JAMES COOK UNIVERSITY

Investigation of the optimal assessment of febrile passengers detected by infrared thermal scanning at an international airport

Final Report

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Professor William John McBride
Dr Elizabeth Buikstra (Project Manager)
School of Medicine
Cairns Campus
James Cook University

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Further copies may be requested from Professor John McBride, School of Medicine, James Cook University, PO Box 6811, Cairns, QLD 4870, Australia.

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Executive Summary

Introduction

Australia is preparing for an influenza pandemic and the H5N1 strain of influenza virus is of current concern to global authorities (Commonwealth of Australia, 2006a). The use of infrared thermal cameras is part of the Australian Management Plan for Pandemic Influenza (Commonwealth of Australia, 2006a). In 2003, the Severe Acute Respiratory Syndrome (SARS) epidemic presented countries with the challenge of detection and quarantine of a communicable febrile illness and this experience has been used to improve strategies for an influenza pandemic. Some countries, including Australia, relied on visual inspection to detect SARS, whereas others such as Hong Kong, Singapore, Taiwan and Canada utilised infrared thermal cameras. The Australian approach was largely unsuccessful (Samaan, Patel, Spencer, & Roberts, 2004), whereas thermal cameras had some success detecting SARS (Chiu, Lin, Chiou et al., 2005).

One country, Taiwan, has emphasised other benefits for infrared thermal screening of incoming passengers (Shu et al., 2005). Between July 2003 and June 2004 fever screening at Taiwan airports detected 40 incoming passengers with dengue fever compared to eight detected by their usual active surveillance (Shu et al., 2005). As North Queensland is receptive for dengue fever epidemics, the detection of dengue fever cases by thermal screening at the Cairns international airport may be an important public health intervention in its own right.

The Australian pandemic plan includes nurses placed at borders for the purpose of detection of influenza only (Commonwealth of Australia, 2006b). Febrile passengers will be offered health advice which remains focused on the symptoms of influenza. The detection of febrile travellers with assessment of only one disease will be criticised if it were found subsequently that a patient with another disease of public health significance was detected by fever screening but not investigated. The hurried deployment of cameras in the highly charged atmosphere of an influenza pandemic is not desirable. There is no Australian research on how best to deploy thermal scanning devices and information obtained from this study provides an evidence base for the most effective deployment of infrared cameras and management of travellers found to be febrile at an international border.

Fever screening at airports, as currently planned, will involve strict protocols and whilst addressing the public concerns with respect to the detection and quarantine of pandemic influenza, does not address the health concerns of the febrile traveller. The cost effectiveness of positioning qualified staff fulltime at airports has been questioned. General Practitioners (GPs) could be an alternate provider for the assessment of febrile travellers, as long as there is a form of quality assurance and high rates of cooperation amongst the travelling public. The “outsourcing” of these assessments may be more cost effective and more satisfying for the affected traveller.

The aim of the study was to determine the optimal method of assessment of febrile passengers detected by infrared thermal screening at an international airport. The study compared immediate investigation of febrile passengers with assessments by GPs. Study measures included the participation rate of passengers, and whether there were cost barriers for passengers contemplating a visit to a GP. Rates and causes of fever were measured in febrile passengers (including information gained from participants about their country/port or origin). Additionally, observations were made about the optimal positioning and operation of the infrared thermal cameras.

Method

There were three intervention arms to the study. Intervention arm 1 (GP Assessment: Patient to Pay) consisted of advice to febrile passengers to visit one of a number of GPs that were named on a list provided to participants. Intervention arm 2 (GP Assessment: Costs Compensated) was the same except that the febrile passenger was informed that there was no cost for the initial general practice visit, one follow-up visit and pathology testing. Intervention arm 3 (Nurse Assessment) was an immediate investigation for the common causes of fever by a trained health practitioner using a specifically designed protocol.

An infrared thermal camera was deployed in a number of different locations at the Cairns international terminal building including: post-primary (after the first immigration/customs entry point), pre-primary (on the mezzanine floor before the first Immigration/Customs entry point), on an aerobridge (aerobridge 1 on one Air Niugini flight), and on an empty aircraft.

Fever was verified by means of a tympanometric measurement (Braun ThermoScan Pro4000 Therm). Study documentation was developed to record information from the thermal camera and the enrolled participants. Information sheets and consent forms were provided in the three most commonly used languages (English, Japanese and Traditional Chinese).

One project manager and seven research officers were employed to conduct the study. Eight GPs were recruited to evaluate febrile travellers during the project. The project was governed by a working group which consisted of representatives from AQIS, Customs, Cairns Port Authority, and James Cook University. This group met regularly during the study in order to discuss the logistics and operation of the project.

Early in the study, it was observed that there were low numbers of participants who visited GPs. The research staff was asked to observe passengers’ behaviour throughout the project, particularly those passengers who were febrile and those who had enrolled into the project, and provide some perceptions and insight to the research team regarding possible reasons for their disinclination to visit GPs.

Summary of Results and Discussion

Flights, Passenger Numbers, and Rates of Fever

There were 196,700 passengers who arrived into the Cairns International airport during the data collection period (April to September 2006). This figure did not include passengers in transit. A total of 181,759 passengers (92.4%) were screened using the thermal camera. Air New Zealand did not agree for their passengers to be screened and up to 1400 passengers per month were consequently not screened. Unscheduled flights were not screened.

The largest number of flights arrived from Port Moresby, closely followed by the Japanese port of Narita. When the ports of origin figures were grouped, the Oceania ports accounted for 49.97% and the Japanese ports accounted for 35.3% of the incoming flights. A large number of flights arrived from Brisbane and Sydney (total ≈17%). Unless the passenger was enrolled into the project and provided information on the questionnaire, the port prior to the Australian ports was unknown. Flights arriving from Hong Kong accounted for 4.27% of the flights.

Screened passenger numbers varied from month to month and ranged from a low of 27,655 in May to a high of 33,071 in August. The largest number of passengers arrived from Narita, followed by Nagoya and Osaka. The Japanese ports accounted for 61.25% of the incoming passengers. The Oceania ports represented over 18% of passenger numbers, whereas Asian ports accounted for 10.95%.

There were 118 passengers identified as febrile ($\geq$ 37.5ºC with symptoms, or $\geq$ 37.8ºC regardless of symptoms). This represented 0.06% of screened passengers.

The rate of febrile passengers arriving from each port and region of origin was calculated. 0.03% of the Japanese passengers were febrile, 0.18% from Oceania, and 0.09% from Asia. The high rate of fevers entering from Oceania ports contributed significantly to the overall fever rate.

Febrile Passengers Enrolled

There were 1052 (0.6%) passengers whose surface temperature exceeded the infrared camera alarm threshold. 963 (91.5%) of these agreed to have an ear temperature measurement. Of the 118 febrile passengers detected by this two-step screening process, there were 76 passengers (64.41%) who consented to be in the study. Eighteen passengers (23.7%) were enrolled into the Nurse assessment arm, 31 (40.8%) into the GP assessment: costs compensated arm and 27 (35.5%) into the GP assessment: patient to pay arm. There was a slight male preponderance. The average age for participants was 29 years with a range from 19 months through to 64 years.

Participants came from a wide range of countries, with Japan and New Guinea accounting for almost half of the participants. Australians returning home from abroad accounted for nearly a fifth of participants. Participants arrived from many different ports with those arriving from the Oceania ports accounting for 46% of the total number of enrolments. Participants arriving from Japanese and Asian ports accounted for 19.7% and 29% of enrolments respectively. A comparison of the countries of residence with the ports of origin from which participants travelled indicated that people who lived in New Guinea travelled from that port, and those who lived in Australia frequently travelled from New Guinea. Japanese travellers usually travelled directly from Japan. People who lived in other parts of the world travelled from a wide variety of ports. Participants visited many different countries in the last 10 days, with New Guinea the most common port.

There were a variety of accommodation choices made by participants when they arrived in Cairns. Over 40% (n=32) had planned to stay at a local resort, hotel, motel or backpackers. Twenty eight percent (n=21) were staying in private accommodation locally, whereas others were in transit to other destinations. Five participants had not prearranged any accommodation. Most participants stayed in Cairns for up to 7 days, suggesting that Cairns is used primarily as a tourist destination. Forty participants (52.6%) had travel insurance.

The duration of illness prior to enrolment ranged from 0-10 days. Most people started to feel unwell either the day before or on the day that they had arrived at the Cairns International Airport. The most common symptoms experienced by participants were cough, headache, sneezing, and runny nose. Participants' temperatures ranged from a low of 37.5°C to a high of 40.3°C with a mean of 37.9°C.

The number of participants who received an immediate medical assessment at the airport (nurse assessment arm), or a delayed assessment with a GP (GP assessment – costs compensated/patient to pay), was 19 of the total 76 enrolled (25%). There was no statistically significant difference between the 3 different approaches.

The diagnoses included malaria (2), viral respiratory tract infection (6), upper respiratory tract infections (2), gastroenteritis (2), viral gastroenteritis (2), Influenza A, Pneumonia, viral meningitis (EBV) conjunctivitis and skin infection (one each). These findings are consistent with previous studies, which have found that whilst malaria is a common cause of fever, most travellers who are febrile have common conditions, such as respiratory tract, gastrointestinal, and urinary tract infections (Bacaner & Wilson, 2005; McClellan, 2002).

Optimal Method for Management of Passengers

An innovative aspect of this study was the recruitment of an interested group of GPs who acted as sentinel practices for the evaluation of febrile travellers. It was hypothesised that the involvement of GPs in providing a clinical approach to investigation and follow up might achieve a better outcome than qualified staff at airports, but that the costs involved with visiting a GP could be a barrier to uptake of this service by travellers. The research team expected that the convenience of on-the-spot investigation would result in most passengers in the nurse assessment arm being investigated. The findings of this study did not support this hypothesis. The low rate of investigation of participants offered immediate testing was a surprise, suggesting that removal of cost and time barriers were not sufficient to ensure high rates of investigation amongst febrile passengers.

The data was analysed for any parameters associated with an individual seeking some form of health assessment, whether from the GP or the health professional (research officer) at the airport. People who had dyspnoea were more likely to accept a health assessment (from nurse or GP). People with temperatures over 38.5°C were more likely to visit the GP. Participants with a cough were more likely to visit the GP or have had pathology tests. Older people, or people arriving from New Guinea, or if they had arthralgia were more likely to have pathology tests.

The findings are broadly relevant to a pandemic influenza scenario. The Australian Pandemic Plan provides a range of options for quarantine and assessment by GPs either in the surgery or at home, depending on the stage of the epidemic. The findings of this study suggest that qualified health professionals should be based at the airport during the pandemic and that mandatory quarantine and testing occur for passengers who are identified as having potential or probable avian influenza. Whilst there was no pandemic influenza crisis during the period of this project, others have reported that some travellers will not seek health care advice during times of crisis. This was observed in mainland China when during the SARS epidemic some travellers were not using masks, were visiting crowded places, and delayed consulting with medical professionals (Lau, Yang, Tsui, & Pang, 2004).

A mandatory approach was used in Singapore during the SARS epidemic where the Infectious Diseases Act was quickly amended to expand the power of the Ministry of Health to prevent and control the spread of SARS. Among the new powers, SARS cases or contacts and suspected SARS cases or contacts, people recently recovered from SARS or who had recently been treated for SARS could be issued with home quarantine orders and compulsory medical examinations. Whilst this seemed to be a harsh measure, there was provision for a $70 per day compensation for people in compulsory quarantine. (Tay Swee Kian & Lateef, 2004).

There is a negative side to introducing measures that diminish individual autonomy and privacy in exchange for collective benefits (Gostin, 2001). Teo, Yeoh and Ong (2005) used Singapore as a case study to discuss the introduction of measures that were targeted at creating a ring of defence around the island and using surveillance to monitor and prevent its spread. Teo et al. found support for the changes; however, there was also resentment among some Singaporeans who complained that their right to privacy had been invaded. The WHO applauded Singapore for introducing a quick and effective response; however, it was the authors' belief that a holistic approach to the management of infectious disease must address the social and psychological implications of strategies that are predicated by medical science, otherwise it is likely that people will suffer unnecessary upheaval, become distressed and would be less likely to cooperate (Teo et al., 2005).

Help Seeking Behaviour and the Low Rates of GP Visits

A theoretically driven and culturally relevant model requires the examination of individual perceptions, attitudes, and beliefs which are embedded in family, community and environmental contexts that may influence the individual's health care seeking behaviour (Bhattacharya, 2004; Pescosolido, 1992). Individual perceptions of the costs and benefits influence health care seeking decisions (Bechtel, Shepherd, & Rogers, 1995; Bhattacharya, 2004). It is unlikely that a person will take a course of action, such as seeking help from a medical professional, unless the perceived costs (e.g., monetary, time, fear, etc.,) are offset by their strong motive to reduce personal health consequences. The perceived consequences of having a fever may not be sufficient for affected travellers to seek health care assistance.

In seeking to have passengers agree to be investigated for an infection such as dengue fever (analogous to pandemic influenza in public health significance) we were asking them to bear costs for themselves that are not primarily for their own benefit but for the benefit of the community into which they would be moving. Given the difficulties in getting people to act for their own benefit, it follows that it would be even more ambitious to try to effect a behaviour change that is rather more altruistic. Effective detection of diseases of interest would almost certainly require mandatory investigation of febrile passengers entering the country.

Use of the Infrared Thermal Camera to Screen for Fever

This study supports the thermal camera as it is a non-invasive, passive, portable and fully self-contained piece of equipment that can be easily transported and set up within a few minutes (Seffrin, 2003). It is a rapid, cost effective and reasonably accurate way to screen large groups of people for fever, with the ultimate purpose of identifying SARS or other fever-related diseases of public health significance (E. Y. Ng, 2005).

Out of the 181,759 screened international passengers, thermal camera temperatures exceeded preset alarms and were recorded for 1334 passengers, which represents 0.73% of arriving passengers. This also indicates that 99.27% of passengers were not delayed by the screening process. Of this group, 1248 core body temperatures were recorded. On 1239 occasions the tympanometric temperatures were higher than the temperatures recorded by the thermal camera. On the nine other occasions, observations of passengers suggested that they had either skin rash, sunburn, had been drinking or had sinus problems which may have contributed to the skin temperature being higher than the core body temperature. These are common sources of potential error that can impact on accurate infrared temperature measurement (E. Y-K. Ng, Kaw, & Chang, 2004; Seffrin, 2003). We found a correlation of 0.4 between skin temperature readings and the core body temperatures readings, with the core body temperature being consistently higher than the skin temperatures. This was a strong positive relationship. E. Y-K. Ng et al. (2004) also found a good correlation between skin and core body temperature in their effectiveness study.

Alarm temperatures could be set by two methods. Firstly, the alarm temperature was set at 1.3°C above the reference temperature (average of the previous ten sampled passengers). Secondly, the alarm temperature value could be preset. In this case, the alarm was preset at 35.4°C (based on previous data). A trial of both methods was undertaken. When the alarm temperature was set using the reference temperature, the mean temperature alarm threshold was 35.3°C with a standard deviation of 0.3°C, with temperatures ranging from 34.2°C to 36°C. A comparison of these two methods suggests that some febrile passengers may have been missed during the period when the alarm on the thermal camera was preset.

Deployment of the Infrared Thermal Camera at Different Sites

The major site for deployment of the thermal camera was the post-primary trial site which was situated just after the Immigration/Customs booths in the Cairns international terminal building. This was the site negotiated with the working group that would have the least impact on passenger flow. The trial occurred over a 21 week duration broken into two separate timeframes (1 April to 9 June and 15 July to 29 September). This was the preferred site for the fever screening as passengers came out of the Immigration/Customs line in an orderly fashion and were generally not in a great hurry as they were yet to collect their baggage from the carousels before entering the AQIS check-point.

The post-primary site meant there would be some mixing of passengers. It was important, in the context of influenza, to trial the thermal camera at sites where there would be minimal or no mixing of passengers between flights. There were three locations where there would be minimal mixing between flights. The pre-primary location which was situated on the mezzanine floor was one of the sites. This site was located just above the Duty Free store and the Immigration/Customs booths. There would still be some mixing of passengers at this site when flights arrived at the airport at the same time. We were advised from airport personnel that passengers would mix for a maximum of about 10 minutes. The other sites included the concourse just below one of the aerobridges and screening passengers onboard an aircraft. At both these sites, there would be no mixing of passengers amongst flights.

The pre-primary trial occurred over 5-week duration between 10 June and 14 July. Whilst this site was initially identified as being a better site with less passenger mixing, the research officers found it quite difficult to engage with passengers who were hurrying to the Immigration/Customs line. Some repositioning of the tensa barriers occurred and was partially successful at slowing passengers down; however, whilst passengers did slow down they were still less interested in participating (i.e., having core body temperatures taken or participating in the project) because of their need to get to the Immigration/Customs line. Based, on research officers' comments it was likely that some febrile passengers may have been missed; however, statistical analyses comparing the pre-primary site with the post-primary site across febrile passengers indicated that it was unlikely that any febrile passengers were missed while the camera was located at the pre-primary site.

The aerobridge trial occurred on one occasion on 30 June. Whilst the trial occurred on one occasion with one flight only, it seemed to be very successful, with passengers walking down the aerobridge onto the concourse and without hesitation forming a single file past the tensa barriers. It was felt that this set up would work very well with other flights. As there were no febrile passengers identified from this flight, this trial site could not be statistically compared with other sites. The major disadvantage of this approach is that multiple sets of screening equipment would be required for each aerobridge, and on occasion, extra staffing to cope with concurrently arriving flights.

The last trial of the thermal camera occurred on an empty aircraft. Members of the working group felt that this would be the least disruptive way of trialling the camera onboard an aircraft (i.e., there would be no impact on passenger travel). The trial occurred on one occasion on 23 August. Volunteers from various airport agencies were recruited to act as passengers. This trial was the least successful of the four trials. There were four major issues identified. Firstly, the camera needed to be held at a distance of at least 2 metres from the person's head (E. Y-K. Ng et al., 2004). In order to achieve this distance, the operator needed to hold the camera above their head. This still did not achieve the required distance, causing the camera to alarm frequently. Another issue encountered was passenger behaviour onboard the aircraft. In order to gain an appropriate reading of skin temperature, the passenger needed to be reasonably still and face forwards. Passengers expecting to depart the aircraft usually move around their seats, gather their belongings, deal with their children, and are generally restless. Whilst this behaviour might be overcome with adequate communication and information onboard the aircraft, there are likely to be passengers who will still not be sitting in the correct position when being screened increasing the time taken to screen. Also, aeroplane windows facing the sun caused the alarm to sound, even after the shades had been drawn. The final issue of concern was the time taken to screen a plane load of passengers. In an empty Boeing 767, the screening time ranged from 5 to 8 minutes (2 trials). This is a long time for passengers to wait until they are able to depart the aircraft.

Logistic Issues

A number of logistic issues were addressed during the conduct of this study. Some useful dot points for consideration for future similar exercises are listed.

- Aviation security identification cards (ASIC) normally take about six weeks to issue. Without these cards staff cannot work unaccompanied in the airport.
- Access to the first aid room could normally only be effected by the duty chief security officer (CSO). Special arrangements were made to issue our staff with a key.
- There are no arrivals at the international airport between midnight and 0400. Staff from other agencies were not present during this period and research staff who were rostered on to cover flights on either side of this period were initially allowed to stay at the airport. This permission was withdrawn later in the study for safety and security grounds. This needs to be taken into account in designing rosters.
- On one occasion passengers missed a connecting flight on the basis of their participation in the study. Protocols were amended to ask passengers specifically about connecting flights and to not proceed with enrolment in the study if that flight was due to leave within one hour.
- Thermal imaging inevitably detected passengers with illness that would not otherwise have been detected. AQIS expressed the view that they have a legal responsibility to assess passengers with a temperature of greater than 38°C. Airlines also insisted on knowing about sick passengers. Ad hoc communication strategies were developed to address these requirements. Use of thermal imaging outside of the research context would require more formalised communication plans.
- It was appreciated that in any induction course for operators of the thermal scanners, some training on culturally appropriate gesturing would be useful.

1.0 Introduction

1.1 Influenza Pandemic

Australia is preparing for another influenza pandemic. Previous pandemics have caused millions of deaths. In 1918, the ‘Spanish flu’ pandemic caused an estimated 20 million to 40 million deaths globally (Commonwealth of Australia, 2006a). More recently the ‘Asian flu’ and the ‘Hong Kong flu’ epidemics in 1957 and 1968 respectively, were less severe but still caused over a million deaths. Pandemics cause considerable chaos with significant economic and social disruption throughout the world (2006a). It is unknown whether there will be influenza pandemic in the future. However, its impact will greatly depend on the relative ease of transmission of the virus and the severity of illness which is generated.

The H5N1 strain of the influenza virus is of current concern to global authorities. This virus is causing widespread disease in birds around the world and is spreading from sick or dead birds to humans (Commonwealth of Australia, 2006a). There has been some human-to-human transmission of the virus, but there is no evidence to date that the H5N1 can spread efficiently between humans.

1.2 Avian Influenza – H5N1

The H5N1 virus is currently causing disease in birds in many countries across Asia, Europe and Africa. After very close contact with sick or dead birds, this virus can be transmitted from birds to humans, and although there have been very few cases, the virus has caused severe illness and death. This virus is associated with a high fatality rate in humans and because of the rapid global spread of the virus in birds continues to be of concern. There were 258 confirmed human cases between December 2003 and November 2006, with 153 of the people infected dying (see Figure 1.1). There have been a small number of clusters of human cases; however, there is no evidence that transmission was efficient, with the majority of people infected having had close, direct contact with birds.

The risk of H5N1 becoming better adapted for human-to-human transmission is continuing and the World Health Organisation (WHO) recommends that all countries prepare for a possible pandemic (Commonwealth of Australia, 2006a).

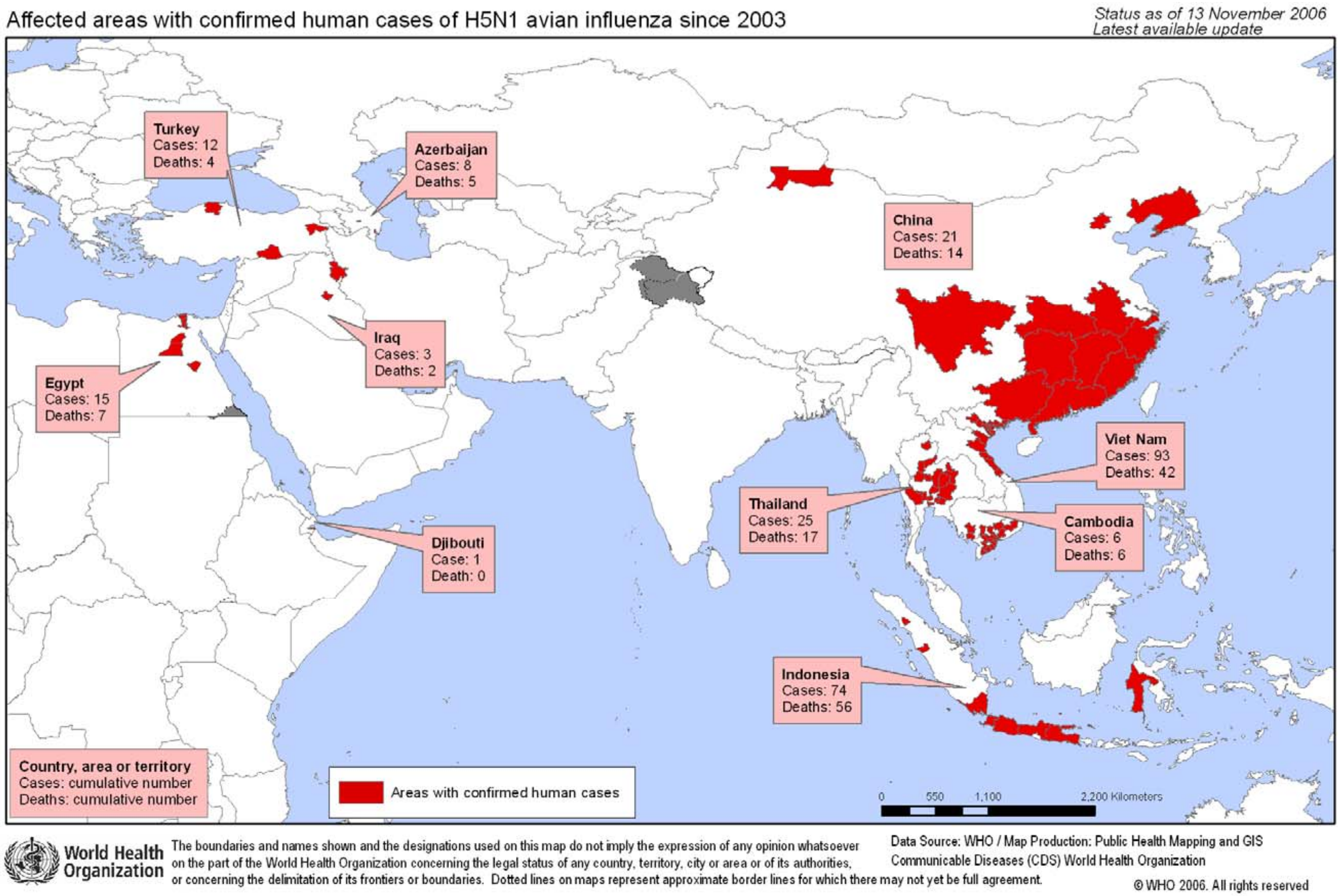

Figure 1.1 H5N1 Avian influenza spread from 2003 til Nov 2006

1.3 Pandemic Preparedness

The forewarning of this potential pandemic has provided Australia with time to implement effective measures that help to prevent or slow the spread of disease. The Australian Government has developed an Australian Health Management Plan for Pandemic Influenza (Commonwealth of Australia, 2006a) to assist the health sector, key stakeholder groups, organisations, the community and individuals in preparing for a pandemic. This plan is divided into four parts which include:

- *Part 1 provides important background information on the nature of influenza and pandemics.*
- *Part 2 describes what the Commonwealth Government is doing to prepare for a possible pandemic, from a health perspective.*
- *Part 3 describes how a pandemic might play out and the actions that would be needed to respond to it.*
- *Part 4 provides practical information about what groups and individuals can do to prepare for a pandemic, to manage during it, and to recover from it*. (2006a, p. 6)

It is anticipated that an influenza pandemic will first emerge overseas. If this occurs, then the Australian Government will be implementing a three-fold plan. Firstly, the government will be assisting in efforts to contain or slow the spread of the pandemic overseas. Secondly, it is essential that the pandemic's arrival is delayed into Australia. And thirdly, the spread of the pandemic is to be contained or slowed on its arrival into Australia (Commonwealth of Australia, 2006a).

This study has focused on one of the measures to delay the pandemic's arrival into Australia. In particular, infrared thermal screening to determine whether a disembarking international passenger has a fever.

Infrared thermal screening will occur at the border, in particular at international airports and the decision to commence fever screening will be made by an Interdepartmental Task Force when pandemic influenza events escalate in overseas locations. Infrared thermal imaging scanners are currently held in the National medical stockpile (Commonwealth of Australia, 2006a). The following section will provide a brief introduction to the technology.

1.4 Infrared Camera Technology

Infrared imaging is a physiological test only (E. Y-K. Ng et al., 2004), which is non-invasive, with the camera and operator positioned at a specified distance away from the person to be screened (E. Y-K. Ng & Sudharsan, 2001). The images produced by the infrared thermal camera include both hot and cold areas. The image of the passenger (Figure 1.1) shows that the face and neck are relatively hotter (redder) than the clothing being worn (represented as blue and green). With this delineation between hot and cold areas on the body, it is possible to use infrared technology as a convenient detection device for fevers, and potentially avian influenza patients in a crowd. Ng et al. suggest that infrared cameras are potentially capable of detecting individuals with elevated (higher than normal) temperature.

Ng et al. (2004) point out that the thermal camera is intended to operate in a stable indoor environment with an ambient temperature ranging from 20 to 25°C which is stable at ±1°C and a relative humidity ranging from 40 to 75%. Infrared radiation is emitted and detected from the skin and is converted to electrical signals, which are then graphically displayed. Also displayed on the thermal camera is a temperature profile and reading. The individual of interest is deemed to have an elevated temperature if the facial temperature is above a threshold setting. There are a number of different factors that affect the readings from the thermal camera, for example, variations in the operating environment and the individual. The screened individual may contribute to the errors by wearing heavy makeup or being on medication. Those individuals who perspire heavily will present as significantly cooler due to the evaporative cooling effect. These are false-negative results. False-positive results can occur in individuals who are pregnant, menstruating, on hormone replacement therapy, have recently consumed alcohol or hot drinks, or have been undergoing physical exertion before being screened. Ng et al. argued that the determination of an appropriate cut-off temperature setting was required.

Figure 1.2 A passenger from the current study being screened using Infrared Thermal Camera

1.5 Characteristics of body temperature

The core body temperature is considered to be the temperature of the heart and the brain. However, this temperature is not easily measured except with the insertion of an invasive catheter. Other body sites, such as rectal, oral, ear, axilliary (under the armpit) to skin (in the head and neck region) are therefore used as estimates of the core temperature (American Society for Testing and Materials, 2003).

The relationship between core body temperature and skin temperature is variable between person-to-person, and is dependent upon a number of different factors including skin blood perfusion and environmental conditions (How, Wah, Ong, Beng, & Jern, 2004). In addition, children tend to have higher body temperatures than adults. Therefore, the false alarm rate for children is probably higher compared to adults.

An elevated body temperature is defined in various textbooks as low as 37.2°C and as high as 38°C. There is a well-established diurnal variation in body temperature with early morning temperature approximately 0.5°C lower than the temperature in the mid-afternoon. A temperature of 37.8°C is accepted by most authorities as being a threshold to define fever.

1.6 Detection of SARS

In 2003, the Severe Acute Respiratory Syndrome (SARS) epidemic presented countries with the challenge of detection and quarantine of a communicable febrile illness. Some countries, such as Australia, used visual inspection to detect SARS, whereas others such as Hong Kong, Singapore, Taiwan and Canada used infrared thermal cameras.

1.6.1 Visual Inspection to Detect SARS

The Australian authorities introduced a system of patient declaration and visual inspection at the airport of arriving international passengers to detect SARS. In a review of border screening during the SARS outbreak it was found that only four of the 29 symptomatic patients with either suspected or probable SARS were detected at the border (Samaan et al., 2004).

1.6.2 Mass Fever Screening using Infrared Thermal Cameras to Detect SARS

When SARS first reached Singapore, the Defence Science and Technology Agency was approached by the Singapore Ministry of Health to design a system that would efficiently screen large groups of people with fever (How et al., 2004). It was considered that the conventional means of taking temperature using aural or oral means were too slow and inconvenient.

The first infrared-based system was thus conceptualised by the Defence Science and Technology Agency and Singapore Technologies Electronics during the SARS epidemic (How et al., 2004). The system uses a two-point detection concept to screen for fever. The first decision point is to identify probable febrile individuals using thermal cameras or imagers and the second is the confirmation that the individual has a fever using conventional clinical thermometers (How et al., 2004). When the system was introduced, it generated international interest in the use of infrared thermal cameras for fever screening. Infrared thermal cameras have been proposed as a non-invasive, rapid, cost effective and reasonably accurate way for mass blind screening of potential SARS infected persons (E. Y. Ng, 2005) and as the most effective point-of-contact screening of individuals in public areas (Blum, Farrier, & Leando, 2003).

Other countries, including Taiwan and Hong Kong, also introduced thermal cameras during the epidemic, as an efficient method of rapid screening for fever. In Canada, thermal image scanners became operational only after the last traveller with SARS entered the country (Centre for Emergency Preparedness and Response, 2004).

Similarly in Hong Kong no patients with SARS were detected and in Singapore all cases of SARS were imported before thermal imaging was introduced (Wilder-Smith, Paton, & Goh, 2003). Four cases of probable SARS were detected by thermal screening in Taiwan after this measure was introduced for incoming and outgoing passengers (Chen et al., 2005).

1.6.3 Advantages and Disadvantages of Thermography

Some authors have cautioned against the use of infrared thermal cameras in mass fever screening. Seffrin (2003) argued that although the use of infrared instruments to measure skin temperatures has many advantages, there are human, environmental and equipment variables that can affect the accuracy of collected data.

Seffrin noted the following advantages to using thermography:

- *Test equipment is completely passive and emits no harmful radiation.*
- *Thermal imaging is non-invasive.*
- *Humans radiate infrared energy very efficiently. The emittance value of human skin is nearly 1.0.*
- *Test equipment does not require the use of tracer dyes or chemicals.*
- *Information is provided in real time and can be analyzed instantly.*
- *Data can be recorded to photographic media, videotape or to a computer.*
- *Equipment is highly portable and fully self-contained.*
- *Equipment can be easily transported and set up within minutes.* (Seffrin, 2003, p. 4)

Seffrin (2003) noted a number of potential error sources were associated with accurate infrared temperature measurement. Firstly, there are a number of common conditions that can product significant and unpredictable changes in body temperature and these include circulatory problems, previous injuries, and the use of drugs and alcohol. These conditions will potentially reduce skin temperature. Perspiration or surface moisture can also result in decreased skin temperature. Recent stress, physical activity, drinking coffee or smoking cigarettes are all capable of increasing skin temperature. Inflammation caused by trauma or sunburn can also cause an increase in skin temperature. Secondly, ambient air temperature and hot or cold air currents can cause significant temperature changes across the human body. Thirdly, with the significant evolution of infrared thermal imaging technology to become more user friendly, these instruments are not self-diagnostic and cannot advise the operator when the system is being used improperly. Also, there appears to be a wide performance variation between different makes and models. This equipment has accuracy limitations for temperature measurement and the typical accuracy specifications are ± 2% of target temperature (FLIR Systems, 2004). With this in mind, a person with a normal body temperature of 38°C could be reported as high as 40°C (fever) while a person with a fever of 39°C could be reported as low as 37°C (below normal temperature) (Seffrin, 2003).

Other authors have argued that thermal scanning was not able to detect any cases of SARS. From preliminary data available from a worldwide survey, of 72 patients with imported probable or confirmed SARS cases, 30 had onset of symptoms before or on the same day as entry into the country. Bell and the World Health Organization Working Group on Prevention of International and Community Transmission of SARS (2004) found from the combined results of Canada, China (including the mainland and Hong Kong), and Singapore that no cases of SARS were detected by thermal scanning and this was among over 35 million international travellers screened at entry during the SARS epidemic. The World Health Organization Writing Group (2006, p. 81) argued that “screening and quarantining entering travellers at international borders did not substantially delay virus introduction in past pandemics, except in some island countries, and will be even less effective in the modern era”.

Wong and Wong (2006) further argued that there are few evaluations of the effectiveness of thermal cameras as a means of controlling the spread of SARS. The authors were unable to find an independent study suggesting that blind mass fever screening with infrared thermal cameras was an effective means of detecting SARS at the border. This claim was refuted by E. Y. Ng and Chan (2006) who emphasized a recent study by Chiu et al (2005) found that infrared cameras successfully picked up 305 febrile patients from 72,327 outpatients and visitors of a hospital. Of these 305 febrile patients, three were confirmed to have SARS.

In the context of SARS, thermal screening of passengers remains of theoretical benefit. In a report from the Population and Public Health Branch, Health Canada, it was concluded that whilst infrared thermal cameras were useful in evaluating large numbers of people for fever it remained to be determined whether this was the most effective approach (Centre for Emergency Preparedness and Response, 2004; St John et al., 2005). Another review in Singapore concluded that infrared thermal screening was an expensive intervention but may be justified in the context of the severe health and economic consequences of the importation of even a single case of SARS (Wilder-Smith et al., 2003). Lau, Tsiu, and Yang (2004) also analysed information obtained from 1,192 patients with probable SARS reported in Hong Kong. Although community-acquired infection did not make up most transmissions, they found that public health measures contributed substantially to the control of the epidemic. The authors concluded that "cross-border communication and prevention, such as those set in place (temperature screening and health declaration), need to be enforced strictly and consistently" (2004, p. 587).

In another study by Ng, Kaw, and Chang (2004), infrared thermal cameras were evaluated for their effectiveness when being used for mass blind fever screening. Ng et al. were looking to scientifically validate infrared systems at airports/immigration checkpoints, particularly in regards to false-negative rates. Data from 85 febrile and 417 normal cases was collected from the Emergency Department, Tan Tock Seng Hospital, which is the designated SARS centre in Singapore. Using bio-statistics with regression analysis and ROC to analyse the data, Ng et al. found that the thermal camera could be used as a first line tool for the mass blind screening of hyperthermia. There was a good correlation between the camera readings and the ear temperature readings. The authors pointed out that for the most accurate and reliable screening operation, the thermal camera threshold should be determined by environmental factors, outdoor conditions, the physiological site offset and the performance characteristics of the thermal camera.

1.6.4 Rates of Fever Detected by Thermal Cameras

As indicated, thermal scanners were introduced in the countries of Canada, China, Singapore and Hong Kong during the SARS epidemic. The following table reports the rates of fever that were published in various reports and articles (Table 1.1). The rates varied from 0.003% in Hong Kong to 0.275% in Taiwan. The rate in Taiwan appears to be considerably higher than other published data and whilst the passengers were identified as febrile by thermal imaging, it is not clear whether this number were all confirmed as being febrile using manual means. There are currently no Australian studies published that highlight the rates of fever entering the borders.

Table 1.1 Rates of Fever identified during SARS epidemic in 2003 by Airport Thermal Screening

Author	Airport/Country	Timeframe	Total No of Passengers Screened	No. with Fever	Rate of Fever
Centre for Emergency Preparedness and Response (2004)	Pearson International Airport Toronto, Canada	May to November 2003	3,920,407	1,365	0.035%
	Vancouver International Airport, Vancouver, Canada	May to November 2003	649,352	70	0.011%
Bell & World Health Organization Working Group on Prevention of International and Community Transmission of SARS (2004)	Canada	March to July 2003	600,000	215	0.036%
	China	March to July 2003	13,000,000	351	0.003%
	China – Hong Kong SAR	March to July 2003	15,100,000	451	0.003%
	China – Taiwan	March to July 2003	1,000,000	1,211 (not confirmed orally)	0.121%
	Singapore	March to July 2003	6,000,000	3,160	0.053%
Shu et al. (2005)	China – Taiwan	July 2003 to June 2004	>8,000,000	22,000 (possibly not confirmed orally)	0.275%
SARS Expert Committee (2003)	China - Hong Kong SAR	April to September 2003	36,300,000	1921	0.005%

1.6.5 Other Benefits of Thermography

One country, Taiwan, has emphasised other benefits for thermal screening of incoming passengers. Between July 2003 and June 2004 fever screening at Taiwan airports detected 40 incoming passengers with dengue fever compared to 8 patients detected by their usual active surveillance. Thirty-three of these 40 patients were viraemic at the time of detection (Shu et al., 2005).

1.7 Dengue Fever in Far North Queensland

North Queensland is receptive for dengue fever epidemics. The vector mosquito, *Aedes aegypti* is endemic and a single viraemic traveller can initiate an epidemic in the right circumstances. There is an increasing number of travellers arriving in Australia with dengue fever (Hueston, 2004; Sung, O'Brien, Matchett, Brown, & Torresi, 2003). The detection of dengue fever cases by infrared thermal screening at the Cairns international airport may be an important public health intervention in its own right.

1.8 Geographical Determinants of Fever

Over 50 million people travel to developing countries each year and up to 8% are ill enough to seek health care either while abroad or on returning home (Freedam et al., 2006). A comprehensive, multi-centre comparison of the spectrum of illnesses acquired by a broad range of travellers was conducted. Thirty specialist travel or tropical-medicine clinics on six continents contributed surveillance data for the period June 1996 to August 2004. Data for 17,353 patients who presented to a clinic were analysed.

The frequency of occurrence of each diagnosis among travellers returning from six developing regions was compared. There were significant regional differences in the morbidity of illnesses. Febrile illness was higher among returned travellers from sub-Saharan Africa or Southeast Asia, acute diarrhoeal illness was more common amongst travellers from south central Asia, and dermatologic problems was more common amongst those returning from Caribbean or Central or South America. Malaria was one of the three most frequent causes of febrile illness from all regions. Dengue fever was also a prominent febrile illness in every region except sub-Saharan Africa and Central America. Rickettsial infection occurred more frequently than typhoid or dengue among travellers from sub-Saharan Africa. Parasite-induced diarrhoea was more common than bacterial diarrhoea in all regions except Southeast Asia. The authors concluded that “travel destinations were associated with the probability of diagnosis of certain diseases” (Freedam et al., 2006, p. 119).

In another study, O'Brien, Tobin, Brown, and Torresi (2001) reviewed 232 patients who were admitted to an Australian infectious disease unit for management of febrile illness which was acquired whilst overseas. The most common diagnosis was malaria which accounted for 27% of patients. This was followed by respiratory infections (24%), gastroenteritis (14%), dengue fever (8%), and bacterial pneumonia (6%). Those who travelled to Asia were associated with a 13-fold increased risk of dengue, but a lower risk of malaria. As a cause of fever, bacterial pneumonia was ≥5 times more likely in those who were more than 40 years of age (O'Brien et al., 2001).

O'Brien and his colleagues conducted further work on illnesses acquired overseas (O'Brien, Leder, Matchett, Brown, & Torresi, 2006). In their study a total of 1,106 patients with an illness acquired overseas over a 6-year period were examined. The most common diagnoses were malaria (19%), gastroenteritis/diarrhoea (15%), and upper respiratory tract infection (URTI) (7%). Similar to the previous studies, they also found that travel destination and classification of traveler can significantly influence the likelihood of a specific diagnosis in travelers.

1.9 Pandemic Plan Protocol

Screening for potential SARS cases required that nurses be placed at the border for the purpose of detecting SARS only. Figure 1.3 provides a copy of the entry screening protocol for detection of SARS.

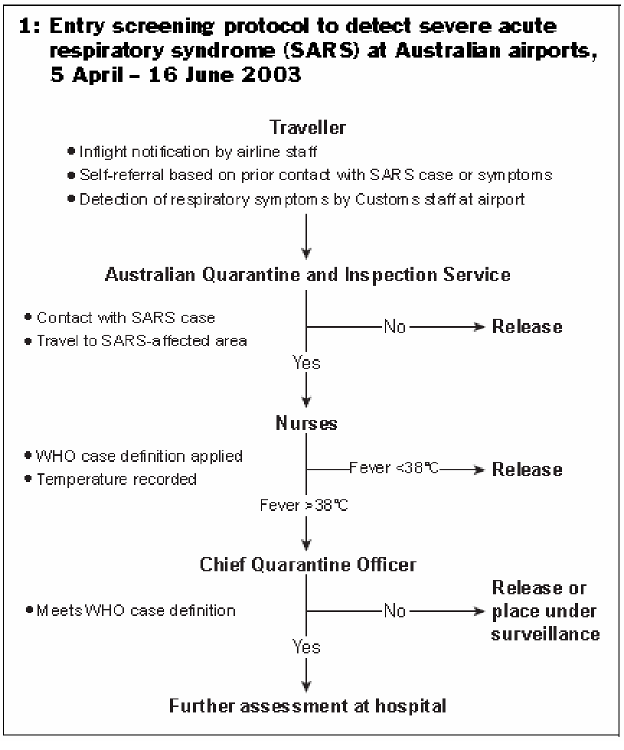

Figure 1.3 Early screening protocols to detect SARS

The Interim infection control guidelines state that "Border nurses are placed at international airports for the purpose of screening travellers for <u>influenza only</u>. They are not provided for general medical assessment" (Commonwealth of Australia, 2006b, p. 37). This highlights that nurses will be placed at borders for the purpose of only detecting influenza. Febrile passengers other than this will be offered health advice which remains focused on symptoms of influenza. The detection of febrile travellers with assessment of only one disease would be open to criticism if it were found subsequently that a patient with another disease of public health significance was detected by fever screening but not investigated.

1.10 Methods of Management of Febrile Passengers

Fever screening at airports as currently planned will involve strict protocols and whilst addressing the public concerns with respect to the detection and quarantine of pandemic influenza, does not address the concerns of the febrile traveller. The positioning of full time qualified staff at airports is expensive and the cost effectiveness of it has been questioned. GPs are an alternate provider for the assessment of febrile travellers, as long as there is a form of quality assurance and high rates of cooperation amongst the travelling public are achieved. The "outsourcing" of these assessments may be more cost effective and more satisfying for the affected traveller. However, the costs involved with visiting a GP are a potential barrier to the affected traveller seeking health care advice.

There are many theories and models that might help to predict whether the affected traveller will cooperate. Eggar, Spark, Lawson, and Donovan (1999) suggest a number of different models and methods that might explain and change health-related behaviour (i.e., seeking help from a health provider). One of the most influential models is the Health Belief Model first developed in the 1950s by Hochbaum, Rosenstock and Kegels (Rosenstock, 1974). The principal idea behind the model is the way in which individuals perceive the world and how these perceptions motivate their behaviour. The model proposes that the readiness to take action for health stems from individuals' perceptions of their vulnerability to disease and its potential seriousness. Health-related action by the individual depends of three classes of action occurring simultaneously: (1) the existence of sufficient motivation to make health concerns relevant; (2) the belief that the individual is vulnerable to a serious health problem; and (3) the belief that doing something would reduce the perceived threat/vulnerability at a subjectively acceptable cost. More recently, the model has been expanded to include the notion of self-efficacy, which is the belief that one has the ability to implement change (Egger et al., 1999).

Using the Health Belief Model as a guide, the current study made the following assumptions. The affected travellers being identified as febrile should provide sufficient motivation and incentive for them to seek assistance. The affected travellers should feel threatened that their fever may be something serious and affecting their health. Also, the affected travellers will feel that seeking professional help will be beneficial and that the costs will be appropriate. The current costs to seek assistance from a GP are around $50 to $60 and it is not known whether travellers consider this amount to be an acceptable cost. One of the hypotheses of the study was to determine whether the costs were acceptable, or a barrier to seeking help.

A relevant question was whether the research findings would translate from the current research project to a situation involving Pandemic Influenza. The Australian Pandemic plan provides a range of options for quarantine and assessment by GPs either in the surgery or at home, depending on the stage of the epidemic. Findings from this study will provide evidence as to which options will be the most useful in the identification of people with influenza. Emulation of the pandemic situation was not appropriate in this study but results should at least be broadly applicable. There is no Australian research on how best to deploy thermal screening devices and information obtained as a result of this study will provide an evidence base for the most appropriate sites for thermal camera deployment at international airports. The study will also provide useful information on the background rates of fever that can be expected from a range of countries in the region.

The aim of this study was to determine the optimal assessment of febrile passengers detected by infrared thermal screening at an international airport. To achieve this aim, the following objectives were identified to:

a) determine the rates of people with a fever entering an Australian international airport.
b) determine the most efficient and effective methods in the investigation of febrile travellers detected by thermal cameras at an international airport, and identify barriers that currently exist for febrile travellers accessing health care.
c) identify any logistical issues that may impact on the successful implementation of the thermal cameras at international airports.
d) explore the most useful sites for thermal camera deployment at international airports.
e) measure the success of thermal screening at Cairns international airport in the detection of dengue fever (a relevant and local public health threat).
f) minimise impact on passenger flow where no perceived threat exists.
g) determine whether the research findings will translate to a situation involving pandemic influenza.

2.0 Method

2.1 Participants

Participants were included in the study if:

- they were arriving international passengers into the Cairns International Airport, and
- they had a core body temperature of 37.8°C and above, and
- they could understand either English, Japanese or Chinese (relevant documentation was translated into Japanese or Traditional Chinese), and
- provided consent to be in the study.

At a meeting with the research officers on 26 April 2006 the criteria for enrolling passengers was changed to include those passengers with a temperature of 37.5°C to 37.7°C, but who were also feeling unwell.

Participants were excluded from the study if they:

- were transit passengers and did not come through the International Terminal Arrivals Hall; or
- could not understand or read English, Japanese or Chinese.

2.2 Design of the Study

There were three intervention arms to the study. Protocols were developed for each intervention arm. These are included as Appendices A, B, and C.

2.2.1 Arm 1 – GP Assessment: Patient to Pay

Intervention arm 1 consisted of advice to visit one of a number of GPs that were named on a list provided to participants. The doctors on the list were provided with information about the study and educated on appropriate fever investigation. The doctors had access to the decision trees provided to nurses (see below) but were free to use their clinical judgement in their management. In this intervention arm there was no financial assistance provided. Information about the likely charges was provided to the traveller. It was stressed that a decision to attend the doctor was purely voluntary – however attendance was measured. Passengers were provided with a number of project documents. These are described in the Materials section (Section 2.5) of this report.

2.2.2 Arm 2 – GP Assessment: Costs Compensated

Intervention arm 2 was the same as arm 1; however the passenger was informed that there was no cost for the general practice visit, one follow-up visit and pathology testing. Arrangements were made for the costs of these approaches to be billed to the study. Passengers were provided with a number of project documents. These are described in the Materials section (Section 2.5) of this report.

2.2.3 Arm 3 – Nurse Assessment

Intervention arm 3 was an immediate investigation for the common causes of fever by a trained health practitioner using a specifically designed protocol. In this arm the research officers (health professionals) immediately investigated the causes of the fever. The research officers made decisions about the types of specimens to collect on the basis of passenger responses to the questionnaire. The decisions criteria were laid out in the form of a decision tree. This service was free to the participant and where necessary or requested they were contacted with test results.

2.3 Ethics

Ethics for the project was approved by the James Cook University Human Ethics Committee on 13 February 2006 - Ethics Approval No. H2259.

In the first instance, passengers disembarking from international flights arriving at the Cairns international airport were viewed using an infrared thermal camera. As they approached the infrared thermal scanner, the passengers would have noticed two project information signs (51 x 77 cms), one directly beside the infrared thermal scanner and one about 15 metres before the passenger passed the infrared thermal scanner. These signs were in English and Japanese (the decision to include Japanese was made by the Working Group that was formed to oversee the project, on the basis that this was the most commonly used other language). An example of the English sign is attached as Appendix D.

Confirmation of fever was obtained using a thermometer inserted into the ear canal. Passengers had this procedure explained to them and were asked to give a verbal consent (see Verbal Script 1 in Appendix E). Most of the passengers detected by infrared thermal screening as being febrile were not in fact febrile and were able to proceed (Verbal Scripts 2 and 3 in Appendix E). Those passengers found to have a fever were asked whether they were prepared to be part of a study investigating the causes of fever in arriving travellers (Verbal Script 4 in Appendix E). Those who agreed to participate were given a written information sheet and asked to sign the consent form. No identifying information was collected prior to the signing of the consent form. After informed consent was obtained, the study participants were asked a short series of questions relating to their travel and current symptoms. Passengers were not aware of the study arm currently operating prior to consent.

Explanation of the study, consent and information gathering took no more than a few minutes where the intervention arm was a GP visit. This was conducted in a discrete location, seated away from patient corridors and out of hearing range of other passengers. This allowed the participant to rejoin other passengers quickly for Immigration/Customs and quarantine formalities. Where a nursing assessment was to occur this was conducted in the First Aid Room at the International Terminal.

Study related procedures varied according to the arm of the study to which the participant was allocated (see Verbal Scripts 5A, 5B, 5C in Appendix E). In all cases the collection of a medical history and collection of pathology tests was appropriate for the participant's medical condition. The collection of specimens included those appropriate for the detection of notifiable conditions. All aspects of the study were voluntary and there was no coercion applied to participate.

The GP arranged for the follow-up and discussion of the participant's own personal results. In the case of participants evaluated at the airport there was counselling about the nature of the tests conducted and contact was made if any of the tests were positive. The participants were also given a contact number to phone should they wish to receive negative results or photocopies of test results. Study participants were invited to leave contact details for receipt of the overall results of the study.

During the study children were approached through their parents. Blue cards for research officers may have been required for this study. This issue was taken up with the Commission for Child and Young People and Child Guardian. A blue card is confirmation of a Working with Children Check and is issued by the Commission for Children and Young People and Child Guardian. The Working with Children Check is a detailed national check of a person's criminal history, including any charges or convictions (Commission for Children and Young People and Child Guardian, 2006). The Commission advised (although not formally in writing) that the research officers would not need a blue card, as long as the child had a parent/guardian present during interview and specimen collection. A written protocol was developed specifically for approaching and including children in the study (see Appendix F Advice regarding children less than 18 years of age).

The dialogue (i.e., verbal scripts), information sheet and informed consent were translated into the primary languages of the incoming flights, that is, Japanese and Traditional Chinese. Once identified, non-English speaking passengers were provided with the relevant translated forms. Passengers were usually easily identified based on the flight on which they were arriving.

As dengue fever is of primary concern to the Cairns area, every febrile passenger who consented to be in the study was also given an information sheet containing information about avoiding mosquito bites.

2.4 Legal Requirements

To cover federal legal requirements for quarantineable diseases ("Quarantine Act", 1908; "Quarantine Regulations", 2000), any passenger who had any of the following symptoms was brought to the attention of an AQIS officer, who made a determination if that passenger should be brought to the attention of the Chief Health Officer, Tropical Public Health Unit, Cairns:

- Temperatures over 38°C.
- Acute unexplained skin rashes and lesions (not heat rashes, dermatitis, eczema, or similar common skin conditions).
- Persistent or severe vomiting (not caused by motion sickness or inebriation).
- Persistent, watery or profuse diarrhoea.
- Bleeding from the eyes, nose, ears, mouth, anus or skin (but not if person is predisposed to nose bleeds, haemorrhoids, or has cuts or abrasions)
- Glandular swelling in the armpits or neck.
- Prolonged loss of consciousness where a person cannot be roused (not due to alcohol, drugs, medication or fainting).
- Persistent coughing and breathing difficulty with no apparent cause (not due to asthma, heart disease, obesity, chronic bronchitis or emphysema).
- Inability to disembark from a vessel without assistance except for a person with restricted mobility or a minor who needs to be accompanied by an airline employee.

If any notifiable diseases, such as Measles, Typhoid fever, Dengue fever, Polio, Influenza, Tuberculosis, and Malaria were brought to the attention of the Research Officers, these were reported to the Australian Quarantine and Inspection Service, who subsequently reported to the Chief Health Officer, Tropical Public Health Unit Cairns. Information regarding quarantineable and notifiable diseases was provided in the protocol called “Interaction with AQIS” (see Appendix G).

2.5 Materials

2.5.1 Thermal Cameras

Two infrared thermal cameras were loaned from the Australian Department of Health and Ageing. Appropriate insurance coverage was obtained for the period of the loan. A Deed of Agreement for the infrared thermal cameras was signed by relevant representatives from James Cook University and Department of Health and Ageing. One of the infrared thermal scanners was used, whilst one was kept as a backup. The second camera was utilised during a trial on board an empty aircraft.

The infrared thermal camera was operated by the research personnel only. Throughout the study, the research officers provided report-back information to the 1st Chief Investigator and Project Manager about the use of the infrared thermal camera. Progress meetings were held regularly to discuss use of the camera.

2.5.1.1 Deployment, site and position of the Infrared Thermal Camera

The infrared thermal camera was deployed in a number of different locations at the Cairns international terminal building including: post-primary (after the first Immigration/Customs entry point), pre-primary (on the mezzanine floor before the first Immigration/Customs entry point), on an aerobridge (aerobridge 1 on one Air Niugini flight), and on an empty aircraft.

The site of the camera was negotiated with a working group which consisted of various representatives from the airport (Cairns Port Authority, AQIS, Customs) in order that there was minimal impact of the thermal screening on passenger movement. Tensa barriers were used to help guide passengers past the infrared thermal camera. The optimum results for thermal screening were achieved when there was a single file queue moving past the screening point at normal walking speed. Tensa barriers were positioned to achieve this flow. The camera was mounted on the supplied tripod. The best position for the camera was at slightly above the average passenger height and angled downward. This ensured that children and adults in wheelchairs were viewed. A standard television monitor (51cm) was purchased as part of the study and the thermal camera was connected to this via RCA connectors. Passengers were able to see their own image as they passed by the camera and this tended to slow their movement enough to obtain a better picture.

2.5.1.2 Settings on the Infrared Thermal Camera

The thermal camera had a number of different settings that were adjusted prior to the start of each shift. Some of the settings were set at the start of the project and were not adjusted throughout the project. Please refer to Appendix H for information regarding the operation of the thermal camera.

There were two different ways in which passengers could be identified as having a higher than normal skin temperature. Firstly, the alarm temperature value could be set at 1.3°C (Delta) above the reference temperature. Secondly, the alarm temperature value could be preset. If a delta value and reference temperature was used, those passengers who were more than 1.3°C above the average temperature for the group caused the thermal camera to alarm. The reference temperature was calculated by sampling (using the camera) the first ten passengers from a flight. Research Officers could then randomly sample passengers throughout the shift so that the reference temperature could be updated to reflect the average skin temperature of arriving passengers.

As of 22 July the thermal camera alarm was set at 35.4°C. The decision to set the alarm temperature at this level was based on the previous temperature figures collected. The mean value for the previous alarm temperatures was 35.4°C, and this was chosen as the preset alarm temperature. The alarm temperature reverted to the reference temperature with a delta value of 1.3°C as of 26 August 2006.

2.5.2 Tympanometric Measure

Fever was verified using a tympanometric measure. The instrument used was a Braun ThermoScan Pro4000 Therm (includes disposable covers). The research officers followed the instructions provided with the ThermoScan.

2.5.3 Documentation

Many different documents were developed for the purpose of the study. Two questionnaires were developed. Questionnaire 1 was for the Nurse assessment arm and collected detailed information about the passenger and where that individual had travelled (see Appendix I). Questionnaire 2 was for the GP assessment arms (x2) (see Appendix J). This was a less detailed questionnaire because research officers were not required to make any decisions about specimen collection. In these arms of the study, the GPs were provided with enough information to assist in their decision-making. Both the questionnaires were developed based on health declarations used in other countries. These questionnaires were piloted with university staff and medical students and revised accordingly. Each of the questionnaires was translated into the primary languages of Japanese and Traditional Chinese.

Two forms were developed to capture information from the thermal camera, as well as the passenger's core body temperature, specific flight information and enrolment details (see Appendices K and L). The first form (Shift Return) was to collect information when the thermal camera alarm sounded. The second form (Trial Shift Return) was introduced as an additional form on 2 September 2006 (the last month of the study) and collected information on passengers who did not cause the thermal camera to alarm.

Table 2.1 provides a list of forms provided to participants who were enrolled in one of the three intervention arms. Slight variations for each form have been developed based on the intervention arm. Some of the forms were the same across each of the interventions.

Table 2.1 List of Project Forms and relevant Intervention Arm

Project Form	Arm 1 GP Assessment: Patient to Pay	Arm 2 GP Assessment: Costs Compensated	Arm 3 Nurse Assessment
Project Information Sheet and Consent Form*	Appendix M	Appendix M	Appendix M
Information Sheet*	Appendix N	Appendix O	Appendix P
Instructions for Passengers on pathology tests collected*	Not applicable	Not applicable	Appendix Q
Letter to GP	Appendix R	Appendix S	Appendix T
Decision Tree	Appendix U	Appendix U	Appendix U
List of GPs	Appendix V	Appendix V	Appendix V
Blank Pathology Forms	Not included as attachment	Not included as attachment	Not included as attachment
Advice about STIs (if the participant ticks Q35 on Questionnaire 1)	Not included as attachment	Not included as attachment	Not included as attachment

Note: * Translated into Japanese and Traditional Chinese

A separate folder was prepared for the research officers. This folder contained generic protocol and other useful information. Items covered in the folder included:

- Interaction with AQIS including quarantineable diseases, reporting of notifiable diseases, and reporting of passengers who may need to go by ambulance to hospital (Appendix G);
- Off script communication with passengers and needlestick Injuries (CD Appendix 1);
- Operation of FLIR Thermocam E45 (Appendix H);
- Information regarding Tympanic Temperature Measurement (CD Appendix 2);
- Nurse assessment arm protocol (CD Appendix 3). This protocol was modified during the project to suit the camera locations;
- Advice regarding children less than 18 years of age (Appendix F);
- Start Up Procedures (CD Appendix 4);
- Equipment Log Sheet (CD Appendix 5);
- Relocation of Camera to Pre-Primary Site (CD Appendix 6);
- Using the Fever Phone (mobile phone)(CD Appendix 7);
- List of useful phone numbers;
- JCU Research Team Time Sheet (CD Appendix 8); and
- Fortnightly rosters (for example, see CD Appendix 9).

2.6 Staffing

One project manager and seven research officers were employed to staff the study. One research officer left the team in June 2006. This research officer was not replaced leaving the remaining six research officers to cover the shifts. Prior to the commencement of the study, the research officers received training on various aspects of the project. One of the primary competencies required by research officers was the ability to perform venipuncture. Four of the nurses were provided with refresher training on venipuncture. The seven research officers attended a training and induction day at the Cairns international terminal on 31 March 2006. The issues covered during the day included: (a) overview of project, (b) security issues, (c) AQIS considerations, (d) Customs considerations, (e) pathology issues, and (f) practice issues.

During the first four weeks the research officers worked in teams of two. Thereafter, the research officers worked in teams of two during the nurse assessment arm (i.e., one week in three). When working in teams of two, the Research Officers worked a combined total of approximately 140 hours per week. This varied depending on the flight schedule. When there was only one research officer on shift, then the hours were halved. Rostering was challenging with the flights ranging from 4.00am to as late as midnight (see example schedule – CD Appendix 10, as an example of flights). Many of the flights arrived up to 3 hours late making rostering even more complicated. The research officers overcame this problem by checking the incoming flights on the internet or with AQIS prior to arriving for their shift. The research officers also exchanged phone numbers and communicated regularly with one another to swap shifts and check on flights. A roster was developed and was modified each fortnight based on research officer availability. Research officer hours were recorded using time sheets (see CD Appendix 8). There was a high degree of flexibility demonstrated by the research staff.

2.7 GP Recruitment and Involvement

Recruitment of GPs into this study was conducted in liaison with the Cairns Division of General Practice. Thirty-eight GPs were invited to attend an Information Evening on 23 March 2006. Seven GPs attended the evening. The information on the project was imparted to the GPs via a PowerPoint presentation, a copy of which is attached as CD Appendix 11. The low numbers of attendees was not unexpected as the evening was held on the Thursday after Cyclone Larry hit the Far North Queensland coast. This was unfortunate but unavoidable. After the Information Evening, follow-up letters were sent out to GPs inviting them to participate in the project. The final list included eight GPs who were prepared to evaluate febrile travellers during the project. The list of GPs was provided to participants with other information relevant to the project (Appendix V).

2.8 Pathology Testing

Pathology testing for Haematology, Microbiology and Immunology was provided by Sullivan Nicolaides Pathology and this company forwarded serum to Queensland Health

Scientific Services for Dengue virus RT-PCR, and/or Dengue serology. This lab also performed PCR testing for Influenza on combined nose plus throat swabs or nasopharyngeal swabs where these specimens were collected.

2.9 Governance of the Project

The project was primarily governed by a working group which consisted of representatives from AQIS, Customs, Cairns Port Authority, and James Cook University (up to 10 attendees). The working group was a subgroup being governed by the Airport Facilitation Committee (FAL). This group met each week for one hour prior to the commencement of the study (6 meetings). The meetings after the commencement of the study were held as required (from weekly to three-weekly). A total of 19 working group meetings was held.

Project progress was reported to five FAL Committee meetings which were held on 16 March, 18 May, 27 July, 21 September, and 27 November 2006.

As the Australian Customs Service (ACS) and the Australian Quarantine and Inspection Service (AQIS) were the two principal key stakeholders at the airport, it was decided to hold debriefing sessions (between 30 and 60 minutes) for these groups. These sessions occurred on 6th and 9th November for Customs, and 7th and 21st November for AQIS.

2.10 Communication of the Project and the Media

Information about the project was reported to a number of different groups as follows:

- Airport Emergency Committee – 1 meeting (13 July)
- Airport Operators Meeting – 1 meeting (5 May)
- Research Officer Meetings – 2 meetings (26 April, 28 July)
- Presentation to Year 10 Science Students (28 June)
- Presentation to and Visit from local Communicable Disease Nurses (29 May and 13 September).

The 1st Chief Investigator and the Project Manager attended the Australian Influenza Symposium on 5th and 6th October 2006. The symposium was organised by the Influenza Centre Melbourne in collaboration with the Therapeutic Goods Administration with support from the Office of Health Protection (DOHA). The symposium highlighted the many and varied projects that were funded under the NHMRC "Urgent research into a potential avian influenza-induced pandemic" grants awarded in 2006. Presentation to the symposium included a 10 minute talk with a PowerPoint presentation (see CD Appendix 12).

The project was also communicated to the media. A plan was developed with the Manager for Public Affairs, Northern Area Health Service who also provided the media release. The NAHS Manager for Public Affairs, the James Cook University Media Liaison Officer and the 1st Chief Investigator communicated with the newspaper, radio and television media.

Table 2.2 provides a list of the radio, television and newspapers and the respective dates in which the project was reported. Each of these articles and media releases is attached in CD Appendix 13.

Table 2.2 List of Media where the Project was reported

Television	Date	Radio	Date	Newspaper	Date
Seven News	21/2	3AW Melbourne	20/2	Cairns Post	21/2, 3/4, 20/7, 13/11
WIN News	21/2	ABC Newcastle	21/2, 22/2	AAP Newswire	21/2, 22/2
ABC Channel 2 Brisbane	21/2	ABC 702 Sydney	21/2	Townsville Bulletin	22/2
ABC Channel 6 Darwin	21/2	ABC 720 Perth	21/2	Australian	22/2
Channel 9 Sydney	22/2	Easy Listening 846 AM Cairns	21/2	Courier Mail	22/2
		ABC 666 Canberra	21/2	Medical Observer	3/3
		ABC 612 Brisbane	21/2	Daily Mercury	22/2
		4AM Mareeba	22/2	Fassifern Guardian	22/2
		Sea FM	22/2	Fraser Coast Chronicle	22/2
		Hot FM	22/2	Gladstone Observer	22/2
		ABC Darwin	22/2	Gympie Times	22/2
		ABC Coast FM – Gold Coast	22/2	Morning Bulletin Brisbane	22/2
		ABC Far North	22/2, 3/2/2007	News Mail Brisbane	22/2
		4CA FM Cairns	22/2	Queensland Times	22/2
		Radio National Breakfast	22/2	Daily Telegraph	22/2
		4BC Brisbane	14/11		

Note: All reported in year 2006, except as indicated for ABC Far North.

The media footage from WIN News is attached as CD Appendix 14.

Also attached are photographs of the television media interviewing the 1st Chief Investigator (see CD Appendix 15).

2.11 Passenger Behaviour

Early in the project, it was observed that there were low numbers of participants who visited GPs. The research staff cooperatively decided to observe passengers' behaviour throughout the project and provide some perceptions and insight to the research team. A set of questions was developed to gain information from the research officers about passengers' attitudes and behaviour. The questions are attached as Appendix W.

2.12 Data Collection

The first of the intervention arms commenced on 1 April 2006. Data was collected for three intervention arms over a six month period. Data on those passengers who participated in the study was collected from either the GP assessment or the Nurse assessment questionnaires, depending on the arm in which participants were enrolled.

Data relevant to the thermal camera and core body measurement was collected using the shift return (Appendix K). When the alarm sounded on the thermal camera the Research Officers recorded: (a) the infrared temperatures, (b) the alarm temperature, (c) the core body temperature, (d) the flight number, and (e) the outcome (whether the passenger was enrolled, declined, or N/A for those passengers who were not febrile).

From 2 to 29 September 2006 (last month of the study), additional data relevant to the thermal camera and core body measurement was collected using the second shift return (Appendix L). The research team was interested in capturing information from the thermal camera *when it did not alarm*. Research Officers randomly chose passengers who did not cause the thermal camera to alarm. These passengers were then asked to have their core body temperatures taken. The information recorded was the same as that for the first shift return, except that research officers included specific comments about the passengers (e.g., glowing face, gender, age group – baby, child, teenager, adult, aged, noticeable group/family behaviour).

Detailed flight information was obtained each week from AQIS. Every Monday morning an AQIS officer would compile flight details from the previous week and send them through to the Project Manager. The Project Manager would then reformat and enter the data into an Access database.

Pathology results were forwarded via direct fax to the 1st Chief Investigator or Project Manager.

Data from all of the forms was entered into an Access database which was developed and maintained by the Project Manager. The database contained three major Access tables which included the following: participant information (demographics, contact details, questionnaire responses, clinical findings, laboratory results, diagnoses), flight information (number of arrivals, flight details, country of origin) and data associated with the thermal camera (infrared temperatures, alarm temperatures, core body temperatures). Access

Relationships were established between the three tables so that participants could be traced to a particular flight and camera temperature.

At the completion of the project, six research officers were interviewed by the Project Manager and provided the research team with their perceptions and insight into passengers' attitudes and behaviour.

2.13 Data Analysis

The three tables in the Access Database were exported into Excel and SPSS files. A further two files that contained a combination of flight, temperature and patient information was also exported to Excel and SPSS. The Excel files were utilised for basic analyses and for presenting graphical representations of the data. Most of the analyses were undertaken using SPSS on an item-by-item basis using descriptive and inferential statistical tools as appropriate to the scale of measurement.

Dichotomous and categorical variables were described using frequencies and proportions. Continuous variables were described using means and standard deviations. Analyses were conducted separately for the 76 participants, 2038 flights, and 1334 recorded temperatures.

Detection of significant differences in proportions between two dichotomous or categorical variables was achieved by the use of cross-tabulations using the $\chi 2$ test of significance and Fisher's exact test of significance if expected cell frequencies in a 2 x 2 matrix were less than five. For those analyses where more than 50% of cells had an expected frequency of less than 5, some of the responses were pooled. Comparisons between dichotomous or categorical variables and continuous variables were achieved through the use of univariate analysis of variance (ANOVA). An F statistic was considered significant if $p < .05$. If both variables being compared were continuous in nature, a Pearson correlation coefficient was used to describe the strength of the relationship. A relationship was considered significant if $p < .05$.

Qualitative data from the interviews with research staff were transcribed verbatim and emerging themes and patterns of meaning were identified.

3.0 Results

3.1 Total Passenger Numbers

The total number of incoming international passengers was 196,700. These numbers excluded transiting international (those passengers who walk straight through to the departure lounge to board a flight to another destination and do not move through the Immigration/Customs or AQIS areas) and domestic passengers. The total number of passengers who were screened using the thermal camera was 181,759, which was 92.4% of the total incoming international passengers. Tables 3.1 to 3.2 provide descriptive information on incoming flights and incoming passengers. They exclude the following: (a) passengers delayed by immigration/customs formalities; (b) unscheduled flights (i.e., some flights arrived into the airport unscheduled and could not be included in rostered shifts); (c) Air New Zealand flights (the airline did not grant approval for their passengers to be deliberately screened however on occasion when flight arrivals coincided with other airlines screening did take place); and (d) flights that were missed due to unforeseen circumstances (e.g., the flight may have arrived early and was subsequently not screened).

Table 3.1 indicates that the largest number of flights arrived from Port Moresby closely followed by Narita. A large number of flights arrived from Sydney. These passengers were transiting through Sydney from many different ports of origin. The largest number of passengers arrived from Narita rather than Port Moresby. This suggests that there are regular but smaller Port Moresby flights. This is supported by the descriptive statistics showing the mean number of passenger per flight from Port Moresby was 39 whereas the mean number from Narita was 159.

Table 3.1 Incoming Passenger Flights and Numbers

Region	Port of Origin	Flight Nos	% of Total No Flights	Pax Nos	% of Total No. Pax	Mean No. of Pax
Japan		*719*	*35.30%*	*111321*	*61.25%*	
	Osaka	180	8.84%	27152	14.94%	151
	Nagoya	181	8.89%	27370	15.06%	151
	Narita	358	17.57%	56799	31.25%	159
Oceania		*1018*	*49.98%*	*33692*	*18.54%*	
	Port Moresby	469	23.02%	18264	10.05%	39
	Mt. Hagen	56	2.75%	1072	0.59%	19
	Kiunga	5	0.25%	27	0.01%	5
	Misima	2	0.10%	27	0.01%	14
	Tabubil	52	2.55%	1057	0.58%	20
	Moro	18	0.88%	332	0.18%	18
	Timika	47	2.31%	808	0.44%	17
	Brisbane (transit)	142	6.97%	4578	2.52%	32
	Sydney (transit)	225	11.05%	7280	4.01%	32
	Auckland	2	0.10%	247	0.14%	124
Asia		*223*	*10.95%*	*30671*	*16.87%*	138
	Korea	7	0.34%	1473	0.81%	
	Hong Kong	87	4.27%	13587	7.48%	156
	Indonesia	2	0.10%	9	0.00%	5
	Jakarta	1	0.05%	4	0.00%	4
	Singapore	40	1.96%	6029	3.32%	151
	Singapore/Darwin	86	4.22%	9569	5.26%	111
Rest of World		*77*	*3.78%*	*6075*	*3.34%*	
	Guam	75	3.68%	6015	3.31%	80
	Majuro	1	0.05%	48	0.03%	48
	Tonga	1	0.05%	12	0.01%	12
Total		**2037**	*100.00%*	**181759**	*100.00%*	

Notes: Pax: Passengers; Those passengers who are arriving from ***Australian*** *destinations are international passengers who have transitted through those ports and have come through the Custom/Immigration/AQIS areas at the Cairns International Airport. Two Air New Zealand flights from Auckland were screened because they overlapped with other incoming flights.*

Table 3.2 provides information on flights and passenger numbers according to month. This table also provides a breakdown of the actual number of incoming international passengers arriving each month into the Cairns international airport. The JCU Research Officers screened between 85.06% and 96.29% of arriving international passengers. Permission could not be obtained to include the Air New Zealand passengers. The numbers from the Air New Zealand flights ranged up to 1400 passengers per month. Had these flights been included in the screening process, the overall numbers screened would have ranged from 95 to 99% of the total numbers of passengers actually arriving into the Cairns International Airport.

Table 3.2 Incoming Passenger Numbers by Month

Region	Port of Origin	April	May	June	July	August	September	Total
Japan		*17925*	*16826*	*18492*	*18744*	*20785*	*18549*	*111321*
	Osaka	4803	4695	5000	4099	4503	4052	27152
	Nagoya	5049	4609	4726	4104	4671	4211	27370
	Narita	8073	7522	8766	10541	11611	10286	56799
Oceania		*4770*	*5022*	*5529*	*6990*	*5918*	*5463*	*33692*
	Port Moresby	3234	3275	2961	3022	2981	2791	18264
	Mt. Hagen	120	78	110	334	155	275	1072
	Kiunga		6			11	10	27
	Misima	27						27
	Tabubil	220	175	166	193	120	183	1057
	Moro		13	72	56	92	99	332
	Timika	131	149	138	139	113	138	808
	Brisbane	385	322	536	1392	1023	920	4578
	Sydney	653	1004	1546	1854	1176	1047	7280
	Auckland					247		247
Asia		*6315*	*4907*	*5273*	*4782*	*5346*	*4048*	*30671*
	Korea				244	1229		1473
	Hong Kong	3176	2291	2940	1800	1570	1810	13587
	Indonesia		4		5			9
	Jakarta						4	4
	Singapore	2350	1809	1801		69		6029
	Singapore/Darwin	789	803	532	2733	2478	2234	9569
Rest of World		*915*	*900*	*916*	*1295*	*1022*	*1027*	*6075*
	Guam	915	900	916	1295	1022	967	6015
	Majuro						48	48
	Tonga						12	12
Total Project		**29925**	**27655**	**30210**	**31811**	**33071**	**29087**	**181759**
Total Actual		**31079**	**29191**	**32437**	**34081**	**35717**	**34195**	**196700**
JCU % of Total Actual		**96.29%**	**94.74%**	**93.13%**	**93.34%**	**92.59%**	**85.06%**	**92.40%**

3.2 Enrolled Participants

De-identified participant information is included in Appendix X. There were 76 participants enrolled in the study. This represents 0.04% of the international arriving passengers who were screened. Monthly enrolments were as follows: April – 12, May – 24, June – 5, July – 12, August - 6, and September - 17. Participants were enrolled into one of the three arms. Eighteen (23.7%) were enrolled in the Nurse assessment arm, 31 (40.8%) in the GP assessment: costs compensated arm and 27 (35.5%) in the GP assessment: patient to pay arm.

3.2.1 Demographics

The following information will follow the items as presented in the questionnaire. Some of the information collected from the questionnaires was relevant for follow-up and not relevant for this report. Those items were therefore excluded from this report.

3.2.1.1 Age

The mean age was 29.36 years (*SD* = 16.5) and the median was 27.85 years. Ages ranged from 19 months through to 64 years old. Two participants did not indicate their age. Figure 3.1 provides a graphical representation of the ages.

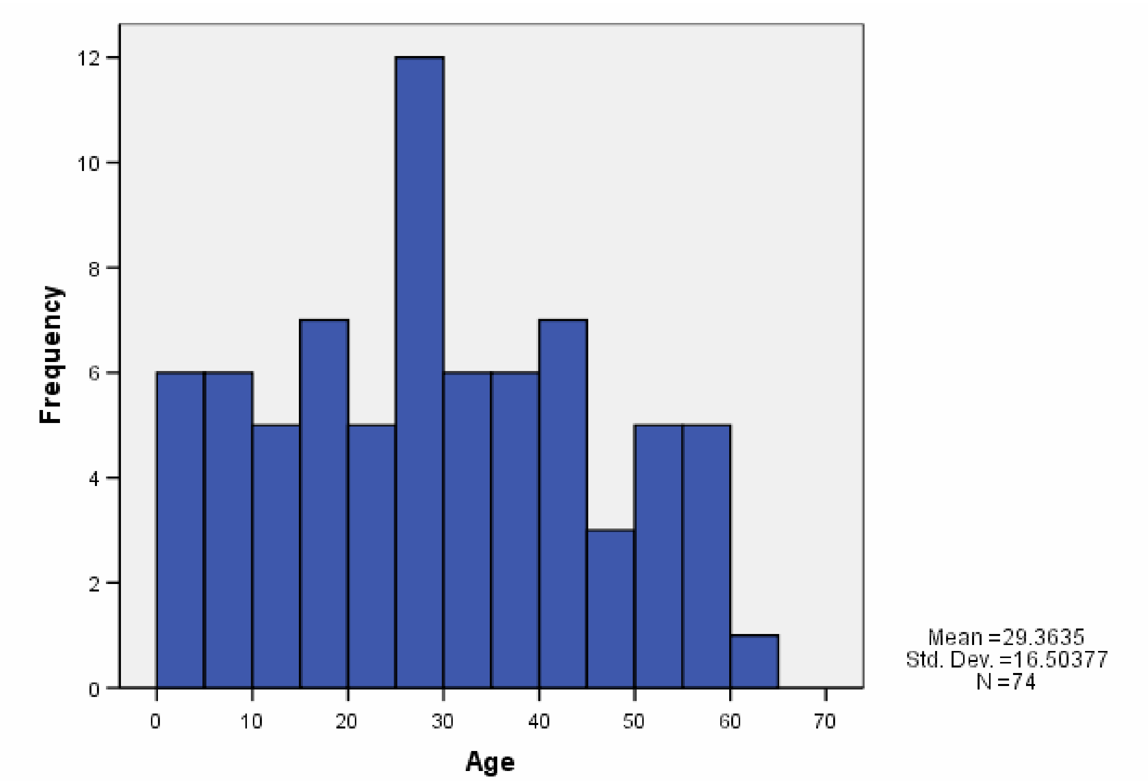

Figure 3.1 Ages of enrolled participants

3.2.1.2 Gender

There were 36 females (47.4%) and 40 males (52.6%).

3.2.1.3 Country in which you normally reside

Participants indicated where they normally lived (see Table 3.3). The countries of residence varied widely, with the Japanese and New Guinea ports accounting for almost half of the enrolled participants. Australians who were travelling abroad and returning home accounted for 18.4%.

Table 3.3 Countries of Residence

Region	Country	No.	Percentage
Japan		17	22.37%
	Japan	17	22.37%
Oceania		35	46.05%
	New Guinea	20	26.32%
	Australia	14	18.42%
	New Zealand	1	1.32%
Asia		5	6.58%
	China	3	3.95%
	Philippines	1	1.32%
	India	1	1.32%
Rest of World		19	25.00%
	Brazil	1	1.32%
	Denmark	1	1.32%
	England	5	6.58%
	France	1	1.32%
	Germany	2	2.63%
	Israel	1	1.32%
	Norway	1	1.32%
	Poland	1	1.32%
	Saudi Arabia	1	1.32%
	Switzerland	1	1.32%
	United Kingdom	1	1.32%
	USA	3	3.95%
Total		**76**	*100.00%*

3.2.1.4 Where are you staying in Cairns?

Participants indicated where they were staying when they arrived at the airport. There were 32 participants who indicated that they were staying at a local resort, hotel, motel or backpackers. Thirteen passengers were in transit and heading to various local destinations such as Innisfail, Tolga, and Atherton, or through to other longer distance destinations such as Sydney, Darwin or Uluru near Alice Springs. Twenty-one passengers were staying at local Cairns addresses, only six of whom were local residents. One passenger indicated staying in a campervan and five passengers had arrived into the airport with no idea where they were going to stay. There were four participants who did not indicate where they were going to stay.

3.2.1.5 How long do you intend to stay in Cairns?

Participants also indicated how long they were intending to stay in Cairns. Table 3.4 indicates that most participants (59.21%) were staying in Cairns for up to 7 days.

Table 3.4 Duration of Stay in Cairns

Time Period	No.	Percentage
Transit	4	5.26%
Up to 7 days	45	59.21%
From 8 days to 1 month	13	17.11%
Longer Term	7	9.21%
Missing data	7	9.21%
Total	**76**	**100.00%**

Of the Australian residents, six participants were local residents, three lived a short driving distance (i.e., Atherton, Cardwell, Innisfail), whilst the remainder were in transit through (some to other Australian locations such as Mackay, Sydney, Perth).

3.2.1.6 Where have you flown in from today?

Participants indicated from which port they had travelled. Table 3.5 provides a breakdown of the participants' responses. Thirty-three (43.4%) of the enrolled passengers had travelled from the New Guinea ports. Nearly 20% (N = 15) of the participants had travelled from Japan. The next most common port was Hong Kong (14.5%, N = 11).

Table 3.5 Port of Origin

Region	Port of Origin	No.	Percentage
Japan		*15*	*19.74%*
	Japan - not specified	11	14.47%
	Nagoya	1	1.32%
	Osaka	2	2.63%
	Tokyo	1	1.32%
Oceania		*35*	*46.05%*
	New Guinea or Port Moresby	33	43.42%
	Brisbane	1	1.32%
	Gold Coast, Brisbane	1	1.32%
Asia		*22*	*28.95%*
	Germany, Singapore, Sydney	1	1.32%
	Hong Kong	11	14.47%
	China	1	1.32%
	Thailand, Sydney	1	1.32%
	Manchester, Heathrow, Hong Kong	1	1.32%
	Oslo, London, Singapore	1	1.32%
	Philippines	1	1.32%
	Singapore	3	3.95%
	Switzerland, Singapore	1	1.32%
	Medan, North Sumatra	1	1.32%
Rest of World		*3*	*3.95%*
	Georgia (South West Asia)	1	1.32%
	Chile	1	1.32%
	Frankfurt	1	1.32%
Missing data		2	2.63%
Total		**76**	*100.00%*

3.2.1.7 Name the countries you have been in the last 10 days

Participants indicated which countries they had visited in the previous 10 days. The following table (Table 3.6) includes those countries mentioned by the participants. In some cases multiple countries were mentioned. Participants had visited New Guinea most often, with Hong Kong and Japan the next most visited countries.

Table 3.6 Countries Visited in last 10 days

Country	No.	Country	No.	Country	No.
Australia	3	Germany	2	New Guinea	27
Brazil	1	Hong Kong	10	Poland	1
California	1	India	2	Singapore	6
Chile	1	Japan	10	Switzerland	1
China	2	Manila	1	Thailand	1
Denmark	1	Medan	1	Thursday Island	1
England	3	North Sumatra	1	UK	4
France	1	Norway	1	USA	1
Georgia	1	Philippines	4		

3.2.1.8 Name the countries you have been in between 10 and 30 days ago

Participants indicated which countries they had visited between 10 and 30 days ago (this information was only collected from participants in the nurse assessment arm). Participants had visited Australia, France, Germany, Israel, Medan (Indonesia), New Zealand, North Sumatra (Indonesia), Norway, New Guinea, Singapore, Thailand, and USA.

3.2.1.9 The countries you have been in between 1 and 6 months ago

Participants indicated which countries they had visited between 1 and 6 months ago. This information was also only available from participants in the nurse assessment arm. Participants had visited Antarctica, Australia, China, England, France, Germany, Israel, New Zealand, Norway, New Guinea, Thailand, and USA.

3.2.1.10 Do you have travel insurance?

There were 40 participants (52.6%) who indicated that they had travel insurance, 29 (38.2%) who did not have insurance. Seven people did not complete this question.

3.2.1.11 On what date did you become unwell?

The information from this item provided the timeframe for the onset of symptoms. As indicated in Table 3.7, the range of days that participants had been unwell ranged from onset on the same day to 10 days of feeling unwell. Most people started to feel unwell either the day before or on the day that they had arrived at the Cairns International Airport. There were nine participants who did not indicate on what day they had become unwell.

Table 3.7 Number of Days that Participants felt Unwell

Number of Days Unwell	No.	Percentage
0	21	27.63
1	24	31.58
2	13	17.11
3	5	6.58
5	1	1.32
7	1	1.32
8	1	1.32
10	1	1.32
Subtotal	**67**	**88.16**
Missing data	9	11.84
Total	**76**	**100.00**

3.2.1.12 Symptoms

Passengers indicated on the relevant questionnaire which symptoms they were currently experiencing. Table 3.8 combines the information from questionnaire 1 and 2. The most common symptoms experienced by participants was cough, headache, sneezing, and runny nose.

Table 3.8 Symptoms of those Febrile Passengers who enrolled in the Study

Days from Onset	Yes	No	N/A	Missing	Totals
Shivers*	3	14	0	1	18
Headache	27	48	0	1	76
Myalgias	20	53	0	3	76
Arthralgia	15	58	0	3	76
Rash	1	74	0	1	76
Rash distribution*	0	0	18	0	18
Rash itch*	0	0	18	0	18
Sore throat	21	54	0	1	76
Glands enlarged*	4	13	0	1	18
Location of gland enlargement*	4 (Neck)	0	13	1	18
Sneezing	19	56	0	1	76
Rhinorrhea	25	50	0	1	76
Cough	30	45	0	1	76
Productive?*	2	1	12	3	18
Blood in sputum*	0	5	11	2	18
Contact with TB*	1	7	5	5	18
Dyspnoea	4	71	0	1	76
Diarrhoea	10	65	0	1	76
With blood?*	0	4	14	0	18
Very watery?*	2	2	14	0	18
Vomiting	8	67	0	1	76
Abdominal cramps	9	66	0	1	76
Dysuria	0	75	0	1	76
Dark urine	1	73	0	2	76
Yellow eyes	0	74	0	2	76
Unusual taste*	1	16	0	1	18
New sexual partner*	1	16	0	1	18
Condom use?*	1	3	14	0	18

* indicates that this question was only applicable to Questionnaire 1 – Nurse assessment arm.

3.2.1.13 Core Body Temperature

On the front of the completed questionnaire, the Research Officers also noted down the core body temperature of the passenger.

Participants' core body temperatures ranged from a low of 37.5 to a high of 40.3°C. As indicated in Table 3.9, 80.3% of participants met the initial criteria of 37.8°C and above. The remaining 19.7% were enrolled with lower temperatures but were feeling unwell. The mean temperature for enrolled passengers was 38.2°C, the mode was 37.9°C, and the median was 38.1°C.

Table 3.9 Core Body Temperatures of Febrile Passengers who enrolled in the Study

Temperature	No.	Percentage	Percentage in each Criteria
37.5	7	9.2	*19.7*
37.6	3	4.0	
37.7	5	6.6	
37.8	7	9.2	*80.3*
37.9	9	11.8	
38	6	7.9	
38.1	5	6.6	
38.2	3	4.0	
38.3	3	4.0	
38.4	8	10.5	
38.5	2	2.6	
38.6	1	1.3	
38.7	1	1.3	
38.8	3	4.0	
38.8	1	1.3	
38.9	2	2.6	
39	1	1.3	
39.1	2	2.6	
39.2	1	1.3	
39.3	2	2.6	
39.4	3	4.0	
40.3	1	1.3	
Total	**76**	**100.0**	***100.0***

3.2.2 Comparison between Countries of Residence and Ports of Origin

Table 3.10 provides a comparison of the countries of residence with the ports of origin from which participants travelled. People who lived in New Guinea travelled from that port, and those who lived in Australia frequently travelled from New Guinea. Japanese passengers generally travelled from Japanese ports. People who lived in other parts of the world travelled from a wide range of ports.

Table 3.10 Comparison of Countries of Residence with Ports of Origin

Country of Residence	Port of Origin	No.
New Guinea	Port Moresby/New Guinea	20
Japan	Japanese Ports	16
Australia	Port Moresby/New Guinea	9
Australia	Hong Kong	3
England	Singapore	3
China	Chinese Ports	2
Australia	Medan/North Sumatra	1
Australia	Philippines	1
Brazil	Chile	1
China	New Guinea	1
Denmark	Hong Kong	1
England	Gold Coast/Brisbane	1
England	Hong Kong	1
France	Hong Kong, Brisbane	1
Germany	Frankfurt	1
Germany	Germany, Singapore, Sydney	1
India	Brisbane	1
Israel	Thailand, Sydney	1
Japan	Hong Kong	1
New Zealand	New Guinea	1
Norway	Oslo, London, Singapore	1
Philippines	Port Moresby	1
Poland	Hong Kong	1
Saudi Arabia	Hong Kong	1
Switzerland	Switzerland, Singapore	1
United Kingdom	Manchester, Heathrow, Hong Kong	1
USA	Port Moresby	1
USA	Sydney, Georgia	1
USA	Hong Kong	1
Total		**76**

3.2.3 Participant Diagnoses

Table 3.11 provides a breakdown of the diagnoses according to the three different arms of the Study.

Table 3.11 Diagnoses for Participants in each of the Study Arms.

Diagnosis	Nurse Assessment	GP Assessment: Costs Compensated	GP Assessment: Patient to Pay
Conjunctivitis and skin infection		1	
Gastroenteritis		1	1
Viral Gastroenteritis	1		1
Influenza A		1	
Malaria		2	
Viral Meningitis (EBV)	1		
Pneumonia			1
Upper RTI	1		1
Viral RTI	3	1	2
Total	**6**	**6**	**6**

Table 3.12 provides a breakdown of the causes of fever according to port of origin. Taking into consideration the usual incubation period of the infectious diseases listed a determination of the likely origin of infection was made. This provided an indication of differences in febrile illness according to the regions from which passengers were travelling, and possibly contracted, the illness. The only case of influenza was most likely to have been acquired in southeast Queensland, however the other respiratory conditions, including pneumonia, were acquired in New Guinea. The participants with illnesses that had associated diarrhoea had contracted the illnesses in Hong Kong, Singapore and New Guinea. The two participants with malaria had contracted the disease in New Guinea.

Table 3.12 Countries from which Diagnosed Illnesses have Originated

Diagnosis	Germany	Hong Kong	Japan	New Guinea	Singapore	Australia
Malaria				2		
Viral Meningitis (EBV)				1		
Influenza A						1
Pneumonia				1		
Upper RTI				2		
Viral RTI	1	1	1	3		
Viral gastroenteritis		1		1		
Gastroenteritis		1			1	
Conjunctivitis & skin infection				1		
Total	**1**	**3**	**1**	**11**	**2**	**1**

3.2.4 Optimal Method for Management of Passengers

3.2.4.1 Comparison of Nurse assessment, GP assessment: costs compensated and GP assessment: patient to pay

In order to determine which arm was the most effective for managing febrile passengers, the three intervention arms were compared. In the nurse assessment arm, if the participant agreed to be assessed by the nurse/phlebotomist and provide blood and other specimens, this was considered an equivalent evaluation to a general practice visit in the two GP assessment Arms. There were 19 participants who received a health assessment (7 Nurse assessment, 6 GP assessment: costs compensated, 6 GP assessment: patient to pay) and 57 who did not. Analyses indicated that there were no differences between each of the assessment arms. The proportion of participants who received a health assessment in the Nurse assessment arm was 0.39, the proportion from GP assessment with costs compensated was 0.19, whereas the GP assessment arm with the patient paying was 0.22. Figure 3.2 provides an illustration of the participants agreeing to a health assessment across the three arms.

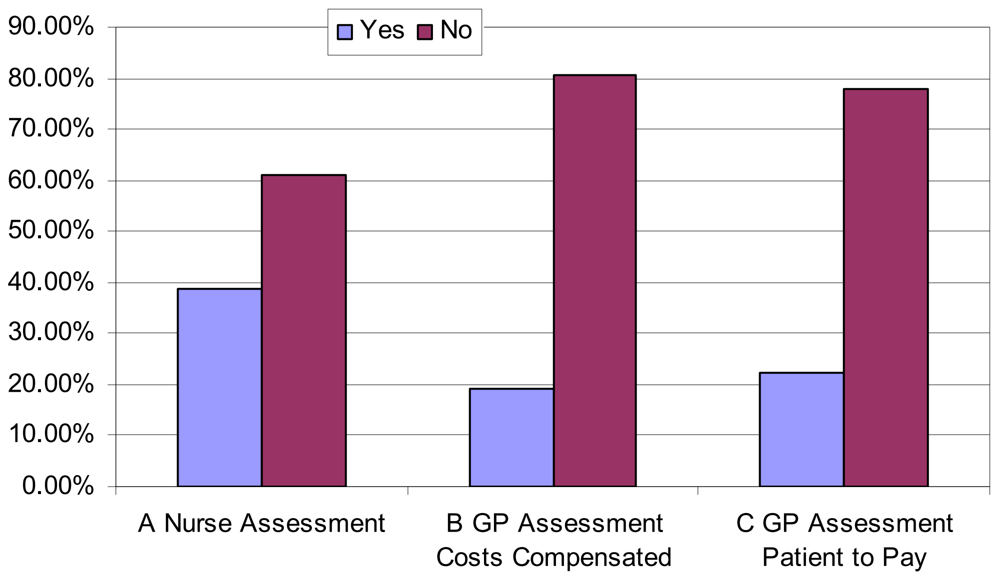

Figure 3.2 Proportion of participants who received a health assessment from each of the assessment arms

Although there were no differences between the three assessment arms, other factors were associated with the likelihood of receiving a health assessment. Comparisons were made of participants who received a GP assessment (with or without pathology tests) or who received pathology tests (with or without the GP assessment). Analyses indicated the following statistically significant differences:

- Participants who had dyspnoea (0.75) were more likely to accept a health assessment than participants without dyspnoea (0.23) [χ2(1, 75) = 5.510, p = .048].
- Participants with higher temperatures (≥38.5; 0.40) were more likely to visit the GP than participants with lower temperatures (≤38.5; 0.16) [$\chi^2(1, 76) = 4.859$, p = .027].
- Participants with a cough (0.37) were more likely to visit the GP than participants without a cough (0.13) [$\chi^2(1, 75) = 5.591$, p = .018].
- Participants with dyspnoea (0.75) were more likely to visit the GP than participants without dyspnoea (0.20) [$\chi^2(1, 75) = 6.602$, p = .034].
- The age for those who had pathology tests (M = 42.21, SD = 17.34) was significantly higher than those who did not have pathology tests (M = 27.58, SD = 15.71) [F(1, 73) = 6.69, p = 0.012].
- Participants who had arrived from New Guinea (0.24) were more likely to have pathology tests than participants arriving from other ports (0.02) [$\chi^2(1, 75) = 8.364$, p = .009].
- Participants with arthralgia (0.33) were more likely to have pathology tests than participants without arthralgia (0.07) [$\chi^2(1, 73) = 7.706$, p = .015].
- Participants with a cough (0.23) were more likely to have pathology tests than participants without a cough (0.04) [$\chi^2(1, 75) = 6.082$, p = .025].

Appendices Y, Z, AA provide a breakdown of those participants who received health assessments (all; GP assessment – with or without pathology tests; pathology tests – with or without GP assessment) according to core body temperature (categorised as high or low with cut-off at 38.5), gender, country of residence (4 major regions), port of origin (4 major regions), symptoms, and had pathology tests (dichotomised).

3.3 Thermal Camera

3.3.1 Skin Temperatures (measured by the Thermal Camera)

Out of 181,759 arriving international passengers, thermal camera temperatures were recorded for 1334 passengers (0.73%), therefore 99.27% of passengers were not delayed by the screening process.

When the alarm sounded, skin temperatures were recorded on 1042 passengers (0.57%). The range of thermal camera temperatures for the 1042 cases was between 34.6°C and 37.8°C. Figure 3.3 provides an illustration of the range of skin temperatures over the duration of data collection.

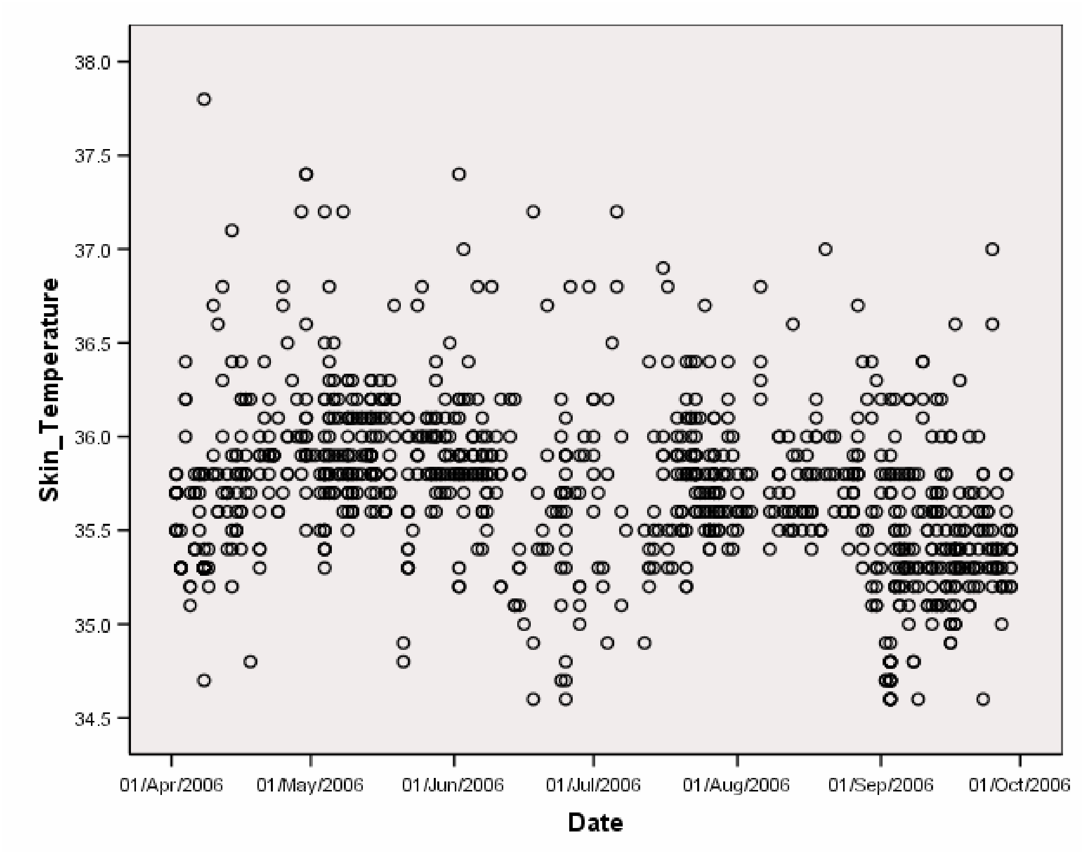

Figure 3.3 Thermal camera temperatures (when the alarm sounds for 1042 participants) from 1 April to 29 September 2006

3.3.2 Sensitivity evaluation of Infrared Thermal Camera

Additional data was collected on the thermal camera from 2nd to 29th September 2006. A sample of passengers were randomly pulled aside and were asked permission for an ear temperature measurement. These passengers had not caused the thermal camera to alarm. Alarm cut-off, infrared, and core body temperature readings were collected. A total of 292 recordings was taken. The range of thermal camera temperatures was between 32.6°C and 35.5°C. Figure 3.4 provides an illustration of the range of skin temperatures over the duration of data collection. None of these passengers had an elevated core temperature.

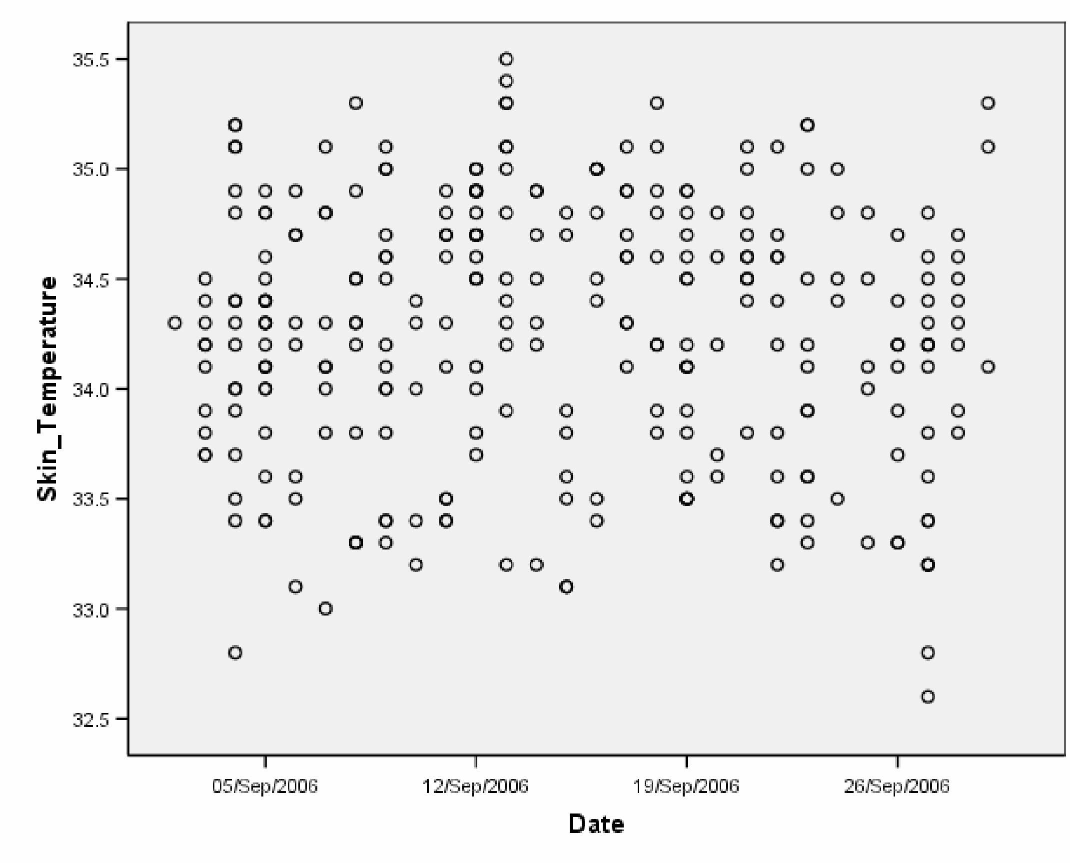

Figure 3.4 Thermal camera temperatures (when the alarm does not sound for trial) from 2 September to 29 September 2006

3.3.3 Images using the Infrared Thermal Camera

An example of video footage and photographs taken from the perspective of the thermal camera are provided in CD Appendices 16 and 17.

At the end of the thermal camera video footage, there are some technical tips for the operation of the thermal camera. For example, the camera is ideally placed to view passengers at a distance of two metres (FLIR Systems, 2004). If passengers come closer to the thermal camera there is an elevated risk of false positive results.

3.3.4 Core Body Temperatures (measured by the ear thermometer or tympanometric instrument)

Of the 1042 passengers who triggered the thermal camera to alarm and were invited to have ear tympanometric temperature measurements, 956 agreed (91.75%). Core body temperatures for these passengers ranged from 34.4°C to 40.3°C.

A total of 292 passengers who did not cause the thermal camera to alarm were pulled aside to have their core body temperatures taken. Core body temperatures for 292 passengers ranged from 34.0°C to 37.6°C.

3.3.5 Differences between the Skin and Core Body Temperatures

With the additional data, a total of 1248 core body temperatures were recorded. This and the following section (3.3.5 and 3.3.6) relate to this total number of recordings.

The skin temperature measured by the thermal camera is expected to be lower than the core body temperature. The difference scores ranged from -1.5 to 3.8. Out of the 1248 core body temperatures recorded there were nine occasions when the thermal camera temperatures were higher than those recorded by the tympanometric instrument. Observations of passengers suggested that they had either a skin rash, sunburn, had been consuming alcohol or had sinus problems which may have contributed to a higher skin temperature.

3.3.6 Relationship between the Skin Temperatures and Core Body Temperature of Passengers

There was an expectation that core body temperatures as measured by the tympanometric instrument would be consistently higher than skin temperatures as measured by the thermal camera. A correlation was performed between thermal camera temperatures and core body temperatures. The relationship was significant ($r = .4$, $p < .001$). This relationship is presented in Figure 3.5 below. Also indicated is the range of alarm temperature readings (34.2 - 36.0°C) for the thermal camera. Most febrile passengers had a thermal camera reading above 35.4°C; however, one passenger had a thermal camera reading of 34.6°C.

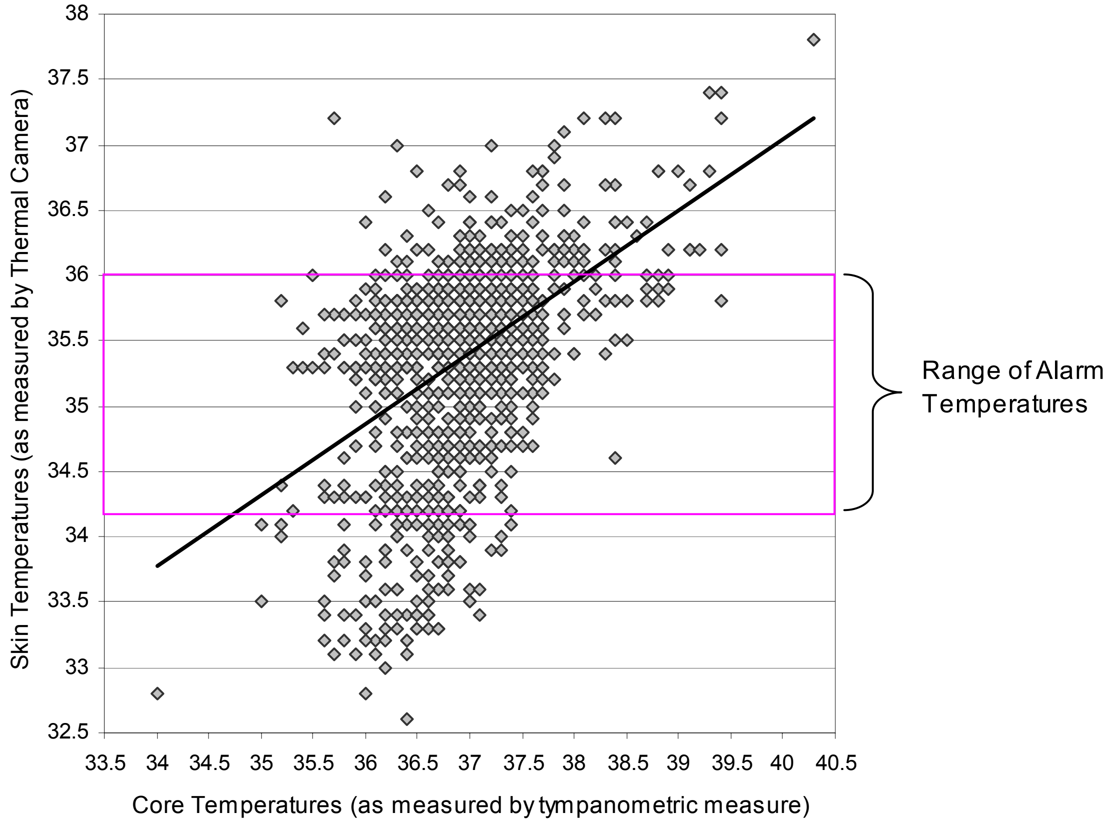

Figure 3.5 Scatterplot of thermal camera and core body temperatures

3.3.7 Alarm and Reference Temperatures

As indicated in the method section of this document, the alarm could be set by two different means. The research officers commenced recording alarm temperatures on 24 April 2006. From this date until 21 July, the alarm temperature was set at 1.3°C (delta value) above the reference temperature.

A trial using a preset alarm temperature was conducted from 22 July until 25 August 2006. Although the research staff felt confident using the moving average function of the camera it was felt that this information may be useful if the camera were deployed in circumstances where staff training was less ideal. As of 22 July, the thermal camera alarm was preset at 35.4°C. The decision to set the alarm temperature at this level was based on the previous temperature figures collected. The mean value for the previous alarm temperature was 35.4°C, therefore this was chosen as the preset alarm temperature.

The alarm temperature reverted to the reference temperature with a delta of 1.3°C as of 26th August 2006. Figure 3.6 provides an illustration of the recorded alarm temperatures from 24th April to 29th September 2006, excluding the period when the alarm temperature was preset at 35.4°C. The mean alarm temperature was 35.28°C with a standard deviation of 0.31°C. Temperatures ranged from 34.2°C to 36°C.

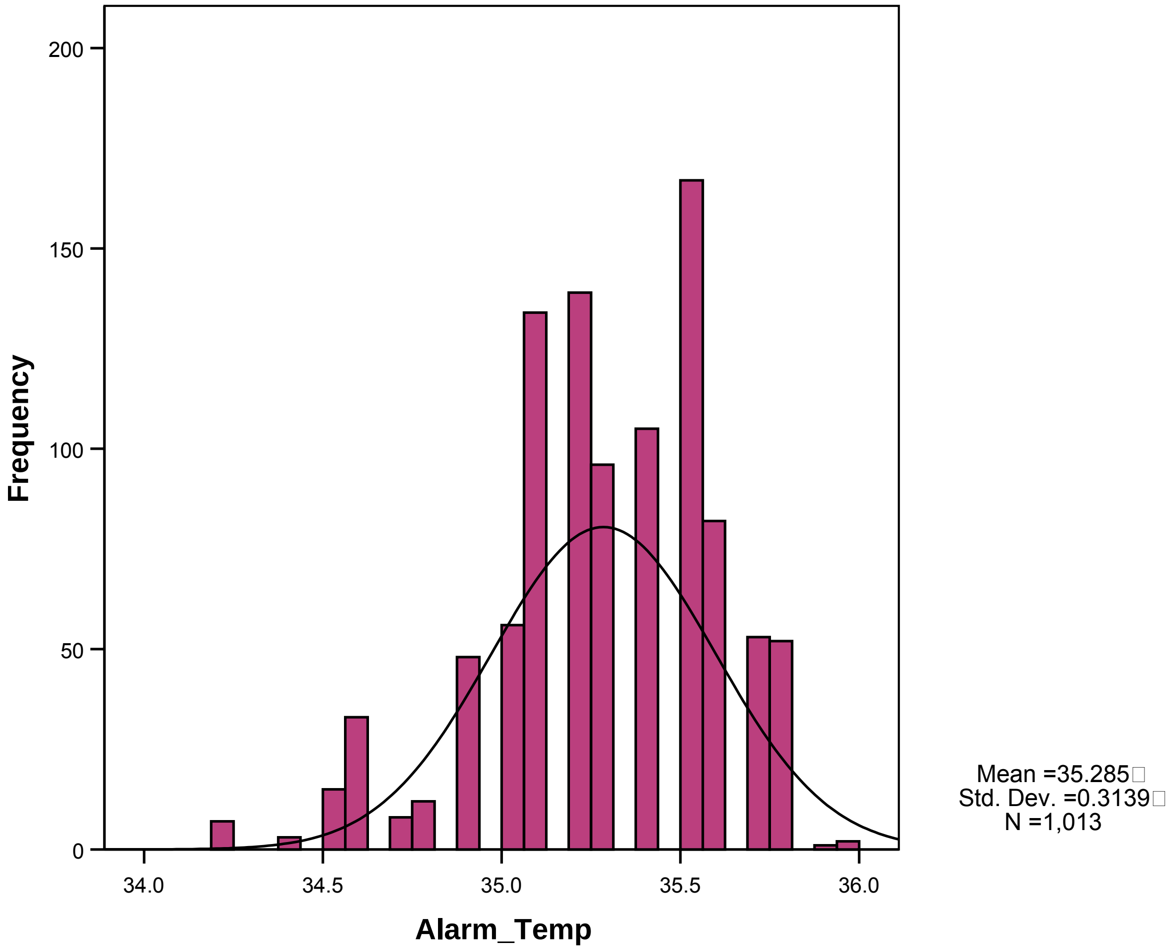

Figure 3.6 Histogram of alarm temperatures

3.3.7.1 Comparison between Preset Alarm and using Reference Temperatures with Delta Value.

It was important to test whether presetting the alarm would make any difference to the number of febrile passengers being identified and once identified, whether there was a difference in the number of enrolments. This would provide information for the effectiveness of operating the camera using a preset temperature rather than a delta value (reference temperature).

Using cross-tabulations, the number of febrile passengers (febrile versus non-febrile) and the frequency with which the alarm temperature was preset (preset versus reference) was investigated. Table 3.13 is the contingency table providing the frequency and percentage for each of the variables.

Table 3.13 The proportion of febrile passengers (febrile versus non-febrile) according to the frequency with which the alarm temperature was preset (preset versus reference)

	Febrile	**Not Febrile**	**Total**
Reference Alarm Temperature	99	630	**729**
	0.14	0.86	**1.00**
Preset Alarm Temperature	9	156	**165**
	0.05	0.95	**1.00**
Total	**108**	**786**	**894**
	0.12	**0.88**	**1.00**

Note: Alarm temperatures were not recorded for the first 24 days of the project; therefore these figures on febrile passengers refer to the period when alarm temperatures were recorded.

The proportion of those participants who were identified as being febrile during the period when the reference temperature was used was 0.14, where the proportion who was febrile during the period when the preset temperature was used was 0.05. The difference in proportions is significant, $\chi^2(1, 894) = 8.364$, $p = .005$. This suggests the possibility that some febrile passengers may have been missed during the period when the alarm on the thermal camera was preset. When looking at the overall numbers of febrile passengers, there were 45 febrile passengers (38%) who had alarm temperatures lower than 35.4°C (ranging from 34.6°C to 35.3°C).

3.4 Participation Rate

3.4.1 After Infrared Temperature Measurement

Out of the 1042 passengers who were approached by research officers after having caused the thermal camera to alarm, 86 (8.25%) did not agree to having their core body temperatures taken. A further 292 core body temperatures were randomly collected from passengers who had not caused the thermal camera to alarm.

3.4.2 After Ear Tympanometric Temperature Measurement

There were 1248 passengers who agreed to have their ear tympanometric temperature taken. Table 3.14 provides a breakdown of the outcomes after core body temperature measurement.

Table 3.14 Outcomes after core body temperature measurement

Criteria	No.	Percentage
Febrile (≥ 37.5) - Included in study	**76**	6.09%
Febrile (≥ 37.8) but declined	**31**	2.48%
Temp 37.5 ≤ 37.7 and unwell but declined	**11**	0.88%
Temp 37.5 ≤ 37.7; no symptoms, declined	5	0.40%
Temp between 37.5 ≤ 37.7 and well - not eligible	41	3.29%
Temp 37.5 ≤ 37.7, before entry criteria changed	9	0.72%
Temp < 37.5	783	62.74%
Passengers who did not cause thermal camera to alarm	292	23.40%
Total	**1248**	100.00%

These figures show that 118 passengers (indicated in bold) had their temperatures measured using a tympanometric instrument and were eligible to be part of the study. Of the total number of international arriving passengers, 118 passengers or 0.06% were identified as febrile.

Table 3.15 provides a breakdown of the number of febrile passengers according to ports of origin and their respective allocated regions.

Table 3.15 Number of febrile passengers arriving from different ports of origin

Region	Port of Origin	Pax Nos	No. of Febrile Pax	% Pax arriving from Port of Origin	% of Febrile Pax
Japan		*111321*	*31*	*0.03%*	*26.27%*
	Osaka	27152	8	0.03%	6.78%
	Nagoya	27370	9	0.03%	7.63%
	Narita	56799	14	0.02%	11.86%
Oceania		*33692*	*60*	*0.18%*	*50.85%*
	Port Moresby	18264	40	0.22%	33.90%
	Mt. Hagen	1072	2	0.19%	1.69%
	Kiunga	27			
	Misima	27			
	Tabubil	1057			
	Moro	332			
	Timika	808			
	Brisbane	4578	9	0.20%	7.63%
	Sydney	7280	9	0.12%	7.63%
	Auckland	247		0.00%	
Asia		*30671*	*27*	*0.09%*	*22.88%*
	Korea	1473			
	Hong Kong	13587	13	0.10%	11.02%
	Indonesia	9			
	Jakarta	4			
	Singapore	6029	5	0.08%	4.24%
	Singapore/ Darwin	9569	9	0.09%	7.63%
Rest of World		*6075*	*0*	*0.00%*	*0.00%*
	Guam	6015			
	Majuro	48			
	Tonga	12			
Total		**181759**	**118**	*0.06%*	**100.00%**

3.4.3 Deployment Sites for the Thermal Camera

The thermal camera could be deployed at a number of sites at the international airport. It was decided to test the thermal camera at each of the sites and gather information that could inform which would be the most appropriate if a pandemic were to occur. Whilst the results are specific for this international airport, recommendations are offered for other international airports.

3.4.3.1 Post-Primary

The post-primary trial site was situated just after the Immigration/Customs booths. The dates for the post-primary trial occurred from 1st April to 9th June (10 weeks) and 15th July to 29th September (11 weeks). A copy of the site layout and photographs are attached as Appendices AB and 18 (CD). This was the preferred site for the study. The passengers came out of the immigration/customs line in a reasonably orderly fashion and they were generally not in a great hurry because they still had to wait to collect their luggage at the carousel.

3.4.3.2 Pre-Primary

The pre-primary trial site was situated on the mezzanine floor just above the Duty Free store and the Immigration/Customs booths. A copy of the site layout and photographs are attached as Appendices AC and 19 (CD). The trial occurred from 10th June to 14th July (5 weeks). The 1st Chief Investigator captured some video footage of the thermal camera images. During the trial research officers found it quite difficult to ask people to participate because they were generally in a hurry to secure an advantageous position in the Immigration/Customs line. The tensa barriers (barriers that corral people to go a certain direction) were re-positioned a number of times to encourage passengers to slow down. Repositioning the tensa barriers was partially successful at slowing passengers down. It was important to identify whether having the thermal camera at the pre-primary site would impact on the number of febrile or enrolled passengers.

Using cross-tabulations, febrile passengers (febrile versus non-febrile) and the location of thermal camera (pre-primary versus post-primary) was investigated. Table 3.16 is the contingency table providing the frequency and percentage for each of the variables.

Table 3.16 The proportion of febrile passengers (febrile versus non-febrile) and the location of thermal camera (pre-primary versus post-primary)

	Febrile	**Not Febrile**	**Total**
Post Primary Site	104	841	**945**
	0.11	0.89	**1.00**
Pre Primary Site	14	83	**97**
	0.14	0.86	**1.00**
Total	**118**	**924**	**1042**
	0.11	**0.89**	**1.00**

The proportion of those participants who were identified as being febrile during the period when the thermal camera was located at the post-primary site was 0.11, while the proportion who were febrile during the period when the camera was located at the pre-primary site was 0.14. The difference in proportions is not significant. This suggests that it is likely that febrile passengers were not missed during the period that the thermal camera was located at the pre-primary site.

3.4.3.3 Aerobridge

At one of the working group meetings, a proposal was put forward to trial the thermal camera on one of the aerobridges. The working group wanted to assess the logistic issues required to set up the site and screen passengers. Aerobridge 1 was the chosen site. The first airline contacted was Continental Airlines because they frequently used aerobridge 1. The manager advised that it was not possible to conduct an aerobridge trial on a Continental Airlines flight primarily because of security issues. Air Niugini was then approached. They approved the trial of the camera during a PX 98 flight (Friday evening flight). The working group discussed the location of the camera during the trial and suggested that aerobridge 1 was too narrow and that the concourse adjoining aerobridge 1 would be more suitable. The trial was held on Friday 30th June 2006 at 8.30pm. The conduct of the trial was considered quite successful. Passengers walked down the aerobridge onto the concourse and without hesitation formed a single file. Whilst this flight had approximately 80 passengers, it was felt that this set up would work very well with larger flights. The site layout for the aerobridge trial is attached as Appendix AD. During the aerobridge trial there were no febrile passengers identified, therefore no further analyses were conducted on the usefulness of this thermal camera location.

3.4.3.4 Empty Aircraft

At one of the working group meetings, a proposal was put forward by AQIS to hold a trial of the thermal camera in an aircraft. After a good deal of discussion on the issues, the decision was made to approach QANTAS to trial the camera in one of their aircraft that was between flights (i.e., empty of passengers and being serviced/maintained). QANTAS approved the trial, which was held on 23 August at 8.30am. The trial occurred on a QANTAS Boeing 767 in bay 5. Because there was no access to real passengers, volunteers were recruited to act as passengers. CPA, AQIS and Customs staff agreed to volunteer. Some of the points noted from the trial:

- The aircraft had been sitting for some time on the tarmac, so that the windows on one side of the plane had heated up considerably. The windows facing the sun caused the alarm to sound. The shades were pulled down to stop the camera alarming, but these, in turn, became warmer and their temperature exceeded the set alarm temperature.
- When holding the camera down at waist level to view passengers, the camera was not able to see faces clearly (the image of the face was larger than the screen). The optimum distance to view faces is two metres. The camera needed to be held up high so that faces could be seen clearly in the screen. It was still not possible to position the camera at optimum viewing distance.

- If passengers' heads were facing downwards, the camera would not be able to gain an appropriate indication of the skin temperature. In a real scenario passengers would need to be instructed to face forwards when the camera was viewing them.
- Screening the entire aircraft took between five and eight minutes (1st Chief Investigator and Project Manager did separate test runs).
- Taking into account the likely passenger behaviour, and the time taken to screen the aircraft it was considered that pre dis-embarkation screening was impractical.

This trial was recorded on two digital recorders. This is included as CD Appendix 20 (available on request from authors).

3.4.4 Perceptions of Passenger Attitude and Behaviour

Early in the project, it was identified that many of the enrolled participants were not visiting the GP. The research staff cooperatively observed passengers' behaviour throughout the project and provided some perceptions and insight to the research team. The data from the interviews with research officers was analysed for any commonalities and differences. A summary of relevant themes is presented in the following section:

3.4.4.1 Passengers' Behaviour when being told they had a Fever

When asked whether research officers noticed anything about passengers' attitudes or behaviours when told they had a fever and whether passengers expressed surprise, research officers agreed that some passengers showed surprise at being told that they had a high temperature, especially if they were feeling well. One research officer commented that some visitors from New Guinea were visiting Cairns for the express purpose of going to the doctor/hospital. Others hypothesized that some passengers had higher temperatures because they had been consuming alcohol on the flight. Parents seemed to be especially surprised by their children having a fever and some even ignored their children's conditions. The passengers who didn't show any surprise at being told they had a fever were aware of their condition and usually feeling quite unwell.

3.4.4.2 Passengers Intentions to visit the GP

Research officers offered comments about what febrile passengers said about their intentions to see a doctor. They identified that passengers were less likely to see the doctor with mild cold or flu-like symptoms. Passengers were likely to take a "wait and see" approach and comment that they would only see the doctor if their symptoms deteriorated. This was more likely to be the case if the passenger was holidaying in Cairns. Research officers commented on the influence of the tour operators and family on passengers' intentions to see a doctor.

3.4.4.3 Passengers' Reactions to Blood Tests

The nurse assessment arm required that research officers obtain pathology specimens from passengers. Research officers gave some explanation for passengers' reactions to being asked to provide blood and other specimens and why they might refuse to have blood tests. One research officer considered that passengers were either too tired after travelling for long distances, that they weren't sure about the research officer's competence to take bloods, or they were worried about their privacy being violated.

Another research officer thought that the group had a great deal of influence over the individual. This research officer had commented that she was quite successful in convincing participants to have blood tests, but some did refuse because the symptoms were perceived as not serious or that the passenger did not care. Some passengers seemed to be scared of needles.

3.4.4.4 Language Differences

Research officers made some comments about the behaviour of those passengers who did and did not speak English. Differences were apparent between the Chinese, Japanese and the peoples from New Guinea. One research officer identified that the Japanese travellers were surprised at being screened, the Chinese ignored the process, and the passengers from New Guinea seemed unsure.

3.4.4.5 Different Passenger Cohorts

Research officers gave their overall impressions of the behaviour of the different passenger cohorts that were arriving into Cairns. New Guinea passengers were always identified as polite and compliant. Japanese passengers were considered to be compliant by some research officers, but one thought that they were always in a hurry. The Chinese and European passengers were considered to be less orderly than the other groups.

4.0 Discussion

The aim of this study was to determine the optimal assessment of febrile passengers detected by infrared thermal screening at an international airport. To achieve this aim, seven objectives were identified. The following section will report on each of the objectives:

4.1 Determine the rates of people with a fever entering an Australian international airport

There were 196,700 passengers who arrived into the Cairns International airport. This figure did not include passengers in transit. A total 181,759 passengers (92.4%) were screened by the thermal camera. There were 118 passengers identified as febrile (0.06%), with 76 febrile passengers (64.41%) who consented to be in the study. Eighteen passengers (23.7%) were enrolled into the Nurse assessment arm, 31 (40.8%) into the GP assessment: costs compensated arm and 27 (35.5%) into the GP assessment: patient to pay arm. There was a slight male preponderance. The average age for participants was 29 years with a range from 19 months through to 64 years. The rate of febrile passengers arriving from each port and region of origin was calculated. 0.03% of the Japanese passengers were febrile, 0.18% from Oceania, and 0.09% from Asia. The high rate of fevers entering from Oceania ports contributed significantly to the overall fever rate.

4.2 Determine the most efficient and effective methods in the investigation of febrile travellers detected by thermal cameras at an international airport and identify any barriers to febrile passengers accessing health care

An innovative aspect of this study was the recruitment of an interested group of GPs who acted as sentinel practices for the evaluation of febrile travellers. It was hypothesised that the involvement of GPs in providing a clinical approach to investigation and follow up might achieve a better outcome than qualified staff at airports, but that the costs involved with visiting a GP could be a barrier to the adoption by travellers. It was expected that the convenience of on-the-spot investigation would result in most passengers in the nurse assessment arm being investigated. The findings of this study did not support this hypothesis. The low rate of investigation of participants offered immediate testing was a surprise, suggesting that removal of cost and time barriers were not sufficient to ensure high rates of investigation amongst febrile passengers.

Data were analysed for any parameters associated with an individual seeking some form of health assessment, whether it is from a GP or a health professional (research officer) at the airport. People who had dyspnoea were more likely accept a health assessment (from nurse or GP). People with temperatures over 38.5°C were more likely to visit the GP. Participants with a cough were more likely to visit the GP or have pathology tests. Older people, or passengers arriving from New Guinea, or if they had arthralgia were more likely to have pathology tests.

The low number of participants who either agreed to be assessed at the airport or visit the GP was unexpected. It appears that human behaviour especially health behaviour is complex and not always predictable (Egger et al., 1999). There have been many theories that have helped to explain health behaviour. Many of the theories are contradictory and lead to different conclusions depending on the circumstances. The major theory that has guided this research was the Health Belief model (Rosenstock, 1974), whereby affected travellers after being identified as febrile will be sufficiently motivated to seek assistance to identify their illness.

Eggar et al. propose that the level of risk of disease is often the key factor in determining the individual's response when faced with a decision concerning behaviours which may lead to ill-health (Egger et al., 1999). At present the risk of becoming infected with avian influenza is very low, which suggests that the travelling public are not concerned and thus not sufficiently motivated to find out the cause of their illness. Indeed, the research officers commented that some febrile travellers were not concerned about having a fever and would not visit the GP unless their symptoms deteriorated.

For some people, the risk of being infected with a serious public health disease, such as SARS was not adequate for them to change their behaviour. A study by Lau, Yang, Tsui, and Pang (2004) investigated the patterns of behaviours and attitudes related to SARS prevention in the Hong Kong cross border traveller population. They found that 40% of respondents were using masks all or most of the time in public places or frequently washing their hands. About one-third of the population were avoiding crowded places in mainland China. Perceived risk of transmission was associated with mask use and visiting crowded places, but not with hand washing, which was associated with duration of stay. Around 70% of travellers would have delayed consulting with a medical professional for influenza-like illness and 12.7% would not wear masks during such episodes of illness. The authors concluded that the group who were travelling during SARS were a "self-selected" group and they were using less preventive measures.

Eggar et al. also argued that "the likelihood of individuals being motivated to adopt health-enhancing behaviours …is a function of the level of knowledge, attitudes and skills which the person possesses in relation to the health risk" (p. 20). It is commonly believed that the mere presence of knowledge is sufficient to motivate individuals to change their behaviour. This is known as the 'knowledge-action' model of behaviour (Egger et al., 1999). Application of this model would suggest that presenting information to the travelling febrile passengers would ensure that they seek advice from a health professional. However, knowledge does not always denote a change in behaviour.

Eggar et al. suggest a number of reasons why. Firstly, individuals are bombarded with an enormous amount of information from modern society and this is perceived according the individual's own psychological predisposition. Individuals tend to select out or bypass those things which they do not want to hear. Indeed, being told that the affected traveller is febrile may be ignored so that the traveller can continue without delay with their schedule (i.e., tour or business). Secondly, once the stimulus is received, the individual interprets this in terms of personal experience. Whether information is selectively interpreted will depend on whether the individual's background, experience, learning and other factors corresponds to that from which the message was generated. Indeed, the current project included individuals from a wide variety of backgrounds, experience and learning. Finally, the input received and analysed must have personal meaning if action is to be taken. To ensure behaviour change, knowledge needs to be incorporated by individuals in a way that affects their attitudes and values towards health, and bringing values and attitudes into the equation helps to explain the knowledge-action gap. However, there is no clear association between attitudes and values to behaviours and many other psychological and environmental factors may play a role.

A plethora of theories/models have been developed to help explain the interrelationship among psychological and environmental factors. Some examples include the model of Strategy Mix Choice for Planned Social Change (Sheth & Frazier, 1982), the Cognitive-Dissonance theory (Festinger, 1957), the Social (Cognitive) Learning theory model (Bandura, 1977), the Theory of Reasoned Action (Fishbein & Ajzen, 1975), and Transtheoretical Stages of Change model (Prochaska & DiClemente, 1983). These are comprehensive models; however, they all focus primarily on individual-level determinants of health care seeking behaviour.

A systematic approach is critical for understanding the relationship between health status and initiating health behavioural changes (Bhattacharya, 2004). The emphasis of the above models on cognitive, attitudinal, and intrapersonal determinants of health care seeking behaviour limits their explanatory power for behaviours from different ethnic backgrounds (Bhattacharya, 2004). For example, the Strategy Mix Choice for Planned Social Change, the Health Belief Model, the Cognitive-Dissonance theory primarily focus on individuals' attitudes and do not address the influence of culture, class, economics, and environment on changes in the individual health behaviours that are so relevant for many countries and cultures.

The focus of the Social Learning theory is on self-efficacy and the development of cognitive and behavioural skills to employ changes in health behaviour; however, there is a lack of recognition of the interactions of factors at multiple levels which may inhibit or improve the individual-level factors for developing self-efficacy (Bhattacharya, 2004). The

Theory of Reasoned Action proposes that individuals are logical thinkers and methodically evaluate the consequences of their health care seeking behaviour. For some families, factors such as family and community norms may determine the action at the individual level, and the rationality in thinking will be obscured (Bhattacharya, 2004). The Transtheoretical Stages of Change model focuses on behavioural changes at the individual level and does not consider structural influences on behaviour. For example, Asian people, such as those travellers from Japan, China, Korea, and Indonesia are more collectivist and focused on ensemble identities, such as those conferred by families and other socially extended groups, rather than on individuals (Barker, 1994; McLaughlin & Braun, 1998). It is proposed that theoretical models that holistically address each culture in their social, cultural, and environmental contexts may be the most appropriate for understanding their health care seeking behaviours (Bhattacharya, 2004).

4.3 Determine the most useful sites for thermal camera deployment at international airports

The major site for deployment of the thermal camera was the post-primary trial site which was situated just after the Immigration/Customs booths in the Cairns international terminal building. This was the major site negotiated with the working group that would have the least impact on passenger flow. The trial occurred over a 21 week duration broken into two separate timeframes (1 April to 9 June and 15 July to 29 September). This was the preferred site for the fever screening as passengers came out of the immigration/customs line in an orderly fashion and were generally not in a great hurry as they were yet to collect their baggage from the carousels before entering the AQIS check-point.

The post-primary site meant there would be some mixing of passengers. It was important, in the context of influenza, to trial the thermal camera at sites where there would be minimal or no mixing of passengers between flights. There were three locations where there would be minimal mixing between flights. The pre-primary location which was situated on the mezzanine floor was one of the sites. This site was located just above the Duty Free store and the Immigration/Customs booths. There would still be some mixing of passengers at this site when flights arrived at the airport at the same time. We were advised from airport personnel that passengers would mix for a maximum of about 10 minutes. The other sites included the concourse just below one of the aerobridges and screening passengers onboard an aircraft. At both these sites, there would be no mixing between flights.

The pre-primary trial occurred over a 5-week duration between 10 June and 14 July. Whilst this site was initially identified as being a better site with less passenger mixing, the research officers found it quite difficult to engage with passengers who were hurrying to the Immigration/Customs line. Some repositioning of the tensa barriers occurred and was partially successful at slowing passengers down; however, whilst passengers did slow down they were still less interested in participating (i.e., having core body temperatures taken or participating in the project) because of their need to get to the Immigration/Customs line. Based, on research officers' comments it was likely that some febrile passengers may have been missed; however, statistical analyses comparing the pre-primary site with the post-primary site across febrile passengers indicated that it was unlikely that any febrile passengers were missed while the camera as located at the pre-primary site.

The aerobridge trial occurred on one occasion on 30 June. Whilst the trial occurred on one occasion with one flight only, it seemed to be very successful, with passengers walking down the aerobridge onto the concourse and without hesitation forming a single file past the tensa barriers. It was felt that this set up would work very well with other flights. As there were no febrile passengers identified from this flight, this trial site could not be statistically compared with other sites. The major disadvantage of this approach is that multiple sets of screening equipment would be required for each aerobridge, and on occasion, extra staffing to cope with concurrently arriving flights.

The last trial of the thermal camera occurred on an empty aircraft. Members of the working group felt that an empty aircraft would be the least disruptive way of trialling the camera onboard an aircraft. The trial occurred on one occasion on 23 August. Volunteers from various airport agencies were recruited to act as passengers. This trial was the least successful of the four trials. First, the camera needed to be held at a distance of at least two metres from the person's head (E. Y-K. Ng et al., 2004). In order to achieve this distance, the operator needed to hold the camera above their head. This still did not achieve the required distance, causing the camera to alarm frequently. Another issue encountered was passenger behaviour onboard the aircraft. In order to gain an appropriate reading of skin temperature, the passenger needed to be reasonably still and face forwards. Passengers expecting to depart the aircraft usually move around in their seats, gather their belongings, deal with their children, and are generally restless. Whilst this behaviour might be overcome with adequate communication and information onboard the aircraft, there are likely to be passengers who will still not be sitting in the correct position when being screened increasing the time taken to screen. Aeroplane windows facing the sun caused the alarm to sound, even after the shades had been drawn. The final issue of concern was the time taken to screen a plane load of passengers. In an empty Boeing 767, the screening time ranged from five to eight minutes (2 trials). This is a long time for passengers to wait until they are able to depart the aircraft.

The thermal cameras were deployed so that the passenger's forehead was the prominent features being measured by the camera. Whilst this appeared to be an effective measure for the purposes of this study, Liu, Chang and Chang (2004) suggest that auditory meatus temperature is a superior alternative compared with forehead body surface temperature due to its close approximation to the tympanic temperature. It is unlikely that reliable viewing of this part of the body could be achieved without inconveniencing the travelling public.

4.4 Identify any logistical issues that may impact on the successful implementation of the thermal cameras at international airports.

There were many issues surrounding the implementation and completion of the study that can provide information about the possible successful implementation of border screening and any impacts on passengers, their families and airport staff/businesses. The following sections will discuss the issues of security, staff time, being on site after hours, connecting flights, management of sick passengers, and cultural issues.

4.4.1 Security Issues

Security was a major issue to overcome early in the project. Before the research officers were to begin work, aviation security identification cards (ASIC) had to be issued. Application involved up to a six week waiting period. With a tight timeframe, the project commenced before all of the ASICs were issued. To overcome this hurdle, the research officers signed a visitor's book, were issued with a security badge whilst working in the terminal building and were escorted at all times. With six out of seven research officers with an ASIC, the remaining research officer had to sign in at the beginning of every shift for a period of 4 weeks. Fortunately, the project had been designed to have two research officers working for the first four weeks; the research officer without an ASIC was therefore able to be escorted by an approved research officer. With the urgent nature of pandemic influenza, it is important to consider how long security applications take and whether there is a process where the ASIC can be fast-tracked. There may be the case that the personnel who are manning the camera are already ASIC approved, however, if they are not then there will need to be adequate airport personnel available as escorts until ASIC approval.

4.4.2 Staff Time

The project also impacted on the security staff's time. Equipment for the project was stored in the first aid room in the international terminal building. The first aid room could only be accessed by the duty Chief Security Officer (CSO). At the beginning of each shift (up to 4 shifts per day) the CSO would be called (via Stenofon) to open the first aid room door and allow the research officers access to the equipment in order to set up. This was a time consuming responsibility for the CSO. Within a week of commencing the project a key was issued to the research officers. The key was held in the AQIS office which could be accessed by the research officers when they commenced their shift.

4.4.3 Out of Hours Issues

Procedures for access to the international terminal were changed during the project. Some of the late shifts were close together (midnight Guam flight, then 4am start) so the research officers who were rostered on the late then early shift would stay at the international terminal in the AQIS common room. In this area there were lounge chairs so that research officers could rest and wait for the next flight. Early in the project, this was identified as being a security and safety issue with research officers no longer being able to stay in the AQIS common room in the terminal. Apparently the airport closes down between midnight and 4am and having people at the airport during this time was both a safety and security concern.

4.4.4 Passengers and Connecting Flights

On one occasion during the project a family was delayed by the project staff for a period of time that resulted in the family missing their connecting flight. This was discussed at an airport operator's meeting and a new procedure was introduced whereby the first question that research officers would ask was something like "Are you going to meet a connecting flight?" and "When is it due?". If passengers were meeting a connecting flight within an hour, then the research officers were not to enrol but encourage the passengers through to the next part of the arrival process.

4.4.5 New Procedure for Sick Passengers

A new procedure was developed for incoming sick passengers who were to be taken to the hospital by ambulance. This was developed as a result of a scenario surrounding the first participant enrolled into the study. The participant was quite unwell and after consultation with AQIS and Chief Health Officer, the research officer phoned an ambulance to take the participant to hospital. Airlines staff only found out about the incident after the participant was taken to hospital. There was an airline concern about the hygiene of the aircraft in which the participant had travelled. After consultation with the airlines and AQIS a new procedure was introduced whereby AQIS are to notify the relevant airline of the sick passenger at the earliest possible convenience. This procedure is attached as Appendix G.

There was some discussion about the requirements of AQIS to be aware of any passenger with the temperature greater than 38°C. It was accepted that thermal imaging would detect passengers that would, in the normal course of events, have been processed without AQIS knowing that they were febrile. In the context of this study this raised an ethical issue in that some passengers may have been inconvenienced against their will. If future studies are conducted the possibility that study personnel act as agents for the Chief Health Officer could be explored. Throughout the study the primary responsibility for the assessment of quarantine risk lay with AQIS officers.

4.4.6 Cultural Issues

Some cultural training could have benefited the research staff. For example, it was pointed out early in the project that hand gestures can be offensive to the Japanese people. When using hand gestures to guide Japanese passengers forward past the thermal camera, the research officers were to ensure that their fingers were pointed downward. If they beckoned passengers with their palms up it was seen to be offensive.

4.5 Using dengue viral infections as a surrogate for Avian Influenza, measure the success of thermal screening at Cairns International airport

The disease that is of most public health importance in North Queensland is dengue fever. Whilst this study did not detect any passengers with dengue fever, we cannot be confident that none of the study participants had this condition. It is reassuring that the local public health authorities (personal communication Anne Richards Tropical Population Health Unit, 28 Sept 2006) were not notified of any dengue fever cases in international travellers over the duration of the study. In addition to this the conduct of this study during winter in the southern hemisphere, and the generally low activity of dengue present in the originating ports, made it likely that very few passengers had dengue fever. The overall sensitivity of the thermal imaging in detecting passengers with fever reinforces our belief that infrared thermal scanning of passengers is a useful tool for the detection of dengue fever. The low rate of subsequent investigations, however, might translate into a failure to diagnose the condition.

4.6 Minimise impact on passenger flow where no perceived threat exists

It was important that the fever screening process have a minimal impact on passenger flow through the Cairns International Airport. We were advised by Customs that they had strict time schedules to meet when passengers arrived into the terminal, in that all passengers were to be cleared of Customs within 30 minutes of the flight arriving. Thus for the vast majority of the study (21 weeks), the thermal cameras were situated at the post-primary site which would ensure that the Customs time schedules were met.

Out of the 181,759 international arriving passengers who were screened, there were only 1334 passengers (1042 alarm sounded; 292 alarm did not sound) stopped and asked to have their core body temperature taken. This represents 0.73% of the international arriving passengers who were screened using the thermal camera. This indicates that 99.27% of passengers were not delayed by the screening process.

4.7 Determine whether the research findings will translate to a situation involving pandemic influenza.

The findings are broadly relevant to a pandemic influenza scenario. The Australian Pandemic Plan provides a range of options for quarantine and assessment by GPs either in the surgery or at home, depending on the stage of the epidemic. The findings of this study suggest that qualified health professionals should be based at the airport during the pandemic and that mandatory quarantine and testing occur for passengers who are identified as having potential or probable avian influenza. Whilst there was no pandemic influenza crisis during the period of this project, others have reported that some travellers will not seek health care advice during times of crisis. This was observed in mainland China when during the SARS epidemic some travellers were not using masks, were visiting crowded places, and delayed consulting with medical professionals (Lau, Yang et al., 2004).

A mandatory approach was used in Singapore during the SARS epidemic where the Infectious Diseases Act was quickly amended to expand the power of the Ministry of Health to prevent and control the spread of SARS. Among the new powers, SARS cases or contacts and suspected SARS cases or contacts, people recently recovered from SARS or who have recently been treated for SARS could be issued with home quarantine orders and compulsory medical examinations. Whilst this seemed to be a harsh measure, there was provision for a $70 per day incentive which mitigated it with an encouraging compliance (Tay Swee Kian & Lateef, 2004).

There is a negative side to introducing measures that diminish individual autonomy and privacy in exchange for collective benefits (Gostin, 2001). Teo, Yeoh and Ong (2005) used Singapore as a case study to discuss the introduction of measures that were targeted at creating a ring of defence around the island and using surveillance to monitor and prevent its spread. Teo et al. found support for the changes; however, there was also resentment among some Singaporeans who complained that their right to privacy had been invaded. The WHO applauded Singapore for introducing a quick and effective response, however, it was the authors' belief that a holistic approach to the management of infectious disease must address the social and psychological implications of strategies that are predicated by medical science, otherwise it is likely that people will suffer unnecessary upheaval, become distressed and are less likely to cooperate (Teo et al., 2005).

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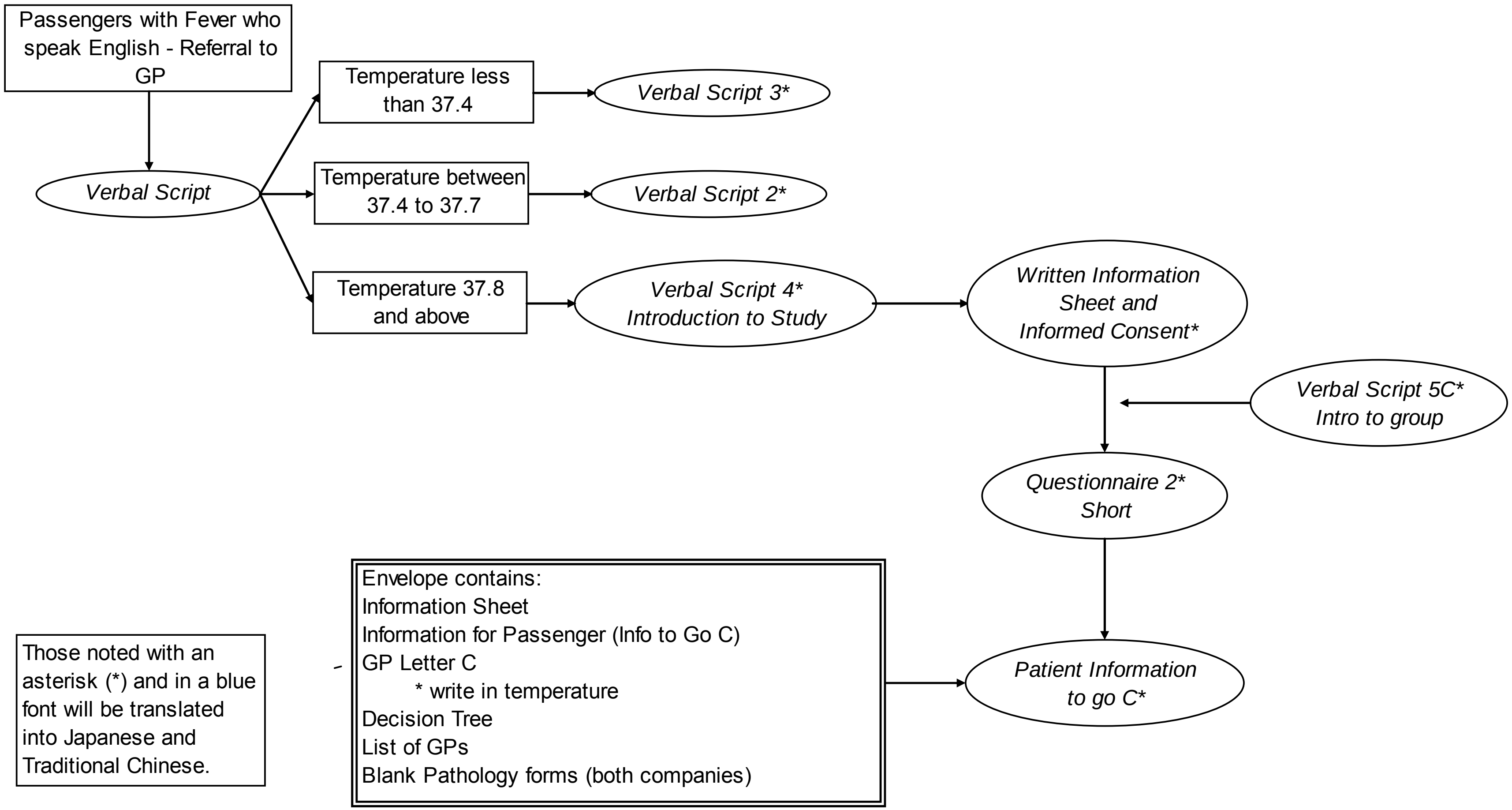
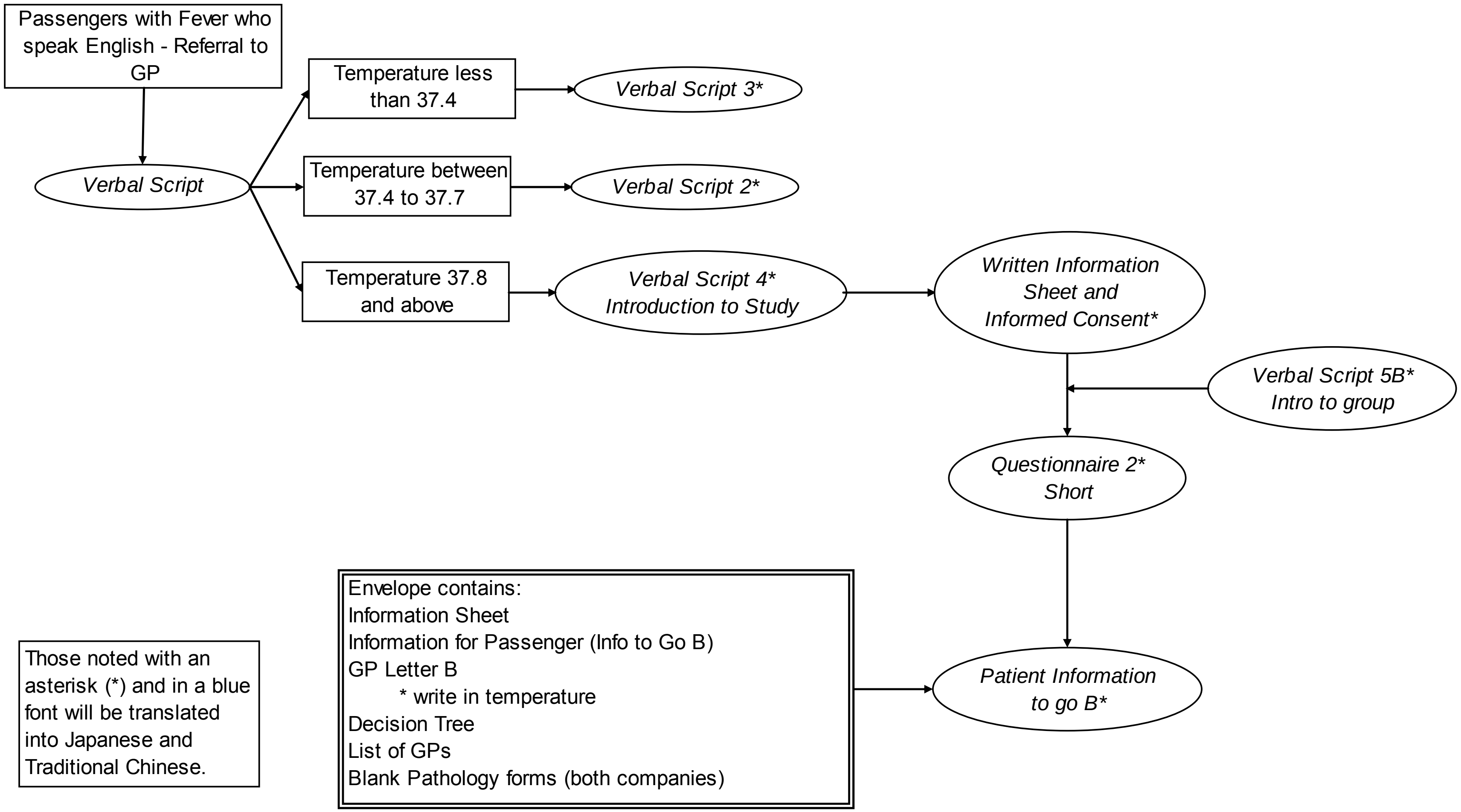
Appendix A

Passengers with Fever - Referral to GP with passenger to pay costs



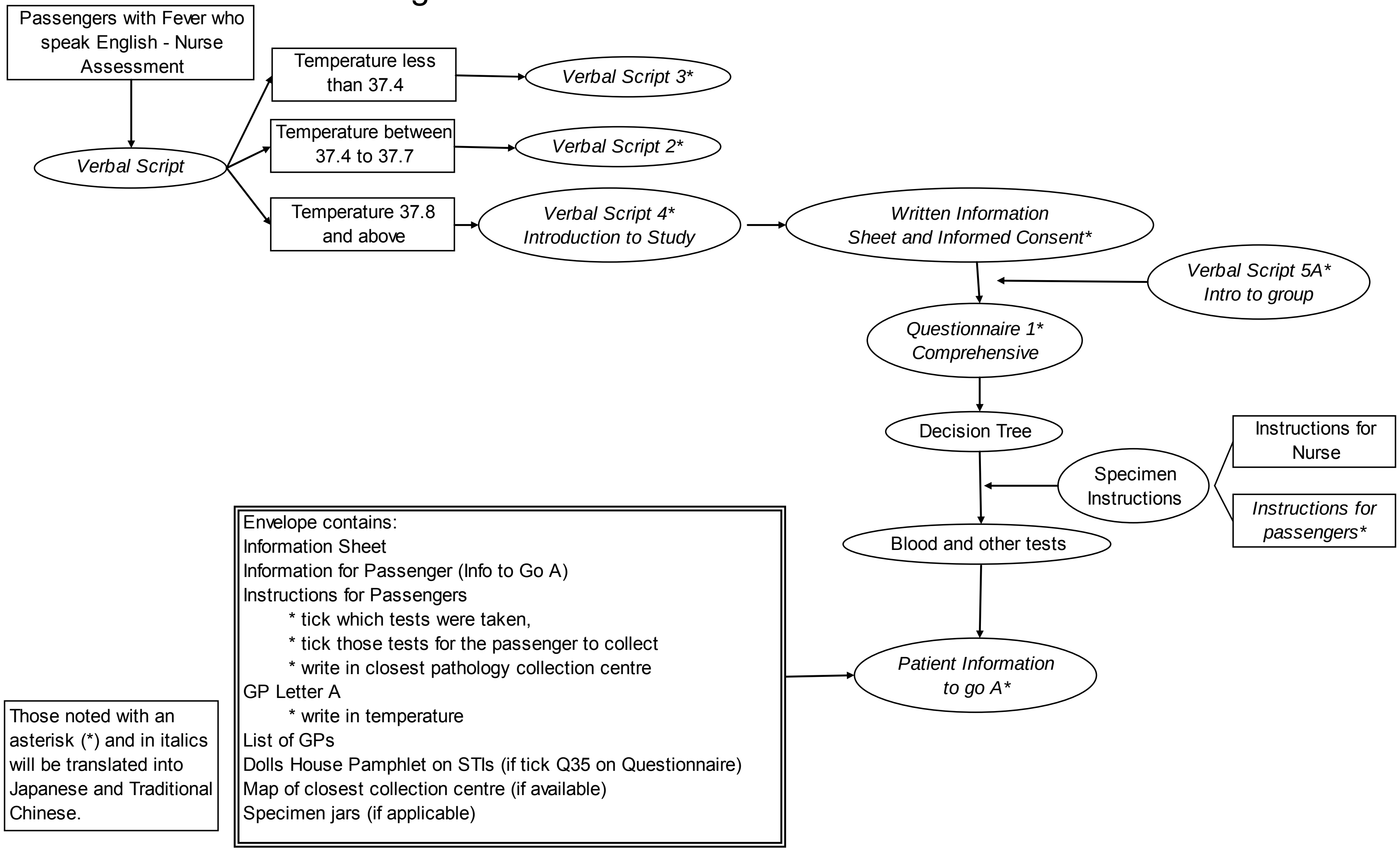
Appendix B

Passengers with Fever - Referral to GP with Costs Compensated



Appendix C

Passengers with Fever - Nurse Assessment



Appendix D

JCU
James Cook University

Airport Fever Screening Project

Infrared cameras will be in use ahead

The Cairns airport, in conjunction with the regional university, is currently evaluating fever screening using infrared cameras.

If you have a fever the staff will invite you to be part of a study.

Participation in this study will be voluntary.

Cairns Port Authority
. . . shaping the future

Appendix E

Verbal Script 1

Hello, my name is ____,
and I am a researcher from James Cook University. We are evaluating fever screening here at the airport and the reading from the scanner indicates you may have a fever. With your permission, I would like to take your temperature with this device, which I will place in your ear. Your participation is entirely voluntary. May I proceed?

Verbal Script 2

Your current temperature is _____ . Our study plans to only evaluate people with a temperature of 37.8 degrees centigrade and above. In some circumstances your current temperature MAY be considered to be elevated. If you feel unwell we would recommend that you go and see a doctor.

Verbal Script 3

Your current temperature is _______. This is normal. You may now go.

Verbal Script 4

Your current temperature is _____ which indicates a fever. I would like to invite you to participate in our study. In this study we are investigating the causes of fever in people arriving at this airport. Some people will have tests here and some will be invited to visit a doctor in Cairns. We will ask you a few questions about your travel and your current symptoms. Are you interested?

Firstly, I would like you to read these two documents: The first is an Information Sheet. If you are happy to participate after reading this, we will ask you to sign the informed consent. You may keep the Information Sheet for any questions that you may have in the future. After you have signed the informed consent, I will let you know how we propose to determine the cause of your fever.

Verbal Script 5A

Today we are assessing fever here at the airport. I will give you a questionnaire to fill out that tells us where you've been and what symptoms you have. I will then make some decisions about the most appropriate tests and we will take blood tests here at the airport. We may want to collect other specimens depending on your symptoms and I will explain those once you have finished the questionnaire.

Verbal Script 5B

Today we are asking passengers with a fever to visit a general practitioner who has a special interest in this study. You will be compensated for any expenses involved in visiting the doctor and for any pathology tests ordered. However this is limited to two visits and only pathology tests which are relevant to the investigation of your fever. We will not pay for other investigations such as x-rays. I will now give you a short questionnaire to fill out. I will then give you a list of the doctors that we recommend and some information to take to them. Whether you visit the doctor or not is entirely up to you. We will also give you some more information to read.

Verbal Script 5C

Today we are asking passengers with a fever to visit a general practitioner who has a special interest in this study. The costs involved with visiting the doctor and any investigations they may order will be your responsibility. I will now give you a short questionnaire to fill out. I will then give you a list of the doctors that we recommend and some information to take to them. Whether you visit the doctor or not is entirely up to you. We will also give you some more information to read.

Appendix F

ADVICE REGARDING CHILDREN LESS THAN 18 YEARS OF AGE

Ethic clearance has been received for inclusion of children under the age of 18 years in the project. However, the following points need to be considered:

1. For all three arms of the project (nurse assessment, GP referral with costs compensated, GP referral with patient to pay), both the febrile child and parent's consent is required. The additional information (parent name and signature) will need to be handwritten onto the consent form.

2. If the febrile child is travelling alone then you won't be able to obtain parental consent. This means that the febrile child cannot be included in the study.

3. If you are unsure about the age of febrile child, then you will need to ask the child their age. Those under the age of 18 and travelling alone cannot be included in the study.

4. We have not obtained Blue Cards for each of the Research Officers. A Blue Card is only required if the employee is going to be alone with a child. *You will not be required at any time to be alone with a child.* If you are given permission to take specimens from a child, then please ensure that the parent is present at all times.

Appendix G

INTERACTION WITH AQIS

The Australian quarantine and inspection service may have an interest in some other passengers that we screen as part of the fever screening project.

The following diseases are quarantineable:

Yellow fever
Rabies
Cholera
Plague
Viral haemorrhagic fevers
Smallpox
SARS
Highly pathogenic avian influenza

You should bring to the attention of the AQIS officer passengers who report the following symptoms:

- **Temperatures over 38** degrees Celsius.
- **Acute unexplained skin rashes and lesions** (not heat rashes, dermatitis, eczema, or similar common skin conditions)
- **Persistent or severe vomiting** (not caused by motion sickness or inebriation)
- **Persistent, watery or profuse diarrhoea**
- **Bleeding** from the eyes, nose, ears, mouth, anus or skin(but not if person is predisposed to nose bleeds, haemorrhoids, or has cuts or abrasions)
- **Glandular swelling** in the armpits or neck.
- **Prolonged loss of consciousness** where a person cannot be roused(not due to alcohol, drugs, medication or fainting)
- **Persistent coughing and breathing difficulty** with no apparent cause(not due to asthma, heart disease, obesity, chronic bronchitis or emphysema)
- **Inability to disembark** from a vessel without assistance except for a person with restricted mobility or a minor who needs to be accompanied by an airline employee.

Reporting of Notifiable Diseases

If a passenger **reports** to you that he/she has any of the following diseases you will need to advise AQIS (it is not a requirement that you ask the passenger). AQIS has a requirement to notify Dr. Hanna from the Tropical Public Health Unit.

Notifiable Diseases:

Measles
Typhoid fever
Dengue fever
Polio
Influenza
Tuberculosis
Malaria

Appendix G (cont)

Reporting of Passengers who may need to go by ambulance to hospital

If, during the enrolment of a passenger to the project, you find that the passenger is very ill and you deem they may require to be transported by ambulance to the hospital you will need to immediately advise the AQIS Duty Supervisor of your concerns. An AQIS officer will assess the passenger and notify Dr. Hanna (Tropical Public Health Unit). At their earliest possible convenience, the AQIS officer will notify the relevant airline of the sick passenger. The nurse is to arrange and an ambulance with the apron co-ordinator.

Appendix H

OPERATION OF FLIR THERMOCAM E45

1. Remove camera from safe in first aid room and fit to tripod. Connect power and video cable to monitor. Turn on monitor and press AV button to AV2
2. Turn on Thermocam by pressing PWR NO button for a few seconds
3. Camera is set to measure a difference from the mean temperatures of up to 10 people – First find a normal person to stand in the usual screening position and focus using outermost ring. To set the mean press and hold in the trigger button with the normal person in the field of view.
    a. A screen appears with question “reset reference temperature at xx.x ºC?”
    b. Use navigation button to highlight yes – then press yes
    c. Press the trigger button briefly on the next 10 people to establish the mean
    d. The process can be repeated periodically
4. The camera is currently set to alarm when temperatures are 1.3ºC higher than the mean – this is called the delta value
5. The delta value can be changed by pressing menu button and going into Meas. Mode (use navigation pad). And navigating to delta alarm – and changing this. With experience we may change the delta value to get the best balance between sensitivity and specificity. We would be aiming for the alarm to go off for about 1% of passengers (if it goes off more frequently increase the delta, if it is not going off enough, decrease the delta)
6. Other settings which should not be altered include
    a. Manual mode
    b. Temperature span (on right side 34 ºC to 40 ºC)
    c. Under Meas. Mode “area max”, Alarm “above” Alarm output “beep”
    d. Under emissivity – 0.98
    e. Under palette “Rainbow” and alarm “red”
    f. Range, Hide graphics, File and setup should not be altered
7. To turn off camera, press and hold the PWR NO button
   Replace lens cap, disconnect RCA plug and power cable and return to safe

Appendix I

Questionnaire 1 Nurse Assessment

These questions relate to who you are, where you have been, and where we can contact you once we know the results of the any tests.
Where relevant, please tick the appropriate box ☑

1. Name____

2. Date of birth ___/___/_______ (dd/mm/yyyy)

3. Gender: Male ☐ Female ☐

4. Country in which you normally reside____________________________________

5. Where are you staying in Cairns?____

6. How long do you intend to stay in Cairns?________________________

7. E-mail address____

8. Phone contact____

9. What is the best way of contacting you? Email ☐ Phone ☐ Neither ☐

10. Would you prefer to contact us? Yes ☐ No ☐

11. Where have you flown in from today?________________________________

12. Name the countries you have been in the last 10 days

____

13. Name the countries you have been in between 10 and 30 days ago

____

14. And the countries you have been in between 1 and 6 months ago

____

15. Do you have travel insurance? Yes ☐ No ☐

These questions relate to your current symptoms

16. On what date did you become unwell? ___/___/_____ (dd/mm/yyyy)

Please tick if you have the following symptoms:

17. Episodes of shivering/shaking .... Yes ☐ No ☐
18. Headache .... Yes ☐ No ☐
19. Muscle aches and pains .... Yes ☐ No ☐
20. Joint aches... Yes ☐ No ☐
21. Rash .... Yes ☐ No ☐
    If yes is it spotty ☐ or diffuse (like sunburn) ☐; is it all over ☐,
    Or only in certain parts (which parts) _______________________________?
    Is it itchy? Yes ☐ No ☐
22. Sore throat .... Yes ☐ No ☐
23. Glands enlarged .... Yes ☐ No ☐
    (in the neck ☐, in other parts of the body ☐)
24. Sneezing.. Yes ☐ No ☐
25. Runny nose.. Yes ☐ No ☐
26. Cough .... Yes ☐ No ☐
    If yes, is this cough dry ☐; or productive of sputum ☐.
    Is there any blood in the sputum?........ Yes ☐ No ☐
    Have you ever had contact with someone with TB? .... Yes ☐ No ☐
27. Trouble breathing...................................... Yes ☐ No ☐
28. Diarrhoea .... Yes ☐ No ☐
    If yes, is there blood in the diarrhoea?...........Yes ☐ No ☐
    Is the diarrhoea very watery?.........................Yes ☐ No ☐
29. Vomiting... Yes ☐ No ☐
30. Cramping, or other pain in the abdomen. .. Yes ☐ No ☐
31. Pain on urination...................................... Yes ☐ No ☐
32. Unusually dark urine .... Yes ☐ No ☐
33. Yellow eyes or skin .... Yes ☐ No ☐
34. Unusual taste sensation .... Yes ☐ No ☐
35. Have you had a new sexual partner in the last few months? .... Yes ☐ No ☐
    Were condoms used? ....Yes ☐ No ☐

36. Are there any other symptoms you can think of? Please describe

---

37. If you think you know the cause of your fever write it down here

---

38. Would you like to be notified of the test results, even if they are normal? Yes ☐ No ☐

Appendix J

Questionnaire 2 GP Assessment

These questions relate to who you are, where you have been, and where we can contact you once we know the results of the any tests.
Where relevant, please tick the appropriate box ☑

1. Name____

2. Date of birth ___/___/_______ (dd/mm/yyyy)

3. Gender: Male ☐ Female ☐

4. Country in which you normally reside______________________________________

5. Where are you staying in Cairns?____

6. How long do you intend to stay in Cairns?________________________

7. E-mail address____

8. Phone contact____

9. What is the best way of contacting you? Email ☐ Phone ☐ Neither ☐

10. Would you prefer to contact us? Yes ☐ No ☐

11. Where have you flown in from today?_________________________________

12. Name the countries you have been in the last 10 days

____

13. Name any other countries you have been to on this trip

____

14. Do you have travel insurance? Yes ☐ No ☐

These questions relate to your current symptoms

15. On what date did you become unwell? ___/___/_____ (dd/mm/yyyy)

Please tick yes or no for the following symptoms

16. Headache .... Yes ☐ No ☐
17. Muscle or joint aches and pains .... Yes ☐ No ☐
18. Rash .... Yes ☐ No ☐
19. Sore throat .... Yes ☐ No ☐
20. Sneezing... Yes ☐ No ☐
21. Runny nose....................................... Yes ☐ No ☐
22. Cough .... Yes ☐ No ☐
23. Trouble breathing............................. Yes ☐ No ☐
24. Diarrhoea .... Yes ☐ No ☐
25. Vomiting.. Yes ☐ No ☐
26. Pain in the abdomen .... Yes ☐ No ☐
27. Pain on urination............................... Yes ☐ No ☐
28. Unusually dark urine .... Yes ☐ No ☐
29. Yellow eyes or skin .... Yes ☐ No ☐

30. Are there any other symptoms you can think of? Please describe

____

____

____

31. If you think you know what the cause of the fever is please write it down.

____

Appendix K Shift Return

Date__________________________

Time of Shift__________________________ **Name/s of Research Officers**____

Flight No	Arriving from	Number of Passengers (approx)	Comments on flight

Passengers screened

Infrared temperature	Alarm Temperature	Tympanometric temperature (reading or declined)	Flight No (**important**)	Outcome (n/a, declined, enrolled)

Appendix L

TRIAL OF THERMAL CAMERA (ONLY FOR THOSE PASSENGERS WHO **DO NOT** SET OFF THE ALARM)

Date__________________________

Time of Shift__________________________ **Name/s of Research Officers**____

Flight No	Arriving from	Number of Passengers (approx)	Comments on flight

Passengers screened

Infrared temperature	Alarm Temperature	Tympanometric temperature (reading or declined)	Flight No (**important**)	Comments (e.g., glowing face, gender, age group – baby, child, teenager, adult, aged, noticeable group/family behaviour)

Appendix M

INFORMATION SHEET

PRINCIPAL INVESTIGATOR	Professor John McBride
PROJECT TITLE:	Fever Screening at Airports for the Detection of Diseases of Public Health Significance
SCHOOL	School of medicine, Cairns campus
CONTACT DETAILS	
	PO Box 902, Cairns 4870. Phone (07) 40 50 6530 or 0417 792 937

James Cook University, in partnership with Queensland Health, is undertaking a study to determine the best way of finding out the cause of fever in people arriving at this airport. You are being asked to participate in this study because you have a fever. If you agree to be in this study you will be asked a short series of questions about where you have travelled and what symptoms you have. You will then be offered either 1) On the spot tests, 2) Advice about doctors in Cairns to visit or 3) Advice about doctors to visit, with reimbursement of visit costs. You will not be able to choose which option we provide however it is entirely up to you whether you have the tests or visit the doctors. We are asking your permission to receive the results of blood tests that are performed and to contact the doctor you visit to find out the cause of the fever. If you are found to have a notifiable disease (e.g. malaria or dengue fever) this will be notified to the public health authorities as required by law. You will be provided with the results of any tests done on you.

The questionnaire and provision of advice will take about 5 minutes. If you are offered blood tests now – that will take another 10-15 minutes.

The risks of a blood test are small but include bruising and/ or bleeding. Up to 20mls (4 teaspoons) of blood may be taken.

The results of this study will assist public health authorities in planning for best way of introducing fever screening at airports. Reports and publications resulting from the study will not include any information that can identify you. Only study personnel will have access to your results.

If you have any questions about the study you can contact Professor McBride by phone (07) 40 50 6530 or 0417 792 937 or email: john.mcbride@jcu.edu.au.

***For any concerns regarding the ethical conduct on the study please contact Tina Langford, Ethics Officer, Ethics Review Committee, James Cook University,
(07) 47 81 4342.***

JAMES COOK UNIVERSITY
TOWNSVILLE Queensland 4811 Australia Telephone: (07) 4781 4111

CONSENT FORM

PRINCIPAL INVESTIGATOR	Professor John McBride
PROJECT TITLE:	Fever Screening at Airports for the Detection of Diseases of Public Health Significance

I have read and understood the information sheet that has been provided to me. The aim of the study has been clearly explained to me and I understand what is required of me. I know that taking part in this study is voluntary and I am aware that I can stop taking part in it at any time and may refuse to answer any questions.

I understand that any information I give will be kept strictly confidential and that no names will be used to identify me with this study without my approval.

I understand that if I am found to have a notifiable disease the Public Health authorities will be informed.

I agree to the researchers having access to blood test results and medical opinions that relate to the fever investigation.

If you agree to participate in the study please print your name in full, sign and date in the area provided below.

Name: *(printed)*	
Signature:	**Date:**

Appendix N

I HAVE BEEN ASKED TO SEE A DOCTOR FOR FEVER. WHAT DO I DO NOW?

There are many causes for fever. You may have a relatively minor viral infection or it could be something more serious. Studies performed elsewhere show that conditions such as malaria and dengue fever are common causes of fever in travelers from certain regions. Conditions such as the common cold do not often cause significant fevers. This study seeks to determine the causes of fever in passengers arriving in Australia.

We are recommending that you visit a doctor for a clinical evaluation and relevant pathology tests**. You will need to meet the costs of the doctor visit and any tests that are done.** If you are an Australian resident or a resident of a country that has reciprocal health care arrangements (including New Zealand, UK, Ireland and several other countries) you may receive partial reimbursement. Alternatively you may be covered by your travel health insurance.

We have included a list of recommended doctors who are knowledgeable about fever in travellers and who are assisting us in this study. When you call to make an appointment with a doctor you should state that you are part of the Airport Fever Screening Project. The appointment may be with one of the other doctors in the practice. This is fine. If you are unsure whether that doctor has contacted the study team could you please contact the study coordinator, Liz Buikstra on 07 4050 6348 so that we can follow up the outcome of your illness.

If you have been to a country where dengue fever exists then you will be investigated for this disease. This region of Queensland has a species of mosquito that can spread dengue fever. We would recommend that you take all necessary precautions to prevent mosquito bites in order to prevent the spread of dengue fever. These measures include wearing long sleeved shirts and the use of mosquito repellent. We are required to notify public health authorities of any suspected cases of dengue fever. If this has been done in your case you may be visited by someone who will check for mosquito breeding in your location.

Although the visit to the doctor is voluntary we would like to stress the importance of this visit if you continue to feel unwell. We enclose a letter that you should give the doctor when you visit them.

Appendix O

I HAVE BEEN ASKED TO SEE A DOCTOR FOR FEVER. WHAT DO I DO NOW?

There are many causes for fever. You may have a relatively minor viral infection or it could be something more serious. Studies performed elsewhere show that conditions such as malaria and dengue fever are common causes of fever in travelers from certain regions. Conditions such as the common cold do not often cause a significant fever. This study seeks to determine the causes of fever in passengers arriving in Australia.

We are recommending that you visit a doctor for a clinical evaluation and relevant pathology tests. **The study will pay for up to two visits to the doctor and the pathology tests.**

We have included a list of recommended doctors who are knowledgeable about fever in travellers and who are assisting us in this study. When you call to make an appointment with a doctor you should state that you are part of the Airport Fever Screening Project. The appointment may be with one of the other doctors in the practice. This is fine. If you are unsure whether that doctor has contacted the study team could you please contact the study coordinator, Liz Buikstra on 07 4050 6348 so that we can follow up the outcome of your illness.

If you have been to a country where dengue fever exists then you will be investigated for this disease. This region of Queensland has a species of mosquito that can spread dengue fever. We would recommend that you take all necessary precautions to prevent mosquito bites in order to prevent the spread of dengue fever. These measures include wearing long sleeved shirts and the use of mosquito repellent. We are required to notify public health authorities of any suspected cases of dengue fever. If this has been done in your case you may be visited by someone who will check for mosquito breeding in your location.

Although the visit to the doctor is voluntary we would like to stress the importance of this visit if you continue to feel unwell. We enclose a letter that you should give the doctor when you visit them.

Appendix P

I HAVE BEEN ASSESSED BY THE RESEARCHER FOR FEVER. WHAT DO I DO NOW?

Using the questions we have asked, the research officer has performed a number of tests that should pick up the most important causes for your fever.

The assessment you have had is not a substitute for a medical assessment by a doctor. Depending on your symptoms the researcher may have recommended strongly that you visit a doctor. In other cases it would be desirable to visit a doctor if your symptoms do not improve.

If the tests we do reveal a diagnosis or indicate a serious problem we will contact you using the information that you have provided to us. If you would like to know the results of your tests, or have copies of the results for your own records then you can contact the project manager, Liz Buikstra, on 07 4050 6348 or by email at liz.buikstra@jcu.edu.au Some results will be available within 24 hours, other results may take several days to be finalised.

If you do decide to see a doctor we would be interested in learning the outcome of that visit. We have included a list of recommended doctors who are knowledgeable about fever in travellers and who are assisting us in this study. When you call to make an appointment with a doctor you should state that you are part of the Airport Fever Screening Project. The appointment may be with one of the other doctors in the practice. This is fine. We would appreciate a phone call if you do visit a doctor.

If you have been to a country where dengue fever exists then you will be investigated for this disease. This region of Queensland has a species of mosquito that can spread dengue fever. We would recommend that you take all necessary precautions to prevent mosquito bites in order to prevent the spread of dengue fever. These measures include wearing long sleeved shirts and the use of mosquito repellent. We are required to notify public health authorities of any suspected cases of dengue fever. If this has been done in your case you may be visited by someone who will check for mosquito breeding in your location.

We would like to stress the importance of you visiting a doctor for a more thorough medical assessment if you continue to feel unwell. We enclose a letter that you should give the doctor if you visit them.

Appendix Q

Specimens that we have ordered (ticked boxes only)

☐ Full blood count, Serum chemistry, C reactive protein, Blood cultures, serum sample
These are tests we are taking from anyone with fever. These tests will give us some ideas as to the cause of fever and will tell us whether you have a serious bacterial infection

☐ Special blood tests for Malaria ☐, Dengue ☐, Hepatitis ☐
These tests have been ordered if your travel history or symptoms indicate that these are appropriate tests

☐ Nasal and throat swabs
This specimen is taken if there is a suspicion of Influenza. A swab will be taken from both nostrils and a separate swab will be taken from the back of the throat. The swabs in the nose can make you sneeze and are a bit uncomfortable. The throat swab can make some people gag – we will try to be as gentle as possible.

Instructions for special tests

☐ Urine test
You will be given a container to collect some of your own urine. The best specimen is taken by collecting the urine after you have started. Pass the container in, then out, of the stream. If you cannot produce urine now you need to take the specimen to the pathology lab.

☐ Faeces test
You will be given a container and some disposable gloves to collect a sample of your faeces. The container has a scoop that will allow you collect faeces that is not watery. Watery faeces can be passed directly into the container. Place the container in the paper bag and deliver to the pathology lab.

☐ Sputum test
You will be given a container to collect some sputum. The best specimen is produced after coughing and comes from deep in the lung. Try not to get any saliva into the container. If you cannot produce any sputum now you will need to take the sample to the pathology lab.

The closest laboratory to you is ___________________________

At ____

JAMES COOK UNIVERSITY

School of Medicine, Cairns Campus
Cairns Base Hospital, PO Box 902, Cairns, Queensland, AUSTRALIA
Telephone: (07) 4050 6830 Web: **www.jcu.edu.au**

Appendix R

Date ____________________

Letter to the general practitioner

Dear Dr

This person is coming to see you as part of the airport fever study. This fever was detected at the airport by infrared scanning as part of a study being conducted by James Cook University. This person has agreed for us to access results and your opinions relating to the cause of their fever. The temperature reading was ______.

This patient has been randomised to the group that will need to meet the costs of their consultation and investigation. If the patient is Medicare eligible or their costs can be covered by travel insurance then these avenues should be pursued.

You may use your preferred pathology provider. We have included pathology forms for both pathology providers. We also ask that you request "one serum tube to QHSS, Brisbane" in addition to any other pathology tests you order. The Brisbane lab will perform dengue PCR on that tube if that is requested (this test will not incur a cost). One other test that the Brisbane lab will perform, if requested, is a PCR test for influenza on a combined nasal/throat swab in viral transport media (this tests will also not incur a cost). The laboratory knows to forward this to QHSS in Brisbane.

We have the contact details for the patient but we do not know which doctor this patient will visit. Could you please contact the Project Manager, Dr Liz Buikstra, on 4050 6348, if this person does visit you and we will follow up the final diagnosis with you.

If you are on the list of general practitioners that we gave to the patient then you will have a copy of the decision tree that nurses will be using in another arm of the study. We suggest you use this decision tree as a guide but you are free to modify or add to the investigations depending on your clinical findings.

Don't hesitate to call Professor McBride on his mobile (0417 792937) if you would like to know more about the study or any advice on the evaluation of your patient.

Yours sincerely

Dr Liz Buikstra
Project Manager

Professor John McBride
Chief Investigator

JAMES COOK UNIVERSITY

School of Medicine, Cairns Campus
Cairns Base Hospital, PO Box 902, Cairns,
Queensland, AUSTRALIA
Telephone: (07) 4050 6830 Web: **www.jcu.edu.au**

Appendix S

Date ____________________

Letter to the general practitioner

Dear Dr

This person is coming to you see as part of the airport fever study. This fever was detected at the airport by infrared scanning as part of a study being conducted by James Cook University. This person has agreed for us to access results and your opinions relating to the cause of their fever. The temperature reading was ______.

This patient has been randomised to the group that will be compensated for the costs of their visit to you and for one follow-up visit. The study will also pay for pathology tests that relate to the investigation of the fever. We will not pay for radiological investigations. If the patient is Medicare eligible or their costs can be covered by travel insurance we would appreciate use of these funding sources but we are happy to make up for any out-of-pocket expenses the patient has. Could you please send an invoice for the medical services to the project manager.

You may use your preferred pathology provider. We have included pathology forms for both pathology providers. We also ask that you request “one serum tube to QHSS, Brisbane” in addition to any other pathology tests you order. The Brisbane lab will perform dengue PCR on that tube if that is requested. One other test that the Brisbane lab will perform, if requested, is a PCR test for influenza on a combined nasal/throat swab in viral transport media. The laboratory knows to forward this to QHSS in Brisbane.

We have the contact details for the patient but we do not know which doctor this patient will visit. Could you please contact the Project Manager, Dr Liz Buikstra, on 4050 6348, if this person does visit you and we will follow up the final diagnosis with you.

If you are on the list of general practitioners that we gave to the patient then you will have a copy of the decision tree that nurses will be using in another arm of the study. We suggest you use this decision tree as a guide but you are free to modify or add to the investigations depending on your clinical findings.

Don’t hesitate to call Professor McBride on his mobile (0417 792937) if you would like to know more about the study or any advice on the evaluation of your patient.

Yours sincerely

Dr Liz Buikstra
Project Manager

Professor John McBride
Chief Investigator

JAMES COOK UNIVERSITY

School of Medicine, Cairns Campus

Cairns Base Hospital, PO Box 902, Cairns, Queensland, AUSTRALIA

Telephone: (07) 4050 6830 Web: **www.jcu.edu.au**

Appendix T

Date ____________________

Letter to the general practitioner

Dear Dr

This person is coming to see you because of a fever. This fever was detected at the airport by infrared scanning as part of a study being conducted by James Cook University. This person has agreed for us to access results and your opinions relating to the cause of their fever. The temperature reading was ______. This patient has been assessed at the airport by one of our research staff and a number of investigations have been performed based on their travel history and current symptoms.

The blood tests that have been performed include FBC, U/E's, LFT's, CRP and Blood culture. Depending on travel history and symptoms we have performed tests for Dengue, Malaria and/or Hepatitis. Specimens of Urine, Stool, Sputum or nasal swabs for Influenza may have been taken.

We have urged all febrile passengers to seek medical attention should their symptoms continue. In some cases we may have contacted them because of abnormal results and urged them to visit you.

Pathology testing for passengers investigated at the airport is being performed by Sullivan and Nicolaides.

Could you please contact the Project Manager, Dr Liz Buikstra, on 4050 6348, if this person does visit you and we will follow up the final diagnosis with you.

We are not asking you to do anything different in your assessment of the patient.

The study has paid for the initial pathology testing but your consultation fees and costs for further investigations must be met by the patient.

Don't hesitate to call Professor McBride on his mobile (0417 792937) if you would like to know more about the study or any advice on the evaluation of your patient.

Yours sincerely

Dr Liz Buikstra
Project Manager

Professor John McBride
Chief Investigator

Appendix U

Investigation of Fever ≥37.8ºC

These are the core investigations to be done on all febrile passengers

FBC
U/E's LFT's
CRP
Blood culture
Serum tube for transportation to QHSS

Additional tests to be done on basis of history

Dengue PCR	Illness onset within the last 7 days and if, in the 10 days prior to onset of illness the passenger has been anywhere outside of an airport in Asia, the Pacific, or other parts of tropical world (not including Hong Kong, Japan, Europe, NZ, Korea, USA (excluding southern states) and Canada)
Dengue serology	Illness onset more than 5 days ago and if, in the 10 days prior to onset of illness the passenger has been anywhere outside of an airport in Asia, the Pacific, or other parts of tropical world (not including Hong Kong, Japan, Europe, NZ, Korea, USA (excluding southern states) and Canada)
Malaria film	If, in the last 6 months the passenger has been to a tropical country (not including Japan, Europe, NZ, Korea, USA and Canada)
Faeces OCP C&S	If there is diarrhoea
Urine M, C&S	If there is dysuria
Sputum M, C&S	If there is a productive cough
add AFB	If contact with TB, OR from PNG, other pacific islands, India, China, Vietnam, Philippines, Cambodia, Laos. OR blood in sputum
Hep A and B	If there is jaundice or dark urine.
Nasal/throat swab	If there is dry cough or sore throat

<u>Tests to be initiated in lab</u>
Hep E serology if ALT >5X normal and serology for A&B negative
Chikungunya PCR if there is history of travel to Ascension/ Reunion Is, India, Indonesia

Appendix V

List of General Practitioners who are participating in the Fever Screening Project

Name	Organisation	Location	Phone Number
Dr. Bruce Bilbe	McLeod Street Medical Centre	67 McLeod Street Cairns QLD 4870	4052 1583
Dr. David Cuming	Redlynch Medical Centre	PO Box 300 Redlynch QLD 4870	4039 1255
"	Kuranda Medical Service	Cnr of Barang & Thongon Streets Kuranda QLD 4872	4093 7118
Dr. Nichola Davis	Trinity Beach Medical Centre	1 Rabaul Street Trinity Beach QLD 4879	4055 6281
Dr. Darren Delaney	Barrier Reef Medical Centre	377 Sheridan Street Cairns QLD 4870	4051 6299
Dr. Garry Hartrick	Abbott Medical Clinic	PO Box 118E Earlville QLD 4870	4033 7666
Dr. Gavin Le Sueur	Cairns 24 Hour Medical Centre	Cnr Forence and Grafton Streets, Cairns	4052 1119
Dr. Paul Sandery	Cairns Family Medical Centre	120-124 Mulgrave Road Parramatta Park QLD 4870	4051 2755
Dr. Catherine Meehan	McLeod Street Medical Centre	67 McLeod Street Cairns QLD 4870	4052 1583

Appendix W

Debriefing Questions for Research Officers – Fever Screening Project

Fever

1. Did you notice anything about passengers' attitudes or behaviour when you told them that they had a fever? Can you give me any examples?

2. Did passengers with fever express surprise or were they aware they had a fever?

Intentions

3. What did those passengers who were febrile generally say about their intentions to see a doctor?

4. Of the passengers who indicated that they had no intentions of seeing a doctor, do you think anything could have been done differently to encourage them to visit a doctor?

Blood Tests

5. In the nurse assessment arm, what were passengers' reactions when you asked them for blood and other specimens? Can you give me any examples?

6. Can you explain why patients generally refused to have blood tests?

7. If blood tests were compulsory for passengers with fever, how do you think they would have reacted?

Measurement of Temperatures

8. When you asked passengers if you could take their temperatures, what did you notice about their attitudes or behaviour?

9. Did you have any passengers who set the alarm off but refused to have an ear temperature taken – what were their comments?

10. How would they have reacted if informed that this was compulsory?

11. Did any passengers express discomfort with ear temperature measurements?

Enrolments

12. How long did enrolment take on average?

13. Of the passengers who chose not to enroll in the project, do you think anything could have been done differently to encourage their enrolment?

Non English Speaking

14. What comments do you have about passengers who did not speak English and how they found the process?

Different Passenger Cohorts

15. What is your overall impression of the behaviour of the different cohorts coming through the international airport? For example, Japanese, Chinese, and PNG.

Camera Locations

16. What comments do you have about pre-primary versus post-primary line locations?

Interactions with Airport Staff

17. What sort of interactions did you have with Customs? AQIS?

Camera Operation

18. How did you find operating the camera? Was it easier using running averages or fixed temperatures?

19. What do you think are the skills needed to:
    a. Operate the camera
    b. Take a temperature
    c. Administer the questionnaire.

Job Experience

20. Did you have any unpleasant experiences on the job? Can you describe them?

Appendix X

Demographic, Flight and Thermal Camera Information for Enrolled Participants

ID	Enrolment	Arm	Age	Gender	Country of residence	Duration stay in Cairns	Final diagnosis	EX	IR Temp	Alarm Temp	Tymp Temp
1	8/04/2006	B	53.6	Male	PNG	few days	Malaria	POM	37.8		40.3
2	12/04/2006	B	12.8	Female	Australia	long term	Conjunctivitis and skin infection	POM	36		38
3	14/04/2006	B	30.7	Male	PNG	12 hrs	Malaria	POM	37.1		37.9
4	16/04/2006	A	43.8	Male	Germany	29days	Viral RTI	SIN	36.4		38.4
5	22/04/2006	C	44.2	Male	Poland	2 days	NA	BNE	35.9		38.7
6	25/04/2006	C	4.8	Male	PNG	1 day	NA	POM	36.7	35.6	38.4
7	25/04/2006	C	33.6	Female	Australia	1 day	NA	POM	36.8	35.6	38.8
8	27/04/2006	C	44.0	Female	Australia	long term	Upper RTI	POM	36.3	35.7	37.9
9	30/04/2006	B	3.9	Male	India	2 days	Gastroenteritis	SIN	37.4	35.8	39.3
10	30/04/2006	B	32.2	Male	Japan	6 Days	NA	NGO	37.4	35.8	39.4
11	30/04/2006	B	29.2	Female	Japan	4 days	NA	NRT	36	35.8	37.5
12	30/04/2006	B	35.2	Male	Japan	4 days	NA	HKG	36.1	35.8	37.5
13	4/05/2006	B	1.6	Male	England	6 days	NA	SIN/DRW	37.2	35.1	38.1
14	4/05/2006	B	19.7	Female	England	1 week	NA	SIN/DRW	36.5	35.1	37.7
15	4/05/2006	B	57.7	Male	PNG/Australia	7 days	NA	POM	36.2	35.1	37.8
16	5/05/2006	B	4.7	Male	Japan	5 days	NA	NGO	36	35.2	38.2
17	5/05/2006	B	20.8	Female	Switzerland	3.5 days	NA	SIN	36.1	35.5	38
18	5/05/2006	B	13.9	Male	PNG	long term	NA	POM	35.9	35.7	37.5
19	5/05/2006	B	13.0	Female	PNG	10 days	NA	POM	36.3	35.7	38
20	6/05/2006	C	30.2	Female	Australia	3 days	NA	POM	36.2	35.7	37.5

ID	Enrolment	Arm	Age	Gender	Country of residence	Duration stay in Cairns	Final diagnosis	EX	IR Temp	Alarm Temp	Tymp Temp
21	9/05/2006	C	7.5	Female	Japan	6 days	NA	NRT	36.1	35.6	37.5
22	9/05/2006	C	35.2	Female	PNG	14 days	NA	POM	36.3	35.7	37.9
23	10/05/2006	C	43.9	Male	PNG	9 days	NA	POM	35.7	35.5	38.2
24	10/05/2006	C	32.9	Female	PNG	1 week	NA	POM	35.7	35.5	37.7
25	11/05/2006	C	7.5	Female	Japan	1 month	NA	NGO	36.1	35.5	37.8
26	11/05/2006	C		Female	Japan	1 month	NA	NGO	36.2	35.5	37.9
27	11/05/2006	C	53.6	Male	Australia	Permanent	Viral gastroenteritis	HKG	35.7	35.5	38.2
28	14/05/2006	A	27.9	Female	USA	1 day	Upper RTI	HGU	36.3	35.5	37.9
29	14/05/2006	A	40.8	Female	Norway	1 June 2006	NA	SIN	36.3	35.8	37.7
30	17/05/2006	A	19.8	Female	USA	2.5 weeks	NA	SYD	36.2	35.6	37.8
31	22/05/2006	B	3.3	Male	Japan	7 days	NA	NRT	36.1	35.4	38
32	22/05/2006	B	17.3	Female	Japan	4 days	NA	KIX	36.1	35.8	37.9
33	22/05/2006	B	18.7	Female	Brazil	3 months	NA	SYD	35.6	35.2	37.9
34	24/05/2006	B	15.3	Male	Australia		NA	POM	35.9	35.7	37.9
35	24/05/2006	B	27.7	Female	PNG	Overnight	NA	POM	36.7	35.7	38.3
36	25/05/2006	B	58.3	Male	New Zealand	1	Viral RTI	POM	36.8	36	39.3
37	1/06/2006	A	11.2	Male	PNG	2 years	NA	POM	35.8	35.5	38.1
38	15/06/2006	B	16.9	Female	China	6 nights	NA	HKG	35.8	35	38.3
39	21/06/2006	A	1.7	Female	Australia	As above	NA	HKG	36.7	35.7	39.1
40	21/06/2006	A	9.8	Male	USA	6 days	Viral RTI	BNE	35.9	35.1	38.8
41	29/06/2006	C	64.5	Male	England	7 days	NA	SIN/DRW	36	35.2	37.5
42	2/07/2006	B	39.5	Male	PNG	Staying Perth for 4 years	NA	POM	35.7	35	37.9

ID	Enrolment	Arm	Age	Gender	Country of residence	Duration stay in Cairns	Final diagnosis	EX	IR Temp	Alarm Temp	Tymp Temp
43	4/07/2006	B	37.8	Male	Japan	3 days	NA	NRT	36.2	34.9	38.9
44	4/07/2006	B	45.9	Female	PNG	14 days	NA	POM	35.8	35.5	39.4
45	6/07/2006	C	55.7	Male	Japan	5 days	NA	KIX	36.8	35.5	39
46	6/07/2006	B	26.2	Female	Philippines	2 weeks	NA	POM	37.2	35.4	39.4
47	14/07/2006	A	23.2	Male	PNG	1 day	NA	POM	36	35.2	37.5
48	16/07/2006	C	26.2	Male	Denmark	Thursday Is for 14 days	NA	HKG	36.9	35.4	37.8
49	17/07/2006	C	27.9	Female	Japan	6 days	Viral URTI	NRT	36.8	35.6	38.8
50	20/07/2006	C	24.4	Male	China	3 days	NA	HKG	36	35.7	38.1
51	21/07/2006	C	11.3	Female	Japan	N/A	NA	NGO	36.1	35.1	38.4
52	26/07/2006	B	31.6	Female	England	5 days	Influenza A	BNE	35.9	35.4	37.8
53	30/07/2006	A	8.9	Female	Germany	3 weeks	NA	SYD	36.4	35.4	38.4
54	4/08/2006	A	45.0	Male	Australia		NA	POM	35.8	35.4	37.7
55	10/08/2006	C		Male	Japan	5 days	NA	NRT	36	35.4	38
56	22/08/2006	A	6.0	Male	China	4 days	Viral RTI	POM	35.8	35.4	38.4
57	25/08/2006	A	27.4	Male	Israel	Don't know	NA	SYD	35.8	35.4	38.5
58	30/08/2006	C	25.3	Female	UK	4 hours	NA	BNE	36.4	35.2	38.5
59	31/08/2006	C	27.8	Male	Saudi Arabia	4 days	NA	HKG	36.3	35.6	38.6
60	1/09/2006	C	54.9	Female	Australia		Pneumonia	POM	35.4	35	38.3
61	3/09/2006	A	41.2	Female	Japan	5 days	NA	KIX	36.2	35.4	38.4
62	3/09/2006	A	56.2	Male	Australia	4 days	Viral gastroenteritis	POM	34.6	34.6	38.4
63	7/09/2006	A	50.2	Male	Australia		NA	BNE	36.2	35.2	38.1
64	7/09/2006	A	19.5	Male		6 days	NA	KIX	36.2	35.2	39.1

ID	Enrolment	Arm	Age	Gender	Country of residence	Duration stay in Cairns	Final diagnosis	EX	IR Temp	Alarm Temp	Tymp Temp
65	13/09/2006	B	27.5	Male		6 days (in Japanese)	NA	KIX	35.7	35.3	38.1
66	11/09/2006	B	37.3	Male	PNG	2 days	NA	POM	35.1	35.1	37.6
67	11/09/2006	B	26.3	Female	PNG	2 nights	NA	POM	35.5	35.1	37.6
68	14/09/2006	B	9.0	Female	Australia		NA	POM	36.2	35	39.2
69	14/09/2006	B	52.3	Female	England	5 days	NA	HKG	36	35.6	37.8
70	20/09/2006	A	47.4	Male	PNG	until better	Meningitis EBV	POM	36	35.1	38.9
71	20/09/2006	A	24.9	Female	France	3 or 4 days	NA	BNE	35.7	35	37.9
72	26/09/2006	C	29.3	Female	PNG	1 night	NA	POM	35.4	35.2	38
73	27/09/2006	C	39.5	Male	PNG	1 day	Viral RTI	POM	35.2	35.1	37.7
74	27/09/2006	C	42.3	Female	PNG	10 days	NA	POM	35.2	35.1	37.8
75	28/09/2006	C	58.3	Male	Australia	Live here	NA	POM	35.5	35.1	38.4
76	28/09/2006	C	23.3	Male	Australia	3 days	Gastroenteritis	HKG	35.8	35.4	38.8

Appendix Y

Participants receiving Health Assessment (GP assessment and/or Pathology Tests) across various Participant Variables

Variable	Level	Yes	No	Total
Tympanic Temp	37.5 thru to 38.4	11	45	56
	38.5 thru to 40.5	8	12	20
Gender	Male	13	27	40
	Female	6	30	36
Country	Japan	2	15	17
	PNG	4	16	20
	Asia	2	3	5
	Rest of World	11	23	34
Country	Australia	6	8	14
	Rest of World	13	49	62
Country	PNG	4	16	20
	Rest of World	15	41	56
Duration of Stay	Less than 1 day or a few days	14	48	62
	Long term or permanent	4	8	12
Port of Origin	Japan	1	14	15
	PNG	11	22	33
	Asia	3	19	22
	Rest of World	3	2	5
Port of Origin*	Rest of World	7	35	42
	PNG	11	22	33
Shivers	Yes	2	1	3
	No	5	9	14
Headache	Yes	9	18	27
	No	10	38	48
Myalgias	Yes	8	12	20
	No	11	42	53
Arthralgia*	Yes	6	9	15
	No	13	45	58
Rash	Yes	0	1	1
	No	19	55	74
Rash Distribution	N/A	7	11	18
Rash Itch	N/A	7	11	18
Sore throat	Yes	6	15	21
	No	13	41	54
Glands	Yes	4	0	4
	No	3	10	13
Location of Gland	N/A	3	10	13
	Neck	4	0	4
Sneezing	Yes	4	15	19
	No	15	41	56
Rhinorrhea	Yes	5	20	25
	No	14	36	50
Cough*	Yes	11	19	30
	No	8	37	45
Productive	Yes	2	0	2
	No	1	0	1
	N/A	3	9	12
Blood in Sputum	No	4	1	5
	N/A	2	9	11

Variable	Level	Yes	No	Total
Contact with TB	Yes	0	1	1
	No	4	3	7
	N/A	2	3	5
Dyspnoea	Yes	3	1	4
	No	16	55	71
Diarrhoea	Yes	5	5	10
	No	14	51	65
With Blood	No	2	2	4
	N/A	5	9	14
Watery	Yes	1	1	2
	No	1	1	2
	N/A	5	9	14
Vomiting	Yes	3	5	8
	No	16	51	67
Abdominal Cramps	Yes	4	5	9
	No	15	51	66
Dysuria	No	19	56	75
Dark Urine	Yes	1	0	1
	No	18	55	73
Yellow eyes	No	19	55	74
Unusual Taste	Yes	1	0	1
	No	6	10	16
New Sexual Contact	Yes	0	1	1
	No	7	9	16
Condom Used	Yes	0	1	1
	No	2	1	3
	N/A	5	9	14

These are descriptive tables only. Significant testing was only undertaken on those tables that met the assumptions.
* χ2 test of significance or Fisher's exact test of significance is expected cell frequencies in a 2 x 2 matrix were less than five indicated $p < .05$ *and* the Phi coefficient or Cramer's *V* was 0.10 or greater.

Appendix Z

Participants receiving GP Assessment (with or without pathology tests) across various Participant Variables

Variable	Level	Yes	No	Total
Tympanic Temp*	37.5 thru to 38.4	9	47	56
	38.5 thru to 40.5	8	12	20
Gender	Male	12	28	40
	Female	5	31	36
Country	Japan	2	15	17
	PNG	4	16	20
	Asia	2	3	5
	Rest of World	9	25	34
Country	Australia	5	9	14
	Rest of World	12	50	62
Country	PNG	4	16	20
	Rest of World	13	43	56
Duration of Stay	Up to a few days	12	50	62
	A longer period or permanent	4	8	12
Port of Origin	Japan	1	14	15
	PNG	9	25	34
	Asia	3	17	20
	Rest of World	3	2	5
Port of Origin	PNG	7	33	42
	Rest of World	9	24	33
Shivers	Yes	2	1	3
	No	3	11	14
Headache	Yes	8	19	27
	No	9	39	48
Myalgias	Yes	7	13	20
	No	10	43	53
Arthralgia	Yes	5	10	15
	No	12	46	58
Rash	Yes	0	1	1
	No	17	57	74
Rash Distribution	N/A	5	13	18
Rash Itch	N/A	5	13	18
Sore throat	Yes	5	16	21
	No	12	42	54
Glands	Yes	2	1	3
	No	3	11	14
Location of Gland	N/A	2	12	14
	Neck	3	1	4
Sneezing	Yes	4	15	19
	No	13	43	56
Rhinorrhea	Yes	5	20	25
	No	12	38	50
Cough*	Yes	11	19	30
	No	6	39	45
Productive	Yes	2	0	2

Variable	Level	Yes	No	Total
	No	1	0	1
	N/A	1	11	12
Blood in Sputum	No	4	1	5
	N/A	0	11	11
Contact with TB	Yes	0	1	1
	No	4	3	7
	N/A	0	5	5
Dyspnoea*****	Yes	3	1	4
	No	14	57	71
Diarrhoea	Yes	4	6	10
	No	13	52	65
With Blood	No	1	3	4
	N/A	4	10	14
Watery	Yes	1	1	2
	No	0	2	2
	N/A	4	10	14
Vomiting	Yes	2	6	8
	No	15	52	67
Abdominal Cramps	Yes	3	6	9
	No	14	52	66
Dysuria	No	17	58	75
Dark Urine	Yes	1	0	1
	No	16	57	73
Yellow eyes	No	17	57	74
Unusual Taste	Yes	1	0	1
	No	4	12	16
New Sexual Contact	Yes	0	1	1
	No	5	11	16
Condom Used	Yes	0	1	1
	No	2	1	3
	N/A	3	11	14
Pathology*****	Yes	7	2	9
	No	10	57	67

These are descriptive tables only. Significant testing was only undertaken on those tables that met the assumptions.
* $\chi 2$ test of significance or Fisher's exact test of significance is expected cell frequencies in a 2 x 2 matrix were less than five indicated $p < .05$ *and* the Phi coefficient or Cramer's *V* was 0.10 or greater.

Appendix AA

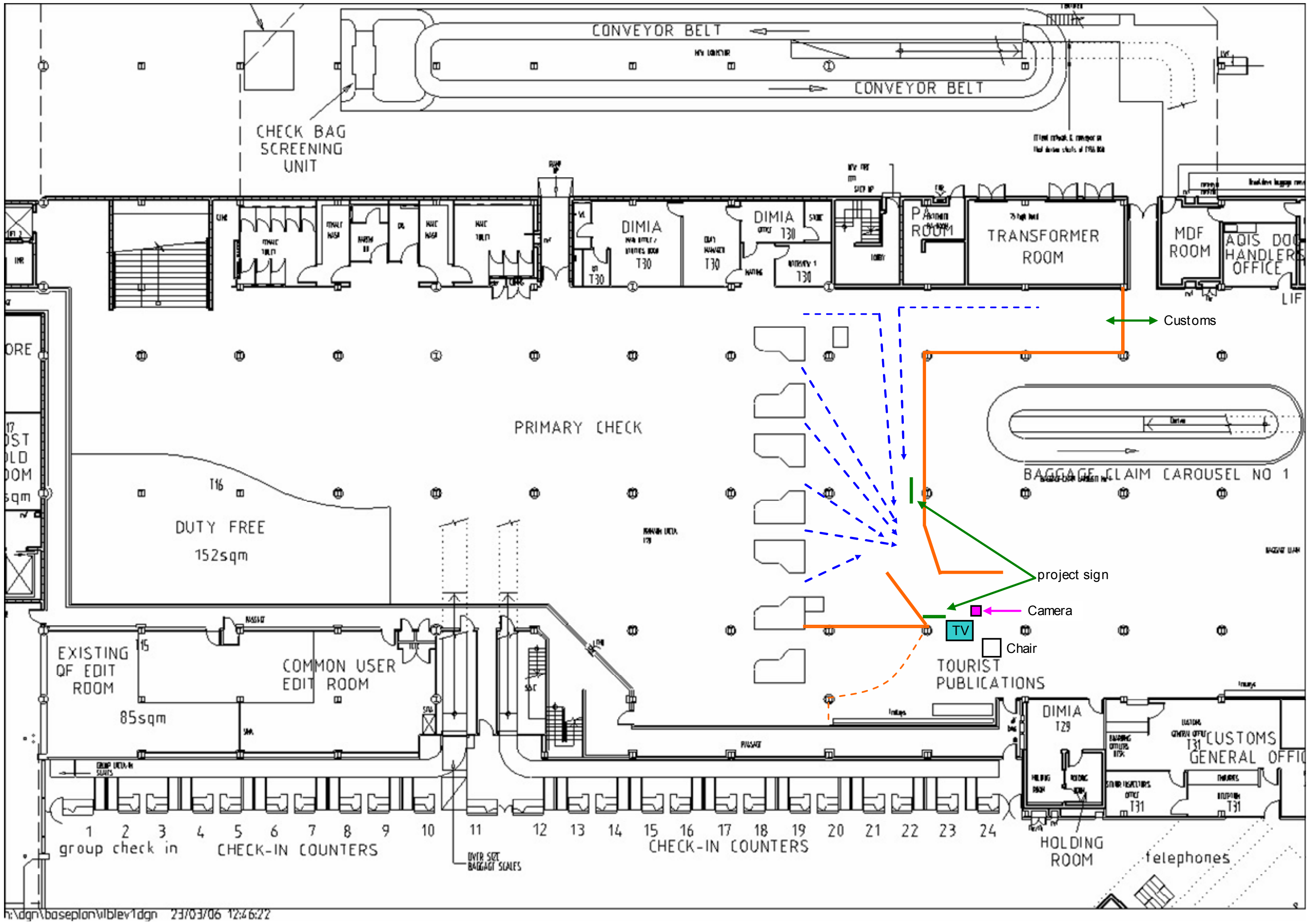
Participants receiving Pathology Tests (with or without GP Assessment) across various Participant Variables

Variable	Level	Yes	No	Total
Tympanic Temp	37.5 thru to 38.4	6	50	56
	38.5 thru to 40.5	3	17	20
Gender	Male	5	35	40
	Female	4	32	36
Country	Japan	0	17	17
	PNG	2	18	20
	Asia	1	4	5
	Rest of World	6	28	34
Country	Australia	3	11	14
	Rest of World	6	56	62
Country	PNG	2	18	20
	Rest of World	7	49	56
Duration of Stay	Less than 1 day or a few days	7	55	62
	Long term or permanent	1	11	12
Port of Origin	Japan	0	15	15
	PNG	8	25	33
	Asia	0	22	22
	Rest of World	1	4	5
Port of Origin*	Rest of World	1	41	42
	PNG	8	25	33
Shivers	Yes	1	2	3
	No	3	11	14
Headache	Yes	4	23	27
	No	5	43	48
Myalgias	Yes	5	15	20
	No	4	49	53
Arthralgia*	Yes	5	10	15
	No	4	54	58
Rash	Yes	0	1	1
	No	9	65	74
Rash Distribution	N/A	4	14	18
Rash Itch	N/A	4	14	18
Sore throat	Yes	4	17	21
	No	5	49	54
Glands	Yes	2	2	4
	No	2	11	13
Location of Gland	N/A	2	11	13
	Neck	2	2	4
Sneezing	Yes	2	17	19
	No	7	49	56
Rhinorrhea	Yes	4	21	25
	No	5	45	50
Cough*	Yes	7	23	30
	No	2	43	45
Productive	Yes	1	1	2

Variable	Level	Yes	No	Total
	No	0	1	1
	N/A	2	10	12
Blood in Sputum	No	1	4	5
	N/A	2	9	11
Contact with TB	Yes	0	1	1
	No	1	6	7
	N/A	2	3	5
Dyspnoea	Yes	1	3	4
	No	8	63	71
Diarrhoea	Yes	2	8	10
	No	7	58	65
With Blood	No	1	3	4
	N/A	3	11	14
Watery	Yes	0	2	2
	No	1	1	2
	N/A	3	11	14
Vomiting	Yes	2	6	8
	No	7	60	67
Abdominal Cramps	Yes	3	6	9
	No	6	60	66
Dysuria	No	9	66	75
Dark Urine	Yes	1	0	1
	No	8	65	73
Yellow eyes	No	9	65	74
Unusual Taste	Yes	1	0	1
	No	3	13	16
New Sexual Contact	Yes	0	1	1
	No	4	12	16
Condom Used	Yes	0	1	1
	No	1	2	3
	N/A	3	11	14

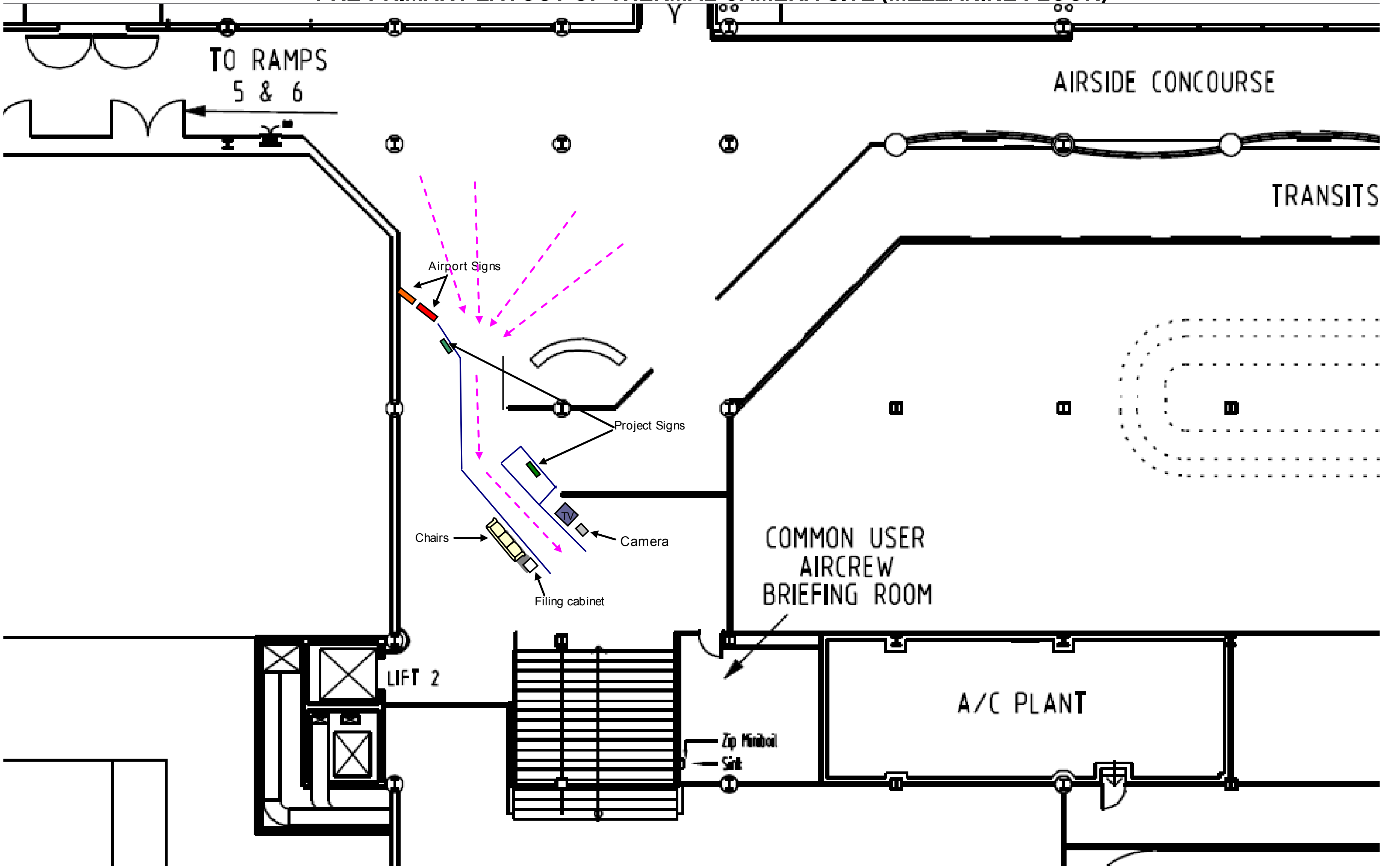
These are descriptive tables only. Significant testing was only undertaken on those tables that met the assumptions.
* $\chi 2$ test of significance or Fisher's exact test of significance is expected cell frequencies in a 2 x 2 matrix were less than five indicated *p* < .05 *and* the Phi coefficient or Cramer's *V* was 0.10 or greater.

Appendix AB
Floor Plan for Positioning of Thermal Camera in International Terminal Building Arrivals Hall



Appendix AC

PRE-PRIMARY LAYOUT OF THERMAL CAMERA SITE (MEZZANINE FLOOR)



Appendix AD

AEROBRIDGE LAYOUT OF THERMAL CAMERA SITE (CONCOURSE AFTER AEROBRIDGE 1)