to finalize the content at each level of the framework and to assign a value to the inclusion of that content at the various levels.
Framework: The framework identifies seven educational levels along with educational outcomes for each level. The framework also identifies the recommended contents at each level and assigns a rating of depth for each component. The framework is not intended as a detailed curriculum, but rather as a guide for educationalists to develop specific programs at each level.
Conclusions: This educational framework will provide an infrastructure around which future educational programs in Disaster Health in Australia may be designed and delivered. It will permit improved articulation for students between the various levels and greater consistency between programs so that operational responders may have a consistent language and operational approach to the management of major events.

FitzGerald GJ, Aitken P, Arbon P, Archer F, Cooper D, Leggat P, Myers C, Robertson A, Tarrant M, Davis ER: A national framework for disaster health education in Australia. *Prehosp Disast Med* 2010;25(1):4–11.

Introduction

Recent events, such as the terrorist attacks in the United States and Europe, and the Indian Ocean tsunami, have raised the level of community and professional awareness in regard to the health impacts of major incidents and disasters. This has produced a heightened level of investment in preparedness, both internationally and throughout Australia. However, there is a need to support this planning and preparedness with increased capability of our professional and general communities. Such enhanced capability requires appropriate research and analysis, as well as education and training.

At present, there is a relative lack of consistent and accessible education programs in health disaster management in Australia, limiting the development of capability in this field. Programs that do exist include:

1. Emergency Management Australia (EMA) has a suite of generic educational programs in Emergency Management including a short course in Disaster Medicine that it hosts on behalf of the Department of Health and Aging (DOHA). This course has not been provided for two years;

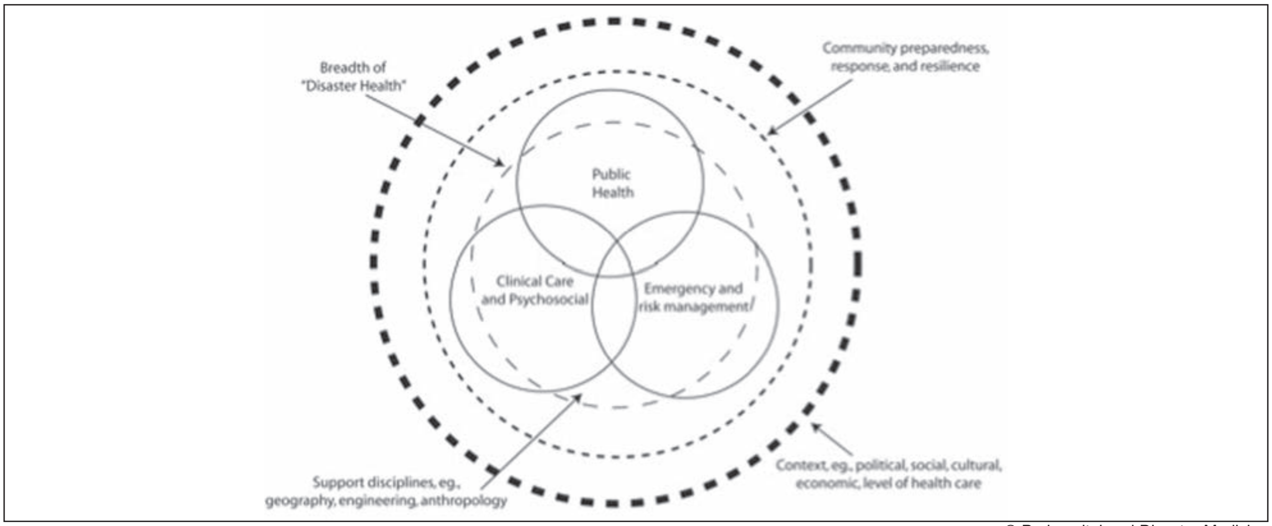

Figure 1—A complete Framework for disaster education[1]

2. Various State health departments in Australia (particularly Western Australia Health) deliver short course and in-service programs, including a state-based version of the National Disaster Medicine Course;
3. Several universities have developed and delivered short course programs for international or domestic groups as well as postgraduate, credentialed programs in disaster health management; and
4. There are several other complementary short course programs that have been developed or imported from international sources including the Major Incident Medical Management and Support (MIMMS) course and courses based on the concepts of incident command systems.

While there is some commonality between these programs and shared teaching, there is a need to take a more consistent approach and to standardize content and curriculum so that the workforce is more reliably and consistently educated and trained. This also may assist with improved communication, inter-agency cooperation, and inter-operability.

There is value in greater integration between these programs and improved capacity to articulate short courses into more extensive, postgraduate, credentialed programs. Finally, such programs should reflect international standards. It is noted that the World Association for Disaster and Emergency Medicine (WADEM) is developing a standard approach to education in disaster medicine[1] and the WADEM, the World Health Organization (WHO), and the International Council of Nurses are working to develop International Disaster Nursing Competencies. Furthermore, the WHO Health Action in Crisis Forum on Emergency Preparedness for the Health Sector and Communities[2] has argued for international efforts to strengthen disaster health knowledge, standards, and education as a priority. Similar efforts are underway in Canada and the United States, adapting WADEM standards in the context of local and national frameworks.[3,4]

Any framework for disaster health management needs to have a sound conceptual basis. Such a framework in which the intersecting domains of public health, emergency management, and clinical and psychosocial care operate within a broader community context is provided in Figure 1.[5]

The educational framework also needs to be consistent with recognized educational principles. Perhaps the most important of these, when developing tiered levels of learning within a framework, is Blooms taxonomy.[6] This is illustrated in Figure 2 and addresses the hierarchy of learning within the cognitive (knowledge) and affective (attitude) domains.

Objective

The aim of this paper is to describe a National Framework for Disaster Health Education in Australia, with a view to ensuring consistency in educational outcomes and facilitating national recognition and transferability of qualifications and course credit within Australia. The objective of this framework is to provide guidance to educators within Australia with a view to achieving a more standardized and integrated approach. This framework is not intended to form the basis of any accreditation program for such courses.

Methods

This framework was developed through the cooperative efforts of the National Collaborative for Disaster Health Education and Research.

Preliminary research included the identification of existing programs in disaster health education and research from around Australia, the WADEM education framework, and generic educational frameworks, such as Blooms taxonomy. The Collaborative that produced this document includes individuals from academic institutions and various government agencies.

The Collaborative met on several occasions, either by teleconference or in person, to develop the framework and

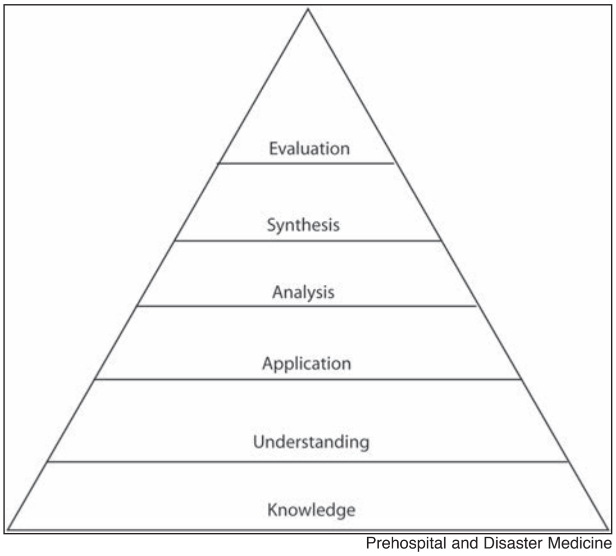

Figure 2—Blooms taxonomy[6]

the learning outcomes for each of the elements. Following initial development of the framework, a modified Delphi approach was used to identify the alignment of learning outcomes to levels. Each member of the Collaborative independently assigned a value based on a three-star rating, the ratings were compiled and levels of agreement identified and areas of disagreement re-circulated until agreement was reached. A final teleconference of members was conducted to finalize a small number of outstanding elements.

Framework

Australia's capacity to deliver disaster health education and research is limited. There are a small number of individuals who have particular interest and expertise in this field. The establishment of a National Collaborative may expedite progressing both the educational and research agenda for Disaster Health Education and Research.

There is considerable value in the maintenance of a nationally consistent approach to the development and delivery of educational programs in disaster health. The characteristics of such programs include:

1. Reflecting nationally agreed disaster management principles and practices based on both best evidence and practice; and
2. Providing flexible delivery modes to accommodate the occupational constraints of the target audience.

The Collaborative identified a number of underlying principles (or assumptions) that were utilized in the development of this framework, including:

1. The framework focuses on health and not on the more generic disaster or emergency management arrangements, although recognizing that knowledge and understanding of the national and local disaster management arrangements is an essential component of disaster health management;
2. The framework is focused on the health aspects of disasters for anyone who has a role to play and not solely health personnel;
3. The framework is integrated, comprehensive, and linked to the Australian Qualifications Framework (AQF) which defines the hierarchy of educational credentials in Australia;[7]
4. There is an emphasis on disaster health, and not disaster medicine,[8] to reinforce the multi-disciplinary nature of disaster health management. It is noted that there is a need for specialized topics that are aimed at a more limited professional and discipline group;
5. The focus of the educational framework is the integration of existing operational knowledge into tactical, operational, and strategic levels and the identification of essential core skills needing additional emphasis;
6. Educational programs are designed to reflect and reinforce the operational management of major incidents, and disasters, and operational strategies;
7. The levels of education are designed so that individuals may articulate from one level to another and amass components of any level in a modular fashion.
8. This framework seeks to articulate educational outcomes and not educational processes. It does not specify the length of courses, although suggestions are made, or the details of content materials or delivery;
9. The framework identifies educational outcomes and not competencies. It is recognized that competency is generated by a combination of education and experience along with personal characteristics of the individual;
10. The framework is designed around an educational core upon which the individual may build further specialization; and
11. The framework is designed around the agreed international approaches to disaster management that have been adopted by Australian institutions, particularly the EMA.

A National Education Framework for Disaster Health

It is proposed that there would be seven levels of education within the National Disaster Health Education Framework. All of these programs would be based on standard core content areas, knowledge and abilities, and would be capable of integration across courses providing articulation pathways. All levels would be open to individuals from any discipline or health based organization. These levels reflect the levels identified by the WADEM.[8]

Level 1: Community Information—Level-1 education programs inform the community of the health aspects of disasters and aid in the development of community resilience. This level is not described in detail.

Level 2: Health Worker Awareness—Level-2 is an introduction to the principles of health disaster management, Australia's disaster management arrangements, and the role required of health workers. This level of education is intended for all health workers and also should be included in undergraduate programs so that a common understanding emerges across disciplines and a common language is developed and used.

This level may be provided by a short lecture or seminar, although it also could be available in a Web-based format as either a "podcast" or simple electronic resource. Universities and other educational bodies that provide health undergraduate education should undertake delivery of this level of education. Service providers, conference organizers, professional associations, and colleges also could offer this program as an orientation, "in-service", or competency development programs.

Level 3: Basic Knowledge—Level-3 is intended to create awareness and basic skills among health workers who likely will be involved in major incident responses. This level addresses the preparedness, planning, response, and recovery arrangements and the role of various individuals, organizations, and leading players in health disaster management. It could be offered as a one-day seminar or incorporated into post-graduate or in-service programs.

Level-4: Advanced Knowledge—Level-4 programs provide those who play a leading or significant role in disaster management with knowledge of the principles of disaster management, detailed preparation, planning, response (relief), and recovery arrangements, and the leading roles required to manage those arrangements. This level could be delivered as a short course (e.g., 40 hours) of instruction.

This level also includes specialist, short-course programs for particular groups who have a specific role to play in the event of a major incident. These specialist programs include, but are not limited to Health Disaster Planning, Mass Casualty Management, Chemical, Biological and Radiological (CBR), International Assistance, Pandemic Preparedness, Mental Health Care, and Disasters Program and Crisis Management and Leadership Program.

Level 5: Expert Knowledge—Level-5 programs are intended to develop expertise among a small group of health workers, who, because of their role, have a specific need for more extensive knowledge and expertise in aspects of health disaster management. Universities offer these programs. It also is possible that these levels of programs would be recognized by employers, professional colleges and operational organizations for in-service or continuing medical education (CME) points, award of post-graduate qualifications, or an articulation pathway for course recognition as a module of a formal academic qualification. A fully articulated model will ensure that the core material will be available through a variety of modes.

Level 6: Specialist Level—Level-6 programs are intended to allow specialization amongst a small group of individuals who will be responsible for leading, designing and managing the system-wide preparation and planning, and the education of personnel or a highly specialized sub-component. These programs should have the ability to reflect the operational and strategic health planning requirements of these personnel.

These programs should be designed and delivered by universities. A national standard may be developed for knowledge and skills along with standard graduate outcomes for these programs and a selection of core skills and knowledge.

Level 7: Research and Innovation—This level is aimed at individuals involved in the design and innovation of future disaster management systems and structures or the further development of the knowledge base of disaster health through research. Education at this level would involve a very small number of people, who ultimately will lead the research and development agenda. These individuals would be expected to undertake Doctorate-level qualifications.

Development and Delivery

The proposed National Disaster Health Education Framework is displayed in detail in Appendix 1. This table illustrates alignment of the framework with the Australian Qualifications Framework (AQF), the WADEM levels, and Blooms taxonomy.

There still is a need to develop a nationally agreed syllabus for each level of this framework, which may act as a guide for education providers to develop relevant programs. The Collaborative has undertaken a preliminary mapping of content for each level of the framework (Appendix 2). Implementation will be the responsibility of professional organizations, state authorities, and educational organizations including universities. This mapping identifies the topics to be included in the educational programs along with an assessment by the Collaborative of the extent of attention. This is achieved through a "star" rating described in the Appendix. The ratings do not extend to Levels 6 and 7.

It is proposed that an underpinning framework for education across Australia will help to develop a common language, course recognition, and credit transfer, and will promote inter-operability and improved inter-agency and cross-discipline cooperation and communication.

This framework should provide flexibility in regard to educational opportunities. Short courses will form the basis of the lower levels. However, they will contribute to training at all levels. For example, delivery of any program within the framework may take a number of forms, including lectures, tutorials, and Web-based or practical exercises. These programs also may be delivered via any delivery modality including face-to-face, external, on-line, or any combination.

Programs may involve disaster exercises, with the opportunity for participants to receive recognition for playing an active role in exercises. These exercises could include discussions, desktop, field, and physical exercises and other more novel approaches.

Articulation

These programs could be articulated into post-graduate or in-service programs of a number of professional disciplines such as nursing and allied health. There also is an option for future professional fellowship programs in disaster health. Those with approved experience, who undertake programs in accordance with the guidance of the Framework, may be eligible for fellowship or clinical development points for some professional organizations such as medical and nursing colleges.

The expert-level core content material will include a mixture of standard disaster management elements and health-specific material. The articulation and advanced standing arrangements will need to be identified. There is scope for any university to recognize and give advanced standing or credit for units completed at other universities or for prior learning with personnel currently developing and delivering these programs.

Future Directions

The Collaborative will continue to review, revise, and improve the National Framework for Disaster Health Education. This will ensure that up-to-date guidance is provided for those who are developing or delivering education/training in the Disaster Health field.

There also is a need to develop an enhanced research capability. There is currently little research undertaken on disaster health issues in Australia. The number of individuals with any significant research experience in the field is small, and thus, any improvement in the level of activity will necessitate collaboration.

The domains of disaster health research have not been identified or categorized in the Australian environment. However, areas of research activity could include, but are not limited to case studies of major events and incidents, resource and equipment development and evaluation, development of innovative response management tools, risk analysis and evaluation, education and training effectiveness, disaster impact, including psychological impact, community resilience and preparedness, technical and management aspects of surge capacity, triage, clinical decision-making and futility, and the effectiveness of command and control systems and leadership.

Development of Australia's research effort in disaster health should involve several strategies:

1. Development of a national collaboration of researchers to build a critical mass;
2. Development of a Research Agenda for Disaster Health in Australia to guide research funding, activity, and innovation. This process is underway;
3. Identification of strategies to develop future capacity through post-graduate education programs, including funded doctoral and post-doctoral studies;
4. Identification of a funding program to encourage the development of research activity, including priority-driven and investigator-driven research and innovation; and
5. Funding of a small core of research infrastructure to provide leadership and coordinate research activities.

Conclusions

The National Disaster Health Education Framework for Australia provides guidance to the direction of education/training programs that are nationally consistent and permit ease of articulation.

A proposed educational framework for disaster health management that aligns with international disaster health frameworks and national educational frameworks and policies is provided. The National Collaborative for Disaster Health Education and Research intends this framework to provide structured guidance to operational and educational organizations in the development and delivery of their programs.

This framework can provide health services with an organized and structured approach to education for disaster health, enabling effective development, delivery, and evaluation of current and future educational programs.

Acknowledgments

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Appendix 1—A National Disaster Health Education Framework

	Level 1 Community Information	Level 2 Health-Worker Awareness	Level 3 Basic Knowledge	Level 4 Advanced Knowledge	Level 5 Expert Knowledge	Level 6 Specialist Level	Level 7 Innovation Level
Level of Learning	Inform community of health aspects of disasters and aid development of community resilience	All health workers are aware of the health aspects of a disaster, emergency management arrangements and their role.	Health workers most likely to be involved will have the basic knowledge and skills to respond appropriately to a disaster according to their role.	Health workers who may be required to play a leading or significant role in the event of a disaster.	Health workers who because of their role have a specific need for more extensive knowledge and expertise in aspects of health disaster management.	Health workers who will provide leadership in the design and development of health disaster management arrangements or to educate and develop others in the field.	Health workers required to lead research and guide future development.
AQF Level	Not applicable	Not applicable	Certificate/ Diploma	Diploma/ Undergraduate/ Postgraduate Certificate	Postgraduate Certificate/ Diploma/ Masters	Masters (specialist disaster)	Doctorates e.g., MD/ PhD/various professional doctoral programs
Outcomes	Upon completion of this program, participants would be informed of the nature of Australia's health disaster arrangements, the importance of community resilience, an awareness of the nature and value of life skills and the role of the community in preparing for and responding to a major incident and disaster.	Upon completion of this program, participants would be aware of the disaster management arrangements for health in Australia, the health aspects of disasters, the principles of health disaster management and the role of key participants in any response.	Upon completion of this program, participants would be knowledgeable of the principles of disaster management, of local and national disaster management arrangements, the risk and potential impacts and the role of key organizations and leading players and be competent in performing their role	Upon completion of this program, participants would have advanced knowledge of the principles of disaster management, of local and national disaster management arrangements, the risk and potential impact and the role of key organizations and leading players Be competent in leading and managing aspects of the health response. This level encompassing both general and specialist courses.	Upon completion of this program, participants would have an extensive understanding of the epidemiology and impacts of disasters, the theory of disaster management and its application to health, of national and international disaster management arrangements, and of contemporary issues in disaster health Be competent in leading and managing all aspects of the health preparations and response (both general and specialist fields)	Upon completion of this program, and in addition to the expert knowledge, participants would have specialist (in-depth) knowledge, qualifications or experience in one or more aspects of health disaster management.	Upon completion of this program, participants should have contributed to the development of new knowledge and understanding in the field of disaster health management.
WADEM Level	Level 1 Community	Level 2 1st Responders (Basic)	Level 3 1st Responders (Advanced or Specialized)	Level 4 1st Responders (Diploma of Bachelor)	Level 5 Professional (Master Degree)	Level 6 Specialist (Masters + Experience)	Level 7 National Leader Research Doctoral
Blooms Taxonomy	Knowledge	Understanding	Application	Analysis		Synthesis	Evaluation

Appendix 2—Curriculum mapping
The curriculum grid maps levels of learning against specific topics and indicates the extent to which those topics should be expressed at each level.
-No contribution
+Basic awareness appropriate for level of learning
++Acquisition of knowledge to a variable level depending on particular discipline group/expertise/course focus
+++Detailed expert knowledge and understanding of the material appropriate to level of learning.
(continued on page 11)

	1	2	3	4	5
	Community	Health	Basic	Advanced	Expert
Overview					
History and background	-	+	++	+++	+++
Risk	+	+	+	++	+++
Issues in disaster management	-	+	+	+++	+++
Impact of disasters	+	+	++	+++	+++
Principles of disaster management	-	+	+	+++	+++
Incident management	-	+	++	++	+++
Disaster Management Cycle					
Prevention	-	+	+	++	+++
Preparedness	-	+	+	++	+++
Response	++	+	+	++	+++
Recovery	+	+	+	++	+++
Functional approaches (All aspects of the disaster cycle will be considered Emergency Management)					
Population Issues					
Mass communication and information distribution	-	-	+	++	+++
Prepared	+	+	++	+++	++
Structure and management					
Structure and governance	-/+	+	+	++	+++
Logistics	-	-	+	++	+++
Volunteers and donations management	+	-	+	++	++
Planning	-	-	++	++	+++
Response	-	+	++	+++	+++
Command, control, and coordination	-	+	++	+++	+++
Scene management	-	+	+	++	+++
Search and rescue	-	-	+	+	++
Team selection	-	-	-	+	+++
Media	-	+	+	++	+++
Information technology and communication flow	-	-	+	++	+++
Evaluation and future planning					
Surge planning	-	-	+	++	+++
Safety and security	-	-	+	++	+++
Quality cycle	-	-	-	+	++
Incident Evaluation	-	-	+	++	+++
Population Health					
Surveillance	-	+	+	++	+++
Environmental	+	+	+	++	+++
Community	+	+	+	++	+++
Displaced persons	-	-	+	++	+++
Nutrition	-	--	+	+	++
Disease control	-	+	+	++	+++
Health assessment	-	-	+	++	+++

Appendix 2—*(continued from page 10)* Curriculum mapping
The curriculum grid maps levels of learning against specific topics and indicates the extent to which those topics should be expressed at each level.
-No contribution
+Basic awareness appropriate for level of learning
++Acquisition of knowledge to a variable level depending on particular discipline group/expertise/course focus
+++Detailed expert knowledge and understanding of the material appropriate to level of learning.

	1	2	3	4	5
	Community	Health	Basic	Advanced	Expert
Population Health					
Surveillance	-	+	+	++	+++
Environment	+	+	+	++	+++
Community	+	+	+	++	+++
Displaced persons	-	-	+	++	+++
Nutrition	-	-	+	+	++
Disease control	-	+	+	++	+++
Health assessment	-	-	+	++	+++
Clinical					
Principles of clinical care in a disaster	-	+	+	++	+++
Triage	-	+	+	++	+++
Prehospital care	-	+	+	++	+++
Retrieval and transport	-	-	+	++	+++
Medical assistance	-	-	+	++	+++
Hospital care	-	-	+	++	+++
Mental health	-	+	+	++	+++
Infectious disease and control	-	+	+	++	+++
Rehabilitation	-	-	+	++	+++
PPE and decontamination	-	+	+	++	+++
Disaster Types (this is based upon Table 3.1 "Classification of known hazards)[5]					
Natural disasters	-	+	+	++	+++
Mixed and man-made	+	+	+	++/+++	++/+/+++
Man-made	+	+	+	++	+++
Education and Training					
Exercises	-	-	+	++	++
Program delivery and design	-	-	-	++	++
Managing field experience as part of training	-	-	-	+	+++
Teamwork and team training	-	-	-	++	+++
Research					
Research methods in disasters	-	+	-	+	++
Develop a research base	-	-	-	-	++
Evidence based practice	-	-	+	+	++
Future Directions (the following are examples of possible inclusions in this topic which will continually evolve)					
Health security	-	-	-	++	+++

Annex 13: Paper 3.9

Bradt D, **Aitken P**. Disaster medicine reporting: The need for new guidelines and the CONFIDE statement. Emergency Medicine Australasia 2010; 22: 483-487

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Emergency Medicine Australasia (2010) **22**, 483–487

EDITORIAL

Disaster medicine reporting: The need for new guidelines and the CONFIDE statement

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This issue of the journal introduces new guidelines for authors of disaster case reports. This editorial examines the drivers and implications of these guidelines.

Government agencies, professional societies, trade associations and special interest groups produce vast literature on various aspects of disasters. Much of this literature worldwide is 'grey' – print published or web published – but unobtainable through electronic indexing services. The electronic information alone is now so extensive that the US National Library of Medicine has created a Disaster Information Management Research Center to help with national emergency preparedness and response efforts.[1] Within the published biomedical literature, a recent 30 years review canvassing a range of electronically indexed databases found the majority of event-specific literature indexed in MEDLINE was published across a broad spectrum of disciplines. The top 10 journals cited are listed in Table 1.[2] Over the last decade, disaster literature accelerated markedly prompted by the events of September 11, 2001, at the World Trade Center, which yielded the greatest number of event-specific, peer-reviewed publications to date (686).[2] New journals devoted to disasters continue to emerge with recent ones receiving MEDLINE indexation before their first full year of publication.

The challenge for the reader keeping up with disaster literature is therefore daunting. Finding good-quality evidence within this corpus of literature creates another set of hurdles for the reader.

First, the disciplines of medicine, public health and disaster management differ in origins, definitions, research paradigms and tools of evidence-based decision making.[3,4] In evidence-based medicine, core concepts are well known to most physicians. These core concepts include population-intervention-comparison-outcome questions, hierarchy of evidence strength based upon methods of data acquisition and criteria for determining adequacy of studies. However, important questions in disaster medicine are not easily testable by evidence-based science. Disaster field conditions are fluid, data are perishable and compete with rumour, and security constraints prevail. As a consequence, controlled studies in disasters are difficult to run. The level of scientific evidence behind many of our actions in disaster medicine remains weak. Disaster relief operations continue to rely heavily on 'eminence-based' decisions by parties striving to broker goodwill and consensus.[5] Underlying issues include lack of agency expertise, dyscoordination between agencies in the field, inappropriate proxy indicators, flawed scientific inference and erosion of the concept of minimum standards.

Second, the cost-effectiveness of many disaster interventions remains unknown. For example, disaster medical assistance teams, mobile field hospitals and hospital ships operate in virtually uncharted cost-effectiveness territory. The extensive work of the US National Institutes of Health, the World Health Organization and the World Bank on cost-effectiveness analysis, such as the Disease Control Priorities Project (DCP2),[6] is remarkable in part for its lack of external validity in disaster relief operations. Donor governments often

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choose options for disaster health interventions based on political criteria for engagement rather than scientific criteria for lives saved.

Third, disaster case reports remain a prominent part of biomedical journal reporting on disasters with a reliance on descriptive accounts. Several different types of report have emerged in the literature.

Table 1. Top 10 journals for peer-reviewed, event-specific literature by number of publications (1977–2009) (adapted from[2])

Prehospital and Disaster Medicine
Journal of Traumatic Stress
Military Medicine
Psychiatric Services
Journal of the American Medical Association
Lancet
Morbidity and Mortality Weekly Reports
Journal of Nervous and Mental Disease
American Journal of Public Health
Environmental Health Perspectives

- Brief case report
- Rapid epidemiological assessment
- Comprehensive case report
- Comprehensive country profile

In our experience, the most common and least useful is the brief case report. These are typically written from a donor's or intervenor's perspective, and are often plagued by anecdotal, descriptive, breathless reporting of process rather than outcome. This type of reporting, as well as the field engagement described, has been characterized as 'disaster tourism'.[7] Dissemination occurs in proportion to the public interest in the event, and esteem of the parent journal, rather than the strength of the science. This practice creates disaster mythology. Peer-reviewed literature may take years to correct the misconceptions devolving from particular disasters.[8–10]

Nonetheless, there is still a role for duly diligent case reports – especially when the science is young. To do this, there needs to be an appropriate reporting structure that encompasses context, perspective and out-

Table 2. CONsensus Guidelines on Reports of Field Interventions in Disasters and Emergencies (CONFIDE)

Key components
Introduction
1. State specific objectives of the report.
Context
2. Describe the disaster in terms of type, location, area affected, population affected, damage assessment and epidemiological impact.
3. Describe the donor agency/organization/individuals (intervenors) undertaking the field intervention to include specific goals of intervention, team membership (disciplines and numbers) and mechanism of accountability to host country health authorities.
Access to the Field
4. Who gave permission to enter the disaster, treat patients, and when were those permissions given?
5. What was the timeline of field intervention? When did the intervenors deploy to the field, when did the deploying team examine its first patient, and how long did the intervenors stay in the field? Specifically, when did the report authors enter and exit the field. Use GMT references.
Self Sufficiency and Unmet Needs in the Field
6. How did the deploying medical team secure its food, water, power and medical waste disposal in the field?
7. What translation requirements existed, and how were those requirements addressed?
8. What other providers served the same catchment population as the deploying team?
Data Environment
9. Did the deploying team contribute to the initial rapid assessment undertaken by the humanitarian community? If not, why not?
10. Did the deploying team serve as a sentinel reporting site and contribute to the local disease surveillance system? If not, why not?
11. Did the deploying team participate in the local health coordination process? If not, why not?
Patient Care and Epidemiology
12. Using descriptive statistics, characterize all patients treated by the team during the deployment.
13. What standardized case management protocols governed patient care?
14. What referral process occurred for patients needing care beyond that available in the treatment facility?
15. At the departure of the deploying team, to whom were patients at the treatment facility handed over or referred for continuing care.
Funding
16. Give the source of funding for the intervention, and estimate direct and indirect support costs.

Table 3. Case reports: proposed utilities and formats

Type 1: Brief Case Report
- report of present practice for epidemiologically unusual disaster or unusual response to it
- perspective – relief agency or disaster victims on the ground
- submission time – within 4 weeks of acute onset disaster
- length – 1500 words
- recommended structure – simple narrative
- caveat – may be newsworthy in general professional practice but unlikely to be accepted as a case report in specialty journal

Type 2: Rapid Epidemiological Assessment
- report of choice for epidemiologically unusual disaster or unusual response
- perspective – relief sector lead agency or international coordinating agency in the field
- submission time – within 3 months of acute onset disaster
- length – 4000 words
- recommended structure
  - background
  - sources and methods
  - pre-existing indicators
  - disaster impact
  - current health indicators
  - health sector overview
  - domestic and international response
  - summary of health situation
  - programmatic rationale
  - recommendations

Type 3: Comprehensive Case Report
- report of choice for overview of disaster impact, relief and rehabilitation (if applicable); amalgamates data from primary and secondary sources, and has strong evaluation component that demonstrates scholarship of integration and application
- perspective – relief sector lead agency or international coordinating agency in the field
- submission time – within 1 year of disaster
- length – 4000 words
- recommended structure
  - mechanism and impact
  - disaster management
    - initial field response
    - relief operations command and control
    - hazards inventory
  - morbidity, mortality and disease surveillance
  - recovery process
  - discussion
    - epidemiological perspective
    - operational perspective
  - implications for provider groups on future best practices

Type 4: Comprehensive Country Profile
- report of choice for overview of emergency/disaster experience in country or catchment area
- perspective – practitioner, donor or host country health authority representative
- submission time – not applicable
- length – 4000 words
- recommended structure
  - baseline demographic and health status
  - underlying socio-political issues especially affecting current professional practice
  - profiles of selected practices/problems/disasters
  - discussion
    - local health burden
    - technical issues

comes. There are reasons for optimism. Disaster relief operations are becoming increasingly standardized in management of information as well as interventions. Initial rapid assessments (IRAs), Health Resources Availability Mapping System (HeRAMS) and syndromic disease surveillance have long histories of development led by the World Health Organization. The cluster system, itself, now has over 30 iterations worldwide. Although field execution is sometimes poor – Haiti is a recent example – use of standardized data-gathering tools and inter-agency processes is increasingly seen as core responsibilities of responders in the health sector.

We also take heart from the systematization of scientific reporting requirements undertaken by biomedical scientists and journal editors. These requirements inform investigators and authors what information is required to ensure readers and reviewers can properly evaluate a study. For randomized controlled trials, the Consolidated Standards of Reporting Trials (CONSORT) statement emerged in 1996[11] followed by the Quality of Reports of Meta-analyses (QUORUM) statement in 1999.[12] For observational studies, the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement emerged in 2007[13] followed by the Meta-analysis of Observational Studies in Epidemiology (MOOSE) statement in 2010.[14] There have also been efforts, such as the Utstein Template,[15] to standardize the language of disasters and promote consistent use of definitions.

In this issue of *Emergency Medicine Australasia,* we take the first step in systematizing disaster case reports by drawing up specific Instructions for Authors coupled with our CONsensus Guidelines on Reports of Field Interventions in Disasters and Emergencies (CONFIDE). We seek to help authors report on complex issues of disasters. We seek to help the reader make informed judgments about these issues by bringing the reader as close as possible to field data. We seek to foster the work of future scholars undertaking critical event analysis, disaster comparisons and translational research. Finally, we seek to engage with other biomedical journal editors in pursuit of best practice standards for disaster reporting. To these ends, key components of the CONFIDE guidelines are listed in Table 2. A summary of our case report typology is presented in Table 3. Additional information for authors is posted on the web.[16] For reasons cited above, in the absence of extremely unusual hazards or compelling epidemiology, the journal is unlikely to publish brief case reports in the future. Other types of disaster case reports will be welcomed.

We acknowledge there are many ways to report science. Disasters remain a multidisciplinary endeavour, and no one owns the truth. Indeed, in disasters of conflict, the first casualty may be truth itself. However, we believe these guidelines will increase the utility of case reports for the reader and other scholars. Improving disaster reporting is merely a first early step. The real goal is improving disaster science. We reaffirm to our readers and authors our commitment to that process, our respect for their work and our own willingness to learn from their experience.

Competing interests

David A. Bradt: Editorial Board, Emergency Medicine Australasia. Peter Aitken: Section Editor Disaster Medicine, Emergency Medicine Australasia.

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Chapter 4 Annexes

Annex 14: Paper 4.1

Leggat P, Speare R, **Aitken P**. Swine flu and travellers: a view from Australia. Journal of Travel Medicine 2009; 16 (6): 373-376.

Journal of
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EDITORIAL

Swine Flu and Travelers: An Australian Perspective

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The World Health Organization (WHO) first reported an influenza-like illness (Swine Flu) caused by a novel influenza virus in the United States and Mexico on April 24, 2009, which had resulted in 59 confirmed deaths in Mexico alone.[1] The virus was reported as swine influenza A H1N1 because it included five RNA strands derived from pigs (three from North America and two from Europe) along with one RNA strand from humans and two from birds.[2] After several changes in nomenclature, the virus outbreak is now designated pandemic (H1N1) 2009. At that time the influenza pandemic phase alert was 3 owing to the widespread occurrence of highly pathogenic avian influenza H5N1, with some bird to human transmission, but no sustained human to human transmission.[1] By April 27, 2009, the WHO had raised the influenza pandemic phase alert to 4, which indicated human to human transmission, and within 2 days it was raised again to 5, which indicated sustained human to human infection in two or more countries in one WHO region.[1] Pandemic alert phase 6, a global epidemic, was declared on June 11, 2009, sometime after the criteria had actually been met. WHO may have been reluctant to initiate this level owing to the lower virulence of the pandemic (H1N1) 2009 influenza virus. Swine Flu spread quickly around the world, facilitated by global airlines travel.[3] The initial spread of Swine Flu closely matched the volumes of international passenger movements,[3] and eventually it was confirmed in Australia on May 9, 2009, just before the start of the Australian winter.

Following the first Australian case, described on May 9, 2009 in the State of Queensland, Swine Flu was soon reported by all states and territories.[4] Although the disease was considered relatively mild for a pandemic strain of Influenza A,[5] serious infections and hospitalizations occurred with the first death being reported on June 19, 2009.[4] As on September 22, 2009, Australia had recorded 36,270 confirmed cases of pandemic (H1N1) 2009, of which there have been 4,712 hospitalizations and 172 deaths.[6] The significant morbidity and mortality due to this so-called mild disease illustrates a misconception promoted by the media and even some health professionals that influenza is a minor disease, unless it has a very high mortality rate. Swine Flu appears to have a mortality rate between 0.6% and 0.1%; however, the case fatality ratio varies with location and population.[7] Combined with a high attack rate, Swine Flu is a significant infection. The mortality was, however, much lower than expected in Australia, which was predicted to be as high as 40,000 to 80,000 hospitalizations and 6,000 deaths.[8] Australian Government authorities suggest that the better than expected outcome was partly due to the concerted public health campaign that was mounted.[8] Figures from 2007, the most recent report, indicated that there were 2,623 deaths in Australia due to seasonal influenza and pneumonia as the underlying cause of death.[8] The number of confirmed cases does not now bear a close relationship with the number of suspected cases or cases diagnosed in clinical groups, as laboratory testing has become largely restricted to those hospitalized and groups at risk of complications. In terms of demographics, although the median age of Australian cases with pandemic

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(H1N1) 2009 was similar to that seen in seasonal influenza,[9] the epidemiologic pattern is different with older children to middle-aged adults having the highest incidence.[9] The correlation between air travel and disease spread has been further emphasized within Australia as clusters have subsequently been noted in association with interstate travel for major sporting events.[10]

The evolving Swine Flu pandemic has had a number of impacts on the Australian community. In addition to the overstretched health resources, it has also impacted on the Australian workforce with increased absenteeism. Absenteeism with influenza-like symptoms peaked in Australia at about 3% in mid-July. The pattern varied between states with peaks of approximately 4% in Victoria early in the epidemic in mid-May, Tasmania and New South Wales in mid-July, and Queensland in early August.[11] The epidemic may also have affected tourism with seasonally adjusted estimates suggesting that there were monthly decreases in short-term visitor arrivals of 0.2% for April, 1.7% for May, 5.1% for June, and 1.2% for July 2009.[12] Seasonally adjusted estimates of short-term resident departures appeared to be less affected with a 10% increase for April, virtually no change for May, a 0.4% decrease for June, and a 9.7% increase for July 2009.[12] This is consistent with the findings of a major travel consumer sentiment survey in the Australian State of New South Wales, in which 84% of respondents indicated that Swine Flu had not affected their travel plans.[13] In fact, it was the global financial crisis that was reported to have had a greater impact on travel, particularly on business travel with 39% of respondents cutting back on flights and accommodation.[13]

The Australian Government released the detailed Australian Health Management Plan for Pandemic Influenza (AHMPPI) in 2008, particularly in response to global concerns regarding pandemic influenza.[14] As with many detailed plans, modifications were required to the Australian pandemic phases in response to the evolving pandemic. Australia is currently operating under a specially developed phase—PROTECT—in order to focus response on vulnerable groups,[15,16] which were defined as those who fit into one of the following categories:

- Chronic respiratory conditions, including asthma and chronic obstructive pulmonary disease.
- Pregnant women, particularly in second or third trimester.
- Morbid obesity.
- Indigenous persons of any age.
- Other possible predisposing conditions, such as cardiac disease (not simple hypertension), and chronic illnesses including diabetes mellitus, metabolic diseases, renal failure, hemoglobinopathies, immunosuppression (including cancer, human immunodeficiency virus infection/acquired immune deficiency syndrome, drugs), and neurological conditions.[16]

The inclusion of morbid obesity as a risk factor was based on data from North America and has not been previously recognized as a risk factor for seasonal influenza.[17] This definition of vulnerable groups was important as it had implications in a number of areas, including identifying those who were:

- At a higher risk of complications from influenza[16]
- Able to receive neuraminidase inhibitors free from the Government[18]
- Strongly recommended to seek medical advice before international travel as per the travel recommendations from the Australian Government travel advisories.[19]

Part of Australia's pandemic plan was the mobilization of the national stockpile of neuraminidase inhibitors (oseltamivir and zanamivir).[18,20] Departing travelers were not a priority in terms of provision of neuraminidase inhibitors; however, community pharmacists, who had neuraminidase inhibitors in stock, could dispense the drug to travelers, who had a prescription.

Specific recommendations were made in the Australian travel advisories concerning Swine Flu and advice was categorized as before travel, during travel, and after travel.[19] Before travel, travelers were warned about the high risk of complications from any influenza, if they were in a vulnerable group, as previously listed. They were also advised to be vaccinated against seasonal influenza and to consider postponing travel if they had influenza-like symptoms.[19] While away, travelers were advised to:

- Practice hand hygiene (washing and drying of hands)
- Practice respiratory etiquette (covering mouth and nose when sneezing and coughing)
- Consult a doctor or the nearest hospital immediately in the event of influenza-like symptoms developing
- Follow the instructions of local authorities.[19]

For travelers, use of alcohol-based hand gels was strongly encouraged, although, to comply with international security restrictions for air travel from Australia, carry-on containers had to have a volume of less than 150 mL. It would also be useful for Australia to encourage travelers to use the technique of using their sleeve to cover sneezes and coughs.[21] Upon their return, travelers were advised to seek medical advice if they were unwell, especially with a respiratory illness (fever and cough), and they were concerned about their symptoms.[19] The travel advisory also warned travelers that they may be required to wear a mask if they were suspected of having Swine Flu. In addition, an Australian guidance note was prepared for aircraft cleaning when a passenger or crew is suspected of having Swine Flu.[22]

Other broader public health measures were also taken at various stages of the evolving pandemic. For example, incoming travelers were subjected to health declarations concerning influenza-like illness symptoms and signs and thermal scanning during the early stages of the global epidemic to slow the spread of the virus and to ensure that travelers were alerted to Swine Flu.[4] These specific measures were ceased when the disease became more widespread. Prior to the Swine Flu pandemic, modeling on the effectiveness of border screening had shown that it would not prevent a pandemic influenza virus from entering Australia.[23,24] However, border screening has too strong a political imperative in Australia not to be implemented in the early stages of this pandemic. A number of general hygiene measures have been promoted throughout the evolving pandemic, including promotion of respiratory and general hygiene amongst the general public, workplace, schools, and the home, as well as amongst travelers.

In terms of lessons learnt so far from the evolving pandemic (H1N1) 2009, there has been some criticism of the AHMPPI, which indicated that it was not appropriate for the milder Swine Flu pandemic seen.[25] In particular, there were concerns about the lack of clinical input from clinicians in the development of the plan as a number of practical issues, such as the adequacy of protective mask stockpile, the means of distributing drugs and equipment, and when to commence drugs such as neuraminidase inhibitors in the absence of a laboratory confirmation, were not planned in detail.[25] A new challenge currently being faced in Australia is the planned urgent roll-out of a vaccination program using influenza A pandemic (H1N1) 2009 antigens. Hopefully, the lessons from the 1976 swine influenza urgent vaccination program in United States will be heeded.[26] Issues of initial concern with the intended program include incomplete registration status of the vaccine, indemnity, use of multi-dose vials, and the complexity of the consent form; however, the initial two concerns have now been addressed. Although Indigenous people have been targeted for vaccination, a welcome addition, pig and poultry workers have been excluded to date. This latter group should be included to prevent pandemic (H1N1) 2009 being transmitted from infected humans into pigs and poultry, an ideal situation for further reassortment.[27] The current pandemic (H1N1) 2009 once again illustrates the importance of travelers having up-to-date travel health information, which should be obtained approximately 6 to 8 weeks before travel from a qualified source, and checking national travel advisories for updates on the international health and safety status for their destinations.

Declaration of Interests

The authors state they have no conflicts of interest to declare.

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Annex 15: Paper 4.2

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Self-reported anticipated compliance with physician advice to stay home during pandemic (H1N1) 2009: Results from the 2009 Queensland Social Survey

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Abstract

Background: One strategy available to public health officials during a pandemic is physician recommendations for isolation of infected individuals. This study was undertaken during the height of the Australian pandemic (H1N1) 2009 outbreak to measure self-reported willingness to comply with physician recommendations to stay home for seven days, and to compare responses for the current strain of pandemic influenza, avian influenza, seasonal influenza, and the common cold.

Methods: Data were collected as part of the Queensland Social Survey (QSS) 2009, which consisted of a standardized introduction, 37 demographic questions, and research questions incorporated through a cost-sharing arrangement. Four questions related to respondents' anticipated compliance with a physician's advice to stay home if they had a common cold, seasonal influenza, pandemic (H1N1) 2009 influenza or avian influenza were incorporated into QSS 2009, with responses recorded using a balanced Likert scale ranging from "very unlikely" to "very likely." Discordance between responses for different diseases was analysed using McNemar's test. Associations between demographic variables and anticipated compliance were analysed using Pearson's chi-square or chi-square for linear-by-linear association, and confirmed using multivariate logistic regression; $p < 0.05$ was used to establish statistical significance.

Results: Self-reported anticipated compliance increased from 59.9% for the common cold to 71.3% for seasonal influenza ($p < .001$), and to 95.0% for pandemic (H1N1) 2009 influenza and 94.7% for avian influenza ($p < 0.001$ for both versus seasonal influenza). Anticipated compliance did not differ for pandemic (H1N1) 2009 and avian influenza ($p = 0.815$). Age and sex were both associated with anticipated compliance in the setting of seasonal influenza and the common cold. Notably, 27.1% of health and community service workers would not comply with physician advice to stay home for seasonal influenza.

Conclusions: Ninety-five percent of people report they would comply with a physicians' advice to stay home for seven days if they are diagnosed with pandemic (H1N1) 2009 or avian influenza, but only 71% can be expected to comply in the setting of seasonal influenza and fewer still can be expected to comply if they are diagnosed with a common cold. Sub-populations that might be worthwhile targets for public health messages aimed at increasing the rate of self-imposed isolation for seasonal influenza include males, younger people, and healthcare workers.

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Background

In late March 2009 an outbreak of a new strain of influenza A (H1N1), swine-origin influenza virus (S-OIV) or "swine flu," was reported in North America [1,2]. This disease quickly spread across the globe, and the World Health Organization declared a pandemic on 11 June 2009 [3]. The first cases of pandemic (H1N1) 2009 influenza in Australia were reported in May 2009, coinciding with the onset of the annual influenza season. As of 01 January 2010, 37,553 cases of pandemic (H1N1) 2009 influenza had been confirmed in Australia, with 191 deaths [4].

At the time the Australian cases peaked, there was no approved vaccine for pandemic (H1N1) 2009 virus; traditional public health measures were critical to containing the outbreak. One strategy available to public health officials is physician recommendations for self-imposed isolation of infected individuals; specifically, to stay home for at least seven days. Such public health measures, however, only work if patients are willing to comply [5-7]. This study was undertaken during the height of the Australian pandemic (H1N1) 2009 outbreak to measure self-reported willingness to comply with physician recommendations to stay home for seven days, and to compare responses for the current strain of pandemic influenza, avian influenza (H5N1), seasonal influenza, and the common cold.

Methods

Data for this study were collected as part of the Queensland Social Survey (QSS) 2009. QSS is an annual statewide survey conducted by the Population Research Laboratory (PRL) in CQUniversity Australia's Institute for Health and Social Science Research. Through a cost-sharing arrangement, QSS enables researchers and policy-makers to incorporate questions into the survey.

Queensland is the second largest Australian state by land area, and the third most populous state. QSS uses a computer-assisted telephone interviewing (CATI) system and trained interviewers to randomly sample households across Queensland, including metropolitan Brisbane (South East Queensland) and the rest of the state (Other Queensland). To ensure equal representation of males and females, households are randomly pre-determined to provide a male or female respondent; if a person of that sex is not available then the household is not included in the survey.

QSS 2009 consisted of a standardized introduction, specific questions incorporated by researchers and the University, and 37 demographic questions. The questions were pilot tested by trained interviewers in 92 randomly-selected households, with modifications to the questions guided by both responses from the pilot study subjects and feedback from the interviewers. Final interviewing was conducted between 20 July 2009 and 19 August 2009, between the hours of 10:30 am to 2:30 pm and 4:30 pm to 8:30 pm on weekdays, and between the hours of 11:00 am and 4:00 pm on weekends.

Four questions related to respondents' anticipated compliance with a physician's advice to stay home if they had a viral respiratory illness were incorporated into QSS 2009. The four questions were:

- If you had a common cold and your doctor recommended that you stay home for at least seven days so as not to infect anyone else, how likely are you to do so?
- If you had the regular flu, but not swine or bird flu, and your doctor recommended that you stay home for at least seven days so as not to infect anyone else, how likely are you to do so?
- If you had the swine flu and your doctor recommended that you stay home for at least seven days so as not to infect anyone else, how likely are you to do so?
- If you had the avian or bird flu and your doctor recommended that you stay home for at least seven days so as not to infect anyone else, how likely are you to do so?

Responses were recorded using a 4-point Likert scale ranging from "very unlikely" to "very likely." Responses were subsequently dichotomized as "yes" (very likely or likely) and "no" (very unlikely or unlikely) and cross-tabulated in a 2 × 2 table. Because the data are essentially repeated measures of likelihood to comply under different circumstances, discordance between responses for the different diseases was analysed using McNemar's test. Bivariate associations between relevant demographic variables and anticipated compliance were analysed using chi-square or Fisher's exact test; where demographic variables were recorded as ordinal data, analyses utilizing chi-square for linear-by-linear association were conducted to identify any significant trend effects. Subsequently, multivariate logistic regression was conducted to identify covariates and interaction effects, and to adjust for confounding. Each variable was entered into or removed from the logistic regression model using both forward and backward methods to identify significant covariates, the remaining variables were then individually entered into the model to identify potential confounders. The final model included significant covariates, potential confounders and significant interaction effects. For all analyses, $p < 0.05$ was used to establish statistical significance; for the multivariate analysis, adjusted odds ratios (AOR) and their 95% confidence intervals (CI) are reported.

QSS 2009 had a target sample size of 1,200 subjects, with 800 subjects from South East Queensland and 400 from Other Queensland; thus the *a priori* estimated sampling error at the 95% confidence level was ± 2.9% overall, ± 3.6% for the South East Queensland sub-sample, and ± 5.1% for the Other Queensland sub-sample.

QSS 2009 was approved by the Human Ethics Review Panel at CQUniversity (H09/06-037) and the incorporation of the influenza-related questions was approved by the Human Research Ethics Committee at James Cook University (H3456).

Results

QSS 2009 contacted or attempted to contact 3,112 households; 1,536 subjects declined participation, 142 households could not be contacted, and 129 were otherwise ineligible. Thus, the final sample for QSS 2009 included 1,292 respondents; 860 from South East Queensland and 432 from Other Queensland for an overall response rate of 41.5%. The sample was nearly equally divided between males and females (50.2% vs. 49.8%). Younger people (aged 18 - 34 years) were under-represented in the sample and older people (aged > 55 years) were over-represented in the sample, otherwise the demographics of the participants reasonably approximated that of the general population[8] as shown in Table 1.

Responses to the four questions concerning anticipated compliance with a physician's advice to stay home are shown in Table 2. Self-reported anticipated compliance increased significantly from 59.9% for the common cold to 71.3% for seasonal influenza (McNemar's test, $p < .001$), and to 95.0% for pandemic (H1N1) 2009 influenza and 94.7% for avian influenza (McNemar's test, $p < 0.001$ for both versus seasonal influenza). Anticipated compliance did not differ for pandemic (H1N1) 2009 and avian influenza (McNemar's test, $p = 0.815$).

Table 1 Demographic characteristics of the QSS sample and of Queensland, Australia [8]

	QSS Sample	Queensland
Age		
18-34	13.0%	30.6%
35-44	20.0%	19.6%
45-54	20.3%	18.4%
55+	56.2%	31.4%
Sex		
Male	50.2%	49.6%
Female	49.8%	50.4%
Employment Status*		
Full-time	35.8%	38.1%
Part-time/Casual	19.4%	17.1%
Unemployed	3.2%	2.9%
Other/Not in Labour Force	40.1%	38.2%
Household Income*		
$0-26,000	17.3%	18.3%
$26,001-52,000	14.1%	24.1%
$52,001-100,000	20.1%	31.5%
$100,001+	20.3%	14.7%
Marital Status*		
Married/Partnered	75.2%	60.2%
Single	24.6%	39.8%

*The Australian Bureau of Statistics uses slightly different categories and thresholds than QSS 2009.

Table 2 Likelihood of complying with a physician's advice to stay home if diagnosed with a viral respiratory disease

	Common Cold	Seasonal Influenza	Pandemic (H1N1) 2009	Avian Influenza
Very Unlikely	16.5%	9.4%	2.6%	2.6%
Unlikely	22.7%	18.1%	1.5%	1.3%
Likely	28.6%	33.8%	14.0%	13.3%
Very Likely	31.3%	37.5%	81.0%	81.4%
Don't Know	0.7%	0.8%	0.5%	0.9%
No Response	0.2%	0.3%	0.2%	0.4%
"Would Comply"	59.9%	71.3%	95.0%	94.7%
"Would Not Comply"	26.2%	27.5%	4.1%	3.9%

"Would Comply" = (Very Likely + Likely)
"Would Not Comply" = (Very Unlikely + Unlikely)

Bivariate associations between demographic variables and anticipated compliance with a physician's advice to stay home for the four viral diseases are shown in Additional file 1: Table S1. As anticipated compliance in the setting of pandemic (H1N1) 2009 and avian influenza was near universal, there were no significant associations between demographic variables and anticipated compliance. For the common cold and seasonal influenza, however, there were a number of significant associations. Respondents who were male, younger, employed (versus unemployed), and had a higher level of education were less likely to report anticipated compliance with stay home advice for both a common cold and seasonal influenza. Married/partnered people and those who lived in South East Queensland were also less likely to comply with advice to stay home for a common cold. People who lived in urban areas, and people employed in the health and community services sector were more likely than others to comply with advice to stay home for seasonal influenza, although 27.1% of health and community service workers would be unlikely to comply with such advice.

In multivariate analysis, only sex and age remained significantly associated with anticipated compliance, and there was no interaction effect between these two variables. (Additional file 2: Table S2) Females were more likely than males to report anticipated compliance for both the common cold (AOR = 1.650; CI: 1.143-2.381) and seasonal influenza (AOR = 1.911; CI: 1.300-2.811).

People age 55 and older were also more likely to report anticipated compliance for both the common cold (AOR = 1.542; CI: 1.002-2.372) and seasonal influenza (AOR = 2.316; CI: 1.431-3.749) when compared to younger respondents.

Discussion

Nearly every respondent in this study reported they would comply with a doctor's advice to stay home for seven days if they were diagnosed with pandemic (H1N1) 2009 influenza, and the same level of compliance could be expected in the setting of avian influenza. These findings are similar to those that have been previously reported; our study adds data in the context of an actual, rather than hypothetical, pandemic.

Prior to the current pandemic, Eastwood et al read a brief description of a pandemic influenza outbreak analogous to the 1918 Spanish flu to Australian telephone survey participants, and found 97.5% of respondents would stay home for seven to ten days if they were told they might have had contact with the disease [7]. Similarly, Barr et al[9] reported 85% of Australians would be at least moderately willing to isolate themselves from others during an influenza pandemic. Blendon et al[10] reported 94% of Americans would comply if they contracted a pandemic influenza and public health officials recommended they stay at home for seven to ten days. In a more recent survey from June of 2009, Blendon et al[11] identified 236 respondents who reported that they themselves or someone in their household had experienced flu-like symptoms, and 75% of those with symptoms had stayed home. Other studies have also found support for explicit government action to contain pandemic influenza, including "encouraging" people to work from home, and quarantining infected individuals [5,12]. Interestingly, DiGiovanni et al[13] reported that compliance with quarantine measures during the 2003 severe acute respiratory syndrome (SARS) outbreak in Toronto, Canada was affected more by compliance monitoring, fighting boredom and stress, and minimizing stigmatization than with any actual threat of enforcement.

From a public health planning perspective, the more useful data from this study may be that regarding the level of compliance with stay at home advice that can be anticipated for seasonal influenza, and the relative lack of compliance that can be expected for the common cold. Seasonal influenza is a more common disease, each year leading to approximately 18,000 hospitalizations and costing around $115 million in Australia; the burden in the United States is much greater with the direct costs of influenza-related medical care exceeding $10 billion [14]. Yet, these data confirm that people do not view seasonal influenza with the same level of concern as pandemic strains of influenza. While it is encouraging that respondents appear to differentiate between seasonal influenza and the common cold, the questions in this survey presumed a physician diagnosis. Large numbers of people do not seek medical care for mild to moderate respiratory illness, and it is not practical to expect lay people to reliably differentiate between a common cold and influenza. Public health efforts to encourage people to self-isolate for influenza-related illnesses may be more successful if they target symptoms (i.e., "cough and fever") rather than specific diagnoses.

This study did find some significant associations between demographic characteristics and likelihood to comply with stay at home advice for seasonal influenza that might be useful for targeting public health efforts to increase compliance. Males were less likely to report anticipated compliance with stay home advice for both a common cold and seasonal influenza, and this is consistent with other studies from Australia [7,9]. Males have also previously been reported to feel less susceptible than females do to pandemic influenza,[5] although this study found no differences between males and females for anticipated compliance in the setting of pandemic (H1N1) 2009 or avian influenza.

Increasing age was associated with increased anticipated compliance with stay at home advice for both the common cold and seasonal influenza, while increasing education and income were associated with decreased anticipated compliance for both diseases. Although the associations for education and income did not withstand multivariate analysis, the finding is consistent with previous work and both variables were retained as potential confounders in the final logistic regression model. Like males, wealthier and better educated people tend to view themselves as less susceptible to influenza, while older people tend to view themselves as more susceptible [5]. Many influenza-related public health campaigns target older populations; targeting stay at home messages to wealthier and better educated populations might be a novel but worthwhile effort for containing seasonal influenza.

Employed respondents were less likely than unemployed respondents to report anticipated compliance with stay home advice for both a common cold and seasonal influenza. This association, also, did not withstand multivariate analysis, but it is an intuitive finding. Even in the setting of pandemic influenza, many people would have to forgo income in order to stay home [10]. For example, a survey of key decision makers at U.S. businesses found 74% of the businesses provided for paid employee sick leave, but 15% of businesses did not provide for any employee sick leave, whether paid or unpaid [15]. Still, this study found no difference in anticipated compliance rates in the setting of pandemic (H1N1) 2009 or avian influenza. This is consistent with the findings of

Barr et al[9] who reported similar rates of "willingness to comply with health protective behaviours" between employed (69.5%, 95%CI: 65.5%-73.5%) and unemployed (71.8%, 95%CI: 67.7%-76.0%) survey respondents in the setting of pandemic influenza. Eastwood et al,[7] however, reported the contrary, finding that employed people who were unable to work from home would be less likely to self-isolate in the setting of pandemic influenza. How closely the level of actual compliance approaches the level of self-reported anticipated compliance may well be affected by issues related to income, financial security, and employer leave policies.

A particularly novel and important finding of this study was that more than one-quarter of health and community service workers reported they would not comply with a physician's advice to stay home if they had seasonal influenza. This may represent a misplaced sense of duty. Previous research has demonstrated that most healthcare workers (HCWs) would not abandon their responsibilities during an influenza pandemic,[16,17] but isolating one's self when one has symptoms or a diagnosis of disease is a different proposition than simply refusing to work. Despite evidence of the efficacy of vaccinating HCWs, [18-23] influenza vaccination rates among HCWs are low,[24] which presents a risk of HCW-to-HCW as well as HCW-to-patient transmission if infected HCWs report to work. Notably, as the 2003 SARS outbreak subsided and precautions were relaxed, a second wave of the disease including 90 cases of nosocomial infections emerged; 42.5% of those nosocomial infections were associated with exposure to an infected HCW. Seventeen nurses contracted SARS, and 12 (70.6%) had worked with a symptomatic co-worker within 10 days of developing symptoms. Indeed, having worked with a symptomatic co-worker was associated with increased risk (RR = 1.88) of an HCW developing the disease [25]. We are not aware of any previous reports measuring anticipated self-isolation among HCWs with influenza. Public health officials and health facility supervisors must impress upon health workers the clinical and ethical importance of protecting both patients and other staff from exposure to employee-borne influenza, including seasonal influenza [26].

This study was limited in that it relied upon a telephone survey to collect data, but telephone surveys have been previously used to gather information regarding public perceptions of risk and willingness to comply with containment strategies for influenza,[5,7,9-12] and even to assess for the prevalence of influenza [27]. The response rate for this survey was 41.5%; while this may indicate some response bias the sample was fairly representative of the general population, and the overall survey was not specific to influenza. That is, there is no reason to suspect that any potential respondent's decision about whether to participate in the survey would be related to their anticipated compliance with a physician's advice to stay home. A more important limitation of the study is that it measured self-reported anticipated behaviour in the context of a physician diagnosis of disease. Actual behaviour may differ, particularly since many individuals with mild to moderate viral respiratory syndromes do not seek physician care. Also, other factors including perceived severity of illness, social norms, and financial considerations could affect compliance. Thus, the rates of anticipated compliance reported by respondents to this survey must be viewed as a best-case scenario, and actual compliance might be lower. Still the results, both in terms of anticipated compliance and associations with demographic factors, are consistent with those of other studies [5,7,9-12]. Finally, early in the Australian pandemic (H1N1) 2009 experience there was a perceived association between international travel and increased risk,[28] but QSS 2009 did not inquire as to respondents' individual travel history or exposure to international travellers.

Conclusions

Ninety-five percent of people report they would comply with a physicians' advice to stay home for seven days if they are diagnosed with pandemic (H1N1) 2009 or avian influenza, but only 71% can be expected to comply with the same advice in the setting of seasonal influenza and fewer still (60%) can be expected to stay home if they are diagnosed with a common cold. Sub-populations that might be worthwhile targets for public health messages aimed at increasing the rate of self-imposed isolation for seasonal influenza include males and younger people. Notably, more than one-quarter of health and community service workers report that they are unlikely to comply with stay home advice for seasonal influenza; thus they too may be an appropriate (although counter-intuitive) target for influenza-related public health campaigns.

Additional file 1: Table S1 - Bivariate associations between demographic variables and anticipated compliance with physician's advice to stay home for seven days for common cold and three strains of influenza. A table showing the bivariate associations between demographic variables and anticipated compliance.
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-10-138-S1.DOC]

Additional file 2: Table S2 - Final models and results of the multivariate logistic regression. A table showing the final models, coefficients, and adjusted odds ratios for the logistic regressions predicting anticipated compliance for the common cold and seasonal influenza.
Click here for file
[http://www.biomedcentral.com/content/supplementary/1471-2458-10-138-S2.DOC]

List of Abbreviations

CATI: computer-assisted telephone interviewing; **PRL**: Population Research Laboratory; **QSS**: Queensland Social Survey; **RR**: relative risk; **SARS**: severe acute respiratory syndrome; **S-OIV**: swine origin influenza virus.

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Authors' contributions

LHB, PA, PAL and RS participated in the development of the research question and the influenza-related questionnaire items for inclusion in QSS 2009. LHB conducted the primary analysis. LHB, PA, PAL and RS participated in the interpretation of the data and the initial drafting of the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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Annex 16: Paper 4.3

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ORIGINAL ARTICLES

Level of Concern and Precaution Taking Among Australians Regarding Travel During Pandemic (H1N1) 2009: Results From the 2009 Queensland Social Survey

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Background. Global disease outbreaks, such as the recent Pandemic (H1N1) 2009 (the so-called Swine flu), may have an impact on travel, including raising the concerns of travelers. The objective of this study was to examine the level of concern of Australians regarding travel during Pandemic (H1N1) 2009 and how this impacted on their travel.

Methods. Data were collected by interviews as part of the Queensland Social Survey (QSS) 2009. Specific questions were incorporated regarding travel and Pandemic (H1N1) 2009. Multivariate logistic regression was used to analyze associations between demographic variables and concern and likelihood of cancelling travel.

Results. There were 1,292 respondents (41.5% response rate). The sample was nearly equally divided between males and females (50.2% vs 49.8%). Younger people (18–34 y) were under-represented in the sample; older people (>55 y) were over-represented in the sample. About half (53.2%) of respondents indicated some level of concern about Pandemic (H1N1) 2009 when traveling and just over one-third (35.5%) indicated they would likely cancel their air travel if they had a cough and fever that lasted more than one day. When cross-tabulating these responses, people who expressed concern regarding Pandemic (H1N1) 2009 when they traveled were more likely than those without concern to cancel their air travel if they had a cough and fever lasting more than one day (44.7% vs 27.7%, $\chi^2 = 33.53$, $p < 0.001$). People with higher levels of education [adjusted odds ratio (AOR): 0.651], people with higher incomes (AOR: 0.528) and people living outside of metropolitan Southeast Queensland (AOR: 0.589) were less likely to be concerned about Pandemic (H1N1) 2009 when traveling, and younger people (AOR: 0.469) were less likely than others to cancel travel if they had a cough and fever.

Conclusions. Pandemic (H1N1) 2009 was of some concern to more than half of Queensland travelers. None-the-less, the majority of Queenslanders would not have postponed their own travel, even if they exhibited symptoms consistent with Pandemic (H1N1) 2009.

Prior to the emergence of Pandemic (H1N1) 2009 (the so-called Swine flu), the spread of highly pathogenic H5N1 avian influenza in wild and domestic birds in Asia, Europe, and other areas had already raised concerns about the possibility of human transmission of pandemic disease.[1] There had been an increasing number of cases involving bird-to-human transmission of H5N1, with resultant severe and fatal human infections,[2] heightening concerns that potential reassortment of influenza virus genes could give rise to a human pandemic influenza A virus. In response to this, Australian hostelers indicated moderate concern about acquiring avian influenza,[3] which was higher than the level of concern regarding terrorism while traveling abroad, but lower than the level of general concern for personal safety.[4]

In 2009, both the global financial crisis (GFC) and Pandemic (H1N1) 2009 impacted on travel, with global travel decreasing 4% to 880 million international

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arrivals.[5] The GFC and Pandemic (H1N1) 2009 may well have had some impact on tourism in Australia. Seasonally adjusted estimates demonstrated that there were monthly decreases in short-term visitor arrivals of 0.2% for April, 1.7% for May, 5.1% for June, 1.2% for July, and 3.3% for August during the height of Pandemic (H1N1) 2009.[6] Seasonally adjusted estimates of short-term resident departures from Australia appeared to be less affected with a 10% increase for April, virtually no change for May, a 0.4% decrease for June, and a 9.7% increase for July 2009.[6] Information on trends on short-term resident departures were suspended thereafter.[6]

During the evolving Pandemic (H1N1) 2009, the Australian Government introduced a number of measures that were directed at both in-coming and out-going travelers.[7] In-coming travelers were subject to increased screening for influenza. Australian travel advisories briefed outgoing travelers on Pandemic (H1N1) 2009 precautions before, during, and after travel. They also detailed what travelers may be subjected to if they were suspected of having Pandemic (H1N1) abroad and to consider postponing travel if they had influenza-like symptoms.[8]

Little is known about the extent to which Pandemic (H1N1) 2009 created concern among Australian travelers and how this may have impacted on their travel plans, particularly if they had influenza-like symptoms themselves. The objective of this study was to examine Australian's level of concern regarding travel during the height of Pandemic (H1N1) 2009 and how this impacted on their travel.

Methods

Data for this study were collected as part of the Queensland Social Survey (QSS) 2009. QSS is an annual state-wide survey conducted by the Population Research Laboratory (PRL) in Central Queensland (CQ) University's Institute for Health and Social Science Research. Through a cost-sharing arrangement, QSS enables researchers and policy-makers to incorporate questions into the survey. QSS uses a computer-assisted telephone interviewing (CATI) system and trained interviewers to randomly sample households across Queensland, including metropolitan Brisbane (Southeast Queensland) and the rest of the state (Other Queensland). A two-stage selection process is used to ensure equal representation of males and females.

QSS 2009 consisted of a standardized introduction, specific questions incorporated by researchers and the University, and 37 demographic questions. The questions were pilot tested by trained interviewers in 92 randomly-selected households, with modifications to the questions guided by both responses from the subjects and feedback from the interviewers. Final interviewing was conducted between July 20, 2009, and August 19, 2009, between the hours from 10:30AM to 2:30PM and 4:30PM to 8:30PM on weekdays, and between the hours of 11:00AM and 4:00PM on weekends.

Two questions related to travel and Pandemic (H1N1) 2009, which was presented as Swine flu in the questionnaire, were incorporated into QSS 2009. The first question asked respondents to rate their level of concern about Pandemic (H1N1) 2009, when traveling, using a 5-point balanced Likert scale; the second question asked respondents to use a 4-point Likert scale to rate how likely they would be to cancel commercial air travel, if they themselves had symptoms of a viral respiratory disease.

Responses were subsequently dichotomized as "yes" (strongly agree/agree or very likely/likely) and "no" (strongly disagree/disagree or very unlikely/unlikely), and cross-tabulated in a 2×2 table. Associations between concern and likelihood of cancelling travel were analyzed using χ^2, as were associations between relevant demographic variables and concern about Pandemic (H1N1) 2009 and willingness to cancel travel. Where demographic variables were recorded as ordinal data, analyses utilizing χ^2 for linear-by-linear association were conducted to identify any significant trend effects. Subsequently, multivariate logistic regression was conducted to identify covariates and interaction effects, and to adjust for confounding. Each variable was entered into or removed from the logistic regression model using both forward and backward methods to identify significant covariates; the remaining variables were then individually entered into the model to identify potential confounders. The final model included significant covariates, potential confounders, and significant interaction effects. For all analyses, $p < 0.05$ was used to establish statistical significance; for the multivariate analysis, adjusted odds ratios (AOR) and their 95% confidence intervals (CI) are reported.

QSS 2009 had a target sample size of 1,200 subjects, with 800 subjects from Southeast Queensland and 400 from Other Queensland; thus the a priori estimated sampling error at the 95% confidence level was ±2.9% for the entire sample, ±3.6% for the Southeast Queensland sub-sample, and ±5.1% for the Other Queensland sub-sample.

QSS 2009 was approved by the Human Ethics Review Panel at CQ University (H09/06-037) and the incorporation of the Pandemic (H1N1) 2009-related questions was approved by the Human Research Ethics Committee at James Cook University (H3456).

Results

QSS 2009 contacted or attempted to contact 3,112 households; 1,536 subjects declined participation, 142 households could not be contacted and 129 were otherwise ineligible. Thus, the final sample for QSS 2009 included 1,292 respondents, 860 from Southeast Queensland and 432 from Other Queensland for an overall response rate of 41.5%. The sample was nearly equally divided between males and females (50.2% vs 49.8%). Younger people (aged 18–34 y) were under-represented in the sample; and older people (aged >55 y) were over-represented in the sample; otherwise, the demographics of the participants reasonably approximated that of the general population.[9]

Table 1 Responses to questions concerning travel and Pandemic (H1N1) 2009

Response	*N* (%)	Sub-total *N* (%)*
*I am concerned about swine flu** during my travel.*		
Strongly agree	291 (22.5)	688 (53.2)
Agree	397 (30.7)	
Neutral	98 (7.6)	
Disagree	387 (30.0)	497 (38.5)
Strongly disagree	110 (8.5)	
If you had a cough and fever that lasted more than one day, how likely would you be to cancel an already booked commercial airline flight for the next day?		
Very unlikely	305 (23.6)	766 (59.3)
Unlikely	461 (35.7)	
Likely	253 (19.6)	458 (35.5)
Very likely	205 (15.9)	

*Totals do not equal 100% because of non-responders.
**Pandemic (H1N1) 2009.

Responses to the two questions concerning travel and influenza are shown in Table 1; 688 (53.2%) of respondents indicated some level of concern about Pandemic (H1N1) 2009 when traveling and 458 (35.5%) indicated they would likely cancel their own commercial air travel if they had a cough and fever that lasted more than one day. When cross-tabulating these responses, people who expressed concern regarding Pandemic (H1N1) 2009 when they traveled were more likely than those without concern to cancel their own commercial air travel if they had a cough and fever lasting more than one day (44.7% vs 27.7%, $\chi^2 = 33.53$, $p < 0.001$). Nonetheless, there were 363 respondents who expressed concern regarding Pandemic (H1N1) 2009, but who would not have cancelled their own commercial air travel if they had symptoms of a viral respiratory infection.

Bivariate associations between demographic variables and both concern about and willingness to cancel travel are shown in Table 2, and the final multivariate models are shown in Table 3. When controlling for covariance and confounding, respondents living outside of metropolitan Southeast Queensland (AOR = 0.589; CI: 0.396–0.874), those with more than 14 years of

Table 2 Bivariate associations between demographic variables and concern about/willingness to cancel travel

	Concerned			Would cancel		
Parameter	Responses	*N* (%)	*p* value	Responses	*N* (%)	*p* value
Sex						
Male	596	327 (54.9)	0.027	613	196 (32.0)	<0.001
Female	590	361 (61.2)		611	262 (42.9)	
Age						
18–34	159	82 (51.6)	0.027*	162	47 (29.0)	<0.001*
35–44	230	130 (56.5)		249	76 (30.5)	
45–54	247	138 (55.9)		254	89 (35.0)	
55+	543	332 (61.1)		553	243 (43.9)	
Location						
Southeast QLD	792	442 (55.8)	0.029	817	292 (35.7)	0.086
Other QLD	394	246 (62.4)		407	166 (40.8)	
Urban	899	518 (57.6)	0.692	934	339 (36.3)	0.124
Rural	285	168 (58.9)		288	119 (41.3)	
Education						
0–10 y	334	210 (62.9)	0.022*	340	152 (44.7)	0.001*
11–12 y	285	160 (56.1)		286	104 (36.4)	
13–14 y	144	88 (61.1)		144	52 (36.1)	
15+ y	412	220 (53.4)		442	143 (32.4)	
Income**						
A$0–26K	210	129 (61.4)	0.001*	214	89 (41.6)	<0.001*
A$26K–52K	172	110 (64.0)		169	72 (42.6)	
A$52K–100K	229	139 (60.7)		249	84 (33.7)	
A$100K+	242	111 (59.8)		254	71 (28.0)	
Marital status						
Partnered	889	530 (59.6)	0.054	930	328 (35.3)	0.006
Single	295	157 (53.2)		292	129 (44.2)	
Employment						
Health/service	101	55 (54.5)	0.914	104	44 (42.3)	0.018
Other	556	306 (55.0)		579	177 (30.6)	

All *p* values for Pearson's χ^2 except * = χ^2 for linear-by-linear association. **A$ = Australian dollars.

Table 3 Final models and results of the multivariate logistic regression

Demographic variable	B	SE	Sig	AOR	95%CI
		Concerned			
Outside SE Queensland	−0.530	0.202	0.009	0.589	0.396–0.874
>14 y Education	−0.430	0.195	0.027	0.651	0.444–0.952
>A$100K income	−0.638	0.206	0.002	0.528	0.353–0.791
Age 18–34 y	0.171	0.227	0.452	1.187	0.760–1.853
Single	−0.250	0.260	0.338	0.779	0.468–1.298
Health/community service worker	0.043	0.272	0.873	1.044	0.613–1.779
		Would cancel			
Age 18–34 y	−0.757	0.302	0.012	0.469	0.260–0.847
0–10 y education	0.162	0.266	0.543	1.176	0.697–1.982
A$0–26K income	0.003	0.407	0.995	1.003	0.451–2.229
>A$100K income	−0.330	0.214	0.123	0.719	0.473–1.093
Single	0.019	0.288	0.946	1.020	0.580–1.793
Health/community service worker	0.346	0.273	0.205	1.413	0.828–2.412

B = coefficient; SE = standard error; Sig = significance; AOR = adjusted odds ratio; CI = confidence interval.

education (AOR = 0.651; CI: 0.444–0.952), and those with incomes greater than A$100,000 per year (AOR = 0.528; CI: 0.353–0.791) were all less likely to express concern regarding Pandemic (H1N1) 2009 when traveling. There were no interaction effects among these variables. Only age was significantly associated with the likelihood of cancelling travel if a respondent was symptomatic, with younger respondents (18–24 y old) less likely than others to cancel pre-existing travel plans (AOR = 0.469; CI: 0.260–0.847).

Discussion

Previous emerging infectious disease outbreaks, such as severe acute respiratory syndrome (SARS), had far reaching impacts on travel and tourism, particularly, with shutdown of airline travel during the height of the SARS outbreak.[10] Avian influenza has not had the same impact; however, it has raised considerable concern among travelers and government travel advisories alike.[4] In this study, about half of the respondents indicated some level of concern regarding Pandemic (H1N1) 2009 in relation to travel, but only one third would cancel their airline travel in response to influenza-like symptoms. This is consistent with the fact that airlines remained operational throughout Pandemic (H1N1) 2009 and Australian travel advisories did not seek to restrict international travel.[8] It is also consistent with the results of a travel consumer sentiment survey conducted in New South Wales, Australia, in August 2009 that found 84% of respondents indicated that Pandemic (H1N1) 2009 had not affected their travel plans,[11] and is reflected in the outbound tourism numbers.[6] The relatively mild to moderate nature of the illness produced by Pandemic (H1N1) 2009 may have influenced travelers' decisions in relation to travel and curtailing their travel.[7]

These findings have important implications for public health and travelers. Although this study did not look at specific travel-related preventive measures against Pandemic (H1N1) 2009, public health education in the Australian community focused on simple measures, such as hand washing, which travelers had previously failed to spontaneously nominate as a preventive measure for avian influenza.[4] These findings can help public health officials to additionally focus education efforts for both domestic and international travelers. Specifically, people living in the metropolitan areas of Southeast Queensland, those with less than 14 years of education, and those making up to A$100,000 per year were more likely to express concern, and might be appropriate audiences for targeted information. Perhaps more importantly, younger travelers (18–35 y old) appear less likely to cancel their own travel even when they are symptomatic; they may be appropriate targets for both public health education and in-coming traveler screening.

This study was limited in that it relied on a telephone survey to collect data; however, telephone surveys have been previously used to gather information regarding public perceptions of risk and behavior during pandemics[12–14] and in response to other emergencies.[15,16] The response rate for the survey was 41.5% and, while this may suggest some response bias, the sample was representative of the general state population. However, it may be difficult to generalize results beyond Queensland, certainly beyond Australia. The survey does rely on self-reported data with its inherent bias, as what respondents report may differ from what they actually do. Nonetheless, the survey was conducted in July and August 2009 during the height of Pandemic (H1N1) 2009.

Also, factors other than Pandemic (H1N1) 2009 may have affected both global and Australian travel statistics, most notably the GFC.[5] In fact, the GFC has been reported to have had a greater impact on travel, particularly on business travel, with 39% of respondents cutting back on flights and accommodation,[11] although much of the GFC's impact on international arrivals to Australia was thought to have taken place during 2008.[6]

Conclusions

Pandemic (H1N1) 2009 was of some concern to more than half of Queensland travelers. Nonetheless, the majority of Queenslanders would not have postponed their own travel, even if they exhibited symptoms consistent with Pandemic (H1N1) 2009.

Acknowledgments

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Declaration of Interests

The authors state they have no conflicts of interest to declare.

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Annex 17: Paper 4.4

Aitken P, Brown L, Leggat P, Speare R. Preparedness for Short Term Isolation Among Queensland Residents: Implications for Pandemic and Disaster Planning. Emergency Medicine Australasia 2010; 22: 435-441

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EMA

ORIGINAL RESEARCH

Preparedness for short-term isolation among Queensland residents: Implications for pandemic and disaster planning

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Abstract

Objective: Short-term isolation might occur during pandemic disease or natural disasters. We sought to measure preparedness for short-term isolation in an Australian state during pandemic (H1N1) 2009.

Methods: Data were collected as part of the Queensland Social Survey (QSS) 2009. Two questions related to preparedness for 3 days of isolation were incorporated into QSS 2009. Associations between demographic variables and preparedness were analysed using χ^2, with $P < 0.05$ considered statistically significant.

Results: Most respondents (93.6%; confidence interval [CI] 92.2–94.9%) would have enough food to last 3 days, but only 53.6% (CI 50.9–56.4%) would have sufficient food and potable water if isolated for 3 days with an interruption in utility services. Subpopulations that were less likely to have sufficient food and potable water reserves for 3 days' isolation without utility services included single people, households with children under 18 years of age, people living in South-East Queensland or urban areas, those with higher levels of education and people employed in health or community service occupations.

Conclusions: The majority of Queensland's population consider themselves to have sufficient food supplies to cope with isolation for a period of 3 days. Far fewer would have sufficient reserves if they were isolated for a similar period with an interruption in utility services. The lower level of preparedness among health and community service workers has implications for maintaining the continuity of health services.

Key words: *disease outbreak, disaster planning, human, influenza, public health, viral disease.*

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Introduction

A new influenza-like illness was first reported by the World Health Organization (WHO) on 24 April 2009, with 59 deaths in Mexico alone.[1] These cases were first confirmed as 'Swine Influenza A/H1N1', now known as pandemic (H1N1) 2009. The WHO raised the Pandemic Influenza alert to Phase 4, indicating human to human transmission, and shortly thereafter it was raised again to Phase 5, indicating widespread human infection.[1] The first Australian case of pandemic (H1N1) 2009 influenza was reported in the state of Queensland in May 2009 with cases soon reported by all Australian states and territories.[2] As in November 2009, Australia had recorded 37 435 confirmed cases of pandemic (H1N1) 2009 influenza, with 4855 hospitalizations and 191 deaths.[3]

At the onset of the Australian outbreak, no vaccine was available for pandemic (H1N1) 2009. Traditional public health infection control practices were the only defence, including social distancing measures, quarantine and self-isolation, which have all been found to be effective and have a critical role in the potential control of pandemics.[4–8] Pandemics, however, are only one potential cause of short-term isolation relevant to disaster preparedness and emergency medical personnel; it might also result from natural disasters such as flooding, cyclones or earthquakes. All community members should be prepared for the possibility of short-term isolation. We sought to determine the degree of preparedness for short-term isolation among community members in an Australian state during pandemic (H1N1) 2009.

Methods

Data for the present study were collected as part of the Queensland Social Survey (QSS) 2009. QSS is an annual statewide survey conducted by the Population Research Laboratory (PRL) in CQUniversity's Institute for Health and Social Science Research. It is a large random sample of Queensland adults that aims to reflect the characteristics of the broader Queensland population. QSS 2009 was the fifth annual statewide survey with multiple reports and papers arising from previous versions.[9]

Through a cost-sharing arrangement, QSS enables researchers and policy-makers to incorporate questions into the survey. QSS uses a computer-assisted telephone interviewing system and trained interviewers to randomly sample households across Queensland, including metropolitan Brisbane (South-East Queensland) and the rest of the state (Other Queensland). A two-stage selection process is used to ensure equal representation of male and female sex.

The QSS 2009 consisted of a standardized introduction, specific questions incorporated by researchers and the University and 37 demographic questions. The questions were pilot tested by trained interviewers in 92 randomly selected households, with modifications to the questions guided by both responses from the subjects and feedback from the interviewers. Final interviewing was conducted between 20 July 2009 and 19 August 2009, between the hours of 10.30–14.30 and 16.30–20.30 on weekdays, and between the hours of 11.00–16.00 on weekends.

Two questions related to preparedness for short-term isolation were incorporated into QSS 2009 in conjunction with a series of questions related to pandemic influenza. The first question asked respondents whether they would have enough food if health officials ordered everyone in their household to stay home for 3 days; the second question asked respondents whether they would have enough food and potable water to last 3 days if all utility services were interrupted. The exact questions are shown in Table 1.

Frequencies of 'yes' and 'no' responses with their respective 95% confidence intervals (CI) are reported. Associations between relevant demographic variables and responses to the preparedness questions were evaluated using χ^2 analysis; where demographic variables were recorded as ordinal data, analyses using χ^2 for linear-by-linear association were conducted to identify any significant trend effects. For all analyses, $P < 0.05$ was used to establish statistical significance.

The QSS 2009 had a target sample size of 1200 subjects, with 800 subjects from South-East Queensland and 400 from Other Queensland; thus, the a priori estimated sampling error at the 95% confidence level was ±2.9% for the entire sample, ±3.6% for the South-East Queensland subsample and ±5.1% for the Other Queensland subsample.

The QSS 2009 was approved by the Human Ethics Review Panel at CQUniversity (H09/06-037); the incorporation of the short-term isolation questions was approved by the Human Research Ethics Committee at James Cook University (H3456).

Table 1. Questions and responses regarding preparedness for short-term isolation

	%	95% confidence interval
If health officials ordered everyone in your household to stay home, would you have enough food to last at least 3 days?		
Yes	93.6%	92.2–94.9%
No	6.2%	4.9–7.5%
Don't know	0.1%	0.0–0.2%
No response	0.2%	0.0–0.4%
Would you have enough food and drinkable water to last 3 days if the power went out, you did not have refrigeration, could not cook and the water supply was contaminated or interrupted?		
Yes	53.6%	50.9–56.4%
No	45.3%	42.6–48.0%
Don't know	0.9%	0.4–1.4%
No response	0.2%	0.0–0.5%

Results

The QSS 2009 contacted or attempted to contact 3112 households; 1536 subjects declined participation, 142 households could not be contacted and 129 were otherwise ineligible for an overall response rate of 41.5%. The final sample for QSS 2009 included 1292 respondents; 860 from South-East Queensland and 432 from Other Queensland. The sample was nearly equally divided between male and female sex (50.2% *vs* 49.8%). Younger people (aged 18–34 years) were underrepresented in the sample; older people (aged >55 years) were overrepresented in the sample; otherwise, the demographics of the participants reasonably approximated that of the general population,[10] as shown in Table 2.

Responses to the two questions concerning preparedness for short-term isolation are shown in Table 1 and 93.6% (CI 92.2–94.9%) of respondents indicated they would have enough food to last 3 days, but only 53.6% (CI 50.9–56.4%) would have sufficient food and potable water if they were isolated for 3 days with an interruption in utility services. Associations between demographic variables and preparedness for isolation are shown in Table 3. Older people and married or partnered people were more likely to report having enough food to last for 3 days; people with annual incomes below $26 000 AUD and people employed in health or community service occupations were less likely to report having sufficient food to last for 3 days. Otherwise, preparedness for short-term isolation without an interruption in utility services was not associated with respondent demographics.

A number of demographic variables, however, were associated with preparedness for short-term isolation with an interruption in utility services. Male sex, older people, people living outside of South-East Queensland and people living in rural areas, unemployed people, people with less education and married/partnered people were all more likely to report having sufficient food and potable water to last for 3 days if utility services were interrupted. Again, health or community

Table 2. Demographic characteristics of the Queensland Social Survey (QSS) sample and of Queensland, Australia[10]

	QSS sample	Queensland
Age (years)		
18–34	13.0%	30.6%
35–44	20.0%	19.6%
45–54	20.3%	18.4%
55+	56.2%	31.4%
Sex		
Male	50.2%	49.6%
Female	49.8%	50.4%
Employment status†		
Full-time	35.8%	38.1%
Part-time/casual	19.4%	17.1%
Unemployed	3.2%	2.9%
Other/not in labour force	40.1%	38.2%
Household income†		
$0–26 000	17.3%	18.3%
$26 001–52 000	14.1%	24.1%
$52 001–100 000	20.1%	31.5%
$100 001+	20.3%	14.7%
Marital status†		
Married/partnered	75.2%	60.2%
Single	24.6%	39.8%

†*The Australian Bureau of Statistics uses slightly different categories and thresholds than QSS 2009.*

Table 3. Association between demographic variables and preparedness for short-term isolation

	OK for 3 days	*P*	OK for 3 days with or without utilities	*P*
Sex				
Male	93.8%	0.994	57.1%	0.040
Female	93.8%		51.3%	
Age (years)				
18–34	91.6%	0.005*	43.7%	<0.001*
35–44	91.4%		41.2%	
45–54	92.4%		57.1%	
55+	96.0%		61.4%	
Location				
South-East Queensland	92.9%	0.058	50.8%	0.001
Other Queensland	95.6%		61.0%	
Urban	93.3%	0.173	49.6%	<0.001
Rural	95.4%		69.0%	
Health status				
Excellent	93.9%	0.732*	56.8%	0.402
Very good	93.8%		56.0%	
Good	94.1%		49.7%	
Fair	94.1%		53.5%	
Poor	90.7%		60.4%	
Chronic disease				
Yes	93.6%	0.798	53.2%	0.518
No	93.9%		55.0%	
English as primary language				
Yes	93.8%	0.897	53.9%	0.430
No	94.1%		53.9%	
Employed				
Yes	92.7%	0.071	50.2%	0.001
No	95.1		59.4%	
Education (years)				
0–10	94.5%	0.348*	57.5%	0.030*
11–12	94.1%		55.7%	
13–14	93.3%		54.4%	
15+	93.0%		50.1%	
Income				
$0–26 000	89.7%	0.184*	55.2%	0.141*
$26 001–52 000	96.7%		58.0%	
$52 001–100 000	94.6%		53.3%	
$100 001+	93.5%		49.6%	
Children in household				
Yes	92.9%	0.320	47.7%	<0.001
No	94.3%		57.9%	
Marital status				
Partnered	94.7%	0.013	56.0%	0.022
Single	90.9%		48.6%	
Employment				
Health field	83.3%	<0.001	41.1%	0.041
Other fields	94.4%		51.8%	

*All P-values for χ^2 except * = χ^2 for linear-by-linear association.*

service workers were less likely to report being adequately prepared for such as situation.

Discussion

Almost all respondents in the present study (93.6%) indicated they would have enough food to last 3 days, but far fewer (53.6%) indicated they would have sufficient food and potable water if they were isolated for 3 days with an interruption in utility services. This distinction is important for disaster preparedness and emergency management professionals. Staff absenteeism during pandemics might disrupt critical infrastructure including utility services;[11] natural disasters might also result in interruptions to both water and power supplies. Even if the water supply is not interrupted it might be contaminated. In the aftermath of Hurricane Rita in the US state of Louisiana, for example, 13% of respondents to a community survey had consumed water that was not bottled and not boiled, despite a boil water order being in effect.[12]

The results from the present study echo those from similar studies in both Australia and the USA. Storms in the Hunter region of New South Wales (NSW), Australia in 2007 caused electricity interruptions to over 200 000 homes and businesses, with some properties having no electricity for more than 1 week.[13] A rapid cluster survey of 320 households affected by that disaster found over 80% of households had enough perishable food for 3 days but less than 40% had enough stored drinking water for 3 days.[14] A survey conducted between 2002 and 2003 in Los Angeles, California in the USA found only 28% of respondent households had emergency supplies including 'food, water or clothing'.[15] They too found younger age, increasing education and increasing income were associated with decreased preparedness, although only the association between education and preparedness was sustained after multivariate adjustment. The reasons for these associations between income, education and preparedness are not clear and require further research. This could have implications for disaster planners responsible for targeted education and community awareness programmes.

In the present study, those living outside of South-East Queensland and people living in rural areas were more likely to have sufficient food and potable water to last 3 days with loss of utility services. This difference was most marked for rural (69.0%) versus urban respondents (49.6%, $P < 0.001$). Similarly, a survey of elderly people served by home delivered meal programmes in the rural US state of Kentucky found 80.2% of respondents had a 3-day supply of non-perishable food.[16] This higher level of preparedness for those in rural areas might reflect awareness among people in those regions of the increased risk of interruption to food supply chains.

The presence of dependents has been noted to be associated with increased likelihood of both having emergency supplies[15] and compliance with evacuation orders.[17] In the present study, married or partnered people were more likely to report having enough food to last for 3 days with or without utility services, whereas households with children under 18 were significantly less likely than those without children to report having adequate provisions to last 3 days if utility services were interrupted.

These findings have important implications for disaster preparedness, emergency response and public health planners. Food and water stockpiling are critical to preparation for short-term isolation. Some disasters, such as cyclones, afford advanced warning and an opportunity to stock-up; indeed, 61% of the households represented in the survey following Hurricane Rita had done just that.[12] Other causes of short-term isolation, however, strike without warning. Even if people are not physically constrained to their homes, the ability to stockpile after an event is questionable. Typically, supermarket stocks will be depleted in 2–4 weeks without replenishment of the food supply chain,[18] but this is likely a 'best case' scenario with panic buying capable of producing shortages in 2–3 days.[19]

It should also be noted that preparedness for emergencies consists of far more than simply stockpiling food and water. The nutritional value of the food, its shelf life, dependence on refrigeration and ability to be eaten without being cooked are all important factors.[18] A number of guides are available to community members including the food lifeboat website[20] and the Food Industry Working Group pantry list.[21] Furthermore, households should have a 'family plan' and a full emergency kit including a broad range of items as suggested by the Emergency Management Australia website.[22] We did not query respondents about other emergency supplies; however, a previous survey following the 2007 NSW storms found only 23% of households had all of the following: torch, battery operated radio, appropriate batteries, mobile phone, emergency contact list and first-aid equipment.[14]

One point of interest is that people employed in health or community service occupations were less likely to report being adequately prepared, with or without loss of utility services. This has not been reported previously. The reasons for this are not available from the present study and further in-depth exploration is needed. This might be an artefact of the classification process: QSS uses the Australian and New Zealand Standard Industrial Classification with the category 'Health and Community Services' inclusive of hospitals, nursing homes, medical, dental services and other health services, veterinary services, child care services and community care services.[23] Still, this issue has important workforce implications for disaster preparedness as health personnel often must see to the needs of their own families before reporting to work in a disaster. There is often a conflict between professional obligation and family commitment, with family safety of primary importance.[24] Disaster management professionals, emergency response agencies and EDs must emphasize the importance of personal preparedness as part of business continuity.[25,26]

The present study was limited in that it relied on a telephone survey to collect data; however, telephone surveys have been previously used to gather information regarding public perceptions of risk and behaviour during pandemics[27–29] and in response to other emergencies.[15,30] Telephone surveys also, by their nature, exclude the homeless or economically disadvantaged sections of the community who do not have home telephones and are likely to be more vulnerable to the effects of a disaster. The response rate for the survey was 41.5% and although this might suggest some response bias, the sample was representative of the general state population. The survey does rely on self-reported data with its inherent bias. Those who report being prepared might actually be over estimating their preparedness or under estimating their needs. We also did not assess perceived likelihood of an event, which has been linked with increased likelihood of having emergency supplies.[15] However, the survey was conducted in July and August 2009 during the height of pandemic (H1N1) 2009.

Conclusion

The majority of the Queensland population (93.6%) consider themselves to have sufficient food supplies to cope with short-term isolation for a period of 3 days. Far less (53.6%) would have sufficient food and potable water if they were isolated for 3 days with an interruption in utility services. Notably, people employed in health or community service occupations were less likely to report having sufficient food to last for 3 days, with or without interruption of utility services. Disaster preparedness and emergency medical personnel might need to focus on this frontline health workforce as part of their pandemic and disaster preparedness efforts.

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Author contributions

All authors have contributed equally to the present paper.

Competing interests

Peter Aitken is the Disaster Medicine Section Editor for *Emergency Medicine Australasia*. The other authors have no conflicts of interest.

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Annex 18: Paper 4.5

Considine J, Shaban R, Patrick J, Holzhauser K, **Aitken P**, Clark M, Fielding E, FitzGerald G. Pandemic (H1N1) 2009 Influenza in Australia: Absenteeism and redeployment of emergency medicine and nursing staff. Emergency Medicine Australasia 2011; 23: 615-623

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Pandemic (H_1N_1) 2009 Influenza in Australia: Absenteeism and redeployment of emergency medicine and nursing staff

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Abstract

Objective: The aim of the present study was to examine the impact of Pandemic (H_1N_1) 2009 Influenza on the Australian emergency nursing and medicine workforce, specifically absenteeism and deployment.

Methods: Data were collected using an online survey of 618 members of the three professional emergency medicine or emergency nursing colleges.

Results: Despite significant increases in emergency demand during the Pandemic (H_1N_1) 2009 Influenza, 56.6% of emergency nursing and medicine staff reported absenteeism of at least 1 day and only 8.5% of staff were redeployed. Staff illness with influenza-like illness was reported by 37% of respondents, and 87% of respondents who became ill were not tested for the Pandemic (H_1N_1) 2009 Influenza. Of the respondents who became ill, 43% ($n = 79$) reported missing no days of work and only 8% of respondents ($n = 14$) reported being absent for more than 5 days. The mean number of days away from work was 3.73 (standard deviation = 3.63). Factors anecdotally associated with staff absenteeism (caregiver responsibilities, concern about personal illness, concern about exposing family members to illness, school closures, risk of quarantine, stress and increased workload) appeared to be of little or no relevance. Redeployment was reported by 8% of respondents and the majority of redeployment was for operational reasons.

Conclusion: Future research related to absenteeism, redeployment during actual pandemic events is urgently needed. Workforce data collection should be an integral part of organizational pandemic planning.

Key words: *influenza, pandemic, policy, workforce, workforce planning.*

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Introduction

The first case of Pandemic H_1N_1 influenza 2009 in Australia was reported on 9 May 2009.[1] This new virus appeared to be both highly contagious and virulent. By 29 May 2009, there had been 4910 confirmed cases and 85 deaths in Mexico: a case fatality rate of 1.7%.[2] The rapid spread, combined with apparently high rates of morbidity and mortality, raised serious concerns for EDs.[3] Large numbers of patients with influenza-like illness (ILI) presented to EDs across Australia, creating increased service demands on top of pre-existing problems of overcrowding from access block and growing service demands.[3] EDs implemented specific infection control precautions to protect patients, staff and visitors from potential cross contamination during a period of evolving knowledge about the disease.[3]

Australian hospitals and their EDs already operate near or over capacity, leaving little surge capacity.[4,5] Seasonal influenza is associated with increased demand across health services, including EDs.[6] General health staff absenteeism increases during outbreaks of seasonal influenza.[7] However, the rates of staff redeployment are not well documented. Analysis of the experience of Pandemic (H_1N_1) 2009 Influenza provides valuable lessons about the impact of a pandemic on the Australian ED workforce, informing future pandemic response capability.

The aim of the present study was to examine the impact of Pandemic (H_1N_1) 2009 Influenza had on the Australian emergency nursing and medicine workforce. It is part of a larger study that identified the impact of Pandemic (H_1N_1) 2009 Influenza on Australian EDs.[3]

Method

Study design

A cross-sectional survey design was used. The specific research questions were:

1. What was the effect of Pandemic (H_1N_1) 2009 Influenza on emergency medicine and nursing staff absenteeism, and what factors influenced staff absenteeism; and
2. What was the effect of Pandemic (H_1N_1) 2009 Influenza on emergency medicine and nursing staff redeployment, and what factors influenced staff redeployment?

For the purposes of the present study, Pandemic (H_1N_1) 2009 Influenza in Australia occurred between 1 May and 30 September 2009. The present study was approved by the Human Research and Ethics Committee at Queensland University of Technology.

Participants

All members of three professional colleges for emergency nursing and medicine in Australia were invited to participate in the study: the College of Emergency Nursing Australasia (CENA), the Australian College of Emergency Nursing (ACEN) and the Australasian College for Emergency Medicine (ACEM). To identify differences between professional groups, participants were classified into three subgroups: (i) nurses; (ii) senior medical officers (SMOs) including Fellows of the Australasian College for Emergency Medicine, and staff specialists; and (iii) registrars (including emergency medicine trainees).

Survey development

The rapid spread of Pandemic (H_1N_1) 2009 Influenza, and the absence of an existing data collection instrument specific to emergency care, necessitated development of a new tool. An electronic survey was developed using Survey Monkey to collect information across five domains: (i) ED workload, in particular, the impact of patients presenting with ILI; (ii) severity profile of patients with ILI; (iii) policies and procedures adopted by EDs to facilitate management of patients with ILI and protection of staff and other patients; (iv) ED operations, staff availability and support during the (H_1N_1) 2009 influenza pandemic; and (v) personal effects of the (H_1N_1) 2009 influenza pandemic on ED staff. Questions types included free-text and 5-point Likert scale.[3] Content and face validity were established through critical review by research team members who were senior emergency nurses (5) and physicians (4) holding current clinical and/or academic appointments in emergency care. They piloted the survey to establish the time required to complete the survey, and made comments regarding wording of questions and titles of medical and nursing staff categories. For the purposes of the present study, an ILI is defined as recent onset of fever (or a history of fever) with cough and/or sore throat.[8]

Data collection

All members of the three professional colleges outlined above were invited to participate in an anonymous elec-

Table 1. ED staff illness during Pandemic (H_1N_1) 2009 Influenza

	Total *n* (%)	Registrar *n* (%)	SMO *n* (%)	Nurse *n* (%)	*P*
Became ill with ILI during Pandemic (H_1N_1) 2009 Influenza					
Yes	177 (36)	79 (45)	55 (37)	43 (26)	0.001
No	309 (64)	95 (55)	92 (63)	122 (74)	
Tested for Pandemic (H_1N_1) 2009 Influenza					
Yes, tested and confirmed H_1N_1	12 (7)	9 (12)	2 (4)	1 (2)	
Yes, tested and not H_1N_1	10 (6)	4 (5)	4 (7)	2 (5)	0.23
No, not tested	150 (87)	62 (83)	48 (89)	40 (93)	
Work days missed because of ILI					
0	76 (43.5)	32 (41)	35 (64)	9 (21)	
1–5	85 (48.5)	42 (54)	17 (31)	26 (62)	0.001
6–10	13 (7.5)	4 (5)	2 (4)	7 (17)	
11+	1 (0.5)	0 (0)	1 (0.5)	0 (0)	
Mean no. work days missed (SD)	3.73 (3.63)	2.93 (1.85)	4.70 (7.15)	4.30 (2.13)	0.12

ILI, influenza-like illness; SD, standard deviation; SMO, senior medical officer.

tronic survey. Each of these colleges emailed their members the electronic survey 30 October 2009, and two reminder emails were forwarded in November and December 2009 respectively. The survey closed 30 December 2009.

Data analysis

The data were cleaned for errors and analysed using the Statistical Package for the Social Sciences (SPSS) Version 17. Descriptive statistics (frequency, mean and standard deviation [SD]) were used to summarize the study data. χ^2 tests (for frequency comparisons) and analysis of variance tests (for mean comparisons) were conducted to identify differences by professional group: nurses, SMOs (ACEM Fellows and staff specialists) and registrars (including emergency medicine trainees). Statistical significance was set at <0.05. For responses using a 5-point Likert scale, a mean response score was also calculated as an indicator of response distribution.

Results

The overall response rate for the survey was 18.4%, with 618 usable responses to the 3355 emails sent. The response rates of specific groups were 19.3% for SMOs (165/856), 14.9 for emergency nurses (162/1087) and 17.7% for registrars (250/1412). Those emails returned or not deliverable were removed from the sample denominator. Of this sample, 327 were emergency physicians or trainees, 250 were registered nurses, and for 41 respondents an occupation was not reported.

Absenteeism

Staff illness with ILI (irrespective of whether or not Pandemic [H_1N_1] 2009 Influenza was confirmed) was reported by 36% of respondents (n = 177/486; 95% CI 31.7–40.3%) (Table 1). Of those who became ill, 87% (n = 150/172; 95% CI 82.2–92.2%) were not tested for the Pandemic (H_1N_1) 2009 Influenza. Pandemic (H_1N_1) 2009 Influenza infection was confirmed in 54% of respondents (n = 12/22; 95% CI 33.7–75.48%) who were tested (Table 1). Of the respondents who became ill, 43.5% (n = 76/175; 95% CI 36.1–50.8%) reported missing no days of work and only 8% of respondents (n = 14/175) reported being absent for more than 5 days. The mean number of days away from work was 3.73 (SD = 3.63) and the majority of respondents absent from work because of illness (48.5%, n = 85) missed between 1 and 5 days (Table 1).

Influenza-like illness was reported by 45% of registrars (n = 79/174; 95% CI 38.0–52.8%), 37% of SMOs (n = 55/147; 95% CI 29.6–45.2%) and 26% of nurses (n = 43/165; 95% CI 13.4–32.8%): doctors had significantly higher rates of ILI (P = 0.001). Nurses who became ill were significantly more likely to be absent from work (79%, n = 33/42; 95% CI 66.21–91.0%) than registrars (59%, n = 46/78; 95% CI 48.0–69.9%) or SMOs (36%, n = 20/55; 95% CI 23.6–49.1%). The average number of absent days as a result of ILI was 4.3 (SD = 2.13) for nurses, 2.93 (SD = 1.85) for registrars and 4.7 (SD = 7.15)

Table 2. ED staff caring for others (outside of work) with ILI during Pandemic (H_1N_1) 2009 Influenza

	Total n (%)	Registrar n (%)	SMO n (%)	Nurse n (%)	P
Caregiver responsibilities†					
No one	294 (56)	110 (62)	83 (55)	101 (61)	
Family members living with	152 (29)	44 (25)	52 (34)	56 (32)	
Family members not living with	40 (8)	17 (10)	12 (8)	11 (7)	
Friends, neighbours, dependents	32 (6)	15 (8)	8 (5)	9 (5)	
Others	6 (1)	2 (1)	3 (2)	1 (1)	
Days of work missed caring for others‡					
0	160 (82.5)	52 (81)	56 (88)	52 (79)	
1–5	30 (15)	12 (19)	7 (11)	11 (17)	
6–10	3 (2)	0 (0)	0 (0)	3 (4)	0.15
11+	1 (0.5)	0 (0)	1 (1)	0 (0)	
Mean no. work days missed (SD)	2.91 (2.95)	2.00 (1.21)	3.25 (4.77)	3.5 (2.71)	0.42

†Respondents could indicate yes to more than one category. ‡Question only asked of those indicating that they had cared for someone. SD, standard deviation; SMO, senior medical officer.

for SMOs. This difference in absenteeism was not statistically significant (Table 1).

Caregiver responsibilities (unpaid or voluntary care for the sick, elderly or disabled and not including professional care provided as an employee of a health service) for others with ILI were reported by 44% of respondents ($n = 230/524$; 95% CI 39.6–48.1%); however, 82.5% ($n = 160/194$; 95% CI 77.1–87.8%) of respondents with caregiver responsibilities reported zero absenteeism (Table 2). Of respondents who did miss work, the mean number of days was 2.9 (SD = 2.9). There was no significant difference between doctors and nurses in terms of rates of caregiver responsibilities, or absenteeism related to caregiver responsibilities (Table 2).

Respondents were asked if particular factors were antecedents to absenteeism during the (H_1N_1) 2009 influenza pandemic: (i) concern about falling ill with Pandemic (H_1N_1) 2009 Influenza themselves; (ii) concern about exposing family members to Pandemic (H_1N_1) 2009 Influenza; (iii) closure of children's school; (iv) risk of being quarantined; (v) extreme stress; and (vi) increased workload (Table 3). Only 2–5% of respondents rated one or more of these factors as contributing to absenteeism, suggesting the workforce impact of these factors was low. Responses were similar for all three professional groups (Table 3).

Redeployment

Redeployment from their usual workplace was reported by 8.5% of respondents ($n = 41/493$) during the (H_1N_1) 2009 influenza pandemic (Table 4). Nurses were more likely to be redeployed (17%, $n = 28/166$; 95% CI 11.2–22.6%) than registrars (5%, $n = 8/176$; 95% CI 1.5–7.6%) or SMOs (3%, $n = 5/151$; 95% CI 0.5–6.2%). Personal risks factor for severe illness from Pandemic (H_1N_1) 2009 Influenza (such as pregnancy or immuno-compromised state) was the rationale for redeployment in 15% of cases ($n = 6$). Of those staff redeployed, personal risk factors for severe illness from Pandemic (H_1N_1) 2009 Influenza were reported as the reason for redeployment by 63% of registrars ($n = 5/8$), and 4% ($n = 1/26$) nurses ($P < 0.001$). The remainder of respondents reporting redeployment cited operational reasons for their movement out of ED: 31% of doctors ($n = 4/13$; 95% CI 5.7–55.9%) and 54% of nurses ($n = 15/28$; 95% CI 35.1–72.1%) reported redeployment from the ED to staff flu clinics. Of the 28 nurses redeployed, the majority held senior nursing roles: four were nurse managers, nurse consultants or deputy director of nursing, three were nurse practitioners, three were nurse educators or nurse researchers, nine were clinical nurse specialists and six were registered nurses. The median years of emergency nursing experience of redeployed nurses was 9 (interquartile range – 6.5 to 16.5). Of the 13 medical staff redeployed, nine were registrars and five were SMOs. The median years in emergency medicine of redeployed doctors was 7 (interquartile range – 4 to 10.5).

Discussion

The present study contributes three major findings related to impact of Pandemic (H_1N_1) 2009 Influenza

Table 3. Factors (other than personal ILI or caring for persons with ILI) causing ED staff to miss work during Pandemic (H_1N_1) 2009 Influenza

	Total *n* (%)	Registrar *n* (%)	SMO *n* (%)	Nurse *n* (%)	*P*
Concern about falling ill with Pandemic (H_1N_1) 2009 Influenza					
Yes	9 (2)	6 (3)	2 (1)	1 (1)	0.13
No	477 (98)	168 (97)	147 (99)	162 (99)	
Concern about exposing family members to Pandemic (H_1N_1) 2009 Influenza					
Yes	12 (2.5)	7 (4)	4 (3)	1 (1)	0.13
No	472 (97.5)	166 (96)	145 (97)	161 (99)	
Closure of children's school					
Yes	8 (2)	3 (2)	2 (1)	3 (2)	0.94
No	475 (98)	170 (98)	146 (99)	159 (98)	
Being quarantined					
Yes	23 (5)	8 (5)	5 (3)	10 (6)	0.52
No	461 (95)	165 (95)	143 (97)	153 (94)	
Extreme stress					
Yes	15 (3)	7 (4)	4 (3)	4 (3)	0.67
No	469 (97)	166 (96)	145 (97)	158 (97)	
Increased ED workload					
Yes	22 (4.5)	11 (6)	4 (3)	7 (4)	0.29
No	461 (95.5)	162 (94)	145 (97)	154 (96)	

ILI, influenza-like illness; SD, standard deviation; SMO, senior medical officer.

Table 4. ED staff redeployment during Pandemic (H_1N_1) 2009 Influenza

	Total *n* (%)	Registrar *n* (%)	SMO *n* (%)	Nurse *n* (%)	*P*
Redeployed from usual workplace					
Yes	41 (8.5)	8 (5)	5 (3)	28 (17)	
No	450 (91)	166 (94)	146 (97)	138 (83)	<0.001
Don't remember	2 (0.5)	2 (1)	0 (0)	0 (0)	
Reason for redeployment†					
Personal risk factors for severe illness from Pandemic (H_1N_1) 2009 Influenza	6 (16)	5 (63)	0 (0)	1 (4)	<0.001
Other operational reasons	32 (84)	3 (38)	4 (100)	25 (96)	

†*Question only asked of those indicating 'yes' to above question. SMO, senior medical officer.*

on the Australian emergency nursing and medicine workforce.

First, just over half of emergency medicine and nursing staff reported being absent from work during the (H_1N_1) 2009 influenza pandemic. Although one-third of the ED staff reported suffering ILI (irrespective of confirmation of [H_1N_1]), personal illness had little effect on absenteeism. Of the staff who suffered an ILI or Pandemic (H_1N_1) 2009 Influenza, just over half missed one or more days of work. Absenteeism due to personal illness is a major economic and social consideration during a pandemic.[9] There are a number of studies of self-reported absenteeism using hypothetical pandemic scenarios.[10-13] A multi-site Australian study of knowledge, attitudes and intended behaviours during pandemic influenza showed that 83.3% of respondents reported they would attend work if a patient in their ED had an ILI, 79.0% of respondents would attend work if a colleague had contracted pandemic influenza, but only 60.6% would attend work if a family member had an ILI.[13] A single site Australian study of self-reported attitudes to working during a pandemic showed 67% of staff would work during a pandemic, whereas 26% of staff stated they would stay home to care for dependents and 10% reported they would not attend work for fear of contracting influenza.[14] Studies of pandemic illness using hypothetical scenarios estimate staff absentee rates ranging from 13% to 85%.[10,15] Reported potential barriers include personal illness, transport difficulties and child-care responsibilities. Perceived barriers to willingness to work during an influenza pandemic included concern about the well-being of family members; a lack of trust in the department of health, lack of information about the risks and expectations of staff; fear of litigation, and the feeling that employers do not take the needs of staff seriously.[11]

In the present study, doctors had significantly higher ILI rates, with more than 1.5 times the ILI rate of nurses. However, nurses who suffered ILIs were significantly more likely to be absent from work, with absenteeism rates more than double that of SMOs. The reason for the higher incidence of absenteeism by nurses is unclear, but might relate to perceptions of ease of replacement: there is a greater availability of nursing workforce available from either hospital-based casual pools or employment agencies but limited casualization of the emergency medicine workforce. Locum and overseas-trained staff are often used to fill medical vacancies in emergency medicine,[16] which might influence surge capacity and implementation of pandemic plans. The casualization of the workforce in health might also contribute to spread of infection, as was noted with SARS in a Singapore hospital.[17] There are few published papers related to general absenteeism rates during the (H_1N_1) 2009 influenza pandemic. One report suggests that Australia's work absenteeism rates during the (H_1N_1) 2009 influenza pandemic were higher than those observed during the 2007 and 2008 influenza seasons; however, there was no 'major social disruption'.[18] New South Wales data indicate that during July and August 2009, between 1.1% and 1.4% of workers were absent for three or more consecutive days and this was higher than the usual 0.7% absenteeism rate during usual influenza season.[18] Australian Influenza Surveillance Reports suggest that absenteeism rates during 2009 were similar to that in 2007.[19]

It was of concern that 43% of respondents who reported suffering an ILI continued to work. This finding is in direct conflict with current recommendations that staff should be actively encouraged to stay away from work if they or someone in their household has a fever, or other signs of respiratory illness.[8] Factors associated with inappropriate work behaviour, such as attending work with an ILI during a hypothetical pandemic included age less than 40 years, health-care workers in non-clinical roles and perceived seriousness of pandemic influenza.[13] Attendance at work during a pandemic influenza outbreak is not limited to health-care professionals.[20] Inability to work from home, lack of paid sick leave and income loss are associated with working adults' poor compliance with pandemic influenza mitigation recommendations.[20] Alternative employment models and workforce redesign warrant further investigation as strategies to comply with infection control recommendations and therefore mitigate the spread of diseases, such as influenza.

During the (H_1N_1) 2009 influenza pandemic both the Australian and Victorian Governments stated that 'health-care workers who develop acute respiratory illness should be tested if capacity exists and excluded from work for 7 days or until fever has resolved, whichever is longer (unless on antivirals for 72 h and fever resolved for 24 h)'.[21,22] Despite this recommendation, and all of the respondents from the present study working in health-care facilities, only 14% of those who reported ILIs were tested for Pandemic (H_1N_1) 2009 Influenza. Internationally, the Centers for Disease Control and Prevention recommended that 'people with ILI illness remain at home until at least 24 h after they are free of fever (100°F or 37.8°C), or signs of a fever without the use of fever-reducing medications'.[23] This lack of consistency of formal guidelines might be associated with variation in individual health behaviours. Perceived staff shortages might also have been a factor in staff continuing to work despite suffering ILI.

Second, factors known to contribute to absenteeism, including caregiver responsibilities, concern about personal illness, concern about exposing family members, closure of schools, risk of being quarantined, stress and increased ED workload, were not reported as important by respondents in the present study. In the present study, caregiver responsibilities were reported by 41% of respondents; however, only 17% of these respondents were absent from work, with an average absence of 2.9 days. Other studies have reported similar rates of caregiver responsibilities for emergency nurses, typically for children.[24] Some study respondents reported caregiver responsibilities for elderly or disabled people. Although absenteeism for child-care responsibilities is reported to be a consequence of pandemic illness,[9] most studies have reported projected absenteeism rates from hypothetical scenarios. Real data related to caregiver responsibilities in the emergency medicine and nursing workforce are lacking. Factors, such as increased feminization of the emergency medicine workforce[25] and an ageing population,[26] will change caregiver responsibilities of emergency nurses and doctors. Objective data related to caregiver responsibilities of the emergency medicine and nursing workforce should inform pandemic plans. Respondents were most concerned about being quarantined, although some reported concerns about becoming ill themselves and exposing family members to the infection. The low reported levels of concern about issues, such as school closures, suggest that study respondents managed increased caregiver responsibilities well. It might be that staff willingness to respond to a health-care disaster supersedes these areas of concern.

Finally, reported rates of redeployment of emergency medicine and nursing staff from their usual workplace during Pandemic (H_1N_1) 2009 Influenza were low (8%). Nurses were redeployed at much higher rates than medical staff. The most common reason for redeployment was operational. Although only a small number of staff in the present study were at risk of severe illness from Pandemic (H_1N_1) 2009 Influenza, workforce data related to 'at risk' groups are lacking. Most organizational pandemic plans presume that all staff will be available to respond and little provision is made for the redeployment of 'at risk' groups. Optimal use of staff with risk factors for serious illness associated with Pandemic (H_1N_1) 2009 Influenza (pregnancy, obesity and significant comorbidities) is lacking in most organizational disaster plans.[27] Existing research has highlighted the need to factor staff limitations into disaster plans for a variety of reasons, including poorly fitting personal protective equipment and staff willingness to be redeployed or alternative duties.[14,24] Management strategies for staff redeployment during pandemics are urgently needed to better inform workforce planning, as *ad hoc* redeployment might adversely affect ED function and the response capacity of EDs. In the present study, redeployment of senior clinicians and senior nurses resulted in EDs working with lower levels of experienced staff, in particular experienced emergency nurses.

Limitations

This project was developed from an urgent call for research by the National Health & Medical Research Council in Australia.[28] The pragmatic requirements and urgent deadlines for project completion and reporting of results to inform the national policy response necessitated particular decisions with respect to study design. Using other survey methods over longer time periods might have enabled a greater response rate. The final response rate was 18.4%, raising the consideration whether respondents were representative of the targeted population.[29] Medical staff with, or training for, emergency medicine credentials are required to register with ACEM. Membership of emergency nursing colleges is voluntary, thus there might have been sampling bias in recruitment. All Australian jurisdictions were represented in the respondent demographics, with distribution proportionate to the population except there were more respondents from Victoria than New South Wales. The mean age for SMOs in Australia is 42.0 years,[30] which is close to the mean age of SMO respondents in the present study of 42.7 years. The mean age of Australian critical care nurses, which includes emergency nurses, is 39.8 years,[31] which is slightly younger than the nursing respondents in the present study who had a mean age of 41.5 years.

Conclusion

The emergency nursing and medicine workforce responded well to the challenges presented during the (H_1N_1) 2009 influenza pandemic, specifically the resultant increase in ED demand. Reported absenteeism affected just over half the emergency nursing and medicine workforce and redeployment rates were low. The factors anecdotally associated with staff absenteeism had little impact on ED staffing during this pandemic. The results of the present study highlight significant disparity between reported absenteeism and redeployment rates during an actual pandemic event and projected absenteeism and redeployment rates from hypothetical pandemic scenarios. Future research related to absenteeism and redeployment rates should occur during actual pandemic events, and workforce data collection should be an integral part of organizational pandemic planning. There is an urgent need for a consistent approach to pandemic influenza mitigation strategies, both within communities and among health-care workers. Health-care workers suffering ILIs should be provided with the time and financial resources to stay away from work. Given that at least half of the emergency nursing and medicine workforce were absent for at least 1 day, contingency plans to replace unwell staff warrants further attention. Further, workforce data related to staff at risk of serious complications of pandemic influenza are lacking, so future research should identify the magnitude of this risk and plan alternative work for these personnel to best use their skills and knowledge.

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Author contributions

RZS and GF conceived the study and designed the study. GF, RZS, JC, PA, MC and KH secured funding. GF, RZS, JC, PA, KH, MC, JP and EF developed and tested the instruments. GF, RZS, JC, PA, MC, JP, EF conducted data collection. JP, EF, GF, RZS, JC, MC and PA analysed the data. JC, RZS, JP, KH, GF, MC, EF and GF prepared the manuscript.

Competing interests

None declared.

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Annex 19: Paper 4.6

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ORIGINAL RESEARCH

EMA

Pandemic (H_1N_1) Influenza 2009 and Australian emergency departments: Implications for policy, practice and pandemic preparedness

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Abstract

Objective: To describe the reported impact of Pandemic (H_1N_1) 2009 on EDs, so as to inform future pandemic policy, planning and response management.

Methods: This study comprised an issue and theme analysis of publicly accessible literature, data from jurisdictional health departments, and data obtained from two electronic surveys of ED directors and ED staff. The issues identified formed the basis of policy analysis and evaluation.

Results: Pandemic (H_1N_1) 2009 had a significant impact on EDs with presentation for patients with 'influenza-like illness' up to three times that of the same time in previous years. Staff reported a range of issues, including poor awareness of pandemic plans, patient and family aggression, chaotic information flow to themselves and the public, heightened stress related to increased workloads and lower levels of staffing due to illness, family care duties and redeployment of staff to flu clinics. Staff identified considerable discomfort associated with prolonged times wearing personal protective equipment. Staff believed that the care of non-flu patients was compromised during the pandemic as a result of overwork, distraction from core business and the difficulties associated with accommodating infectious patients in an environment that was not conducive.

Conclusions: This paper describes the breadth of the impact of pandemics on ED operations. It identifies a need to address a range of industrial, management and procedural issues. In particular, there is a need for a single authoritative source of information, the re-engineering of EDs to accommodate infectious patients and organizational changes to enable rapid deployment of alternative sources of care.

Key words: *emergency department, influenza, pandemic, planning, policy.*

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Introduction

In April 2009, an outbreak of a novel influenza-like illness (ILI) was detected in Mexico.[1,2] Testing revealed the infection was caused by a new strain of influenza type A (H_1N_1), previously found in pigs, but not previously known to infect humans. By 29 May 2009, Mexico reported 4910 confirmed cases and 85 deaths,[3] a death rate of 1.7% among confirmed cases. This initial high estimate of mortality resulted in considerable international concern and attention. However, the passage of time and the accumulation of data showed that although the Pandemic (H_1N_1) Influenza 2009 attack rate was high, it caused mainly mild to moderate disease with suggestions that this was simply consistent with seasonal influenza rates.[4] Nevertheless, this outbreak of a novel disease met the World Health Organization criteria of a pandemic[5,6] and provided an opportunity to examine its impact and management within EDs with the aim of addressing issues that might be critical in a more severe pandemic. This paper addresses the implications of this experience for future policy, planning and operations and for the management of infectious patients in EDs in everyday practice. The full details of this research have been reported elsewhere.[7]

Emergency departments are at the forefront of Australia's pandemic response, providing immediate patient care and system-wide access, particularly for the more severely ill patients. Initially, patients with ILI were directed to EDs,[8] with television and newspapers reporting resultant disruption[9–16] on top of pre-existing overcrowding attributable to access block.[17]

Methods

Our research addressed four research questions:

1. How did presentation rates of Pandemic (H_1N_1) Influenza 2009 compare with ILI presentations in previous years?
2. What impact did Pandemic (H_1N_1) Influenza 2009 have on the functioning of EDs and their staff?
3. What management strategies were deployed by Australian EDs to manage Pandemic (H_1N_1) Influenza 2009?
4. To what extent did existing pandemic planning, policy and procedures prepare Australian EDs for Pandemic (H_1N_1) Influenza 2009?

We conducted a three-pronged study to examine the impact of Pandemic (H_1N_1) Influenza 2009 on EDs:

1. Study one analysed the literature, publicly accessible data and data obtained directly from state and jurisdictional health departments. Data were retrieved on patients with ILI coded as such on ED data systems.
2. Study two was an anonymous electronic survey of ED directors conducted in October–December 2009 to obtain data on the impact of the pandemic, and to identify management strategies used to cope with the challenge. This survey was distributed by the Australasian College for Emergency Medicine to directors of all 96 accredited Australian EDs.
3. Study three was an anonymous electronic survey conducted in October–December 2009 of all members of the three professional emergency care colleges: the Australasian College for Emergency Medicine, the College of Emergency Nursing of Australasia and the Australian College of Emergency Nursing.

The Colleges emailed an invitation to all members to participate in the survey. Two reminders were emailed, attempting to increase the response rate. Both surveys were conducted online using Survey Monkey (SurveyMonkey, Palo Alto, CA, USA). No existing survey instrument could be identified in the literature, and therefore a new survey tool was developed. The survey was trialled and refined among the research team and immediate contacts. The survey included both open-ended and directed questions, and also sought evaluative responses based on a 5-point Likert scale. A copy of the survey is accessible on line.

Quantitative data were analysed using PASW 17 (formerly known as SPSS) software (IBM®, Armonk, NY, USA), and open text was analysed for themes using Leximancer (Version 3.07; Leximancer™, Brisbane, Qld, Australia).

Ethics approval was obtained from the Queensland University of Technology's research ethics committee through expedited review for low-risk research (Approval no. 0900000807).

Results

The response to the survey from ED directors was disappointing, with only 12 of 96 (12.5%) completing the open text questions of the survey, and four providing quantitative data. Limited quantitative data were obtained directly from state and jurisdictional health departments where available. The overall response rate for Survey three was 18.4%, with 618 usable responses to the 3355 emails sent.

Health department data showed the presentation rate of patients with ILI to EDs in the 2009 influenza season was higher than previous years, ranging from 1.4 times in Victoria to 3.0 times in New South Wales.[18] There was no significant differences in sex of presenting patients, but the age profile revealed more presentations in 2009 by younger adults compared with earlier years,[18] confirming anecdotal reports of a differential impact on younger people.

Issue and theme analysis of the relative importance scales and open text survey responses revealed a number of consistent issues that appear to have policy implications.

1. Most respondents reported their perception of increased demand for care in their ED; 88% selected 4 or 5 on the 5-point scale. Most reported that the pandemic negatively impacted on the care of non-influenza or non-(H_1N_1) 2009 patients in their ED.
2. The responding directors reported that a pandemic plan was in place for their department, and that this plan was activated. Some indicated that the disaster plan was not activated and felt this limited the system response. However, only 39% of staff reported knowledge of the pandemic plan, although 98% of those stated that it had been at least somewhat useful in dealing with the pandemic.
3. Respondents were generally positive about the information they received, with 92% reporting it useful, and 90% sufficient in coverage. However, 23% reported that it was either 'not at all' or 'seldom' consistent and open text responses referred to excessive, contradictory and confusing information from various sources. Media coverage was viewed as sensationalist, resulting in many unnecessary ED presentations.
4. Specific clinical protocols were drafted to manage suspected (H_1N_1) 2009 influenza presentations. These protocols reportedly changed multiple times during the pandemic.
5. Special administrative measures were employed to manage the pandemic, including separate reception areas, changed visiting policies, referral of patients to general practitioners and changes in overall models of care. However, staff noted considerable difficulty isolating patients given the physical facilities. Most (64%) respondents reported that a flu clinic was established in their health service district during the pandemic. These were staffed by ED staff, other hospital staff and in one case, community health staff.
6. Almost all staff (94%) reported increased personal stress during the pandemic. Contributing factors included lack of space for patients, increased demand, access block, filling staff deficits and staff absenteeism. Concerns about becoming ill or exposing family members to the virus were less significant than expected. The use of personal protective equipment (PPE) created time constraints for already busy staff, and was reported as uncomfortable to wear over prolonged periods, resulting in variable staff compliance with its use.
7. Staff also reported stress from an increased administrative burden related to statistical reporting and obtaining permission to prescribe antiviral medications.
8. During the pandemic, 37% of respondents reportedly became ill with an ILI, whether confirmed as Pandemic (H_1N_1) 2009 Influenza or not. Of those who became ill, 87% were not tested for the virus, but among those tested, half were positive. Of those who became ill, 43% reporting not missing any days of work. Some ED staff also cared for people with ILI outside of work; however, 83% of respondents did not miss any work.
9. At the time of survey (29 October to mid-December 2009), 26% of staff reported already being vaccinated against (H_1N_1) 2009 influenza. Those not already vaccinated were asked whether they intended to get vaccinated. Of these ($n = 376$), 49% responded with either 'definitely not' or 'probably not', and only 30% had either a definite or probable intention to get vaccinated. The remaining 21% were unsure whether they would get vaccinated.

Discussion: Lessons learned

Emergency departments will remain at the forefront of Australia's disaster management response, and even in mild pandemics will be engaged in caring for the more critically ill patients. Although Pandemic (H_1N_1) 2009 Influenza ultimately proved to be relatively mild, initial data correctly raised international concern and resulted in the activation of international pandemic responses management arrangements. The experience from this pandemic has significance for informing policy, planning, preparedness and response management, which might better position Australia's pandemic preparedness for a more serious challenge. The following matters should be considered in any such review.

Review pandemic and disaster plans

There is a need to review pandemic plans to capitalize on the experience from this pandemic, to articulate national jurisdictional and local plans, and to harmonize pandemic and disaster planning. Pandemic (H_1N_1) 2009 Influenza came to a health-care environment sensitized by severe acute respiratory syndrome and avian influenza, and thus there was far greater preparedness than in previous pandemics. Although most ED staff recognized the value of planning and found existing plans helpful, a significant number were unaware that such plans existed. This is reinforced by another Australian study,[19] in which fewer than half the emergency nurses surveyed reported being adequately prepared for biological incidents. Fine-tuning the planning framework would provide a balance between central standardization of policies and procedures, and adaptability to local circumstances. In addition, local educational programmes should ensure staff are aware of the plans in place.

Of particular significance is the relationship between pandemic and disaster planning. Although few reported activation of their organization's disaster plan, those felt it delivered a higher level of support. The relationship between pandemic and disaster planning needs clarification. Pandemics' gradual development and prolonged nature might remove the sense of urgency and crisis that characterizes most disasters. Reliance on standard and scalable operational management principles should eliminate confusion.

Establishing a single authoritative source of information

This pandemic demonstrated the difficulties inherent in dealing with unclear and evolving information. Initial concern about a high mortality based on Mexican and US estimates was not sustained, but engendered an initial reaction appropriate to a more serious challenge. This response changed as more accurate information became available.

The overwhelming flow of often inconsistent information was troublesome for the participants in this study. Daily updates were difficult to digest. Information from different sources, including state, national and international authorities, often conflicted with local advice. The tendency to trust local advice is understandable; however, when such advice conflicts with national authoritative advice, it adds to the confusion. Staff appealed for a single source of authoritative advice. In the USA, the Centers for Disease Control and Prevention is often viewed as the sole unarguable source of *independent* advice. Australia needs a similarly well-regarded information source, to which all other sources defer. This role is currently provided by the Chief Medical Officer of Australia.

A carefully structured and consistent message is necessary regardless of the means of distribution. Updates need to be kept simple, explaining what is different from previous information. The media plays a significant role in both distributing information and creating confusion. Local media will tend to seek local 'talent' and view attempts to control messages as manipulation. While respecting the critical role the media play within a democracy and during pending disasters, such as pandemics, floods and cyclones, conflicting and confusing information can be destructive during an emergency. Communication strategies require review, with media engagement, to facilitate provision of an unambiguous message. However, the outcome of any such review must also take into account the need for local context relating to operational aspects.

Standard clinical approaches are critical

Standard clinical guidelines for patient management are critical to effective management of disasters. Rapid development of clinical standards and guidelines was recognized by ED staff as critical to the pandemic response and appreciated. However, the evolving nature of this pandemic resulted in changing protocols and apparent inconsistency in their application. This was sometimes contributed to by local experts. Consistent application of guidelines in disaster scenarios requires discipline on behalf of all.

Design of EDs

Pandemic (H_1N_1) 2009 Influenza demonstrated the difficulty of managing infectious patients within EDs. EDs have traditionally championed open design to maintain visibility and promote the overview of patients; however, these designs are not conducive to infection control. Curtains make poor barriers and limit capacity for environmental control. This challenge confronts those caring for patients presenting on a day-to-day basis with infectious diseases, such as meningitis or tuberculosis. Thus, management of infectious patients should be considered in ED design, and further consideration should be given to the ability to isolate patients on an individual basis, or collectively in the event of a major outbreak. Design considerations should include scalable arrangements, which allow for progressive surge in capability while preserving the capacity to continue to manage the remaining workload.

As a prelude to physical design changes, changed work practices might be necessary. For example, EDs might need to function as an isolation area, implementing enhanced infection control procedures. ED infection control procedures must be reviewed, including standard risk-related policies for PPE and antiviral agents.

Availability of resources

Stockpiling resources is an essential component of pandemic preparedness. Issues were reported about consistency of accessibility and use of stockpiled items. In particular, the 'embedded stockpile' needs to be managed. Stocks of masks and antiviral agents, both in bulk stores and distributed throughout operational units, constitute the first level of a stockpile hierarchy, which also includes institutional stores, jurisdictional bulk stores and national dedicated stockpiles. Stockpiles need to be secured and distributed to all relevant primary-care services to complement the strategic management approach.

Enhancing surge capacity within EDs and establishment of flu clinics

The increased staff distress identified in this study reinforces the need for enhanced surge capacity within EDs. On this occasion, the increase in demand ranged from 1.4 to 3 times the expected attendance for ILI.[20] In New York City, peak increases in ED presentations occurred on days following the first reports of Pandemic (H_1N_1) 2009 Influenza, and subsequently after the reported first death.[21] International disclosure of the existence of the pandemic and concerns about the threat it posed created understandable alarm. The public presented in significant numbers to EDs, and although most had relatively mild illness, these were interspersed with a small number of seriously ill patients who were otherwise young and healthy. However, each patient imposed a significant burden, requiring not only assessment, diagnosis and intervention, but also isolation and follow up. There was also a clear view that managing this issue in EDs adversely affected other patients, including those with serious illnesses. EDs need to identify strategies to enhance their response capacity to sudden increases in demand deriving from major incidents and disasters.

One important strategy in the management of pandemic influenza has been the creation of flu (or fever) clinics. Respondents reported that these reduced pressure on EDs, many of which are poorly designed to cope with infectious diseases. However, some clinics were created by EDs themselves, from within their staffing establishment, thus further contributing to staff distress. At the same time, general practices often lack the resources, and their clinics lack appropriate physical design. Further consideration should be given to the mechanism of establishing dedicated pandemic centres or flu clinics, and the sourcing of appropriately skilled staff. Concentrations of infectious patients anywhere might add to disease transmission. Consideration should be given to mobile assessment teams intended to maintain patients in home isolation.

Enhanced efficient reporting

Respondents reported that requirements to report on the pandemic to multiple authorities were troublesome. Ad hoc and repeated demands for data caused considerable angst. A single, simple reporting framework needs to be developed for disasters to avoid this drain on already stretched senior staff. Authorities at all levels need to understand the burden of their requests for information and exert discipline over the repeated nature of those requests. The format of SMEAC[22] (situation, mission, execution, administration and logistics, and command and signal) briefs, commonly used by both the military and emergency services, might be useful in reporting during future pandemics.

Staff support

One of the most troublesome aspects of pandemic management is the concern that staff will become infected and thus reduce health system capacity. This study, with its limited generalizability, provided little evidence to support this assumption. However, that is not to say that a more severe illness would not have that effect. Staff reported remaining at work in spite of perceiving that they had the illness.

However, there was concern that the use of PPE made work difficult, and that there was variability in the management of 'at-risk' staff, and in the application of policies relating to testing of staff, worker's compensation and redeployment. If a staff member has contracted or is isolated because of contact with an infectious disease that the employer believes is incompatible with work, and might have been acquired at work, should the disease be compensable? A review of human resource policies during pandemics should occur to seek consistency in staff support.

Limitations

There are a number of limitations to this study, some of which have been identified above.

1. The survey used a web-based survey instrument. This method of survey is most efficient and protective of the individual's privacy. However, it requires deliberative action by the individual to access the site and complete the survey. Despite reminders and encouragement, the response rate was 12.5% for Study two and 18.4% for Study three. Thus, the results are unlikely to be representative of the views of the majority. Individuals who access a survey might be more concerned, aware and engaged in broader policy than most staff. Nevertheless, the issues identified even from a limited survey of staff remain legitimate and in need of attention. Further research is necessary to test the representative nature of these issues.
2. The survey was a newly designed instrument, which lacked extensive validation.
3. The retrospective and self-reporting nature of this method of survey is subject to selection and recall bias. Further research is necessary to more accurately identify the issues during the pandemic.
4. Emergency department experience is not representative of the total patient load. EDs, by their nature, tend to attract the more serious end of the health continuum. General practitioners would have experienced similar increases in demand and suffered similar impacts. We remain unaware of the actual incidence of this disease, as patient testing ceased by policy, when it became apparent that positive diagnosis would not change management.
5. The data available to this study were largely restricted to public hospital EDs. There might be differences in patients attending private hospital EDs.

Conclusions

Considering the evolving nature of this pandemic, on all reasonable assessments it was managed well, both generally and within EDs. The issues identified in this paper are offered to enhance future preparedness of Australian EDs rather than to criticize the way the pandemic was managed on this occasion.

Pandemics will continue to pose challenges to Australia's health system, as they result in widespread and prolonged increases in health-care demand. The message for Australia, and indeed all island nations, is clear – we cannot protect ourselves from pandemics despite our large 'moat', and border control will not protect us when international travel delivers infected patients to the community within the incubation period of a virus.

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Author contributions

Co-principal investigators: GF, RZS, Paul Arbon (PB), JC, Peter Aitken (PA) and MC; associate investigators: JF, SM and KH; research officer: EF; Research Assistant: JP. RZS, PA and GF conceived and designed the study. GF, RZS, JC, PA, MC and KH secured funding. GF, RZS, JC, PA, PB, KH, MC, JP and EF developed and tested the instruments. GF, RZS, JC, PA, MC, JP and EF conducted data collection. JP, EF, GF, RZS, JC, MC and PA analysed the data. GF, RZS, PA, JP, JC, EF and PB prepared the manuscript.

Competing interests

None declared.

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Annex 20: Paper 4.7

Seidl I, Johnson A, Mantel P, **Aitken P.** A strategy for real time improvement (RTI) in communication during the H1N1 emergency response. Australian Health Review 2010; 34: 493-498

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A strategy for real time improvement (RTI) in communication during the H1N1 emergency response

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Abstract

Objective. To develop and implement a strategy that would enable the Emergency Operations Centre (EOC) to assess the effectiveness of communication strategies and guide real time improvements within the life cycle of the emergency.

Design, setting and participants. An anonymous internet-based questionnaire featuring multiple choice and open text questions was administered to stakeholders of the EOC of a regional tertiary hospital.

Main outcome measures. The outcomes were perceptions of sufficiency and relative usefulness of various sources of information on Pandemic (H1N1) 2009, including differences between local, state-wide and authoritative worldwide information sources.

Results. A total of 328 responses were received over two rounds of questionnaires. Email communication from the Health Incident Controller (HIC) was the most useful source of information (74% found it very useful, compared with authoritative international websites at 21% (Centers of Disease Control) and 29% (World Health Organization)). A total of 94% felt this strategy contributed to improvements. Free text responses also helped the EOC and HIC to tailor communication methods, style, content and tone during the response.

Conclusions. Real time improvement is a useful strategy for implementing change to practice during the life cycle of the current emergency and has broader applicability than Pandemic (H1N1) 2009. Local stakeholders demand local content for their information feed and messages from a trusted local leader are the most superior forms of communication.

What is known about the topic? Communication is crucial in the successful response to an emergency situation, with a link to the quality of the response.
What does this paper add? The use of online surveys, in particular the ability to make improvements immediately during the collection of responses, has not been previously reported in the literature. The key component of this is the ability to implement improvements during the life cycle of the current, rather than the next emergency.
What are the implications for practitioners? Those managing an emergency response, whether in relation to Pandemic (H1N1) 2009, or indeed any other emergency or disaster, should consider internet-based questionnaires as a method for obtaining rapid feedback and making real time improvements to their communication tone, style and methods.

Introduction

Communication and information management are common challenges in disaster response.[1,2] They have the ability to influence the quality of disaster management.[3] Although information is acknowledged as needing wider distribution in a disaster situation,[4] communication issues, both technical and organisational, are important considerations in coordinating the medical health response.[5]

Emergency Operations Centres (EOCs), are established in response to crises to help provide this coordinated response.

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It can be difficult however for the EOC, and Health Incident Controller (HIC) to be sure that communication is meeting the needs of stakeholders, particularly operational staff, during the life cycle of the crisis. Incident Management Systems (IMS) such as the Australasian Inter-service Incident Management System (AIIMS) do not cover technology solutions[6] and post-disaster organisational debriefs provide feedback only after the emergency has resolved. The result is a reactive approach, as problems related to communications are not dealt with until they have occurred and improvements not implemented until the next emergency.

Pandemic (H1N1) 2009 has had significant and ongoing effects on both health services and the community. It became apparent early in the pandemic that communication would be of paramount importance. The aim of this project was to develop and implement a strategy that would enable the EOC to assess the effectiveness of communication strategies and guide real time improvements within the life cycle of the emergency, specifically Pandemic (H1N1) 2009. This paper reports the results of a quality improvement study, the centre of which was a rapid feedback electronic survey, designed to dynamically assist the EOC and HIC in tailoring communication methods, style, content and tone.

Setting

The Townsville Health Service District (THSD) includes a 500-bed tertiary teaching hospital, eight rural and remote hospital facilities, two residential aged care facilities and two community health centres. It serves a dependency of 700 000 people as the tertiary referral centre for North Queensland, an area more than one and a half times the size of France.

THSD uses an AIIMS framework when establishing an EOC in response to an emergency or disaster.[7] AIIMS helps facilitate a cross-organisational response through use of common concepts and processes[8] allowing the EOC to be interoperable with other agencies. In the regions of Queensland, these agencies form the District Disaster Management Group (DDMG). For the Pandemic (H1N1) 2009 emergency, health authorities assumed lead agency status.

Method

A multidisciplinary team comprising medical administrators, an emergency physician, a clinical epidemiologist and a media and communications adviser was established to develop and implement an appropriate tool, analyse results and develop improvement strategies. During the evolution of the pandemic this team was able to measure the penetration, level and appropriateness of communication methods used.

In order to evaluate the various sources of information and methods of communication the team used an internet-based survey application to build and administer a simple anonymous questionnaire. The first questionnaire was distributed within six days of the establishment of the EOC and was open for 24 hours. This consisted of seven questions. All were optional and three questions enabled free text comments. Information was gathered on demographics, usefulness of information on H1N1, value placed upon various information sources, satisfaction with information being provided internally, and identified deficiencies with information on H1N1, and any additional comments respondents wished to provide to the EOC.

This questionnaire was emailed from the HIC to all staff of THSD, members of the DDMG and representatives of local general practitioners. Access to the questionnaire was via a hyperlink contained in the email. Responses were reviewed during the collection process and further interrogation of results was undertaken at the completion of each round. Soon after the first questionnaire was disseminated, it was noted from response demographics that some key stakeholders had been omitted. This error was rectified with a separate email being sent while the first questionnaire was still open. Overall, two rounds of the questionnaire were disseminated between 5 and 11 May 2009 during World Health Organization (WHO) Phase 5 of Pandemic (H1N1) 2009. Each questionnaire was open for at least 24 h. Follow up emails were also sent to encourage participants to complete the questionnaire. During the second round questionnaire, the link was posted on the THSD intranet site to better include staff without regular email access.

Communication content and strategies were modified in real time throughout the two-stage process. Two questions were added to the second questionnaire to gauge whether respondents had completed the first survey and whether they felt the surveys were contributing to improvements in the EOC.

Results

The number of responses for each survey was 164 (equal n coincidental) giving an overall total of 328. As stated, the omission of external agencies was noticed when responses from non-Queensland health employees comprised less than 4%. Once the email went to the external agencies this rate of response rose to 6%. At the completion of round one 94% of respondents were employees of Queensland Health (Question 1) with the majority of responses being from administration staff (39%), followed by nurses (29%), allied health (14%), doctors (10%), operational support staff (4%) and other (4%). Fourteen respondents chose not to answer Question 2.

Question 3 looked at respondent's opinions on the usefulness of the information sources available. The email from the HIC was found to be the most useful with 72% of responses rating it as very useful. Results are listed in Table 1. Free text comments were also allowed for this question.

Question 4 indicated that 39% of staff were not certain they were getting enough information about Pandemic (H1N1) 2009 to enable them to do their jobs. The breakdown of responses by occupation group has been provided in Table 2.

Question 5 found high satisfaction levels of respondents with both state-wide (Queensland Health), and local (Townsville Health Service District EOC) communications at 90.9% (289 of 318) and 90.8% (274 of 302) respectively. However, the levels of respondents very satisfied with communication was higher for THSD EOC (74.2%) than for state-wide communications (62.6%). Very few were dissatisfied with communications either state-wide (2.2%; 7 of 318) or local (1%; 3 of 302).

Question 6 listed those areas in which specific information was available on H1N1. Information was sufficient, deficient or contradictory (Table 3). Although most topics had ~80% describing information levels as 'just right' this was not the case from the

Table 1. Responses rating the usefulness of various sources of information on H1N1 Influenza 2009
Question: Please rate the usefulness of the following sources of information about swine flu

Source of information	Very useful	Somewhat useful	Neutral	Not useful	Completely useless	Not applicable	Response count
Newspaper	11.9% (37)	30.8% (96)	32.4% (101)	16.0% (50)	3.2% (10)	5.8% (18)	312
Television	19.0% (59)	37.3% (116)	26.0% (81)	13.8% (43)	1.6% (5)	2.3% (7)	311
World Health Organization (www.who.int)	28.7% (87)	32.3% (98)	26.1% (79)	3.6% (11)	0.7% (2)	8.6% (26)	303
Centers for Disease Control (www.cdc.gov)	21.1% (62)	22.1% (65)	34.7% (102)	5.8% (17)	1.0% (3)	15.3% (45)	294
Qld Health Information Bulletins	51.1% (161)	38.1% (120)	8.3% (26)	0.6% (2)	0.6% (2)	1.3% (4)	315
Townsville Health Service District ('TDHS' emails from Health Incident Controller)	73.5% (236)	20.6% (66)	4.4% (14)	0.6% (2)	0.0% (0)	0.9% (3)	321
Qld Health Internet Site (www.health.qld.gov.au/swineflu)	38.0% (115)	34.7% (105)	16.5% (50)	3.6% (11)	0.0% (0)	7.3% (22)	303
QHEPS Swine Flu intranet site (http://qheps.health.qld.gov.au/swine_flu/)	33.1% (98)	33.4% (99)	20.9% (62)	1.7% (5)	0.7% (2)	10.1% (30)	296
THSD Intranet Swine Flu site (http://qheps.health.qld.gov.au/tville/swineflu.htm)	37.1% (108)	30.9% (90)	20.6% (60)	1.0% (3)	0% (0)	10.3% (30)	291
Free text comments permitted. *n* of responses:							15

Table 2. Occupationally relevant information
Question. Are you getting enough information to do your job?

Answer options	Response frequency (%)	Response count
Yes, definitely	60.9	199
Yes, I think I have enough	34.9	114
Unsure	3.0	10
No, I need a little more	1.2	4
No, I'm completely in the dark	0.0	0

respondents. Although 67.3% were satisfied with the amount of information, 23.6% felt they needed more information. Subgroup analysis of this was revealing with medical staff more likely than other groups to be satisfied with knowledge of their role and allied health and administration staff less so.

Question 7 was open for free text comments. In all, 19.2% of the respondents used this opportunity to add additional comments. These free text comments were collated and examined for potential use. Table 4 provides examples of free text comments leading to specific improvement initiatives.

The second questionnaire contained additional questions, to determine whether respondents had completed the first survey and whether this had contributed to improvements. This showed that 89.7% of second survey respondents did not complete the first. Yet of those, 93.3% felt that the surveys had contributed to improvements. Overall, this figure rose to 94.2%.

Discussion

The aim of this project was to develop and implement a strategy that would enable the EOC to assess the effectiveness of communication strategies and guide real time improvements within the life cycle of the emergency. The tool developed was an internet-based questionnaire that sought to measure the penetration, depth and usefulness of the information being provided to staff of the THSD and key stakeholders during the rapidly evolving Pandemic (H1N1) 2009 emergency.

Information technology is playing an increasingly important role in information sharing during disasters.[1,2,9] The choice of an internet-based electronic questionnaire was important. With the advent of Web 2.0 and social networking, familiarity with the internet and online surveys is high across generations.

The advantages of electronic surveying have been noted in the marketing literature.[10] The use of a commercial internet-based survey application to develop the online questionnaire resulted in rapid distribution, within one week of EOC establishment, and initial responses commencing almost immediately. The survey was able to be distributed to the entire THSD without the filters of middle management or workforce representatives whereas the guarantee of anonymity created an environment in which respondents could express their concerns without fear of personal repercussions. Response rates in electronic surveys are often as high or higher than traditional mail methodology,[11] which most importantly could also not achieve the speed required to make real time improvements.

Table 3. Satisfaction with topic specific information
Question. The information you're receiving regarding the following areas on swine flu is? [Tick all that apply]

Topic	Not enough	Just right	Too much	Conflicting	Confusing	Needs 'plain language' translation	Response count
General disease information	9.5% (31)	79.1% (257)	5.2% (17)	3.4% (11)	1.5% (5)	1.2% (4)	325
Infection control	9.0% (29)	83.6% (270)	3.1% (10)	2.2% (7)	0.9% (3)	1.2% (4)	323
Personal protective equipment and measures	11.8% (38)	79.5% (256)	3.7% (12)	2.5% (8)	1.9% (6)	0.6% (2)	322
Health service plans	11.5% (37)	78.5% (252)	5.0% (16)	1.9% (6)	1.9% (6)	1.2% (4)	321
Your role in the response	23.6% (75)	67.3% (214)	2.5% (8)	2.8% (9)	2.8% (9)	0.9% (3)	318
Free text comments permitted. *n* of responses:							16

Table 4. Examples of free text comments leading to specific improvement initiatives

Comment	Specific improvement initiative
Not sure specifically what happens in the EOC but the information from [the Health Incident Controller] hits the mark so I assume the EOC is his support base.	Special edition of the District newsletter released outlining the roles, responsibilities and functions of the EOC.
Not sure what the difference between EOC and THSD is, or not able to tell who is communicating at a certain time and whether its important to know the difference (other than for this survey!).	
If staff become unwell, 'What is the contingency plan for backup?' i.e. who can help with generalised care e.g. Catering, etc.	Staff Health Plan finalised and published on District Intranet.
Other than flu vaccinations, is there anything else administrative staff can do?	Improvement to HIC email communications to focus on role of non-clinical staff.
Information was more effective on intranet, as each time I accessed the info I knew it would be the most up to date, rather than random pieces of paper strewn about. Vital info is all I am looking for.	A desktop icon for direct access to intranet site was placed on every District computer with additional links to WHO and CDC websites.
Send a list of 'reliable sources' for people to search when they have time or wish to educate themselves more. Newspapers I don't believe come into this category nor the news. Over sensationalise everything!!! Next we will have pigs flying!	
Would be beneficial for students on placement to have access to the free vaccine, given they are working in the same environments and are in direct contact with patients.	Liaison with local University to explore student access to vaccination.
Don't use the term 'swine flu'.	Replaced with H1N1 Influenza 09 (Human Swine Influenza) as per state-wide guideline into which we had input.
Fit testers to remain current not 'refreshed after 2 years.	Inclusion of the Personnel Protective Equipment video on the THSD intranet site along with an extension of the PPE testing period.
The video on how to use the duck bill mask contained conflicting information which in my opinion is harmful. At the start of the video it is stressed not to touch the fabric of the mask. At the end of the video when it comes to fitting the mask the video shows the staff member touching the mask all over adjusting then testing then adjusting. This sends mixed messaged to the wearer, either you cannot touch the mask or you can. You leave yourself liable in the event a staff member becomes contaminated.	
Too much reading. An initial group of messages which outline the problems and possible pandemic courses, but later bulletins should be pithy and too the point (many fewer words). If there is a significant change in 'trajectory' of the pandemic or in the thoughts of the experts, then take time to expand and expound upon those.	Executive summary put at the beginning of the Health Incident Controller emails with the remaining detail provided further on for those who wished to read on.
You are all doing a great job. Make sure you all get some rest amongst the chaos.	Fatigue was recognised as a potential issue and a sleep chair was installed in the EOC.

Real time methodology involves immediate consideration of ideas for improvement by the HIC and EOC. These ideas are considered through a filter of feasibility, acceptability and suitability, before implementation. (see Fig. 1). Improvements in communications occurred during the life-cycle of the current emergency. Real time improvement is distinct from debrief

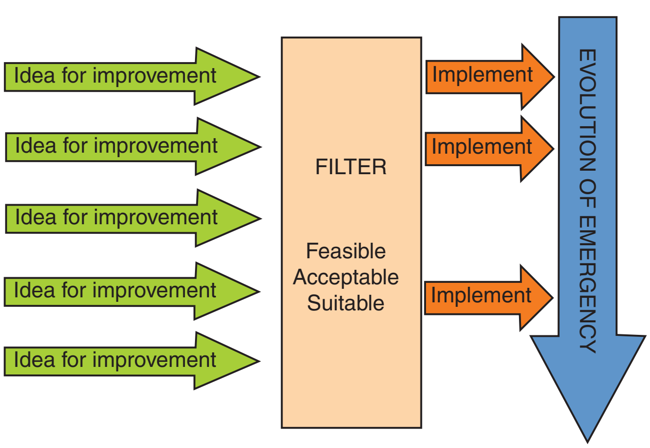

Fig. 1. Diagram showing real time improvement methodology.

methodology in which the management group meets post-event to discuss possible improvements.

Post-incident debriefs identify improvements that can only be instituted for the next emergency, not the current one. This may mean important contextual differences, such as the emergency type, duration or personnel changes (in the EOC itself, among health responders or the population affected). There is a limited ability to apply these lessons in the context of the next disaster, whereas our ability to learn from our past experiences can also be questioned.[12,13] Moreover, debrief methodology often focusses on the management group to determine its own lessons learned. That is, the people responsible for communications, rather than those receiving it determine the recommendations.

We do not propose the elimination of formal debriefs, given their critical role following an emergency incident.[14] However, by their very nature as a post-incident action, there is obviously limited ability to provide real time feedback.

The use of online questionnaires has provided this real time feedback and enabled the EOC to identify both effective communication strategies and aspects which needed improvement. Responses were analysed to identify areas to sustain, improve or fix with 'improve' and 'fix' areas altered immediately, rather than after closure of questionnaires. This allowed the EOC and HIC to tailor communication methods, style, content and tone. Free text comments were particularly valuable in this regard, and being consistent with the literature, yielded useful opportunities for improvement.[15] Quality improvement is not always about raw data analysis and statistics. It can be the function of ideas, experience and trial-and-error. Indeed, this study commenced with a focus on improvement, rather than measurement.

The main form of communication used within THSD during the Pandemic (H1N1) 2009 emergency has been email communication direct to staff and stakeholders from the HIC. While this was the centrepiece, other methods have included local and statewide intranet sites. There was a strong sense that the communication strategies were working well, reinforcing the approach taken, and that improvements had occurred as a direct result of the surveys. Examples of improvements are the development of a desktop icon for direct access to the intranet site being placed on every District computer and a special edition of the District Newsletter. The intranet site also provided links to reliable information sites such as the WHO and Centers for Disease Control, as requested by free text comments, whereas the District Newsletter had a focus not just on Pandemic (H1N1) 2009 but addressed areas of uncertainty, such as roles, identified from the feedback. Of note 9.5% (31 of 325) of the health workers who responded felt they did not have enough general disease information. Though not unexpected, this is in contrast with a contemporaneous cross-sectional survey of Sydney residents, which found that 44% did not have enough information about the ‘swine flu’ situation.[16]

Dissemination of information in an emergency setting has no ‘textbook’ solution. It must be tailored to stakeholder group needs and recognise that stakeholders also demand regular and locally contextualised information. We found that respondents favoured local communications, with emails from the THSD HIC regarded as the most useful source of information. The importance of regular updates is further emphasised by a recent study which found that the community lacked provision of structured routine updates on the pandemic.[16] It was also not sufficient to rely on central ‘capital city’ communications, as these were rated relatively less useful to local staff. The onus then is on those responsible for local communications to ensure the accuracy of information disseminated is given the status it is afforded.

Managing the delicate balance between providing enough information for people to function in their roles and unnecessarily raising anxiety requires careful stewardship. We found stakeholders wanted detailed, easy-to-understand information, imparted in a way that allows selective consumption. Put simply, an executive summary, followed by plain language detail.

Both free text comments and internal cross-occupational analysis of questionnaire feedback allowed for communications to be adjusted to target specific groups. For example, administrative and allied health staff identified a higher rate of information need regarding response roles than other groups, leading to specific action from the EOC. It has been previously shown that where non-clinical staff sense that their contribution is important to the wider response, they are more likely to attend work.[17]

Our study has several limitations. It is a single centre study and survey-based, reliant on respondents’ perceptions of and attitudes to communications, which are subjective by nature. However, perceptions and attitudes do influence behaviour, both positive and negative.[18] It is recognised the method of distribution may lead to selection bias, favouring those with computer access. However, the benefits of alternate sampling techniques were outweighed by the response timelines of the online approach. Ongoing evaluation is necessary (including other centres) to further test this method’s utility. Already there has been use by a metropolitan Health EOC with early results appearing to offer similar findings.

Conclusions

In the 21st century, rapid and effective communication is essential for command and control systems to work well. Moreover, the modern HIC, responsible for dissemination of local information, must recognise that most health professionals, allied staff and emergency agencies expect electronic communication to increasingly become the norm.

Using internet-based surveys during an emergency response is a simple, yet effective way to improve communications. The real time nature of this technique has enabled both feedback and quality improvement strategies to occur within the life cycle of the emergency as opposed to waiting for a post-action debrief. This has allowed communication to be truly a two way process. Rather than the EOC simply disseminating information, the rapid stakeholder feedback allows them to state their needs and also influence communication content and style.

The real time improvement strategy described has already demonstrated its usefulness in the Pandemic (H1N1) 2009 emergency. It will continue to be used at THSD, with very minimal modifications for current and future emergencies. We anticipate that as it becomes routine for local stakeholders to respond to surveys of this nature, continuous real time improvement of communication, and by extension operations, will be possible, regardless of the situation.

Competing interests

The authors declare that they have no competing interests.

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Chapter 5 Annexes

Annex 21: Paper 5.1

Aitken P, Leggat P, Robertson A, Harley H, Leclerq M, Speare R. Pre and post deployment health support provided to Australian Disaster Medical Assistance Team members: Results of a national survey. Travel Medicine and Infectious Disease 2009; 7: 305-311.

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Pre- and post-deployment health support provided to Australian Disaster Medical Assistance Team members: Results of a national survey

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Summary *Background:* Calls for disaster medical assistance teams (DMATs) are likely to continue in response to international disasters. As part of a national survey, the present study was designed to evaluate Australian DMAT experience in relation to pre- and post-deployment health care.
Methods: Data was collected via an anonymous mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 South East Asian Tsunami disaster.
Results: The response rate for this survey was estimated to be around 50% (59/118). Most of the personnel had deployed to the tsunami affected areas. The DMAT members were quite experienced with 53% of personnel in the 45—55 years age group (31/59). Seventy-six percent of the respondents were male (44/58). Only 42% (25/59) received a medical check prior to departure and only 15% (9/59) received a psychological assessment prior to deployment. Most respondents indicated that both medical and psychological screening of personnel would be desirable. Most DMAT personnel received some vaccinations (83%, 49/59) before departure and most felt that they were adequately immunised. While nearly all DMAT members participated in formal debriefing post-deployment (93%, 55/59), far less received psychological debriefing (44%, 26/59), or a medical examination upon return (10%, 6/59). Three respondents reported experiencing physical ill health resulting in time off work following their return.

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While only one reportedly experienced any adjustment problems post-deployment that needed time off work, 32% (19/59) found it somewhat difficult to return to work. There were multiple agencies involved in the post-deployment debriefing (formal and psychological) and medical examination process including Emergency Management Australia (EMA), Australian Government, State/Territory Health Departments, District Health services and others.

Conclusions: This study of Australian DMAT members suggests that more emphasis should be placed on health of personnel prior to deployment with pre-deployment medical examinations and psychological assessment. Following the return home, and in addition to mission and psychological debriefing, there should be a post-deployment medical examination and ongoing support and follow-up of DMAT members. More research is needed to examine deployment health support issues.

Introduction

Disasters are increasing in frequency.[1] In the past 50 years, more than 10,000 disasters have been reported affecting 12 billion people and resulting in 12 million deaths.[1,2] Disasters are more likely to occur in developing countries.[2,3] where their effects may also be more pronounced. Even within developed countries, disasters occur and some authors argue that most hospitals would be unable to cope with anything more than a small number of seriously injured patients without outside assistance,[4] although, as highlighted by the 2009 Victorian bush fires, this capacity to cope is probably higher than these 2005 estimates due to improved disaster and surge capacity planning.[5,6] Despite the level of preparedness of any country, some large scale disasters will make it likely that there will be calls for disaster medical assistance and humanitarian aid following such disasters, [7–9] which will require the timely mobilisation of national and international resources.

On 26 December 2004, the South East Asian tsunami hit countries around the Indian Ocean rim, particularly around its earthquake-associated epicentre off Indonesia. The full impact of the tsunami is still being assessed years after the natural disaster, which is thought to have killed more than 150,000 people and affected millions.[10] The tsunami was a landmark event in the history of Australian disaster management. This was the first time an organised civilian based team was deployed internationally from Australia representing the Australian government. This had previously been the primary responsibility of the Australian Defence Force (ADF). However, Australian civilians had previously deployed as individuals through Non Government Organisations (NGO), such as the International Red Cross or Medicines Sans Frontieres (MSF). Following the tsunami, seven civilian teams Alpha to Golf were deployed under Australian Assistance Plan (AUSASSISTPLAN).[11] Table 1 summarises the disaster medical assistance teams (DMATs) that responded to the South East Asian tsunami. The teams came from multiple different states, were deployed to a number of different countries and filled a variety of roles based on both needs and timeline of response. Further teams were also subsequently deployed following the Yogyakarta earthquake in Java, Indonesia in 2006.

The agencies responsible for the organisation of DMATs remain accountable for the welfare, health and safety of DMAT members, whether employees, contract workers or volunteers. Therefore it is essential that staff deployed to provide disaster assistance have adequate health support pre- and post-deployment, whether this is through government or non-government organisations. This is necessary for their personal health protection, to minimise any additional burden to the affected community, and maximise the effectiveness of the response.

Much of the literature concerning DMATs, including the Australian DMAT experience,[11–18] consists of individual team reports, which are often anecdotal. The lack of standards for DMATs has also made in-depth evaluation difficult for both an external reviewer and team members. Hence, there have been few studies examining DMAT deployments and few dedicated studies of DMAT members in Australia. The present survey was part of a national program evaluating the Australian DMAT experience and examining potential models for future use in Australia. The survey was undertaken in order to target the existing Australian DMAT experience base and explore and identify issues raised by these groups. The experience base primarily includes those individuals actually deployed 'on the ground', and this aspect of the survey explores their health support experiences pre- and post-deployment.

Methods

All team members associated with Australian DMAT deployments from the 2004 Asian Tsunami disaster were surveyed via their State and Territory jurisdictions. Our study protocol was reviewed and approved by the James Cook University Human Research Ethics Committee in 2006 (Approval No. H2464). The support of the Commonwealth Australian Health Protection Committee (AHPC) was also sought and given for the survey. Representatives of the AHPC, through their State and Territory jurisdictions, identified 118 DMAT personnel from Teams Alpha to Golf and mailed out questionnaires on our behalf to preserve anonymity. No follow-ups were able to be undertaken.

Data was collected by means of a self-reporting questionnaire, which included an information sheet. The questionnaire was piloted and validated by use of a sample of senior medical staff with disaster deployment experience. The questionnaire was completed anonymously. A reply paid envelope was included for convenience; however, other options for return were given, including facsimile. There were no penalties or rewards for participation, and

Table 1 Australian DMATs deployed following the Asian tsunami.

Team	Number	Main states	Destination	Date deployed
Alpha	14	NSW (17), WA (7), Qld (3), Vic (1)	Banda Aceh	29 December 2004
Bravo	14		Banda Aceh	29 December 2004
Charlie	17	NSW/WA/Qld	Maldives	30 December 2004
Delta	5	NSW	Sri Lanka	30 December 2004
Echo	23	SA	Banda Aceh	7 January 2005
Foxtrot	24	Qld	Banda Aceh	18 January 2005
Golf	21	Vic/NT	Banda Aceh	29 January 2005

Key: NSW-New South Wales, WA-Western Australia, Qld-Queensland, Vic-Victoria, SA-South Australia, NT-Northern Territory.

informed consent was implied if team members completed and returned their questionnaires. The pre- and post-deployment health component of the survey itself constituted about four A4 sized pages and comprised the following formats of questionnaire completion: simple tick-box format, ranking and short answer responses. Data was collected on demographic details as well as pre- and post-deployment health issues.

Data was entered into a spreadsheet program and analysed using the Statistical Package for the Social Sciences (Version 14.0, SPSS, 2006). Descriptive statistics were used, as the sample was relatively small.

Results

The overall response rate for this survey was 50% (59/118). The majority of DMAT members who responded had deployed to Aceh (39), while seven had been to the Maldives and one to Sri Lanka. Some had deployed more than once including subsequently to Yogyakarta (8). Team members responded from all states which deployed personnel with highest response numbers from Queensland (22), South Australia (14) and Western Australia (13). It is noted that response rates from both New South Wales (6) and Victoria (1) were lower than other states while overall numbers involved for Northern Territory were low (2). Responses were received from those with medical (24), nursing (11), logistics (6), allied health (3) and command (3) roles as well as mixed roles consisting of medical/command (2), medical/logistics (1), nursing command (1) and nursing logistics (1).

The majority of team members responding to the survey were aged 45—55 years (31) with 16 aged 25—35 years, 8 aged 55—65, 3 aged 25—35 and one person aged more than 65 years of age. This is consistent with the mean level of clinical experience in their specialty of 21 years (SD = 9). Approximately 75% were male (44/59) with 14 females responding and one unknown. Of the 59 responses, 15 had volunteered to go, 36 had been asked to go and one person indicated that they had been ordered to go. Seven did not respond to this item. Survey responses are described in Tables 2—4.

Pre-deployment

Of the survey participants 58% (34/59) had significant experience in international disasters although only 5% stated that they had experience in disaster management before deployment (3/59). Only 42% (25/59) had a physical health check prior to deployment, while even less had a psychological evaluation (15%, 9/59). Nearly all (96%, 57/59) felt that good physical health is essential for deployment, with the majority stating they would recommend both a physical check to others before deploying (91%, 54/59) and a psychological evaluation (73%, 43/59). Only 17% disagreed with a formal psychological evaluation prior to deployment. Even less (4%, 2/59) did not agree with suitability as a team member being evaluated prior to deployment. Of note, most also felt that people should be prevented from deploying based on the results of their physical health check (91%, 54/59) or psychological evaluation (86%, 51/59).

Despite less than half having a physical health check prior to deployment, most stated they did receive adequate vaccines prior to deployment (83%, 49/59) and they were adequately immunised (92%, 54/59). Those who did not feel they were provided with adequate vaccines were asked to recommend others. Fifteen respondents made recommendations, most indicating multiple vaccines.

Post-deployment

While nearly all DMAT members participated in formal debriefing post-deployment (93%, 55/59), far less received psychological debriefing (44%, 26/59) or a medical examination upon return (10%, 6/59). Three respondents reported experiencing physical ill health resulting in time off work following their return. While only one reportedly experienced any adjustment problems post-deployment that needed time off work, 19 found it somewhat difficult to return to work. None reportedly experienced any other problems. There were multiple agencies involved in the post-deployment debriefing (formal and psychological) and medical examination process including Emergency Management Australia (EMA), Commonwealth, State/Territory Health Departments, District Health and others.

Discussion

This study represented the first national survey of Australian DMAT members deployed to date. The experiences of these deployed professionals in relation to deployment health have been sought and the findings need to be incorporated as part of future planning and preparedness.

Table 2 Levels of Agreement of statements concerning pre- and post-deployment health issues

Statement	1 Strongly Disagree	2 Disagree	3 Neither Disagree or Agree	4 Agree	5 Strongly Agree	Not Applicable/ missing
Pre-Deployment						
I had significant experience in disaster management before deployment	15 (25%)	33 (56%)	1 (2%)	3 (5%)	0 (0%)	7 (12%)
I had significant experience in international disasters before deployment	6 (10%)	12 (20%)	6 (10%)	14 (24%)	20 (34%)	1 (2%)
I was adequately immunised	1 (2%)	2 (3%)	2 (3%)	24 (41%)	30 (51%)	0 (0%)
Good physical health is essential for deployment	0 (0%)	1 (2%)	0 (0%)	18 (30%)	39 (66%)	1 (2%)
A formal psychological evaluation should be performed prior to deployment	1 (2%)	9 (15%)	13 (22%)	27 (46%)	9 (15%)	0 (0%)
Suitability as a team member should be evaluated prior to deployment	1 (2%)	1 (2%)	7 (12%)	20 (33%)	30 (51%)	0 (0%)
Post-deployment						
I found it easy to return to work	0 (0%)	8 (14%)	10 (17%)	18 (30%)	22 (37%)	1 (2%)

This is particularly relevant as the Australian Government has recently launched an Australian Medical Assistance Teams (AUSMAT) program[19] and it is essential that future staff deployed have adequate health support pre, during and post-deployment.

This study of the Australian DMAT experience found that although team composition was varied, health professional membership was consistent with that described by other authors.[20] The DMAT members were quite experienced with half of personnel in the 45—55 years age group and, on average, with more than 21 years experience. The majority also had significant experience in international disasters before deployment, although most had little or no experience in disaster management.

Pre-deployment

The success of a team will very much depend on the selection of the right members. Selection should not be based entirely on skills; fitting into a team and being able to carry out the work required in the field is more desirable.[21] In our study, more than half had been asked to go while one-quarter had volunteered. Bar-Dayan et al.[22] found that those who had volunteered for the disaster team were found to be more supportive than those who had been invited to work with the team.

People should only deploy to disasters if they are in good physical and mental health[23] and DMATs need to be prepared physically.[24] Medical and psychological evaluation prior to deployment of those responding to humanitarian crises and other disasters is generally regarded as standard,[25,26] and most respondents indicated that both medical and psychological screening of personnel would be desirable and that this should influence whether a person is fit to deploy. This contrasts with what actually occurred for participants in the present study, with only two-fifths receiving a medical check prior to departure and only a few receiving a psychological assessment prior to deployment. However, this is consistent with a survey of NGOs by Moresky et al.,[27] where half of the NGOs surveyed reportedly did not require a pre-deployment physical examination of their volunteers. With in Australia, the WA AusMAT group has developed guidelines for pre-existing medical and psychological conditions and their influence on the decision whether to deploy a team member.[27]

There is a need for better training and preparation in stress management for responders[29] and counselling should be made available for team members.[24] DMAT personnel in one small study had various views on what constituted the most appropriate pre-deployment psychological briefing and assessments.[30] Pre-deployment briefings provided by a consultant psychiatrist to all team members in the Project Hope mission to Banda Aceh were well received.[31] It is accepted that some of the early teams to deploy (Alpha, Bravo and Charlie teams) deployed at very short notice with limited opportunity for briefings.

Most DMAT personnel received some vaccinations before departure and most felt that they were adequately immunised. Immunisation, particularly tetanus, needs to be current.[32—35] Suggested immunisations, based on the DART experience in Canada, are diphtheria, pertussis, tetanus, polio, and also immune serum globulin for hepatitis A and B, typhoid, cholera and tuberculosis.[36] This should be considered in light of the deployment location, and guidance sought from specialist areas, such as travel clinics,[33] especially those experienced with such operational deployments. A comprehensive structured vaccination program was needed for DMAT personnel and team members, who do not wish to participate in pre-deployment vaccination programs considered necessary for the

Table 3 Pre- and post-deployment health screening

Screening	Yes	No	Missing
Pre-deployment			
Did you have a physical health check prior to the deployment?	25 (42%)	34 (58%)	0 (0%)
Would you recommend this to others prior to deployment?	54 (91%)	4 (7%)	1 (2%)
Do you think people should be prevented from deploying based on the results of their physical health check?	54 (91%)	3 (5%)	2 (3%)
Did you have a psychological evaluation prior to the deployment?	9 (15%)	50 (85%)	0 (0%)
Would you recommend this to others prior to deployment?	43 (73%)	16 (27%)	0 (0%)
Do you think people should be prevented from deploying based on the results of their psychological evaluation?	51 (86%)	7 (12%)	1 (2%)
Did you receive suitable vaccines prior to the deployment?	49 (83%)	10 (17%)	0 (0%)
Post-deployment			
Formal debriefing after return	55 (93%)	4 (7%)	0 (0%)
Medical examination after return	6 (10%)	52 (88%)	1 (2%)
Any physical ill health post-deployment resulting in time off work	3 (5%)	56 (95%)	0 (0%)
Any adjustment problems post-deployment resulting in time off work	1 (2%)	58 (98%)	0 (0%)
Psychological debriefing	26 (44%)	33 (56%)	0 (0%)
Experienced any other problem post-deployment	0	59 (100%)	0 (0%)

destination, should not be deployed, as stated requirements in Western Australia.[28] Birch and Miller[33] emphasise the need for DMAT members to obtain comprehensive travel health advice before deployment. This would be facilitated if potential DMAT members maintained readiness, particularly in terms of general fitness, training and preventive health, in particular routine and travel immunisation status. The importance of personnel readiness and health considerations was also identified by Bridgewater et al.[12] and Pearce et al.[17]

Specific considerations include chemoprophylaxis against malaria,[33,34] adequate stocks of personal medications[32] with a 2-week supply suggested by US DMATs[20] and advice about what other drugs to take.[33] Other pre-deployment health considerations include sunscreen,[20] measures to prevent insect bites,[20,34] ensuring staff have insect repellent, impregnated mosquito nets and suitable clothing,[33] and the security of food and water.[34] Personal security concerns also remain paramount and appropriate protective measures should be used and planning instituted for medical support and evacuation, if needed.[16,33]

Post-deployment

Post-event evaluation is important and must be coordinated.[37] Performance during routine events may be significantly different to that during an emergency.

Pearce et al.[17] also emphasizes the importance of debriefing and follow-up. Most DMAT members in our survey reported receiving a formal debriefing. Where conducted, States mostly undertook formal debriefings, as well as medical examinations and psychological debriefings. EMA also took a role in formal debriefings for about one-fifth of DMAT members. A coordinated approach to psychological debriefing amongst the Australian Government and States is needed. In the USA, a legal precedent has been set for providing psychological support to fire and police personnel who have been emotionally traumatised in their work. Relief organisations have the same responsibilities to their staff.[38]

Most DMAT members did not have a medical examination upon return and only two-fifths had a psychological debriefing upon return. Although few respondents reported medical, psychological or other problems following return, delayed complications of disasters, such as epidemics of communicable diseases, substance abuse and psychiatric illness, may affect the victims and rescuers alike.[39] An

Table 4 Agency involved in post-deployment debriefing or medical examination

Agency	Formal Debriefing	Medical Examination	Psychological Debriefing
Emergency Management Australia	10	0	3
Australian Government	1	1	1
State/Territory Health Department	20	1	11
Local district health department	0	0	1
Self-referred	0	1	1
Other	25	3	9

international medical aid worker providing assistance in an unknown and highly disorganised environment may face a formidable personal and organisational challenge unless backed by experience.[40] The emotional toll on these workers may be high[38] and psychological factors are usually greater than anticipated.[37] Palmer notes 'all those involved in catastrophes will be changed by the experience'.[23] Repatriation and the return to normal life may be difficult; it is often easier to take part in relief work than to return home.[40] In general, the more problematic the deployment has been, the more problematic the readjustment.[23] Approximately 90% of responders experience psychological reactions in response to an event[41] with post-traumatic stress disorder (PTSD) found in 7–32%.[30,41–44] PTSD was diagnosed in 24% of members of the Turkish Red Crescent Disaster Relief team one month following their deployment to the Asian tsunami. No significant difference was noted in the distribution according to gender, age, profession or previous disaster experience but the symptoms were significantly greater in women, nurses and those with less than three previous disaster experiences.[45] Stevens et al.[30] in a survey of 20 Australian DMAT members, found that none of the respondents identified stressors that would normally be classified as potentially traumatizing events.

There is also a sense of positive which has been described by Lewis-Rakestraw,[46] who found that lasting friendships can be created by DMAT deployment (both within the team and with those in the affected country), and a sense of accomplishment and achievement developed. The challenge; however, is to ensure the team members are supported so that experience can be gained in a supported environment. Stevens et al.[30] also found high levels of support for both pre- and post-deployment psychological support but low levels of support for having a mental health professional as part of a DMAT to support team members.

This study represented an analysis of data collected on a cross-sectional survey of Australian DMAT members. This group, who may have been part of more than one DMAT, may encounter different hazards and risks from humanitarian aid workers and other groups responding to disasters. In addition, the limited response from some states, particularly New South Wales and Victoria, suggested coverage concerns. The inability to undertake follow-ups may also have contributed to the poor response in these jurisdictions. This is offset to some degree by the overall response rate, levels of experience amongst responders and the representative mix of disciplines. Hence, although generalisation and extrapolation of this data will therefore be limited, the data can be useful in developing a more effective response to pre- and post-deployment health of members of future DMATs.

Conclusions

This study of Australian DMAT members suggests that more emphasis should be placed on health of personnel prior to deployment with pre-deployment medical examinations and psychological assessment. Following the return home, in addition to mission and psychological debriefing, there should be a post-deployment medical examination and ongoing support and follow-up of DMAT members. More research is needed to examine pre- and post-deployment health support issues of DMATs.

Dedication

The authors wish to dedicate this research to the thousands of people affected by the South East Asian tsunami and Yogyakarta earthquake.

Conflict of interests

The authors have no conflict of interest to declare.

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Annex 22: Paper 5.2

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Health and safety aspects of deployment of Australian Disaster Medical Assistance Team members: Results of a national survey

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KEYWORDS
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Summary *Background:* Disaster medical assistance teams (DMATs) have responded to numerous international disasters in recent years. As part of a national survey, the present study was designed to evaluate Australian DMAT experience in relation to health and safety aspects of actual deployment.
Methods: Data were collected via an anonymous mailed survey distributed by State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the time of the 2004 South East Asian tsunami disaster.
Results: The response rate for this survey was 50% (59/118). Most of the personnel had deployed to the tsunami affected areas. The DMAT members were quite experienced with 53% of personnel in the 45—55 years age group (31/59) and a mean level of clinical experience of 21 years. 76% of the respondents were male (44/58). Once deployed, most felt that their basic health needs were adequately met. Almost all stated there were adequate shelter (95%, 56/59), adequate food (93%, 55/59) and adequate water (97%, 57/59). A clear majority, felt there were adequate toilet facilities (80%, 47/59), adequate shower facilities (64%, 37/59); adequate hand washing facilities (68%, 40/59) and adequate personal protective equipment (69%, 41/59). While most felt that there were adequate security briefings (73%, 43/59), fewer felt that security itself was adequate (64%, 38/59). 30% (18/59) felt that team members could not be easily identified. The optimum shift period was identified as 12 h (66%, 39/59) or possibly 8 h (22%, 13/59) with the optimum period of overseas deployment

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as 14—21 days (46%, 27/59). Missing essential items were just as likely to be related to personal comfort (28%) as clinical care (36%) or logistic support (36%). The most frequently nominated personal items recommended were: suitable clothes (49%, 29/59); toiletries (36%, 22/59); mobile phone (24%, 14/59); insect repellent (17%, 10/59) and a camera (14%, 8/59). The most common personal hardship reported during their deployment was being away from home/problems at home (24%, 14/59); however, most felt that their family was adequately informed of their whereabouts and health status (73%, 43/59).

Conclusions: This study of Australian DMAT members suggests that, in the field, attention should be given to basics, such as adequate food, water, shelter and personal hygiene as well as appropriate clothing, sunscreen and vector protection. The inclusion of appropriate personal items can be assisted by provision of a minimum suggested personal equipment list, with local conditions and the nature of the deployment being taken into account. A personal survival kit should also be recommended. There should be medical and psychological support for team members themselves, including the provision of a dedicated team member medical cache. Concern for their own health and ability to communicate with family members at home are major issues for deployed team members and need to be addressed in mission planning. This should also recognise security issues, including briefings, evacuation plans and exit strategies. The team members concerns about adequate security and the risk profile of humanitarian intervention in natural disasters compared with complex humanitarian emergencies may help determine future deployment of civilian or defence based teams.

Introduction

Recent world events, such as the South East Asian tsunami, have increased public awareness about the need to prepare for disasters. While it is important to realise that catastrophic disasters have occurred throughout time, the number of natural disasters and the total number of people affected globally have been increasing.[1] In the past 50 years,[1] there have been more than 10,000 disasters reported affecting 12 billion people and resulting in 12 million deaths.[1,2] It is also worth noting that developing countries are unfortunately over represented,[2,3] where their effects may also be more pronounced. Even within developed countries, disasters occur and some authors argue that most hospitals would be unable to cope with anything more than small number of seriously injured patients without outside assistance,[4] although, as highlighted by the 2009 Victorian bush fires in Australia, this capacity to cope is probably higher than these 2005 estimates due to improved disaster and surge capacity planning.[5,6] Despite the level of preparedness of any country, some large scale disasters will make it likely that there will be calls for disaster medical assistance and humanitarian aid following such disasters,[7–9] which will require the timely mobilisation of national and international resources.

On 26 December 2004, the South East Asian tsunami hit countries around the Indian Ocean rim, particularly around its earthquake-associated epicentre off Indonesia. The full impact of the tsunami is still being assessed years after the natural disaster,[10] which is thought to have killed more than 250,000 people and affected millions. The tsunami was a landmark event in the history of Australian disaster management. This was the first time an organised civilian based team was deployed internationally from Australia representing the Australian government. This had previously been the primary responsibility of the Australian Defence Force (ADF). However, Australian civilians had deployed previously as individuals through Non-Government Organisations (NGO), such as the International Red Cross or Médecins Sans Frontières (MSF). Following the South East Asian tsunami, seven civilian teams (Alpha to Golf) were deployed under the Australian Assistance Plan (AUSASSISTPLAN).[11] Table 1 summarises the disaster medical assistance teams (DMATs) that responded to the South East Asian tsunami. The teams, which came from multiple different states, were deployed to a number of

Table 1 Australian DMATs deployed following the South East Asian tsunami.

Team	Number	Main States	Destination	Date deployed
Alpha	14	NSW (17), WA (7), Qld (3), Vic (1)	Banda Aceh	29 December 2004
Bravo	14		Banda Aceh	29 December 2004
Charlie	17	NSW/WA/Qld	Maldives	30 December 2004
Delta	5	NSW	Sri Lanka	30 December 2004
Echo	23	SA	Banda Aceh	7 January 2005
Foxtrot	24	Qld	Banda Aceh	18 January 2005
Golf	21	Vic/NT	Banda Aceh	29 January 2005

Key: NSW, New South Wales; WA, Western Australia; Qld, Queensland; Vic, Victoria; SA, South Australia; NT, Northern Territory.

different countries and filled a variety of roles based on both local needs and the timeline of response. Two further teams were also subsequently deployed following the Yogyakarta earthquake in Java, Indonesia in 2006.

The agencies responsible for the organisation of DMATs remain accountable for the welfare, health and safety of DMAT members, whether employees, contract workers or volunteers.[12] This applies to both government and non-government organisations and should consist not only of pre- and post-deployment health checks, but also must consider the health aspects of the deployment itself. This is necessary for the team member's personal health protection, to minimise any additional burden to the affected community, and to maximise the effectiveness of the response. Unfortunately this is often inferred but not clearly documented. Harley and Leclercq[13] outlined the importance of ensuring that personnel, health and safety issues of the deployed DMAT members should be clearly articulated and stated that all DMAT members should be government employees during their deployment to overcome potential insurance and liability issues.

Much of the literature concerning DMATs, including the Australian DMAT experience,[14–21] consists of individual team reports, which are often anecdotal. The lack of standards for DMATs has also made in-depth evaluation difficult for both external reviewers and team members. Hence, there have been few studies examining DMAT deployments and few dedicated studies of DMAT members in Australia. The present survey was part of a national program evaluating the Australian DMAT experience and examining potential models for future use in Australia. The survey was undertaken in order to target the existing Australian DMAT experience base and explore and identify issues raised by these groups. The experience base primarily includes those individuals actually deployed ''on the ground'', and an aim of the present survey was to explore health and safety aspects of their actual ''on the ground'' deployment.

Methods

All team members associated with Australian DMAT deployments from the 2004 South East Asian tsunami disaster were surveyed via their State/Territory jurisdictions. Our study protocol was reviewed and approved by the James Cook University Human Research Ethics Committee in 2006 (Approval No. H2464). The support of the national Australian Health Protection Committee (AHPC) was also sought and given for the survey. Representatives of the AHPC, through their State and Territory jurisdictions, identified 118 DMAT personnel from Teams Alpha to Golf and mailed out questionnaires on our behalf to preserve anonymity. No follow-ups were able to be undertaken.

Data were collected by means of a self-reporting questionnaire, which included an information sheet. The questionnaire was piloted and validated by use of a sample of senior medical staff with disaster deployment experience. The questionnaire was completed anonymously. A reply paid envelope was included for convenience; however, other options for return were given, including facsimile. There were no penalties or rewards for participation, and informed consent was implied if team members completed and returned their questionnaires. The health and safety aspects of deployment component of the survey itself constituted about four A4 sized pages and comprised the following formats of questionnaire completion: simple tick-box format and short answer responses. This included issues for DMATs identified in a previous literature review.[22] Data were collected on demographic details as well as deployment health issues.

Data were entered into a spreadsheet program and analysed using the Statistical Package for the Social Sciences (Version 14.0, SPSS, 2006). Descriptive statistics were used, as the sample was relatively small.

Results

The overall response rate for this survey was 50% (59/118). The majority of DMAT members who responded had deployed to Aceh (39), while seven had been to the Maldives and one to Sri Lanka. Some had deployed more than once, including subsequently to Yogyakarta (8). Team members responded from all states which deployed personnel with highest response numbers from Queensland (22), South Australia (14) and Western Australia (13). It is noted that response rates from both New South Wales (6) and Victoria (1) were lower than other states, while overall numbers involved for Northern Territory were low (2). Responses were received from those with medical (24), nursing (11), logistics (6), allied health (3) and command (3) roles as well as mixed roles consisting of medical/command (2), medical/logistics (1), nursing command (1) and nursing logistics (1).

The majority of team members responding to the survey were aged 45–55 years (31) with sixteen aged 25–35 years, eight aged 55–65, three aged 25–35 and one person aged more than 65 years of age. This age distribution is consistent with the mean level of team members clinical experience in their specialty of 21 years ($SD = 9$). Approximately 75% were male (44/59). Survey responses are described in Table 2.

During deployment, most felt that their basic health needs were adequately met. Almost all stated there were adequate shelter (95%, 56/59), adequate food (93%, 55/59) and adequate water (97%, 57/59). A clear majority felt there were adequate toilet facilities (80%, 47/59), adequate shower facilities (64%, 37/59), adequate hand washing facilities (68%, 40/59) or adequate personal protective equipment (PPE) (69%, 41/59). Most felt that there were adequate security briefings (73%, 43/59), though less felt that security itself was adequate (64%, 38/59). Approximately 30% (18/59) felt that team members could not be easily identified.

Assuming no other difficulties and 24/7 shift coverage was required, most respondents felt the optimum shift period was 12 h (66%, 39/59) or possibly 8 h (22%, 13/59). Only one person suggested 24-hour shifts while two nominated unspecified other and four failed to respond. The optimum period of overseas deployment was felt to be 14–21 days (46%, 27/59). One month was preferred by 15 (25%), while longer deployments and 7–10 day deployments were both nominated by 8 respondents (13%).

Table 2 Levels of agreement of statements concerning health and safety aspects of deployment.

Statement	1, Strongly disagree	2, Disagree	3, Neither disagree or agree	4, Agree	5, Strongly agree	Not applicable/ missing
There was adequate security	1 (2%)	9 (15%)	10 (17%)	29 (49%)	9 (15%)	1 (2%)
There were adequate safety briefings	1 (2%)	7 (12%)	8 (14%)	28 (47%)	15 (25%)	0 (0%)
There was adequate shelter	0 (0%)	2 (3%)	1 (2%)	29 (49%)	27 (46%)	0 (0%)
There was adequate food	1 (2%)	2 (3%)	1 (2%)	30 (51%)	25 (42%)	0 (0%)
There was adequate water	1 (2%)	1 (2%)	0 (0%)	31 (54%)	26 (44%)	0 (0%)
There were adequate toilet facilities	1 (2%)	6 (10%)	5 (9%)	36 (61%)	11 (18%)	0 (0%)
There were adequate shower facilities	6 (10%)	6 (10%)	8 (14%)	25 (42%)	12 (20%)	2 (3%)
There were adequate hand washing facilities	2 (3%)	6 (10%)	10 (17%)	28 (48%)	12 (20%)	1 (2%)
Team members had adequate PPE	4 (7%)	5 (9%)	4 (7%)	30 (51%)	11 (18%)	5 (9%)
Team members could be easily identified	8 (14%)	10 (17%)	5 (9%)	23 (38%)	12 (20%)	1 (2%)
My family was adequately informed of my whereabouts and health status	2 (3%)	9 (15%)	5 (9%)	26 (44%)	17 (29%)	0 (0%)

Thirteen respondents stated a total of 28 items that they regarded as essential items, which were not available. Of note is that these were just as likely to be related to personal comfort (28%, 8/28), as clinical care (36%, 10/28) or logistic support (36%, 10/28). Participants were asked to name what they regarded as the three most important personal items. The most frequently nominated items were: suitable clothes (49%, 29/59); toiletries (36%, 22/59); mobile phone (24%, 14/59); insect repellent (17%, 10/59) and a camera (14%, 8/59).

While most felt that their family was adequately informed of their whereabouts and health status (73%, 43/59), a number of concerns were evident. Participants were asked to name the biggest personal hardship faced during their deployment, with the most common response named as being away from home/problems at home (24%, 14/59). Other hardships nominated were experiencing human suffering, death and destruction (5); lack of quality sleep (4); long hours/high load demands (4); not knowing what to expect (3); no clean washing or showering water (2); heat (2); incompetent leadership (2); and the initial integration into the medical team (2).

Discussion

This study represented the first national survey of Australian DMAT members deployed to date. The experiences of these deployed professionals in relation to deployment health have been sought and the findings need to be incorporated as part of future planning and preparedness. This is particularly relevant as the Australian Government has recently launched an Australian Medical Assistance Teams (AUSMAT) program [23] and it is essential that future staff deployed have adequate health care during deployment. Pre- and post-deployment health support provided to these DMAT members has been published elsewhere.[24]

This study of the Australian DMAT experience found that although team composition was varied, health professional membership was consistent with that described by other authors.[25] In particular, most DMAT members were quite experienced and most had significant experience in international disasters before deployment, although the overwhelming majority had little or no experience in disaster management.

This survey did not examine specific health care of DMAT members themselves; however, Birch and Miller[26] emphasise the importance of the health of the team members, which ultimately is the responsibility of the team leader and lead agency. Wallace[25] also emphasises the need for team leaders to watch for and recognise both environmental and mental stress, as well as monitoring illness and injury amongst the team. There should also be limitations on the physical activity of team members, such as not using older team members with bad backs as stretcher bearers.[27] Both physical and mental fatigue, are major problems during prolonged operations.[28] It is not surprising therefore that almost all respondents in this study indicated that the optimal shift time was between 8 and 12 h with the most common optimum deployment period reported as 14—21 days. Long hours and lack of quality sleep were also nominated as problems on a par with experiencing human suffering, death and destruction. Leisure time is important in the field and rest breaks may need to be enforced to help reduce fatigue [25,26,28] and maintain morale.[29] Two weeks at the highest sustained in-operations tempo (12 h shifts and 7 day weeks) was also described as the maximum tolerance for deployed troops by D'Amore and Hardin[30] following Expeditionary Medical Support (EMEDS) unit deployment to Houston following tropical storm Alison.

Medical coverage and a medical cache specifically for team members only should always be available.[25] Yoshinaga et al.[31] found that the Japanese Disaster Relief team members had different health problems to the disaster victims. Partridge et al.[32] also found that it was not uncommon for relief workers to become sick, and who found that together the 60 workers deployed following typhoon Sudal made 163 patient contacts in the emergency clinic. While most of these were for minor medical complaints or minor trauma, 8% of visits were for serious medical problems or trauma.[32]

The ability of team members to be able to reliably communicate with family in the outside world, also greatly aids morale.[33] This was noted in our study to be the most significant personal hardship faced by those deployed. Following feedback from team members deployed to the South East Asian tsunami from the Disaster Preparedness and Management Unit (DPMU) in the Western Australian Department of Health, the process of ''Home Based Support'' was included in the subsequent Yogyakarta deployment. This included daily emails to all family members of the deployed team and a process that if any of the family members needed to contact their loved one on the team this could be facilitated through the DPMU. This level of support was identified in the post deployment evaluation to be beneficial to both the family and team members of the deployed team.[34] On this point, it should be noted that psychological support should also be provided during the deployment.[35] In contrast, a smaller survey of 20 Australian DMAT members by Stevens et al.[36] found low levels of support for the deployment of mental health professionals as part of a DMAT to support team members. There was increased support for these personnel deploying, if also occupying other roles, during extended operations or when the primary purpose was the welfare of the affected population. The predominant concern for family members in the survey by Stevens et al. was the safety and security of loved ones who had been deployed.[36] This was the primary stressor for 60% of respondent's families whereas personal welfare was the primary stressor for 15% of respondents.[36]

In general, personnel aspects of logistics were considered adequate, including security, safety briefings, shelter, food, water, toilet facilities, shower facilities, hand washing facilities, and PPE. Specifics concerning PPE were not sought, but PPE obviously need to be consistent with the hazardous conditions faced,[25] and include a hard hat or light helmet, heavy work gloves, eye protection and safety boots that all meet appropriate standards.[25]

Most of our respondents felt that security briefings were adequate and that security itself was adequate. Safety issues, evacuation plans and exit strategies were also identified by Jackson and Little,[19] following their NGO based deployment to Nias. Safety and security were considered an important part of DMAT deployment, particularly as injury is a major cause of death amongst humanitarian aid workers.[37] The major cause of death and injury among humanitarian staff was reportedly motor vehicle accidents during the 1970s and 1980s,[26,38] but the commonest cause of death in the most recent study was violent trauma, including gun shot, shrapnel and land mine wounds.[37] The breakdown of local structures and security problems make relief activities in armed conflicts very different to those following a natural disaster.[7] Combatants in complex humanitarian emergencies also increasingly regard the medical and relief workers as targets.[39]

It is vital that the security of the humanitarian community be given a high priority.[39] There needs to be a clear understanding of who is responsible for security issues, and organisations need to brief staff appropriately.[26] Other security measures include curfews[40] and driver training.[7,26] Security commonly entails civil military interaction, but defining and obtaining security remain a polarising issue in humanitarian assistance.[41] Teams based on military models find the integration of security much easier to achieve. The security concerns expressed by team members, and the risk profile of humanitarian intervention in natural disasters compared with complex humanitarian emergencies often associated with armed conflict, seems a natural divide, political issues aside, for future deployment of civilian or defence based teams.

Food and water security are also important. Water supplies for both team members and patients need to be included in plans for self-sufficiency. An adequate amount of reasonably safe water is generally preferable to a lesser amount of pure water.[42] Food options include supply rations airlifted weekly[43] or prepared meals, such as the US Military ''Meals Ready to Eat'', which can be eaten hot or cold.[44] In larger operations, a self-serve area with food and water can be maintained for staff and workers enabling ready access by staff.[45] Maintenance of personal hygiene amongst DMAT personnel is particularly important. Despite the lack of problems reported by Australian DMAT members, Cohen and Mulvaney[33] note US DMATs have found it difficult to maintain good personal hygiene and to find clean toileting areas, mainly because fresh water was not available after hurricanes. Shower facilities and personal hygiene were more cause for concern for team members in this survey than basic shelter, food and water. It is also worth noting that shelter was rated in the context of the disaster by respondents, with basic shelter felt to be adequate when the affected population had no shelter at all.

The importance of personal items is clearly seen in the survey. Missing essential items were just as likely to be related to personal comfort as clinical care or logistic support. Suitable clothing was identified by half of respondents as the most important personal item to be considered, although toiletries and insect repellant were also considered important. Vector protection is particularly important in many deployments to minimise risk of contracting diseases, such as malaria or dengue fever, and should be a basic component of the health care of deployed team members. US DMATs provide a minimum suggested personal equipment list, with local conditions and the nature of the deployment being taken into account, when organising equipment.[25] A dual bag approach is used by both US DMATs[33] and Rapid-UK, a British based international search and rescue team.[46] One bag contains everything the member needs for the first 3 days and can be used in the event the remaining bag is delayed during transport. This personal survival kit approach is supported by Pearce et al.[20] Robertson et al.[21] and Pearce et al.[20] went further to suggest that ''team-identifying clothing'' and uniforms were needed. A logo on team clothing acts as an identifier [47] and helps ''to promote esprit de corps''.[48]

The health aspects of deployment do not exist in a vacuum and should be part of a continuum of care. Medical and psychological evaluation prior to deployment of humanitarian teams is generally regarded as standard.[37] People should only deploy if they are in good physical and mental health,[49] and teams need to be prepared physically.[50] Interestingly, less than half received a medical check prior to departure and only a small number received a psychological assessment prior to deployment.[24] This is consistent with the survey by Moresky et al.,[51] where about half of the NGOs surveyed did not require a pre-field physical examination of their volunteers.

This study represents analysis of data collected on a cross-sectional survey of Australian DMAT members. This group may encounter different hazards and risks from humanitarian aid workers and other groups responding to disasters. In addition, the limited response from some states, particularly New South Wales and Victoria, suggested coverage concerns. The inability to undertake follow-ups may also have contributed to the poor response in these jurisdictions. This is offset to some degree by the overall response rate, levels of experience amongst responders and the representative mix of disciplines. Hence, although generalisation and extrapolation of this data will therefore be limited, the data can be useful for developing a more effective response to deployment health of members of future DMATs.

Conclusions

This study of Australian DMAT members suggests that, in the field, attention should be given to basics, such as adequate food, water, shelter and personal hygiene as well as appropriate clothing, sunscreen and vector protection. The inclusion of appropriate personal items can be assisted by provision of a minimum suggested personal equipment list, with local conditions and the nature of the deployment being taken into account. A personal survival kit should also be recommended. There should be medical and psychological support for team members themselves, including the provision of a dedicated team member medical cache. Concern for their own health and ability to communicate with family members at home are major issues for deployed team members and need to be addressed in mission planning. This should also recognise security issues, including briefings, evacuation plans and exit strategies. The team members concerns about adequate security and the risk profile of humanitarian intervention in natural disasters compared with complex humanitarian emergencies may help determine future deployment of civilian or defence based teams.

Dedication

The authors wish to dedicate this research to the thousands of people affected by the South East Asian tsunami and Yogyakarta earthquake.

Conflict of interests

The authors have no conflict of interests to declare.

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Ethical statement

James Cook University, Human Research Ethics Committee, Clearance number H2464.

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Annex 23: Paper 5.3

Aitken P, Leggat P, Robertson A, Harley H, Leclerq M, Speare R. Education and Training Requirements for Australian Disaster Medical Assistance Team members: Results of a national survey. Prehospital and Disaster Medicine 2011; 26(1): 41-48

Education and Training of Australian Disaster Medical Assistance Team Members: Results of a National Survey

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Conflict of Interests
The authors have no interests to declare.

Keywords: Australia; disaster medical assistance teams; Southeast Asia; education; training

Abbreviations:
AHPC = Australian Health Protection Committee
DMAT = Disaster Medical Assistance Teams
MIMMS = Major Incident Medical Management and Support Course
NDMS = National Disaster Medical System
NGO = non-governmental organization
EMA = Emergency Management Australia

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Abstract
Introduction: Calls for disaster medical assistance teams (DMATs) are likely to continue in response to international disasters.
Objective: As part of a national survey, the present study was designed to evaluate the education and training of Australian DMATs.
Methods: Data were collected via an anonymous, mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 Southeast Asia tsunami disaster.
Results: The response rate for this survey was 50% (59/118). Most of the personnel had deployed to the tsunami-affected areas. The DMAT members were quite experienced, with 53% of personnel in the 45–55-year age group (31/59). Seventy-six percent of the respondents were male (44/58). While most respondents had not participated in any specific training or educational program, any kind of relevant training was regarded as important in preparing personnel for deployment. The majority of respondents had experience in disasters, ranging from hypothetical exercises (58%, 34/59) to actual military (41%, 24/49) and non-governmental organization (32%, 19/59) deployments. Only 27% of respondents felt that existing training programs had adequately prepared them for deployment. Thirty-four percent of respondents (20/59) indicated that they had not received cultural awareness training prior to deployment, and 42% (25/59) received no communication equipment training. Most respondents felt that DMAT members needed to be able to handle practical aspects of deployments, such as training as a team (68%, 40/59), use of communications equipment (93%, 55/59), ability to erect tents/shelters (90%, 53/59), and use of water purification equipment (86%, 51/59). Most respondents (85%, 50/59) felt leadership training was essential for DMAT commanders. Most (88%, 52/59) agreed that teams need to be adequately trained prior to deployment, and that a specific DMAT training program should be developed (86%, 51/59).
Conclusions: This study of Australian DMAT members suggests that more emphasis should be placed on the education and training. Prior planning is required to ensure the success of DMAT deployments and training should include practical aspects of deployment. Leadership training was seen as essential for DMAT commanders, as was team-based training. While any kind of relevant training was regarded as important for preparing personnel for deployment, Australian DMAT members, who generally are a highly experienced group of health professionals, have identified the need for specific DMAT training.

Aitken P, Leggat PA, Robertson AG, Harley H, Speare R, Leclercq MG: Education and training of Australian disaster medical assistance team members: Results of a national survey. *Prehosp Disaster Med* 2011;26(1):41–48.

Introduction

In the past 50 years, there have been >10,000 reported disasters, affecting 12 billion people and resulting in 12 million deaths.[1,2] The impact of disasters is more likely to be felt in developing countries,[2,3] where they are both more likely to occur and their effects may be more pronounced. But, disasters even can occur within developed countries. Despite the preparedness of any country, some large-scale disasters will make it likely that there will be calls for disaster medical assistance and humanitarian aid,[4–6] which will require the timely mobilization of national and international resources.

Team	Number	Main States	Destination	Date Deployed
Alpha	14	NSW (17), WA (7), Qld (3), Vic (1)	Banda Aceh	29 December 2004
Bravo	14		Banda Aceh	29 December 2004
Charlie	17	NSW/WA/Qld	Maldives	30 December 2004
Delta	5	NSW	Sri Lanka	30 December 2004
Echo	23	SA	Banda Aceh	07 January 2005
Foxtrot	24	Qld	Banda Aceh	18 January 2005
Golf	21	Vic/NT	Banda Aceh	29 January 2005

Table 1—Australian Disaster Medical Assistance Teams deployed following the South East Asia tsunami (NSW = New South Wales; NT = Northern Territory; Qld = Queensland; SA = South Australia, Vic=Victoria; WA = Western Australia)

On 26 December 2004, the South East Asia tsunami hit countries in the Indian Ocean rim, killing >250,000 people and affecting millions, with the full impact of the disaster still being assessed years after the event.[7] The South East Asia tsunami was a landmark event in the history of Australian disaster management. This was the first time an organized, civilian-based team from Australia (representing the Australian Government) was deployed internationally. This previously had been the primary responsibility of the Australian Defence Force (ADF). However, Australian civilians had deployed as individuals through non-governmental organizations (NGO), such as the International Red Cross or Médicines Sans Frontiéres (MSF). Following the tsunami, seven civilian teams (Alpha to Golf) were deployed under the Australian Assistance Plan (AUSASSISTPLAN).[8] The disaster medical assistance teams (DMATs) that responded to the South East Asia tsunami are listed in Table 1. The teams came from multiple states, were deployed to a number of different countries, and filled a variety of roles based on needs and the timeline of response. Subsequently, further teams also were deployed following the Yogyakarta earthquake in Java, Indonesia in 2006.

Disaster medical assistance teams remain accountable for the standards of care provided by their team members, with the education and training of team members prior to deployment being an essential component of preparedness. The delivery of appropriate education and training for DMAT members requires an understanding of learning needs, preferred learning styles, the effectiveness of existing programs, and the value of experience in preparing team members for deployment.

Much of the literature concerning DMATs, including the Australian DMAT experience,[9–16] consists of individual team reports, which often are anecdotal. The lack of standards for DMATs also has made in-depth evaluation difficult for external reviewers and team members. Hence, there have been few studies examining DMAT deployments, and few dedicated studies of DMAT members in Australia. The present survey was part of a national program evaluating the Australian DMAT experience, and examining potential models for future use in Australia. The survey was undertaken in order to target the existing Australian DMAT experience base and to explore and identify issues raised by these groups. The experience base primarily includes those individuals actually deployed "on the ground", and this aspect of the survey explores their education and training related to DMAT deployment.

Methods

All team members associated with Australian DMAT deployments from the 2004 South East Asia tsunami were surveyed via their State/territory jurisdictions. The study protocol was reviewed and approved by the James Cook University Human Research Ethics Committee in 2006 (Approval No. H2464). The support of the national Australian Health Protection Committee (AHPC) also was sought and given for the survey. Representatives of the AHPC, through their State and Territory jurisdictions, identified 118 DMAT personnel from Teams Alpha to Golf and mailed questionnaires on the authors' behalf to preserve anonymity. No follow-ups could be performed.

Data were collected by means of a self-reporting questionnaire, which included an information sheet. The questionnaire was piloted and validated by use of a sample of senior medical staff with disaster deployment experience. The questionnaire was completed anonymously. A reply paid envelope was included for convenience; however other options for return were given, including facsimile. There were no penalties or rewards for participation, and informed consent was implied if team members completed and returned their questionnaires. The education and training component of the survey itself constituted about four A4-sized pages, and comprised the following formats of questionnaire completion: (1) simple tick-box format; (2) ranking; and (3) short answer responses. Data were collected on demographic details as well as education and training issues.

Data were entered into a spreadsheet program and processed using the Statistical Package for the Social Sciences (Version 14.0, SPSS, 2006, Chicago, IL). Descriptive statistics were used, as the sample size was relatively small.

Results

The overall response rate for this survey was 50% (59/118). The majority of DMAT members who responded had deployed to Aceh (39), while seven had been to the Maldives, and one to Sri Lanka. Some had deployed more than once, including to Yogyakarta (8). Team members responded from all states that deployed personnel with highest response numbers from Queensland (22), South Australia (14), and Western Australia (13). Response rates from both New South Wales (6) and Victoria (1) were lower than other states, while overall numbers involved for Northern Territory were low (2). Responses were received from those with medical (24), nursing (11), logistics (6), allied health (3), and command (3) roles, as well as mixed roles

Course	Completed		If completed—How effective was this course in preparing you for deployment?				
	YES n (%)	NO n (%)	1 Negative Effect n (%)	2 No Effect n (%)	3 Minimal n (%)	4 Good n (%)	5 Very Good n (%)
MIMMS	20 (34)	39 (66)	0 (0)	2 (10)	6 (30)	8 (40)	4 (20)
National Disaster Medicine Course EMA	15 (25)	44 (75)	0 (0)	0 (0)	3 (20)	9 (60)	3 (20)
State based Disaster Medicine Course	16 (27)	43 (73)	0 (0)	1 (6)	1 (6)	13 (82)	1 (6)
MPH (anywhere)	11 (19)	48 (81)	0 (6)	1 (9)	2 (18)	3 (27)	5 (46)
Recovery Course	6 (10)	53 (90)	0 (0)	0 (0)	2 (33)	3 (50)	1 (17)
Specific refugee health course	5 (9)	54 (91)	0 (0)	0 (0)	0 (0)	1 (20)	4 (80)
Other course	19 (32)	40 (68)	0 (0)	0 (0)	3 (16)	13 (68)	3 (16)

Table 2—Education and training programs completed by Australian Disaster Medical Assistant Teams (DMATs) deployed following the Asian tsunami
(EMA = Emergency Management Australia; MIMMS = Major Incident Medical Management and Support Course; MPH = Master of Public Health)

consisting of medical/command (2), medical/logistics (1), nursing command (1) and nursing logistics (1).

The majority of team members responding to the survey were 45–55 years of age (31) with 16 25–35 years of age, eight 55–65 years of age, three 25–35 years of age, and one person >65 years of age. This age distribution is consistent with the mean level of clinical experience in their specialty of 21 ± 9 years). Approximately 75% were male (44/59) with 14 females responding, and one response was missing. Of the 59 responses, 15 (25%) had volunteered to go, 36 (61%) had been asked to go, and one person indicated that they had been ordered to go. Seven did not respond to this item.

While most respondents had not participated in any specific training or educational program (Table 2), any kind of relevant training was regarded as important for preparing personnel for deployment. Thirty-four percent (20/59) had completed a Major Incident Medical Management Support (MIMMS) course, arguably the most widespread disaster-based teaching program in Australia. Only 27% (16/59) and 25% (15/59) of respondents indicated that they had completed the National Disaster Medicine course, run previously at the Australian Emergency Management Institute by Emergency Management Australia (EMA) and the Department of Health and Ageing, or state-based disaster medicine courses, respectively. Even less had completed formal training in public health (19%, 11/59), recovery (10%, 6/59), or refugee health (9%, 5/59). Twenty-five provided responses about which aspects of these courses provided most help preparing for deployment. The most common response was work experience and training (7), followed by logistics planning (4), mock training (3), and knowledge of tropical disease (2).

The majority of respondents had experience in disasters (Table 3), ranging from hypothetical exercises (58%, 34/59) to actual military (41%, 24/49), and NGO (32%, 19/59) deployments. Any experience, theoretical or practical, was regarded as effective preparation for DMAT deployments, although actual field experience was preferred. Forty provided responses about which components of these experiences helped most in preparing for deployment, with the the value of experience again evident. Previous emergency experience (23%, 9/40) and previous deployment (20%, 8/40) were the most frequent responses, followed by familiarity with clinical and public health issues (10%, 4/40), being flexible for the conditions (8%, 3/40), knowing what to expect (5%, 2/40), understanding issues and equipment (5%, 2/40), and specific training (5%, 2/40).

Fifty-eight percent (34/59) had significant experience in international disasters, although only 5% (3/59) felt they had experience in disaster management before deployment (Table 4). Only 27% of respondents felt that existing training programs adequately prepared them for deployment. In contrast, nearly all (88%, 52/59) agreed that teams must be trained adequately prior to deployment, and similar numbers

Experience	Completed		If completed—How effective was this experience in preparing you for deployment?				
	YES n (%)	NO n (%)	1 Negative Effect n (%)	2 No Effect n (%)	3 Minimal n (%)	4 Good n (%)	5 Very Good n (%)
Hypothetical or discussion exercise	34 (58)	25 (42)	1 (3)	1 (3)	9 (26)	19 (56)	4 (12)
Field exercise	37 (63)	22 (37)	1 (3)	1 (3)	4 (11)	20 (54)	11 (30)
Skills workshop	23 (39)	36 (61)	1 (4)	0 (0)	5 (22)	12 (52)	5 (22)
Previous military deployment	24 (41)	35 (59)	1 (4)	0 (0)	0 (0)	5 (21)	18 (75)
Previous NGO deployment	19 (32)	40 (68)	1 (4)	0 (0)	1 (5)	4 (21)	13 (68)
Previous government based deployment	23 (39)	36 (61)	1 (4)	0 (0)	1 (4)	7 (30)	14 (61)
Other experience	22 (37)	37 (63)	1 (5)	0 (0)	1 (5)	7 (32)	13 (59)

Table 3—Exercises and deployment experiences of Australian DMATs deployed following the South East Asia tsunami (NGO = non-governmental organization)

(86%, 51/59) felt that a specific DMAT training program should be developed. Thirty-four percent (20/59) of respondents indicated that they had not received cultural awareness training prior to deployment, while 42% (25/59) indicated that they had not received communication equipment training prior to deployment. Most respondents felt that DMAT members needed to be able to handle practical aspects of deployments, including training as a team (68%, 40/59), use of communications equipment (93%, 55/59), ability to erect tents and shelters (90%, 53/59), and use of water purification equipment (86%, 51/59). Almost all respondents (85%, 50/59) felt that leadership training was essential for DMAT commanders.

Discussion

This study represented the first national survey of Australian DMAT members deployed to date. The education and training experiences of these deployed professionals in relation to deployment have been sought, and the findings ideally incorporated as part of future planning and preparedness. This is particularly relevant as the Australian Government recently has launched an Australian Medical Assistance Teams (AUSMAT) program.[17]

Need for Training

This study of the Australian DMAT experience found that, although team composition was varied, health professional membership was consistent with that described by other authors.[18] The DMAT members were quite experienced, with 53% of personnel in the 45–55 years age group (31/59) having, on average, >21 ±9 years) experience. Despite this experience level, only 27% of respondents felt that existing training programs adequately prepared them for deployment. Disaster management differs from care of individual patients both qualitatively and quantitatively. It is not just a question of magnitude, with an increase in patient numbers, but also a different type of patient and a system under extreme stress.[19] Standard medical and nursing training is unlikely to prepare hospital or community staff adequately for work in complex emergencies or disasters.[20,21] Similarly, the military acknowledge that it is unacceptable to send units trained for combat, and hope they quickly adjust to emergency relief practices. These staff, including medical, find they do not have the training necessary for providing humanitarian assistance.[22,23]

The growing need for disaster relief work and a rapid response has led many organizations to place inexperienced or

Statement	1 Strongly Disagree n (%)	2 Disagree n (%)	3 Neither Disagree or Agree n (%)	4 Agree n (%)	5 Strongly Agree n (%)	Not Applicable/ Missing
I had significant experience in disaster management before deployment	15 (25)	33 (56)	1 (2)	3 (5)	0 (0)	7 (12)
I had significant experience in international disasters	6 (10)	12 (20)	6 (10)	14 (24)	20 (34)	1 (2)
Existing training programs adequately prepared me for deployment	9 (15)	18 (30)	12 (20)	7 (12)	9 (15)	4 (7)
There should be a training program specifically for DMAT deployment	1 (2)	0 (0)	7 (12)	25 (42)	26 (44)	0 (0)
I received cultural awareness training prior to deployment	5 (9)	15 (25)	9 (15)	22 (37)	8 (14)	0 (0)
I received skills training prior to deployment	5 (9)	21 (36)	13 (22)	15 (25)	3 (5)	2 (3)
I received communication equipment training pre deployment	5 (9)	20 (33)	10 (17)	18 (30)	5 (9)	1 (2)
Teams should train together pre-deployment	0 (0)	1 (2)	9 (15)	37 (63)	12 (20)	0 (0)
All team members should have the ability to use communications equipment	0 (0)	4 (7)	0 (0)	24 (41)	31 (52)	0 (0)
All team members should have the ability to erect tents and shelters	0 (0)	4 (7)	2 (3)	26 (44)	27 (46)	0 (0)
All team members should have the ability to use water purification equipment	0 (0)	3 (5)	5 (9)	26 (44)	25 (42)	0 (0)
Leadership training is essential for DMAT commanders	0 (0)	0 (0)	9 (15)	13 (22)	37 (63)	0 (0)
Teams need to be adequately trained prior to deployment	1 (2)	0 (0)	5 (9)	21 (35)	31 (52)	1 (2)

Table 4—Levels of agreement of statements concerning education and training for Disaster Medical Assistance Team members

inadequately trained personnel in the field. Such enthusiastic but inexperienced workers may be of limited usefulness.[4,24,25,28] They even may have a negative impact, as such personnel can threaten the program success, frustrate beneficiaries and donors, provide an additional burden for the local population,[4,26] and even damage the credibility of the agency.[27]

Relief teams coming from abroad, whether government–, military–, or NGO-based, must be well-qualified and professionally trained.[4,28] Staff trained in basic principles will make more appropriate decisions and fewer mistakes.[25, 29] However, there is general acknowledgment that training must be improved across all levels of deployment and from all disciplines.[24,30] The Pan American Health Organization (PAHO) states that basic training in disaster management should be strengthened at all levels of education[31] with a need to develop internal training programs and guidelines.[32] There have been efforts by a number of countries[33,34] and organizations, such as the World Association for Disaster and Emergency Medicine (WADEM), to standardize education in disaster medicine.[35] Presently, there is no accepted international standard upon which the education and training of international humanitarian aid or DMATs can be assessed.

Training Completed

In this survey, most respondents had not participated in any specific training or educational program. This is consistent with the international humanitarian aid experience. A survey of NGOs deploying health workers to acute human emergencies found only 34% (18/53) provided classroom teaching or orientation prior to departure, and less than half provided pre-field training in health care.[25]

Of the respondents in this survey that had completed programs, any kind of relevant training was regarded as important. Courses completed included MIMMS (34%, 20/59), national disaster medicine course (27%, 16/59) and state-based courses

(25%, 15/59). The MIMMS was regarded as least helpful of the specific courses, but this should be viewed in context. The MIMMS has a focus on the initial management of mass casualty incidents[36] rather than humanitarian aid, and DMATs are unlikely to be deployed in the initial stages. Basic principles, including command structure, are likely to still be beneficial.

Less had completed formal training in public health (18%, 11/59), recovery (10%, 6/59), or refugee health (9%, 5/59). Although the numbers are small, public health and refugee health-based programs seemed to provide significant benefit for team members. Again, this is likely to be consistent with the timeline of response and likely will be DMAT roles.[37]

The Importance of Experience

The importance of experience was a common theme in the participants' responses. The majority of respondents stated they had actual experience in international disasters (58%, 34/59), either through military (41%, 24/49) or NGO (32%, 19/59) deployments. Only 5% (3/59) stated they had experience in disaster management before their DMAT deployment. This actual experience was felt to be beneficial, and provided more help in preparing for deployment than did coursework or other forms of instruction. The value of military, developing country, and remote medical experience also was noted following the Team Charlie deployment to the Maldives.[16]

However, preserving an experienced cohort of team members often is problematic. The majority of people responding to humanitarian crises are novices who volunteer for short periods, then return to their normal occupations without passing on their experiences.[38] In general, the lack of a career structure for international relief work encourages high turnover and recruitment of inexperienced personnel.[39] Moresky *et al*,[25] found that only 18 out of 53 (34%) NGOs surveyed required that personnel had previous international experience. The Tsunami Evaluation Coalition also made note of the shortage of relevant expertise and high turnover of international staff.[39] A lack of needed skills also is a major cause of poor employee morale, which may be a reason for the high turnover of staff,[29] while PTSD symptoms in team members has been found to be significantly greater in those with less than three previous disaster experiences.[40] This reinforces the need for a structured and adequately trained and supported DMAT program that enables retention of staff and experience.

Specific DMAT Training

Nearly all of the DMAT members that responded to the survey agreed that teams must be adequately trained prior to deployment, and that a specific DMAT training program must be developed. The value of disaster medicine training was noted by Robertson *et al*[16] and the need for specific training stated by Pearce *et al*[15] in their description of the Western Australia and Southern Australian deployment experience.

Any training and educational program should be based on a set of predefined and established learning objectives. Education and training in disaster medicine is no different. Various training options exist in disaster medicine with no consensus view, however, on which of these methods is most effective.[41–44] Evaluation of different educational methodologies shows each has its own advantages and disadvantages.[45] The selection of the most appropriate of these educational methodologies, with respect to learning objectives, group characteristics, learning preferences, and available time and money, is an important part of the planning process for any educational session or program.[46,47] The selected teaching style also must consider the target groups prior knowledge and stage of learning, so that the learner is challenged while still integrating new information with old.[48–50]

This can be even more challenging when training involves multidisciplinary groups and inter-agency cooperation.[51] Teamwork skills must be addressed specifically during training,[52] and training may improve team efficiency and effectiveness of completing key tasks in a crisis situation.[53] Only one of the respondents disagreed with the statement that team members should train together. It also is imperative that realistic training is carried out, and training standards and minimum training requirements are established before training commences.[54,55]

In addition to these issues, emergency response training poses a number of unique problems. There is a need to retain material learned in training over a long period of time between emergencies, to apply information learned from the training conditions to the unforeseen conditions during the emergency, and to develop effective mechanisms for teamwork.[52] For knowledge and skills to be retained, when DMAT deployment is infrequent, requires an ongoing educational and exercise program.

The design of a specific DMAT training program must include a broader focus than clinical care alone. Most of the survey respondents felt that DMAT members needed to be able to handle practical aspects of deployments, such as use of communications equipment (93%, 55/59), ability to erect tents and shelters (90%, 53/59), and use of water purification equipment (86%, 51/59). In this survey, 34% of respondents (20/59) indicated that they had not received cultural awareness training, and 42% (25/59) indicated that they had not received communication equipment training prior to deployment. Almost all respondents (85%, 50/59) felt that leadership training was essential for DMAT commanders.

This is consistent with statements by the US-based National Disaster Medical System (NDMS), that state that teams should be trained in field deployment and living, air-medical conditions, casualty collection and regional evacuation point operations, NDMS organization, structure, and administrative requirements.[56] Each team member also must be familiar with all of the equipment and basic load supply, as well as their job function.[18] They also must be able to use all the equipment[54,56] and learn the function of the Incident Command System (ICS).[30,56] The three key areas identified by the Swiss that warrant further training and development are rapid assessment, flexibility in assistance, and rapid decision-making.[26] Burkle *et al* also note that international emergency and disaster medicine increasingly requires a strong knowledge base in health and human rights, logistics, international humanitarian law, international organisational management, negotiation, and mediation.[57,58]

Security courses are available and should be considered;[20] a number of NGOs now offer staff training in security.[29] However, many organizations lack the capacity to train field personnel in areas such as security, management, standardized programs, field educational methods, and cultural sensitivity,[25] while existing educational programs need support.[59] Moresky *et al*[25] found that the majority of organizations used manuals as the primary method of training for workers before going into the field (31/53, 59%), with most (45/53, 85%) also supplying their workers with trip briefings from prior personnel.

There has been a recent increase in the number of training courses available for health workers considering disaster response.[24] These include the International Committee of the Red Cross (ICRC) month-long Health Emergencies in Large Populations (HELP) course designed to prepare medical coordinators in disasters,[4,29,60] and the Combined Humanitarian Assistance Response Training (CHART) course and others offered by the International Rescue Committee and the Office of Foreign Disaster Assistance.[25,29] A number of Websites and databases list training opportunities with Humanitarian agencies, including the Australian Development Gateway,[61] Relief Web, InterAction, and the International Health Exchange.[24,25] However, few of these courses are aimed specifically at staff deploying as part of an international disaster response, and the completion of courses by individuals does not allow team building to occur. An additional resource for self-directed learning is the "Virtual Disaster Library" developed by the WHO and PAHO, which has > 400 scientific and technical documents available both online and as a CD-ROM.[62]

A more medically-based educational program for disaster relief workers has been developed by the US-based DMATs with a national training program for DMATs proposed.[18] Training consists of classroom programs and field training, and an annual conference that offers workshops and training courses for members. Ongoing training also helps DMATs to function as a team once deployed. A similar DMAT-specific training program is being developed in Western Australia, with both an initial training program and ongoing participation to maintain currency, but it should be broadened to other States and Territories. Ideally, this would promote standardization of education across state-based teams, and incorporate practical aspects of team deployment, as well as team-based training. Specific leadership for commanders should also be provided.

Additional Target Groups

Education and training should not be restricted to the deployed staff. Training also is needed for the operations room staff, which should address media training, information technology and telephone skills, report log training, press releases, dealing with next of kin, and handling specific requests.[54] Program managers also need training in management skills, such as project assessment and planning, finance and personnel management, and quality assurance and reporting.[29] If mixed civil–military models are used, then military personnel and NGO staff must train together before deployment. While this may not produce agreement, it can help produce mutual understanding.[63–65]

This study represented an analysis of data collected on a cross-sectional survey of Australian DMAT members. This group may encounter different challenges to humanitarian aid workers and other groups responding to disasters. In addition, the limited responses from some states, particularly New South Wales and Victoria, suggested coverage concerns. The inability to undertake follow-ups also may have contributed to the poor response in these jurisdictions. This is offset to some degree by the overall response rate, levels of experience among responders, and the representative mix of disciplines. Hence, although generalization and extrapolation of these data will be limited—the data can be useful in developing a more effective response to the deployment health of members of future DMATs.

Conclusions

This study of Australian DMAT members suggests that more emphasis should be placed on the education and training of teams. Prior planning is required to ensure the success of DMAT deployments, and training should include practical aspects of deployment, such as use of communications equipment and water purification systems, ability to erect tents and shelters, and cultural awareness. A few of the respondents had received cultural awareness or communications equipment training prior to deployment. Leadership training was seen as essential for DMAT commanders as was team-based training.

While most respondents had not participated in any specific training or educational program, any kind of relevant training was regarded as important for preparing personnel for deployment. The most commonly completed course related to major incident medical management and support, but seemed to offer less benefit than more generic disaster health courses. Few had completed formal training in public health, recovery, or refugee health. Australian DMAT members, who generally are a highly experienced group of health professionals, felt that existing training programs did not adequately prepare them for deployment. They felt that teams must be adequately trained prior to deployment, and have identified the need for specific DMAT training.

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Dedication

The authors dedicate this research to the thousands of people affected by the South East Asia tsunami and Yogyakarta earthquake.

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Annex 24: Paper 5.4

Aitken P, Leggat P, Robertson A, Harley H, Leclerq M, Speare R. Leadership and Standards for Australian Disaster Medical Assistance Team members: Results of a national survey. Prehospital and Disaster Medicine, 2012; 27(2): 1-6.

Leadership and Use of Standards by Australian Disaster Medical Assistance Teams: Results of a National Survey of Team Members

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Keywords: Australia; disaster; Disaster Medical Assistance Team; DMAT; leadership; measures of effectiveness; medical assistance; Southeast Asia; standard

Abbreviations:
AHPC: Australian Health Protection Committee
AUSMAT: Australian disaster medical assistance teams
DMAT: Disaster Medical Assistance Teams
ICS: Incident Command System
MOE: measures of effectiveness
NGO: non-governmental organization
PAHO: Pan American Health Organization

Abstract

Introduction: It is likely that calls for disaster medical assistance teams (DMATs) will continue in response to international disasters.

Objective: As part of a national survey, the present study was designed to evaluate leadership issues and use of standards in Australian DMATs.

Methods: Data was collected via an anonymous mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 Asian Tsunami disaster.

Results: The response rate for this survey was estimated to be approximately 50% (59/118). Most of the personnel had deployed to the Asian Tsunami affected areas. The DMAT members were quite experienced, with 53% (31/59) of personnel in the 45-55 years of age group. Seventy-five percent (44/59) of the respondents were male. Fifty-eight percent (34/59) of the survey participants had significant experience in international disasters, although few felt they had previous experience in disaster management (5%, 3/59). There was unanimous support for a clear command structure (100%, 59/59), with strong support for leadership training for DMAT commanders (85%, 50/59). However only 34% (20/59) felt that their roles were clearly defined pre-deployment, and 59% (35/59) felt that team members could be identified easily. Leadership was identified by two team members as one of the biggest personal hardships faced during their deployment. While no respondents disagreed with the need for meaningful, evidence-based standards to be developed, only 51% (30/59) stated that indicators of effectiveness were used for the deployment.

Conclusions: In this study of Australian DMAT members, there was unanimous support for a clear command structure in future deployments, with clearly defined team roles and reporting structures. This should be supported by clear identification of team leaders to assist inter-agency coordination, and by leadership training for DMAT commanders. Members of Australian DMATs would also support the development and implementation of meaningful, evidence-based standards. More work is needed to identify or develop actual standards and the measures of effectiveness to be used, as well as the contents and nature of leadership training.

Aitken P, Leggat PA, Robertson AG, Harley H, Speare R, Leclercq MG. Leadership and use of standards by Australian disaster medical assistance teams: results of a national survey of team members. *Prehosp Disaster Med.* 2012;27(2):1-6.

Introduction

On December 26, 2004, the Southeast Asian tsunami hit countries around the Indian Ocean rim, particularly around its earthquake-associated epicenter off Indonesia, resulting in the deaths of more than 250,000 people, and affecting millions in the region. The Australian Government responded to this event with several civilian disaster medical

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STATEMENT	1 Strongly Disagree n (%)	2 Disagree n (%)	3 Neither Disagree or Agree n (%)	4 Agree n (%)	5 Strongly Agree n (%)	Not Applicable/ Missing n (%)
I had significant experience in disaster management before deployment	15 (25)	33 (56)	1 (2)	3 (5)	0 (0)	7 (12)
I had significant experience in international disasters before deployment	6 (10)	12 (20)	6 (10)	14 (24)	20 (34)	1 (2)
My role was clearly defined pre deployment	14 (24)	22 (37)	3 (5)	11 (19)	9 (15)	0 (0)
Team members could be easily identified	8 (14)	10 (17)	5 (8)	23 (39)	12 (20)	1 (2)
Leadership training is essential for DMAT commanders	0 (0)	0 (0)	9 (15)	13 (22)	37 (63)	0 (0)
There needs to be a clear command structure	0 (0)	0 (0)	0 (0)	13 (22)	46 (78)	0 (0)
My team used indicators of effectiveness for the deployment	1 (2)	13 (22)	14 (24)	26 (43)	4 (7)	1 (2)
There needs to be meaningful evidence based standards developed	0 (0)	0 (0)	16 (27)	18 (30)	21 (36)	4 (7)

Table 1. Levels of agreement of statements concerning experience, leadership and standards

assistance teams (DMATs); these efforts have been summarized elsewhere.[1] Subsequently, the Government developed an Australian disaster medical assistance teams (AUSMAT) program,[2] and recently deployed teams following the Samoa tsunami, Pakistan floods, and Christchurch earthquake. This trend is likely to continue. Disasters are increasing in frequency[3,4] and are more likely to occur in developing countries,[4,5] where their effects may be more pronounced. International disaster assistance is increasingly regarded as a right or obligation,[6] with the Australian Government recently increasing the budget for foreign aid.[7] Despite the level of preparedness of any country, some large-scale disasters will also necessitate calls for international disaster medical assistance and humanitarian aid.[8-10] How well a society survives a disaster is directly related to the skills possessed by its leaders and the advanced preparations they have made.[11] The importance of leadership holds equally true for international disaster assistance teams.

Much of the literature concerning DMATs, including the Australian DMAT experience,[12-19] consists of individual team reports, which often are anecdotal. If disaster medical assistance is to improve, the international relief community must develop and streamline systems for data collection and analysis, then translate the information into implementing change to improve their programs.[20] The lack of standards for DMATs has made in-depth evaluation difficult for both external reviewers and team members. Hence, there have been few studies examining DMAT deployments, and few studies of DMAT members in Australia. The present survey was part of a national program evaluating the Australian DMAT experience and examining potential models for future use in Australia. The survey was undertaken in order to target the existing Australian DMAT experience base, and to explore and identify issues raised by these groups. The experience base primarily includes those individuals actually deployed "on the ground," and this aspect of the survey explores their views on DMAT leadership, the actual use of standards by DMATs, and support for their development.

Methods

The methods for this study have been described in detail elsewhere.[1] All team members associated with Australian DMAT deployments from the 2004 Southeast Asian Tsunami disaster were surveyed via their State/Territory jurisdictions. Representatives of the Commonwealth Australian Health Protection Committee (AHPC), through their State and Territory jurisdictions, identified 118 DMAT personnel, and mailed out questionnaires on the authors' behalf. No follow-ups were undertaken. The study protocol was reviewed and approved by the James Cook University Human Research Ethics Committee in 2006 (Approval No. H2464). The support of the AHPC also was sought and given for the survey. Data were entered into a spreadsheet program, and analyzed using the Statistical Package for the Social Sciences, Version 14.0 (SPSS, Chicago, Illinois USA). Descriptive statistics were used, as the sample was relatively small.

Results

The overall response rate for this survey was 50% (59/118). The demographic details of the respondents have been reported elsewhere.[1] Survey responses are described in Table 1. There was unanimous support for a clear command structure (100%, 59/59), with strong support for leadership training for DMAT commanders (85%, 50/59). However, only 34% (20/59) felt that their roles were clearly defined pre-deployment, and 59% (35/59) felt that team members could be identified easily. When asked to name the biggest personal hardship faced during deployment, 49 provided responses, with two naming incompetent leadership.

No respondents disagreed with the need for meaningful, evidence-based standards to be developed; however, only 51% (30/59) of those who responded stated that indicators of effectiveness were used for the deployment.

Discussion

There was unanimous support for a clear command and control structure in this survey. This reinforces the findings from individual Australian team reports,[18,19] and is consistent with the international experience. An Israeli study of the response of the Thai medical system to the tsunami disaster found that leadership was crucial for effective function,[22] while the Project Hope/United States Naval Ship (U.S.N.S) Mercy collaboration attributed much of its success in a joint deployment to the quality of leadership.[23] Civilian health professionals not familiar with military command structures, both on board the Mercy as a hospital ship and through to Fleet Command, may have struggled to recognize that they were subordinate to the command of Navy officials.[23] Use of civilian medical leaders with prior military experience addressed this, and ensured both their own credibility for clinical volunteers and military hosts alike, and helped the integration of the civil-military staffing arrangements.

Performance standards in humanitarian aid are noted to suffer, at least in part, due to mismanagement,[24] and research after the Rwanda crisis showed that aid workers saw organizational and management issues as prime stressors in their work.[25] This is consistent with the results of this survey, where poor leadership was stated to be one of the major personal hardships faced by team members.

As Kizer notes, "public health emergency management is not a democratic process."[26] It is essential that one person is in charge of the emergency response and that everyone knows the chain of command. The incident leader must be able to make appropriate decisions quickly, and often on the basis of incomplete or uncertain data. This autocratic style of leadership is more customary in law enforcement, military, and firefighting, and is different from the more collaborative approach used in health. Therefore, leadership and management roles among the potentially responding entities need to be established clearly, and understood in advance.[26] The importance of this was evident in Project Hope, with a joint civil-military deployment aboard the USNS Mercy.[23] Few respondents in this survey felt that their roles were clearly defined pre-deployment. While this has more direct application to operational roles, any uncertainty can also be reflected in team function and command structure.

The incident command system (ICS) has become the accepted standard for disaster response in many countries.[27] Adherence to this is necessary to integrate successfully into the response. Failure to do so may lead to death of personnel, lack of adequate medical supplies, and staff working beyond their training or certification.[27] An ICS also can help ensure resources are directed to areas in most need.[28] There also needs to be a command structure both between agencies[29] and internationally.[30]

International experiences in inter-agency coordination reveal numerous issues of jurisdiction, authority, capacity, and competency.[31] While clearly defined roles and responsibilities enable effective collaboration, there is a need for greater standardization of language, including terms and definitions, and use of color coding and symbols for personnel and materials[32] including identification of leaders. Effective exchange of information and international decision-making in disaster management requires a high degree of interoperability among a large number of organizations through common infrastructures.[33] Problems in coordination may arise due to poor leadership, as without a strong chain of command and proper protocols in place, confusion is inevitable.[34,35]

Team leaders also have a broad range of responsibilities other than overall success of the mission, and must be concerned with team composition, transportation, communication, re-supply, and safety of team members.[11] Maintaining effective team welfare and dynamics in a physically and psychologically challenging post-tsunami environment requires a considerable conscious effort in terms of leadership.[16] The health of team members is not just a personal responsibility, but also that of the team leader and the lead agency.[29] Team leaders must watch for and recognize stress, both environmental and mental, and must monitor for illness and injury among members.[21] Both physical and mental fatigue are major problems during prolonged operations, and it is important to develop measures to minimize fatigue.[36] The temptation for off-duty staff to "hang around" should be discouraged, and sufficient breaks should be taken, as they contribute to good relationships in the field. Such breaks may need to be enforced.[21,25,36] Team leader fatigue is also an issue and fatigue analysis systems screening key personnel[37] such as team leaders should also be considered.

The success of a team will very much depend on the selection of the right members. Selection should not be based entirely on skills; fitting into a team and being able to carry out the work required in the field is more desirable.[38] Team leaders should also not be selected entirely on their leadership skills. It is preferable that leaders be health professionals who can serve two or more roles in a deployment.[39] While good leadership is essential in disaster teams, leadership is generally a learned skill,[40] with leadership training uniformly supported by participants. No single set of characteristics guarantees good leadership. The leadership characteristics required in situations of extreme adversity will be very different from those needed in a time of stability.[41] A management style that emphasizes cooperation, participation and fairness, and is based on personal example, is the best way for a disaster manager to influence others. They must be familiar with different styles of leadership, and know when and how to use them as these may vary with the phase of the disaster, the environment, the staff involved, and the interpersonal relationships established.[41] There is also a need for team leaders to have an awareness of the issues associated with conflict. This may be individual or group, local or national.[42]

Standards may also assist leadership not just by promoting standardization, but also by providing organizational and reporting frameworks. The "People in Aid" code has a focus on organizational issues such as human resources in plans and budgets, risk management, and communication with staff.[25]

Despite this, standards, indicators, and measures of effectiveness are not consistently used. In this study, only half of the respondents described use of indicators, and while the reasons for this were not explored, this is not a new issue. The 100,000 avoidable deaths in the Rwanda crisis were attributed to poor performance on the part of relief agencies,[43,44] while the 1994 wide-scale mismanagement of cholera by inexperienced relief workers in Zaire led to a recognition of the need to improve professional standards and the effectiveness of the response.[45]

The effectiveness of emergency interventions may be difficult to measure,[46] helping explain why much of the response to emergencies is poorly evaluated.[47] This is contributed to by the lack of available standards, benchmarks, and indices, which makes assessment and the ability to learn from experience more difficult. This lack of standards extends to training, with no way to assess the abilities and competencies of the organizations and people who volunteer to help an affected population.[48]

Methodologies for quality management have slowly been developed,[47] but there is still a need for agencies and governments to agree to benchmarks, standards and codes of practice for health disaster preparedness and response, and for guiding recovery. There needs to be honest and transparent accountability, responsibility and evaluation against agreed standards of performance.[49] An evidence-based grading system incorporating indicators to measure the effectiveness of a humanitarian response is required. Different methodologies may also be needed to assess indicators in countries without access to data.[50,51] The importance of measures of effectiveness (MOE) is seen in a study of the perceived effectiveness of health related disaster relief in the former Yugoslavia, where members of international organizations believed that a higher proportion of needs were being met by their assistance (73.4%) than did the local population (52.1%, $P < .001$).[52]

Perhaps the more important finding was that no respondents disagreed with the need for development of meaningful, evidence-based standards. The selection or development of appropriate standards is the issue. The SPHERE Project has been one of the first, and probably best known, systematic efforts to improve accountability. SPHERE addresses key indicators for five sectors; water supply and sanitation, nutrition, food aid, shelter and site management, and health services,[47,53] with clearly defined guidelines and minimum standards.[54,55] The SPHERE standards are also used by both NGOs and the military in humanitarian aid, so also may be seen as a common link between the two.[56]

There has been some reluctance to accept the SPHERE standards, however. This reluctance is due to concerns about levels of flexibility and the potential use of minimum standards as a punitive tool, despite these being a collective expert opinion recognizing context and constraints.[45,56] The debate should shift from potential threats to organizations to the rights of people affected by disasters, and "ultimately, all humanitarian organizations should be held accountable when they do not meet minimum standards when there is a reasonable expectation of doing so."[45] The SPHERE Project also encourages intergovernmental organizations to provide an overall coordinating framework for international and local disaster relief. However, present practice is variable, and recognized minimum standards for such coordination do not exist. The establishment of a global information network has been suggested. This would be in place before a disaster occurs, and could link all relief communication efforts.[50,57] It also could be supported by standardized flow charts for deploying international disaster assistance,[58] and use of standardized essential minimum data sets.[50]

A number of other codes or standards have emerged. These include the 1994 voluntary Code of Conduct, with 10 underpinning principles that promote the impartial character of aid, respect of local cultures, building on local capacities, involvement of beneficiaries, and respect for local dignity;[55] "People in Aid," aimed at organizational practice;[25] the "Quality Compass;"[59] the "Ombudsman" project;[20] and the "Active Learning Network for Accountability and Performance."[60] In January 2005, the United Nations also adopted the Hyogo Framework for Action 2005-2015 Resolution, which addresses the specific gaps in present responses, and the challenges that disasters pose to communities across the globe.[61]

Establishment of standards is simply the first step; adherence to standards is necessary for them to be effective. The Pan American Health Organization (PAHO) in conjunction with the World Health Organization (WHO), has developed guidelines for deployment of Foreign Field Hospitals in disasters.[62] Compliance with these has been limited.[63] Similarly, the Tsunami Evaluation Coalition (TEC) found that many international agencies did not live up to their own standards with regard to respect and support for local and national ownership.[64] The lack of quality enforcement mechanisms means the same problems keep reappearing, and the failure of agencies to meet their formal commitments to SPHERE or Good Humanitarian Donorship principles suggests that the various quality initiatives are not having sufficient impact. The TEC recommends that, if improvement is to occur, there is a need for a regulatory system to ensure agencies put the affected population at the center of measures of effectiveness, and to provide detailed and accurate information to the donor public on assistance outcomes, including the affected populations' views of that assistance.[64] Such a system should recognize that "emergency humanitarian medical assistance is only part of medical practice and therefore needs training, accreditation, and accountability."[65] The international law of humanitarian response in peacetime is, however, remarkably undeveloped, and the establishment of international rules and standards does not mean people will comply.[66] Compliance and adherence to standards also requires funding; quality control through supervision is indispensable but expensive.[47]

Health needs to learn from solutions developed by other organizations with different approaches to leadership. The military have found proven MOE to be an effective way to define goals in the accomplishment of mission objectives.[67] There are inherent differences between the military and other organizations with respect to adherence to protocol and ability to enforce standards within an organization. There may also be differences in evaluation due to the significant cultural differences between the military and NGOs,[68] and the latter's independent nature.[20] If MOE are to be developed to predict the value or measure of a system or organization, they need to be operationally credible; have predictive values; be sensitive to factors influencing outcome; be measurable; support decision-making; be able to complement the operating system; be easily understood; be universally accepted; and improve, not worsen, efficiency, communication and coordination.[69] MOE also need to be measured more than once to be meaningful and show progress, or lack of it, toward mission accomplishment.[69] Similarly, the development of the International Search and Rescue Advisory Group (INSARAG),[70] has been achieved by a response element with more clearly defined roles and leadership. This has enabled development of accepted networks and international classification.

Limitations

This study represented an analysis of data collected on a cross-sectional survey of Australian DMAT members. This group may encounter different hazards and risks from humanitarian aid workers and other groups responding to disasters. In addition, the limited response from some states, particularly New South Wales and Victoria, suggested coverage concerns. The inability to follow up with survey participants may have contributed to the low response rate from these states. This is offset to some degree by the overall response rate, levels of experience among responders, and the representative mix of disciplines. Hence, although generalization and extrapolation of this data will therefore be limited, the data can be useful in developing a more effective response to deployment health of members of future DMATs.

Conclusions

This study of Australian DMAT members shows unanimous support for a clear command and control structure in future DMAT deployments. This is needed to ensure clear communication and assist coordination of response, as well as collaboration with, and cooperation among, different agencies. Failure to ensure this may lead to a disjointed or ineffective response, with both task omission and task duplication. There also may be risks to the health of deployed team members, and ultimately to the reputation of the sponsoring organization. This mandates clearly defined team roles and reporting structures, with clear identification of team leaders to assist inter-agency coordination. There was strong support for leadership training for DMAT commanders; however, further work is needed to define the contents of this program.

The authors recommend that team leaders are both selected and developed. Selection needs to occur against defined criteria which should include significant previous deployment experience, as well as leadership experience in their usual clinical roles. They should also be subject to the same "fitness to deploy" criteria as other team members, and ideally be able to fill a clinical role if needed. Nomination by other team leaders or team members is also recommended, rather than direct application for team leader positions, to help ensure their ability to work as part of a team. They should have no adverse post-deployment personnel reports. The development of these individuals should then be supported through a program that addresses issues such as knowledge of the emergency management and humanitarian aid system both nationally and internationally, team management, team welfare and security, conflict resolution, use of standards and indicators, communications protocols and equipment, and media management.

Despite limited use of measures of effectiveness, members of Australian DMAT would support the development and implementation of meaningful, evidence-based standards. More emphasis should be placed on this; however, further work is needed to identify or develop the actual standards and measures of effectiveness to be used, and to implement them.

Acknowledgments and Dedication

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Annex 25: Paper 5.5

Aitken P, Leggat P, Harley H, Speare R, Leclercq M. Logistic support provided to Australian disaster medical assistance teams: results of a national survey of team members. Emerging Health Threats 2012; 5: 10.3402/ehtj.v5i0.9750.

ORIGINAL ARTICLE

Logistic support provided to Australian disaster medical assistance teams: results of a national survey of team members

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Background: It is likely that calls for disaster medical assistance teams (DMATs) continue in response to international disasters. As part of a national survey, the present study was designed to evaluate the Australian DMAT experience and the need for logistic support.

Methods: Data were collected via an anonymous mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 Asian Tsunami disaster.

Results: The response rate for this survey was 50% (59/118). Most of the personnel had deployed to the South East Asian Tsunami affected areas. The DMAT members had significant clinical and international experience. There was unanimous support for dedicated logistic support with 80% (47/59) strongly agreeing. Only one respondent (2%) disagreed with teams being self sufficient for a minimum of 72 hours. Most felt that transport around the site was not a problem (59%; 35/59), however, 34% (20/59) felt that transport to the site itself was problematic. Only 37% (22/59) felt that pre-deployment information was accurate. Communication with local health providers and other agencies was felt to be adequate by 53% (31/59) and 47% (28/59) respectively, while only 28% (17/59) felt that documentation methods were easy to use and reliable. Less than half (47%; 28/59) felt that equipment could be moved easily between areas by team members and 37% (22/59) that packaging enabled materials to be found easily. The maximum safe container weight was felt to be between 20 and 40 kg by 58% (34/59).

Conclusions: This study emphasises the importance of dedicated logistic support for DMAT and the need for teams to be self sufficient for a minimum period of 72 hours. There is a need for accurate pre deployment information to guide resource prioritisation with clearly labelled pre packaging to assist access on site. Container weights should be restricted to between 20 and 40 kg, which would assist transport around the site, while transport to the site was seen as problematic. There was also support for training of all team members in use of basic equipment such as communications equipment, tents and shelters and water purification systems.

Keywords: *disaster*; *medical assistance*; *Australia*; *Southeast Asia*; *logistics*; *communication*; *disaster medical assistance teams*

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On 26 December 2004, the South East Asian tsunami hit countries around the Indian Ocean rim killing more than 250,000 people and affecting millions (1). Following the tsunami, seven civilian teams were deployed under AUSASSISTPLAN (2) with these listed in Table 1. The teams came from multiple states, deployed to a number of different countries and filled a variety of roles based on needs and timeline of response. This was the first time an organised civilian based team was deployed internationally representing the Australian government, with previous deployments the responsibility of the Australian Defence Force (ADF). Australia has since deployed teams to Samoa, Pakistan and New Zealand. Further deployments are likely given

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Table 1. Australian DMATs deployed following the Asian tsunami

Team	Number	Main States	Destination	Date deployed
Alpha	14	NSW (17), WA (7), Qld (3), Vic (1)	Banda Aceh	29 December 2004
Bravo	14		Banda Aceh	29 December 2004
Charlie	17	NSW/WA/Qld	Maldives	30 December 2004
Delta	5	NSW	Sri Lanka	30 December 2004
Echo	23	SA	Banda Aceh	7 January 2005
Foxtrot	24	Qld	Banda Aceh	18 January 2005
Golf	21	Vic/NT	Banda Aceh	29 January 2005

Key: NSW-New South Wales, WA-Western Australia, Qld-Queensland, Vic-Victoria, SA-South Australia, NT-Northern Territory

that some large disasters may overwhelm the best prepared of nations (3–5), while disasters are also more likely to occur in developing countries (6,7), with external assistance even more necessary.

Responding agencies must be prepared to provide the equipment and supplies needed to carry on their operations, often in austere environments or those with disrupted infrastructure. This needs to include food, water, accommodation, clothing, security, finances, communications and possibly transportation (8).

Much of the literature concerning DMATs, including the Australian DMAT experience (9–15) consists of anecdotal team reports. The lack of standards for DMATs has made in-depth evaluation difficult for external reviewers with few studies examining DMAT deployments and few dedicated studies of DMAT members in Australia. The present survey was part of a national program evaluating the Australian DMAT experience and examining potential models for future use in Australia. The survey was undertaken in order to target the existing Australian DMAT experience base and explore issues raised by these groups. The experience base primarily includes those individuals actually deployed and this aspect of the survey explores the issue of logistic support for DMATs. Specifically, we sought to determine the level of support for dedicated logistics in deployable teams and whether specific elements of logistic support caused more difficulties than others.

Methods

All team members associated with Australian DMAT deployments from the 2004 South East Asian Tsunami were surveyed via their State/territory jurisdictions. The study protocol was reviewed and approved by the James Cook University Human Research Ethics Committee in 2006 (Approval No. H2464). The support of the Commonwealth Australian Health Protection Committee (AHPC) was also sought and given for the survey. Representatives of the AHPC through their State and Territory jurisdictions identified 118 DMAT personnel from Teams Alpha to Golf and mailed out questionnaires on our behalf to preserve anonymity. No follow-ups were able to be undertaken.

Data were collected by means of a self-reporting questionnaire, which included an information sheet. The questionnaire was piloted and validated by use of a sample of senior medical staff with disaster deployment experience. The questionnaire was completed anonymously. A reply paid envelope was included for convenience; however other options for return were given, including facsimile. There were no penalties or rewards for participation, and informed consent was implied if team members completed and returned their questionnaires. The logistics component of the survey constituted four A4 sized pages and was comprised of simple tick-box format, Likert scale responses and free text comment. Data were also collected on demographic details of team members.

Data were entered into a spreadsheet program and analysed using the Statistical Package for the Social Sciences (Version 14.0, SPSS, 2006). Descriptive statistics were used, as the sample was relatively small.

A structured literature review was also performed in support of the survey using the search terms 'disaster medical assistance team', 'disaster team' and 'disaster' + 'logistics'.

Results

The overall response rate for this survey was 50% (59/118). The majority of DMAT members who responded had deployed to Aceh (39 members), while seven had deployed to the Maldives and one to Sri Lanka. Some had deployed more than once including subsequently to Yogyakarta (8 members). Team members responded from all states which deployed personnel with highest response numbers from Queensland (22 members), South Australia (14 members) and Western Australia (13 members). It is noted that response rates from both New South Wales (6 members) and Victoria (1 member) were lower than other states while overall numbers involved for Northern Territory were low (2 members). Responses were received from those with medical (24 members),

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nursing (11 members), logistics (6 members), allied health (3 members) and command (3 members) roles as well as mixed roles consisting of medical/command (2 members), medical/logistics (1 member), nursing command (1 member) and nursing logistics (1 members).

The majority of team members responding to the survey were aged 45–55 years (53%; 31/59) with 16 (27%) aged 25–35 years, eight (14%) aged 55–65, three (5%) aged 25–35 and one person (2%) aged more than 65 years of age. This is consistent with the mean level of clinical experience in their specialty of 21 years (SD = 9). Most respondents were male (75%; 44/59) with 23% female (14/59) with one response missing. 57% of survey participants (34/59) had significant experience in international disasters although very few felt they had experience in disaster management before deployment (5%; 3/59).

Survey responses are described in Table 2. There was unanimous support for dedicated logistics with 80% (47/59) strongly agreeing. Only one respondent (2%) disagreed with teams being self sufficient for a minimum of 72 hours with 75% (44/59) strongly agreeing. Most felt that transport around the site was not a problem (59%; 35/59); however, 34% (20/59) felt that transport to the site itself was problematic. Only 37% (22/59) felt that pre-deployment information was accurate. Communication with local health providers and other agencies was felt to be adequate by 53% (31/59) and 47% (28/59) respectively, while 20% (12/59) and 17% (10/59) disagreed with this. Only 28% (17/59) felt that documentation methods were easy to use and reliable. Less than half (47%; 28/59) felt equipment could be moved easily between areas by team members with even less agreement (37%; 22/59) that packaging enabled materials to be found easily. The maximum safe container weight was felt to be 20 to 40 kg by 58% (34/59) while 20% (12/59) felt this should be less than 20kg and 12% (7/59) opted for 40 to 60 kg. Survey participants were also asked to indicate if any essential items were not available. Of the 22% (13/59) that indicated yes, these were just as likely to be related to logistic support (17%; 10/59) as clinical care (17%; 10/59) or personal comfort (14%; 8/59).

Discussion

This study represented the first national survey of Australian DMAT members. The experiences of these deployed professionals in relation to logistic support for deployment should help inform future planning and preparedness. This is particularly relevant given the ongoing development of an Australian disaster medical assistance team (AUSMAT) program (16).

Critical to a successful health response are important non-medical elements such as communication, sanitation, safety and security, logistics, supply systems, administration and finance (17,18). Each organisation should develop its own logistics capacity (19) with logistics support a common element of many international models (20,21). The need for dedicated logistics was strongly supported by respondents in this study and reinforces comments from descriptive accounts of Australian deployments (14,15).

The logistics role may occupy a significant component of the team depending on the level of self-sustainability required. A typical US DMAT has 34 personnel with 7 non-medical team members (22), while the Canadian DART includes a 20-member logistics team to maintain self-sustainability in support of a 200 member team (23,24). Most Australian DMAT have used embedded external logistic support from agencies such as Fire and Rescue (11,15), emphasising the multi agency nature of response.

An effective and well co-ordinated logistics operation is crucial in a humanitarian context, with the need to respond quickly and efficiently essential during disasters (25). For this to occur, logistics needs to be incorporated prior to the response phase, and should be seen as an essential element of both pre and post deployment activities. Definitions of logistics differ, often based on organisation function. OCHA describes the basic task of a logistics system as being ‘to deliver the appropriate supplies, in good condition, in the quantities required, and at the places and time they are needed’ (26). In the immediate aftermath of any disaster, these supplies include items that are vital for survival, such as food, water, temporary shelter and medicine, among others, as well as the relocation of disaster-affected people, transfer of casualties, and the movement of relief workers (25,26).

Deployable teams must be self-sufficient (3,27–30). This avoids placing additional demands on the affected community for food, water and shelter (30,31) and is particularly important in austere environments such as post tsunami in Banda Aceh (11), or the Bam earthquake (32). This should cover at least the initial 72 hours (22,33), consistent with the results of this survey, but should ideally be for the duration of the stay (30,31). Food and water safety is important. Hazards include lack of hand washing facilities, inadequate refrigeration, use of unsafe ingredients and improper temperature controls. Water supplies for both team members and patients need to be included with an adequate amount of reasonably safe water preferable to a lesser amount of pure water (29). A minimum of 3 to 5 litres/person/day is needed for survival, with 15 to 20 litres for fluid replacement, personal hygiene, cooking and sanitation (34). Water safety methods include boiling for at least a minute (although fuel supplies may be limited) and chemical disinfection of water using sodium hypochlorite solution, iodine or halogen tablets (34,35). Logistic support should consider the use of supply rations airlifted weekly (24), or use of prepared meals such as military ration packs which can be eaten hot or cold (36). Locally prepared food with

Table 2. Levels of agreement of statements concerning logistic issues

Statement	1 Strongly disagree	2 Disagree	3 Neither disagree or agree	4 Agree	5 Strongly agree	Not applicable/ missing
There needs to be dedicated logistic support	0 (0%)	0 (0%)	0 (0%)	12 (20%)	47 (80%)	0 (0%)
Teams should be self sufficient for a minimum of 72 hours	1 (2%)	0 (0%)	3 (5%)	11 (19%)	44 (75%)	0 (0%)
Transport to the site was not a problem	6 (10%)	14 (24%)	8 (14%)	22 (37%)	9 (15%)	0 (0%)
Transport around the disaster site/s was not a problem	0 (0%)	14 (24%)	10 (17%)	25 (42%)	10 (17%)	0 (0%)
Pre deployment information was accurate	6 (10%)	19 (32%)	12 (20%)	17 (29%)	5 (8%)	0 (0%)
Communication with local health providers was adequate.	1 (2%)	11 (19%)	12 (20%)	26 (44%)	5 (8%)	4 (7%)
Communication with NGO's and agencies (e.g. EMA, AusAID) was adequate.	1 (2%)	9 (15%)	20 (34%)	26 (44%)	2 (3%)	1 (2%)
Documentation methods were easy to use and reliable	6 (10%)	27 (46%)	7 (12%)	15 (25%)	2 (3%)	2 (3%)
All team members should have the ability to use communications equipment.	0 (0%)	4 (7%)	0 (0%)	24 (41%)	31 (53%)	0 (0%)
All team members should have the ability to erect tents and shelters.	0 (0%)	4 (7%)	2 (3%)	26 (44%)	27 (46%)	0 (0%)
All team members should have the ability to use water purification equipment.	0 (0%)	3 (5%)	5 (8%)	26 (44%)	25 (42%)	0 (0%)
Packaging of equipment enabled materials to be found easily	9 (15%)	15 (25%)	11 (19%)	19 (32%)	3 (5%)	1 (2%)
Equipment could be moved easily between areas by team members	4 (7%)	13 (22%)	12 (20%)	24 (41%)	4 (7%)	1 (2%)

local ingredients is best received by patients and also supports the local economy (29). The minimum caloric intake level is 2100 kcal/day (29).

Sanitary disposal of human waste is essential to prevent contamination of water supplies and spread of communicable disease by insect or rodent vectors, while medical and biohazard waste must also be handled and disposed of carefully (34). Biohazard bags should be used with individuals responsible for disposal (37). The maintenance of personal hygiene is important for the health of team members, with access to hand washing, shower and laundry facilities, refuse disposal and chemical or pit toilets essential (29,34). Waterless hand sanitisers may need to be used (34).

Coordinated and organised equipment caches are essential (38). In addition to water, food and sanitation, base camp equipment should include shelter, generators, lighting and team medical needs (30,31). General equipment includes fuel cans, duct tape, spare bulbs, batteries and fuses, toolkit, tarpaulins and tools. All equipment must be tailored to the deployment environment with each team member able to use all equipment (39,40).

Teams should bring their own medical equipment, including patient shelter, based on the anticipated role and patient numbers. This should use local data and must be adaptable to local population needs (20). Both clinicians and logisticians should be involved with the detailed planning needed for supply of items such as oxygen, clinical waste disposal, and blood and blood products. Given space and weight considerations, drugs and fluids need to be chosen carefully (41), while oxygen concentrators use less space than oxygen cylinders (37). The storage and distribution chain needs to ensure medical material is kept within specified temperatures (42), and provides security of controlled substances (37). Teams need to take care if narcotics are imported and used in a crisis (43). Guides are available including WHO emergency health kits for primary health care workers designed to assist a population of 10,000 for 3 months, and fit on the back of a pick-up truck (29,44).

Equipment selection also needs to consider the working environment and the effects of noise, vibration, altitude, decompression and exposure to the elements. Power supply and battery life need to be considered (41). Specific items of equipment include point-of-care testing (POCT) and ultrasound, as access to diagnostic facilities may help decrease the numbers transferred to remaining hospital facilities (45). POCT should be considered by international assistance teams (41), and has proven useful in airborne critical care and during the Hurricane Katrina response (46).

Transportation can severely restrict operations and has been noted previously as a major problem after the tsunami (19,47,48). In this study transport to the site was seen as more problematic than transport around the site itself. Air transport support is critical (49) but all transport options may be effected depending on the disaster and local conditions, with an important logistics function being the ability to secure means of transport (50). Military affiliations may improve transport access with transportation able to be arranged by government (33).

To avoid delays, pre-event simplification of bureaucracy is essential. The UN has attempted to ensure simplified customs procedures including waiving of economic restrictions, duties and taxes, expeditious processing without examination, and simplified inspection procedures (51). Equipment manifests should be prepared in advance to help smooth international customs procedures (39). Failure to do this may lead to significant delays (44). Manifests also prevent material being omitted. Lack of a prior designated disaster cache may mean teams are unable to perform procedures due to a lack of equipment or power (52). Lists and pre-packing also makes operational set-up faster and easier and aids equipment access if packaged according to functional areas (36,53). Only 37% of the respondents felt packaging enabled materials to be found easily.

Given the need for large volumes of supplies and low likelihood of use, there are cost considerations with pre packaging. A loan arrangement with a supplier, with return of unused supplies, is convenient and economical (54). This may involve maintenance of storage and requisition lists within a Health authority and ability to activate the mobilisation of equipment and drugs. This ensures equipment and drugs are part of district supplies, and are constantly turned over reducing wastage (55). Other options are separate supply maintenance for a more rapid response, but drugs and supplies rotated every six months by external agencies (56). The provider must also expect that not all equipment will be returned post response (8). Stock rotation is not just important from a cost perspective, but also for functionality. Plastic and rubber materials may deteriorate, stock expire or changes in safety standards, such as needle-less intravenous lines (50), necessitating stockpile update. There are drawbacks with reliance on external partner organisations, and while private public partnerships are proposed as a means of improved community resilience (57), often logical and functional collaborations seem to fail when they are needed most (58).

Having equipment pre-packed in cases able to be carried by hand allows aircraft to be unloaded without machinery, and teams to move in and out of the disaster zone in small vehicles (37). Less than half the respondents felt equipment could be moved easily between areas by team members. The maximum safe weight was felt to be 20 to 40 kg, consistent with the US DMAT where each member is responsible for their own gear with weight limitations of 30 kg for warm weather and 40 kg for cold weather (22). While these weights are related to personal equipment, this still reflects safe maximum carriage weights for an individual. Unless logistics support can guarantee movement of equipment by machinery, all equipment, whether personal or team based, should be easily transportable by hand. Heavier items should be configured so they can be carried manually and clearly marked as ‘two-man’ or ‘four-man’ lift with handles for ease, and safety, of movement.

Communication and information management is one of the most consistent challenges in disaster response (23,28,59–61). Valid information is critical to enable decision-making and resource prioritisation (62) and the quality of disaster management may depend on the quality of communication and information (63). Both technical and organisational aspects of communication are important considerations in coordinating the health response (64).

Team members need to be able to reliably communicate with coordination centres locally and at home, and with other team members (31). Normal communication networks may not be functional (62) and there needs to be both alternatives and redundancy. Mobile phones have been used (52,65) but a communication vacuum may emerge once batteries fail (52). This is not restricted to international response—access to batteries and recharging may also be problematic with domestic deployment (50). Options include radios with the ability to change frequencies or operate underground, satellite phones, laptop computers and fax machines (31), while satellite communications has been used for telehealth in India and disaster management in large remote areas (66,67). The further development of wireless technology and peer networks may offer increasing solutions (59,60). There are security challenges with use of any technology (59), including media listening to mobile phone conversations on non-secure networks (23).

To achieve broad based, proficient handling of communications technology, it must be appropriate, easy to use, meaningful to the user, and capable of overcoming language and cultural barriers (61,67). While dedicated communications support is essential, and a common team element (20,21), all team members need to be trained in use of communications equipment (40). Communications support also needs to consider documentation. While few respondents in this survey felt that documentation methods were easy to use and reliable, this is not an uncommon problem. Medical records can be difficult to maintain at disaster sites. Solutions include waterproof military 'Casvac' cards, but civilians may not understand these (68).

It is important to avoid arriving with too many assets without a clear strategy on how they will be used (logistical push method) (69). Needs assessments should help determine equipment needs, with accurate pre-deployment information essential for this to be effective. Modeling approaches may also help. A basic key can be calculated and presetting done with final fit-out based on information from a forward team (70). Analysis of past experiences to determine patient characteristics, medications dispensed and investigations used may help in predicting casemix, medicines and supplies needed for subsequent similar deployments (71).

Logistics is arguably most developed in business supply chains and the military. There is an opportunity to learn from general supply chain mechanisms to enhance the coordination capacity of disaster supply chains (72–74). There are differences however. The primary objective of commercial supply chains is to minimise costs associated with business operations, while humanitarian logistics seeks to minimise the suffering of the affected population with cost a secondary consideration (74). Disaster logistics also has to accept that it will be unable to satisfy all needs and that aid needs to consider the human suffering associated with lack of access to a given good or service (deprivation costs), while commercial logistics does not usually experience the same level of resource scarcity or consequences of delivery failure (74).

Disaster logistics also faces significant challenges. There may be damage to infrastructure and communication systems, large volumes of critical supplies to be transported in a short timeframe if loss of life and property is to be prevented and a huge amount of uncertainty about what is actually needed, where it is needed, and what is available at the site (74). Sheu similarly classifies the challenges of emergency management logistics into four distinct areas:

1) Defining emergency logistics with note that the destination point in emergency logistics is near affected areas where people are living under emergency conditions;
2) An inability to control the timeliness of relief supply distribution, especially in the critical three-day period following a disaster;
3) Challenges in providing resource management for emergency logistics during periods of operational uncertainty and communications difficulties;
4) The demand for nearly inaccessible, yet crucial, real-time relief data (75).

The military have long recognised the importance of dedicated logistics support. This has been acknowledged as a key element of a successful disaster response (76), with the military approach possibly more suited to deployable team logistic support than commercial supply chain logistics. NATO defines logistics as 'the science of planning and carrying out the movement and maintenance of forces' (77). This includes material, personnel, facilities, services and medical and health service support (77). Of note, similar to deployable medical teams, rapid military deployments out of area require deployable logistic support units within combat formations, assured access to strategic lift and deployable logistic assets (77). The US Army have published a series of documents dating back to 1996, which have provided an action plan for logistics development. The tenets needed to achieve focused logistics are described as: a seamless logistics system, distribution-based logistics, total asset visibility, agile infrastructure, rapid force projection, and an adequate logistics footprint (78).

Tomasini and Wassenhove have recently proposed a humanitarian logistics model that, has some similarities to both NATO and the US Army tenets (79). This includes the flow of materials, information, finance, people and knowledge and skills in a system that needs to be agile, adaptable and aligned, consistent with Lee's Triple-A model of supply chains (79).

A number of overarching frameworks and mathematical models for humanitarian logistics exist, however, few of these are for deployed teams, instead focussing on distribution logistics (73) or vehicle routing in country (80). One example is a dynamic relief-demand management model for emergency logistics operations under imperfect information conditions in large-scale natural disasters (81). This consists of:

1) Data fusion to forecast relief demand in multiple areas;
2) Fuzzy clustering to classify affected area into groups;
3) Multi-criteria decision making to rank the order of priority of groups. While complex and more suited to large-scale operations, tests accounting for different experimental scenarios indicate that the overall forecast errors are lower than 10% (81).

It is important to recognise from this, that logistic support for deployable teams needs to integrate with the larger relief effort. This integrated approach is an essential component of the Cluster System. The Logistics Cluster service offers Inter-Agency Logistics Response Teams (LRT) and Inter-agency Transport and Logistics Services which includes set up of staging areas, strategic and tactical cargo movement by air and sea, mobile storage, ground transport capacity, infrastructure repair, office and accommodation facilities, and the necessary coordination and information management (82).

A number of international organisations also offer logistic support. The IFRC offers a Global Logistics

Service designed to not only support the core work of the Red Cross Red Crescent network but to share resources with other humanitarian organisations (25). Of note, the IFRC uses a decentralised disaster supply chain approach, which is felt to work much better than a centralised approach (83). OCHA has made available a 'Disaster Response Preparedness Toolkit', which includes resources, direct services and links (26).

Despite the availability of these resources and increasing recognition of the importance of logistics, a number of barriers need to be considered. These have been identified as the political-administrative factors that make it hard to organise an effective response (84), and the implications of organisational culture (85). Coordination has also been shown to be more effective when there are pre-established networks with local personnel. This mandates logistic preparedness where possible, or enabling 'swift trust' development (86).

This study represented an analysis of data collected on a cross-sectional survey of Australian DMAT members. This group may encounter different challenges to humanitarian aid workers and other groups responding to disasters. In addition, the limited response from some states, particularly New South Wales and Victoria, suggested coverage concerns. This is offset to some degree by the overall response rate, levels of experience amongst responders and the representative mix of disciplines. Hence, although generalisation and extrapolation of this data will therefore be limited, the data can be useful in developing more effective logistic support for deployment.

Conclusions

This study of Australian DMAT members reinforces the importance of logistic support for deployment of DMAT. There was unanimous agreement with the need for dedicated logistic support with strong support for teams to be self sufficient for a minimum period of 72 hours. There is a need for accurate pre deployment information to guide resource prioritisation with clearly labelled pre packaging to assist access on site. Container weights should be restricted to 20 to 40 kg, which would assist transport around the site. Transport to the site was seen as problematic and although recognised as inherently difficult pre-determined arrangements may help to some degree. All team members should be trained in use of basic equipment such as communications equipment, tents and shelters and water purification systems.

Logistic support should be incorporated into team structure before, during and post deployment. Deployable teams should have a logistic framework that is able to support the flow of all equipment and personnel in a timely and effective manner, and which is flexible enough to be able to adapt to an uncertain, and fluid, environment.

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Dedication

The authors wish to dedicate this research to the thousands of people affected by the South East Asian tsunami and Yogyakarta earthquake as well as those affected by recent events in Samoa, Pakistan and Christchurch.

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Annex 26: Paper 5.6

Aitken P, Leggat P, Harley H, Speare R, Leclercq M. Human resources support provided to Australian disaster medical assistance teams: results of a national survey of team members. Emerging Health Threats, 2012; 5: 10.3402/ehtj.v5i0.18147

ORIGINAL RESEARCH ARTICLE

Human resources issues and Australian Disaster Medical Assistance Teams: results of a national survey of team members

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Background: Calls for disaster medical assistance teams (DMATs) are likely to continue in response to international disasters. As part of a national survey, this study was designed to evaluate Australian DMAT experience in relation to the human resources issues associated with deployment.

Methods: Data was collected via an anonymous mailed survey distributed via State and Territory representatives on the Australian Health Protection Committee, who identified team members associated with Australian DMAT deployments from the 2004 South East Asian Tsunami disaster.

Results: The response rate for this survey was 50% (59/118). Most personnel had deployed to the Asian Tsunami affected areas with DMAT members having significant clinical and international experience. While all except one respondent stated they received a full orientation prior to deployment, only 34% of respondents (20/59) felt their role was clearly defined pre deployment. Approximately 56% (33/59) felt their actual role matched their intended role and that their clinical background was well suited to their tasks. Most respondents were prepared to be available for deployment for 1 month (34%, 20/59). The most common period of notice needed to deploy was 6–12 hours for 29% (17/59) followed by 12–24 hours for 24% (14/59). The preferred period of overseas deployment was 14–21 days (46%, 27/59) followed by 1 month (25%, 15/59) and the optimum shift period was felt to be 12 hours by 66% (39/59). The majority felt that there was both adequate pay (71%, 42/59) and adequate indemnity (66%, 39/59). Almost half (49%, 29/59) stated it was better to work with people from the same hospital and, while most felt their deployment could be easily covered by staff from their workplace (56%, 33/59) and caused an inconvenience to their colleagues (51%, 30/59), it was less likely to interrupt service delivery in their workplace (10%, 6/59) or cause an inconvenience to patients (9%, 5/59). Deployment was felt to benefit the affected community by nearly all (95%, 56/59) while less (42%, 25/59) felt that there was a benefit for their own local community. Nearly all felt their role was recognised on return (93%, 55/59) and an identical number (93%, 55/59) enjoyed the experience. All stated they would volunteer again, with 88% strongly agreeing with this statement.

Conclusions: This study of Australian DMAT members provides significant insights into a number of human resources issues and should help guide future deployments. The preferred 'on call' arrangements, notice to deploy, period of overseas deployment and shift length are all identified. This extended period of operations needs to be supported by planning and provision of rest cycles, food, temporary accommodation and rest areas for staff. The study also suggests that more emphasis should be placed on team selection and clarification of roles. While the majority felt that there was both adequate pay and adequate indemnity, further work clarifying this, based on national conditions of service should be, and are, being explored currently by the state based teams in Australia. Importantly, the deployment was viewed positively by team members who all stated they would volunteer again, which allows the development of an experienced cohort of team members.

Keywords: *disaster*; *medical assistance*; *Australia*; *Southeast Asia*; *human resources*; *indemnity*; *deployment conditions*; *disaster medical assistance teams*

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Disasters are increasing in frequency, with more than 10,000 disasters reported in the past 50 years, affecting 12 billion people and resulting in 12 million deaths (1, 2). Some large disasters will overwhelm the preparedness of any region or country, with probable calls for disaster medical assistance and humanitarian aid (3, 4). This will require the timely mobilisation of national and international resources. Disasters are also more likely to occur in developing countries (2, 5), where their effects may be more pronounced. On 26 December 2004, the South East Asian tsunami hit countries around the Indian Ocean rim, particularly around its earthquake-associated epicentre off Indonesia. The full impact of the tsunami is still being assessed years after the natural disaster, which is thought to have killed more than 250,000 people and affected millions (6). The tsunami was also a landmark event in the history of Australian disaster management, as it was the first time that organised civilian based teams, described elsewhere (7), were deployed under the Australian Assist Plan (AUSASSISTPLAN) (8). The agencies responsible for the organisation of DMATs have dual accountabilities. They need to provide the most effective response based on the needs of the affected community, while also ensuring the welfare, health and safety of those deployed, whether employees, contract workers or volunteers. It is, therefore, essential that staff deployed to provide disaster assistance not only have the appropriate backgrounds and expertise but human resources issues, such as deployment period, shift length, remuneration, insurance and indemnity have been properly addressed.

Much of the literature concerning DMATs, including the Australian DMAT experience (9–16), consists of individual team reports, which are often anecdotal. The lack of standards for DMATs has also made in-depth evaluation difficult for both an external reviewer and team members. Hence, there have been few studies examining DMAT deployments and few dedicated studies of DMAT members in Australia. The present survey was part of a national program evaluating the Australian DMAT experience and examining potential models for future use in Australia. The survey was undertaken in order to target the existing Australian DMAT experience base and both explore and identify issues raised by these groups. The experience base primarily includes those individuals actually deployed 'on the ground', and this aspect of the survey explores the human resources issues associated with their deployment.

Methods

The methods for this study have been described elsewhere (7). Briefly, all team members associated with Australian DMAT deployments from the 2004 South East Asian Tsunami disaster were surveyed via their State/Territory jurisdictions. Representatives of the AHPC through their State and Territory jurisdictions identified 118 DMAT personnel and mailed out questionnaires on our behalf. The human resources component of the survey itself constituted 25 questions. This was grouped as two sections which consisted of four questions in which respondents were asked to select an option related to time periods of deployment or shift length (all with opportunity for other response) and 19 Likert scale responses. There was also space provided for additional comment in each section. Data was also collected on demographic details. No follow-ups were undertaken due to conditions placed on the study by the ethics approval. Our study protocol was reviewed and approved by the James Cook University Human Research Ethics Committee in 2006 (Approval No. H2464). The support of the Commonwealth Australian Health Protection Committee (AHPC) was also sought and given for the survey. Data was entered into a spreadsheet program and analysed using the Statistical Package for the Social Sciences (Version 14.0, SPSS, 2006). Descriptive statistics were used, as the sample was relatively small.

Results

The overall response rate for this survey was 50% (59/118). The demographic details of the respondents have been given elsewhere (7). Survey responses are described in Table 1.

Approximately 58% (34/59) of those responding stated they had significant experience in international disasters before deployment. All except one respondent stated they received a full orientation prior to deployment. Despite this only 34% of respondents (20/59) felt their role was clearly defined pre deployment although approximately 56% (33/59) felt their actual role matched their intended role.

While 49% (29/59) stated it was better to work with people from the same hospital, only 12% (7/59) felt it was better to work with people from the same state. The majority felt that there was both adequate pay (71%, 42/59) and adequate indemnity (66%, 39/59). All stated they would volunteer again, with 88% strongly agreeing with this statement.

Most respondents were prepared to be available for deployment for 1 month (34%, 20/59), once placed on standby, while equal numbers were prepared to be available for two weeks (22%, 13/59) or longer than 3 months (22%, 13/59). Seven (12%) were only prepared to be available for one week and one person for 1 day. Five preferred unspecified other time periods. The notice

Table 1. Levels of agreement of statements concerning human resources issues

Statement	1 Strongly disagree	2 Disagree	3 Neither disagree or agree	4 Agree	5 Strongly agree	Not applicable/ missing
I had significant experience in disaster management before deployment	15 (25%)	33 (56%)	1 (2%)	3 (5%)	–	–
I had significant experience in international disasters before deployment	6 (10%)	12 (20%)	6 (10%)	14 (24%)	20 (34%)	–
My role was clearly defined pre deployment	14 (24%)	22 (37%)	3 (5%)	11 (19%)	9 (15%)	–
My actual role matched my intended role	3 (5%)	15 (25%)	8 14%	21 (36%)	12 (20%)	–
My clinical background was well suited to my tasks	3 (5%)	11 (19%)	8 (14%)	20 (34%)	13 (22%)	4 (7%)
I received a full orientation prior to deployment	–	1 (2%)	–	19 (32%)	33 (56%)	6 (10%)
It is better to work with people from the same hospital	4 (7%)	16 (27%)	10 (17%)	20 (34%)	9 (15%)	–
It is better to work with people from the same State	6 (10%)	17 (29%)	19 (32%)	5 (8%)	2 (3%)	10 (17%)
There was adequate pay	2 (3%)	7 (12%)	6 (10%)	29 (49%)	13 (22%)	2 (3%)
There was adequate indemnity	1 (2%)	4 (7%)	14 (24%)	23 (39%)	16 (27%)	1 (2%)
My deployment was able to be easily covered by staff from my workplace	–	13 (22%)	12 (20%)	25 (42%)	8 (13%)	–
My deployment caused an inconvenience to colleagues	4 (7%)	12 (20%)	13 (22%)	26 (44%)	4 (7%)	–
My deployment caused an inconvenience to patients	8 (13%)	23 (39%)	10 (17%)	4 (7%)	1 (2%)	12 (20%)
My deployment interrupted the ability to provide a clinical service in my workplace	7 (12%)	25 (42%)	10 (17%)	2 (3%)	4 (7%)	11 (19%)
My deployment benefited the affected local community	–	1 (2%)	2 (3%)	23 (39%)	33 (56%)	–
My deployment benefited my local community	1 (2%)	4 (7%)	29 (49%)	20 (34%)	5 (8%)	–
I enjoyed the experience	–	–	4 (7%)	11 (18%)	44 (75%)	–
My role in the deployment was recognised on return	1 (2%)	3 (5%)	–	28 (47%)	27 (46%)	–
I would volunteer again	–	–	–	7 (12%)	52 (88%)	–

needed to deploy ranged from less than 6 hours for 22% (13/59) to 3 days for a similar number (22%, 13/59). The most common period stated was 6–12 hours by 29% (17/59) followed by 12–24 hours for 24% (14/59). Twenty-seven respondents (46%) stated the optimum period of overseas deployment to be 14–21 days followed by 1 month for 15 (25%), 10–14 days by eight (14%) and 7–10 days by one (2%). Eight respondents (14%) preferred deployments longer than 1 month. The optimum shift period was felt to be 12 hours by 66% (39/59) and 8 hours by 22% (13/59). One person preferred 24 hour shifts, two preferred unstated 'other length' shifts and four did not respond to this question.

Discussion

This study represented the first national survey of Australian DMAT members deployed to date. The experiences of these deployed professionals in relation to the human resources issues related to their deployment have been sought and the findings need to be incorporated as part of future planning and preparedness. This is particularly relevant as the Australian Government continues to develop an Australian Medical Assistance Teams (AUSMAT) program (17), with recent deployments to Samoa, Pakistan and New Zealand.

This study of the Australian DMAT experience found that although team composition was varied, health professional membership was consistent with that described by other authors (18). The DMAT members had significant clinical and international experience, although most had little or no experience in disaster management.

Clinical background, role and team selection

An essential human resources issue is team selection, which must be tailored to meet the specific needs of the affected community (19) and based on a full understanding of the type of disaster and expected injury patterns (20–22). Central to this is the clinical background of team members and roles in deployment. The importance of team structure (15) and team member selection (9, 15) has been noted previously in reports of Australian DMAT activity with team success very much dependent on the selection of the right person for a specific job crucial in both normal and emergency situations (23). Despite nearly all receiving an orientation pre-deployment there were concerns expressed in this study by team members who did not feel their clinical background was well suited to their tasks, their role was not clearly defined pre deployment or that their actual role did not match their intended role. While this may reflect planning and team selection issues, it should also be noted that, for early deployments, there was little time available for full orientation to occur and that needs change rapidly.

To be effective, teams need to be multidisciplinary, have the appropriate training, and have predefined strategies for how to carry out these tasks. While planning should aim to keep roles as close as possible to the respondents' usual daily duties (24), those selected should also have as broad a base of experience and expertise as possible to increase their value and ability to work in a variety of situations (25), with flexibility the key. Administrative staff should also be health professionals who can serve two or more roles in a deployment (26). There also needs to be a clear understanding of all team members' roles and responsibilities, and how they contribute to the overall objectives (27). Job identification and responsibility are essential for staff morale, with team cohesiveness helping them better withstand prolonged exposure to the stresses generated by the disaster (28). A review of the coping mechanisms of health care teams in Thailand following the tsunami, found those who had volunteered for teams, were found to be more supportive of other team members, than those simply asked to work with teams. This was thought to reflect the contribution of positive attitude towards motivation and team function. In this study most respondents had been asked to go (28). Selection should also not be based entirely on skills; fitting into a team and being able to carry out the work required in the field is more desirable (29), reinforcing the need for pre-deployment screening of both physical and psychological health (30).

The selection process needs to be rigorous and complete. In the US example, people wishing to become NDMS team members need to complete a federal application, submit to background checks, maintain their professional credentials, be able to physically perform their assigned job, and comply with training requirements. The social and personal impact of deployment is considered in even more detail by some organisations which have found having partners attend an introduction day where they gain an understanding of the commitment and dangers may eliminate a number of applicants (29). Organisations need to be sure that volunteers have considered the effects of deployment on themselves, their home life and career; conditions of work in the field; support and funding; any issues of conscience and what it will be like returning home (29, 31).

Experience

Unfortunately, the majority of people responding to international disasters may be novices who volunteer for short periods then return to their normal occupations without passing on their experiences (32). The growing need for disaster relief work and a rapid response has led many organisations to place inexperienced or inadequately trained personnel in the field. Such inexperienced but enthusiastic workers may be of limited or decreasing usefulness (33), and may even have a negative impact as such personnel can threaten the success of a program, frustrate beneficiaries and donors, and damage the credibility of the agency (34). The Tsunami Evaluation Coalition made note of the lack of career structure in general for international relief work which encourages this high staff turnover, general shortage of relevant expertise and recruitment of inexperienced personnel (35). The development of future models should seek to develop and retain the core of experience developed from previous deployments.

Local and state based teams

The preference in this survey was to work with people from the same hospital rather than simply with people from the same state. Reasons for this were not explored but there are obvious team advantages with established working relationships. Each US DMAT has a sponsoring organisation, such as a major medical centre (18, 31). This means US DMATs may serve two different functions. They act as a local resource to the institution sponsoring them, and can also be activated as a federal reserve (26). There can, however, be problems with availability if all staff come from one institution. Even a hospital the size of Massachusetts General has found constraints with the ability to cover staff deployment (36, 37), while both staff availability, and ability to cover their absence, has also been an issue for the US military (37). Having a regional base for team membership may spread deployment load, help maintain local service delivery and increase response capability through a jurisdiction and allow enhanced intra-jurisdictional response if the primary institution is affected. Ease of access to ongoing training programs, through geographic proximity, should still enable relationship and team building to occur.

Period of availability and notice

Most respondents were prepared to be available for deployment, once put on notice, for 1 month, which is consistent with the US DMAT experience (31). Rotating call periods are essential to cover leave and existing work commitments. Although local people provide the first response, there may still be a need to respond quickly once activated (25), depending on the role of the deployment. Teams need to have a response structure and strategy in place that can be activated immediately (38), which includes all team members having current passports (25). The notice needed to deploy in this survey ranged from less than 6 hours to 3 days, with the most common period required being 6–24 hours. There are also inherent delays in activation given the request for aid must travel through pre-established diplomatic channels once the affected country has determined that its own resources have been overwhelmed or destroyed (5, 25). While this takes time, 'shortcutting' this procedure may have unwanted consequences including perceived invasion, incarceration of relief staff, and political repercussions (25). Teams and individuals who respond to disasters without authority or accreditation will only add to the problems of the affected country, further draining their resources (38).

Period of deployment and shift length

Redmond et al. note that, after 5 days on scene, both mental and physical exhaustion can set in, reducing the effectiveness of the team and increasing the risk to patients. A strict rule to disengage after 5 days was used by their Manchester based team and had to be accepted by the team before departing (39). In contrast, the preferred period of deployment in this survey was 14–21 days with longer periods of deployment such as 1 month or longer also preferred to shorter periods of deployment.

This longer deployment period mandates a need for extended operation planning (40) and development of measures to minimise both physical and mental fatigue (41). This includes the provision of rest cycles, short breaks, food, temporary accommodation and rest areas for staff as an aid to management of stress and morale (40). Leisure time activities are also often limited due to safety concerns, power shortages, curfews, transport difficulties and the closure of local businesses (42). Rest breaks may need to be enforced as the temptation is for off duty staff to 'hang around' (18, 27, 41), with rest often difficult when teams work in 12-hour shifts as preferred by respondents in this study.

Funding and indemnity

The funding model has a great influence on the scope of the project (27). Significant expenditure can be anticipated and will vary according to the type, extent and magnitude of the disaster, the number of people sent, the type and amount of equipment, and the length of time deployed, while team members also need to have job security and medico-legal indemnity (25). While most felt that there was both adequate pay and adequate indemnity this needs to be predetermined with funding, insurance and indemnity issues resolved before deployment, including guidelines on what will be funded on deployment and policy developed on use of cash advances and credit card use (16). National conditions of service would also aid inter operability of state based teams (15).

The US approach of 'federalising' DMAT members for operational deployment eliminates a number of potential problems, including licensing issues (18, 31, 43, 44), liability (31), insurance coverage (43, 33), and wage guidelines (18). Although training is usually voluntary (44), they are treated as Federal employees for the duration of duty, so their expenses are met, and they are paid or have their normal salaries reimbursed by the US Public Health Office (31, 45). This also means they have the protection of the Federal Tort Claims Act, in which the Federal Government becomes the defendant in the event of an interstate malpractice claim (31). In return, DMAT members are required to maintain appropriate certification and licensing within their discipline (31, 45). This option has since been explored by some state based AUSMAT in Australia, including Western Australia, which now has position numbers within the human resource system to enable all AUSMAT members to become short term state health department employees to address these issues whilst on deployment.

Deployment was felt to benefit the affected community by nearly all, while less felt that there was a benefit for their own local community. This is a reflection of the direct and tangible benefits provided to the affected community versus indirect and intangible benefits for the donor community. Nearly all felt their role was recognised on return, they enjoyed the experience and would volunteer again. This is important as it aids retention of an experienced cohort and when supported by an appropriate policy framework and database assists future deployment of teams most likely to add value to the affected region.

This study represented an analysis of data collected on a cross-sectional survey of Australian DMAT members. There was a 50% response overall, but a limited response from some states, particularly New South Wales and Victoria, suggested coverage concerns. The inability to undertake follow-ups, due to ethics limitations, may also have contributed to the poor response in these jurisdictions. Of the seven teams deployed, four were mixed state teams and three were single state teams with four deployed initially and three up to 1 month later. The five-person team deployed to Sri Lanka and was most at risk of not being represented. This is offset to some degree by the overall response rate, small size of that team, other teams being deployed in the same response phase, levels of experience amongst responders and the representative mix of disciplines. The use of self reported data and the inherent limitations of this are also acknowledged. Hence, although generalisation and extrapolation of this data will therefore be limited, the data can be useful in developing a more effective response to deployment health of members of future DMATs.

Conclusions

This study of Australian DMAT members provides significant insights into a number of human resources issues and should help guide future deployments. The preferred 'on call' arrangements were for periods of 1 month while the majority needed between 6 and 24 hours notice to deploy. The preferred period of overseas deployment was 14–21 days with 12-hour shifts. This extended period of operations needs to be supported by planning and provision of rest cycles, food, temporary accommodation and rest areas for staff. While uncertainty is inherent in this style of deployment, the study also suggests that more emphasis should be placed on team selection and clarification of roles. Only 34% felt their role was clearly defined pre-deployment and 24% felt their clinical background was not well suited to their tasks. Working with others from the same hospital was preferred to state, regional or national based teams, and, although respondents acknowledged the inconvenience their deployment caused to their colleagues, they did not feel it interrupted service delivery or inconvenienced patients. While the majority felt that there was adequate pay and adequate indemnity, further work clarifying this based on national conditions of service should be, and are, being explored currently by the state based teams in Australia and the Australian Health Protection Committee. Importantly, the deployment was viewed positively by team members who all stated they would volunteer again, which allows the development of an experienced cohort of team members.

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Dedication

The authors wish to dedicate this research to the thousands of people affected by the South East Asian tsunami and Yogyakarta earthquake, as well as those affected by recent events in Samoa, Pakistan, New Zealand and Japan.

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