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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), 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

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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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