Disaster Medical Assistance Teams: A Literature Review

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Disaster Medical Assistance Teams: A Literature Review

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GLOSSARY OF ACRONYMS

ACLS	Advanced Cardiac Life Support
ADF	Australian Defence Force
ALS	Advanced Life Support
AME	Aeromedical Evacuation
ANSI	American National Standards Institute
APLS	Advanced Paediatric Life Support
ATLS	Advanced Trauma Life Support
BLS	Basic Life Support
CBR	Chemical Biological Radiological
CCATT	Critical Care Aero-medical Transport Team
CDC	Centres for Disease Control and Prevention
CINAHL	Cumulative Index to Nursing & Allied Health Literature
COBRA	Chemical Ordinance Biological Radiological Antiterrorism
CT	Computed Tomography Scan
DART	Disaster Assistance Response Team
DHA	Department Humanitarian Affairs
DMAT	Disaster Medical Assistance Team
DMORT	Disaster Mortuary Assistance Teams
DRASH	Deployable Rapid Assembly Shelter/Surgical Hospital
ED	Emergency Department
EHO	Environmental Health Officer
EMA	Emergency Management Australia
EMAT	Emergency Medical Assistance Team
EMEDS	Expeditionary Medical Support Unit
EMS	Emergency Medical Services
FEMA	Federal Emergency Management Agency
FFH	Foreign Field Hospital
GIS	Geographic Information Systems
HUREX	Humanitarian Relief Experts
I&D	Incision and Drainage
ICU	Intensive Care Unit
ID	Infectious Diseases

IDF	Israeli Defence Force
IFRC	International Federation of Red Cross and Red Crescent Societies
IMSuRT	International Medical Surgical Response Team
INSARAG	International Search and Rescue Advisory Group
JDR	Japan Disaster Relief
JMT	Joint Management Team
LSG	Logistical Support Group
MATS	Medical Assistance Teams
MOE	Measures Of Effectiveness
NDMS	National Disaster Medical System
NERRTC	National Emergency Response and Rescue Training Centre
NGO	Non Government Organisation
NMRT-WMD	National Medical Response Team – Weapons of Mass Destruction
NNRT	National Nurse Response Team
NPRT	National Pharmacist Response Team
OT	Operating Theatre
PAHO	Pan American Health Organization
PDA	Personal Digital Assistant
PPE	Personal Protection Equipment
RAAF	Royal Australian Air Force
RDRTF	Renal Disaster Relief Task Force
SAR	Search and Rescue
SDC	Swiss Humanitarian Aid Unit
SMART	South Manchester Accident Rescue Team
SUMA	Supply Management Software
UK	United Kingdom
UN	United Nations
UNDAC	United Nations Disaster Assessment and Coordination
UNDRO	United Nations Disaster Relief Organisation
US/USA	United States/United States of America
VMAT	Veterinary Medical Assistance Teams
WA	Western Australia
WMD	Weapons of Mass Destruction
WHO	World Health Organization

INTRODUCTION

Disasters and complex emergencies are associated with a tremendous outpouring of humanitarian assistance from a world caught up in the confusion and alarm that these events provoke (Burkle 2001a). All of us are moved by the Good Samaritan response to misfortune and the outpouring of aid is normal and natural (PAHO/WHO 1999).

Improvements in telecommunications and travel have reduced the barriers of distance; the 'global village' concept has arisen with people now having the ability to watch disasters unfold on television from across the world. This results in tremendous public attention, and calls for governments not directly affected by the event to 'do something' (Abrams 1990).

Recent world events, such as the September 11th and Bali bombings, the Asian tsunami and hurricane Katrina, have focussed world and media attention on disasters and how they are managed. The Asian tsunami has probably seen the largest collective outpouring of aid and humanitarian assistance to a disaster in world history. How effective is this aid and how is it best given?

History of Disasters

Disasters will always occur (McEntire 1998), and no civilization in history has been immune from their effects (Dara et al. 2005).

The risk of disasters is increasing. Data from the International Federation of Red Cross and Red Crescent Societies (IFRC) and Centre for Research on Epidemiology of Disasters show a significant increase in frequency of recorded disasters over the last 50 years, with almost 2 billion people affected by disasters in the past 10 years (Campbell 2005; IFRC 2001).

Kizer (2000) and Noji (2000) describe several reasons for this, apart from improved data collection, including global warming, increased technology (especially in developing countries with immature safety systems), rapid human population changes and urbanisation, civil war and conflict with a potential for population displacement, and the rise of terrorism.

Karl Western commented that 'disasters could only become more frequent as population density increases' (Leus 2000). Kizer (2000) also points out that because of population growth and urbanisation we can expect increased mortality and morbidity from both natural and man made disasters simply because of the greater population density

Rights versus the expectations and politics of aid

Gunn (2005) describes how the worldwide understanding of disasters and approaches to disaster management have changed in recent years, increasing the potential involvement by parties not directly affected:

- Major emergencies and **disasters are** no more considered fatalistic phenomena, but rather as **foreseeable events that can be prevented**.
- Those who provide **assistance** can now look upon it not as a gesture of sympathy, but **as a duty based on mutual aid**.
- The stricken nations and communities are claiming **relief** not as a charity but **as a right**.
- **Disaster aid** is being seen not as an 'ad hoc', emergency repair episode but **as an essential factor in long-term development**.
- The world community now perceives emergency **relief** not as a magnanimous contribution but **as a humanitarian obligation**.

These comments are underpinned on the basic precept that **health and security are a human right** (Judd, 1992; WHO, 2005).

Schull & Shanks (2001) note that the impact of media coverage is unpredictable, often driven by access and the need for brief headlines. There is also debate in the humanitarian community whether responding to needs or upholding rights should be the basic approach of humanitarian work (Sondorp, Kaiser & Zwi 2001).

METHODOLOGY

A literature search was performed using the search engines and databases listed in Table 1. This table also describes the key words and search phrases used.

Table 1: Summary of literature results by search engine

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

Library holdings for the following were reviewed:

- The Townsville Hospital Medical Library
- James Cook University Main Library
- Emergency Management Australia Library

Given the time constraints, the following items were excluded from analysis:

- Articles in foreign languages
- Articles not easily obtainable from Library sources
- Unpublished reports that were not accessible

Specific websites were also accessed in the search for relevant information. These include:

- Emergency Management Australia (EMA) <www.gov.au>
- Federal Emergency Management Association (FEMA) <www.fema.gov>
- Disaster Medical Assistance Teams (DMAT) <www.dmatcom.org>
- World Health Organization (WHO) <www.who.int>
- United Nations (UN) <www.un.org>

In this review, although Google reported 200,000 pages on DMAT, the focus is on websites in the disaster health field. Documents previously sourced as part of an earlier submission by the Western Australia (WA) Department of Health were also used.

Publication patterns in disasters and disaster medicine over the last 50 years were also reviewed, as shown in the Table 2 below.

Table 2: Frequency of disaster medicine literature by decade

SEARCH TERM	1956-1965	1966-1975	1976-1985	1986-1995	1996-2005
"Disaster"	16	336	1152	2104	4939
"Disaster medicine"	2	15	15	80	75
"Disaster medical assistance teams"	0	0	0	8	9
"DMAT"	0	0	2	9	13

LITERATURE REVIEW

1 POTENTIAL USEFULNESS OF DISASTER MEDICAL ASSISTANCE TEAMS (DMATS)

1.1 Anticipated Need for DMATs

1.1.1 International

Despite an excellent level of preparedness, some dramatic situations in the wake of a large scale disaster will make the mobilisation of international resources necessary, particularly in developing nations (Russbach 1990).

Economic status is related to disaster vulnerability (McEntire 1998). Approximately 90% of disaster related injuries and deaths occur in countries with per capita income levels below US$760 per year (Haddow & Bullock 2003). These countries not only have more disasters but less capacity to cope, and even less capacity to plan and prepare (Keim & Rhyne 2001; Lennquist 2004; Leus 2000). Disaster management programs tend to be viewed as superfluous (Haddow & Bullock 2003). The frequency of disasters in some of these areas also means that there is limited time for recovery between disasters (Campbell 2005).

A review of the disaster preparedness of nations in Oceania found a remarkably low prevalence of emergency planning, indicating a very low level of capacity for preparedness development, concluding that the region would be highly dependant on external assistance. In Oceania, between 1992 and 1996, disasters affected an average of 4.5 million people annually, with an average annual damage bill of US$1 billion (Keim and Rhyne 2001).

At a more local level, there have been 127 major natural disasters reported in the Western Pacific region in the decade 1990 to 2000. This constituted 23% of the total of 561 natural disasters worldwide, resulting in 41,530 dead, 434,706 injured and 6,151,609 homeless. The most common natural disasters were typhoons/cyclones (58), floods (31) and earthquakes (16). The most disaster prone countries in the region were the Philippines (38), China (26) and Vietnam (17) (Asahi, Pesigan & Reyes 1999).

It is likely that there will be calls for disaster medical assistance and humanitarian aid following such disasters (McEntire 1998; Lennquist 2004). ‘Less developed countries are increasingly requesting assistance in developing programs leading to improved disaster preparedness, prevention and mitigation’ (Burkle 2001b). The challenge of providing effective relief in the setting of complex humanitarian emergencies will become even more pressing (VanRooyen & Eliades 2001).

1.1.2 National

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

Kizer (2000) questions the ability of hospitals in developed countries to respond to disasters, raising concerns about levels of planning and preparedness, and 'surge capacity'. For example, a relatively mild and short lived influenza outbreak in the USA in the winter of 1999, resulted in widespread emergency department (ED) and intensive care unit (ICU) shortages. Could issues such as labour shortages (especially nursing), 'just-in-time' inventory approaches and higher bed occupancy rates minimise the ability to absorb a rapid influx of seriously ill patients even if the infrastructure was undamaged?

Dara (2005) notes that most hospitals in the USA are just one industrial accident away from the 'tipping point' for a disaster and a resultant acute shortage of critical care beds and staff.

Born & DeLong (2004) note that the civilian medical community in the USA is relatively unprepared to deal with the type of events that can rapidly overwhelm local and regional medical systems. Most orthopaedic surgeons and traumatologists had never even considered the paradigm shift that occurs in disasters, where the focus shifts from unlimited resources used to provide the greatest good for the individual patient to limited resources allocated to the greatest number of victims.

Hospitals are also vulnerable to building collapse as they are often old and have a high rate of occupancy. Many hospitals have been destroyed during disasters including hurricanes Andrew and Hugo, and the Northridge earthquake (Milsten, 2000).

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

1.2 Epidemiology of Disasters

1.2.1 Epidemiology

It is important to learn from the past to define priorities and make sure that essentials are dealt with first (Campbell 2005). Different disasters produce different types of injury patterns; an understanding of disaster epidemiology is necessary to help estimate likely injury patterns, needs and timelines of response (Milsten 2000; Noji 2000). This holds not just for natural disasters but also complex health emergencies, as knowledge of their epidemiological consequences and effect on public health infrastructure should assist in planning medical personnel requirements (VanRooyen & Eliades, 2001).

These epidemiological patterns have been described by a number of authors in varying degrees of detail and will not be reported in full here (Redmond 2005a).

1.2.1.1 Earthquake

Earthquake injury patterns have been described by numerous authors (Angus et al. 1997). After the Los Angeles earthquake, the peak patient presentations occurred

on day 1, with an 8.8-fold increase in attendances. The increase began to decline on days 2 and 3, but remained for 11 days before returning to baseline. Most of the patient load in the first 3 days was related to minor trauma such as lacerations and orthopaedic injuries. After the third day, the majority of care shifted to a non-trauma profile for gastrointestinal, gynaecological and miscellaneous needs (Kazzi et al. 2000).

This is consistent with descriptions of other earthquakes, with the trauma burden largely confined to days 1 to 3, and a sustained increase in demand for medical services lasting at least 10 days following the quake (Kazzi et al. 2000; Liang et al. 2001). The same pattern was seen following the Loma Prietta, Chi Chi, Great Hanshin and Gujurat earthquakes (Thiel et al. 1992; Chen et al. 2001; Roy et al. 2002).

The Ukrainian Mobile Hospital of the Ministry for Extreme Situations arrived in Turkey on day 6 after the earthquake in 1999 and was operational for 20 days. One third of the 5,432 patients were children, and infectious diseases the most common condition. Although about one third needed to be seen by a general or orthopaedic surgeon, only 35 needed actual surgery (Roshchin 2000). A Ukrainian team in Gujurat saw 2,313 people, of whom one quarter were children. Within 10 days, presentations changed from trauma to general medical and infectious diseases (Roschin 2002).

The need for assistance occurs soon after an earthquake, during the 'golden period' when traumatic injuries predominate (Kazzi et al. 2000; Liang et al. 2001). Retrospective studies of resuscitation after earthquakes suggest the potential to save lives rapidly declines from the time of event, to near zero 24 hours later (Pretto & Safar 1991), long before international medical teams arrive; following the 1992 earthquake in Turkey, official medical and search and rescue responders arrived after most deaths had occurred (Angus 1997).

A problem specific to earthquakes is the crush syndrome and renal failure. After Iran's Bam earthquake, 10.6% of hospitalized patients suffered acute renal failure, most requiring haemodialysis (Bidari et al. 2005). Optimal early hydration is needed as a major prophylactic measure. The community could require additional medical assistance for up to 2 weeks, mostly for primary care problems such as respiratory infections, medication refills, and cardiac and psychiatric conditions (Kazzi et al. 2000).

1.2.1.2 Hurricane

Nufer and Wilson-Ramirez (2004) found similar patient needs following hurricanes Andrew and Iniki. Five of the 6 most common complaints (wounds, musculoskeletal pain, medication refill, rash and abdominal complaints) occurred with similar frequency. There was a higher proportion of upper respiratory complaints after hurricane Iniki but this was thought to be insignificant from a planning perspective. Teams need to be stocked with adequate wound care supplies, tetanus toxoid, antibiotics and analgesics. This is supported by a study comparing the medical supply needs of patients after floods and hurricanes (Nufer et al. 2003).

After hurricane Charley, the South Florida DMAT established a mobile field hospital. Most of the 1,016 patients treated during the 11-day stay were medical patients with respiratory complaints, exacerbation of chronic illnesses, and lost medications, while trauma consisted of lacerations and wound infections (Williams & Weissman 2005). Over 500 tetanus vaccinations were administered (Cohen & Mulvaney 2005). A large component of the work involved providing psychosocial support (Williams & Weissman 2005).

After a natural disaster, a hospital ED can expect to see 3 to 5 times the normal number of patients, and during a hurricane, patient numbers can be expected to rise between 6 and 65% with a return to normal patient volumes within a few days to 2 weeks (Henderson et al. 1994; Milsten 2000).

1.2.1.3 Asian Tsunami

After the tsunami, in a Thai district hospital, the peak emergency presentation numbers occurred on day 1, returning to near normal by day 4. Most health care volunteers had left by the end of week 1, and the hospital had returned to normal activities by the end of week 2 (Wattanawaitunechai, Peacock & Jitpratoom 2005). This is consistent with the experiences of Kongsaengdao, Bunnag and Siriwiwattnakul (2005) who found that there were 3 phases of injuries; those incompatible with life occurred in the first few minutes, followed by complications such as massive haemorrhage, haemothorax and pneumothorax over the next few hours, and late complications, including infectious diseases, developed over days to weeks.

Although the Australian Defence Force (ADF) team responding to the Aitape tsunami arrived 52 hours post-event and performed 209 operations on 251 patients, most of this was related to wound management. Few infants or elderly had survived, and patients with intracranial, intrathoracic, abdominal and spinal injuries had already died prior to their arrival (Taylor, Emonson & Schlimmer 1998).

1.2.1.4 Complex Health Emergencies

Trauma is not necessarily the main cause of death in disasters associated with conflict. During the war in the eastern region of the Democratic Republic of the Congo, an estimated 10.7 million deaths occurred over a 22 month period, however only 11% were due to trauma, the remainder being attributable to preventable infections such as measles, acute respiratory infections, malaria, diarrhoea, and malnutrition. Psychiatric or psychological disorders were also be detected in about 50% of refugees (Brennan & Nandy 2001).

Decision makers in Washington and in European capitals have expressed surprise over the deaths of people in complex emergencies from such simple things as childbirth, malaria and diarrhoea, deaths avoidable with simple interventions (Leus, Wallace & Loretti 2001). Most trauma deaths during complex emergencies, however, are not preventable because they generally occur in insecure sites where relief agencies have poor access (Brennan & Nandy 2001).

1.2.1.5 Conclusions

A trimodal distribution of medical issues can be seen after a sudden onset disaster (Maegele et al. 2005; Taylor, Emonson & Schlimmer 1998).

The initial phase, seconds to minutes afterwards, is characterised by high mortality due to injuries not compatible with life (Maegele et al. 2005; Taylor, Emonson & Schlimmer 1998).

In the second phase, minutes to hours afterwards, medical care is focussed on early trauma management (Maegele et al. 2005; Taylor, Emonson & Schlimmer 1998). There is a 'golden 24-hour' period during which most casualties are recovered and when most fatalities occur (Noji et al. 2001). The main problems encountered are adequate first aid and evacuation, which have to be performed immediately by the local people (Russbach 1990). DMATs are rarely on site soon enough after the impact phase of the disaster to deal with the acutely injured victims (Noji 2000; Wallace 2002). This phase also relates to the capacity of the medical and surgical system to cope with a large number of casualties (Russbach 1990).

In the third phase, occurring days to weeks after the disaster, major efforts are needed to prevent and treat complications such as sepsis, multiple organ failure and psychological problems (Maegele et al. 2005; Taylor, Emonson & Schlimmer 1998), as well as the large number of displaced persons and lack of essential resources such as safe water, food, energy and shelter (Russbach 1990).

During the post-disaster phase, trauma issues are usually related to recovery and clean-up operations or delayed medical attention due to inaccessibility. More commonly, long-term health issues, daily urgent medical needs, mental health and stress, environmental and infectious disease concerns, public health issues and special needs populations will form the bulk of health and medical issues. Primary care will need to be addressed as soon as 24 to 48 hours after the disaster (Wallace 2002).

1.2.2 Timeliness of Response

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

'Every minute counts in the successful rescue of disaster victims, time lost due to misunderstandings and incompatible routines is critical.' Standardisation (compatibility, inter-operability, inter-changeability, commonality) with mutual cooperation is essential (Dauphinee 2000). This call for standardisation was echoed by Cruz Vega et al. (2001) at the 5th Asia Pacific Conference on Disaster Medicine and needs to occur for true multi-disciplinary cooperation.

International search and rescue teams often attract much publicity, which may mask their limitations. The effectiveness of international medical teams is also limited by the delay in getting to the affected area. While survival from entrapment declines rapidly after 24 to 36 hours (Redmond, Watson & Nightingale 1991), international medical

relief activities in disasters often do not begin until days 5 to 7 after the event, mainly due to the distances involved (Asari et al. 2000; Noji 2000; Redmond, 2005a).

After the Gujarat earthquake, outside medical assistance arrived only after local health services had provided emergency assistance and immediate care. Specialised field hospitals, set up a week or more afterwards, were too late to reduce morbidity and mortality (Bremer 2003; Roy et al 2002). These teams need to arrive in the first 24 to 48 hours to handle the vast bulk of the casualties (Bremer, 2003).

Other examples of delay in arrival include:

- Armenian earthquake 1988: French team arrived day 4, UK rescue team arrived day 6 (Asari et al. 2000)
- Hurricane Andrew 1992: DMAT arrived day 4 (Nufer, Wilson & Ramirez et al. 2004)
- Hurricane Iniki 1992: DMAT arrived day 8 (Nufer, Wilson & Ramirez et al. 2004)
- Los Angeles earthquake 1994: 10 DMATs arrived day 2 (Kazzi et al. 2000)
- Bangladesh tornado 1996: Japan Medical Team for Disaster Relief arrived day 5 (Asari et al. 2000)
- Aitape tsunami 1998: ADF team arrived day 3 (Taylor, Emonson & Schlimmer 1998).
- Asian tsunami 2005: French Armed Forces Health Services arrived more than 7 days post-disaster (Meynard et al. 2005).

Almost 40 international teams provided search and rescue after the Bam earthquake; 5 teams arrived within 24 hours, 10 teams in the first 48 hours, and a total of 34 urban search and rescue teams, with 1,345 personnel, had arrived within 72 hours. By day 4, there were 1,600 personnel from 44 countries and 12 foreign hospitals present in the disaster zone. This can present a logistic and coordination challenge to the local community just to provide liaison and interpreters, which is even more problematic if teams are not self-sufficient (Radfar et al. 2005).

Jagger (2005) has attempted to identify the resistance factors associated with response delays. He found that there are both factors specific to an organisation and common obstacles. Fourteen of the 46 'resistance factors' were highlighted consistently. The magnitude of a given event versus the state of readiness and capacity of local services was found to be a key issue.

In a review of the 104 teams that responded to Taiwan's Chi Chi earthquake, only 7% of the Emergency Medical Assistance Teams (EMATS) were providing on site care within 12 hours of the earthquake, 17% within 18 hours, and 20% within 24 hours. Eighty per cent of the teams needed more than 24 hours to begin delivery of patient care services. This is partly explained by notification, travel and set up. Only 63% of the teams received notification within 24 hours of the earthquake, 29% departed in less than 1 hour post notification and 79% left within 6 hours. Seventy-three per cent arrived after 12 hours of travel, and 47% were able to provide care within 1 hour of arrival (Hsu et al. 2002).

Local responders should therefore plan on being self-sufficient for at least 72 hours, although outside assistance is often on site sooner (Stopford 2005). Local medical

facilities may, however, be disrupted and require international help, not only in dealing with the disaster, but also to maintain routine health facilities for unrelated conditions. International aid may help restore routine medical and surgical facilities overwhelmed by a disaster and may later support specialist elective services (Redmond 2005a).

It should also be noted that local medical personnel will often respond to a disaster only once the safety of their own families is assured (Chen et al. 2001; Auf der Heide 1989).

1.3 Factors Affecting Efficiency of DMAT Response

1.3.1 Cash versus Equipment

International donation of goods is, in many ways, a good analogy for the use of international DMATs as many of the same problems arise and are often easier to understand.

Unilateral contributions of unrequested goods are inappropriate, burdensome and divert resources from what is needed most (de Ville de Goyet 2000). Even unwanted goods consume personnel and space for storage, cataloguing and transport or destruction; at least 25% of goods donated to the former Yugoslavia were perceived to be unusable (Frisch 2005; Noji 2000; Rubin & Heuelmans 2000).

Cash, rather than goods, is often more appropriate (Campbell 2005; de Ville de Goyet 2000; Martone 2005; Redmond 2005b). 'Individuals or families may themselves make far more effective use of humanitarian funds than external humanitarian organizations' (de Ville de Goyet 2000). Residents are able to choose what to acquire based on their particular needs, helping revitalise local businesses at the same time (Martone 2005); cash contributions support the local economy by the purchase of local goods and commodities (Redmond 2005b). Without attention to the local economy, food aid can destroy the local market and wipe out self-sufficiency.

If donated equipment is unfamiliar or cannot be maintained locally, its impact and useful life are limited, and its introduction more likely to devalue and undermine local practice than to support it. Similar consideration needs to be given to disaster medical assistance – is the assistance appropriate? Is it effective? How will it integrate with the local community (Redmond 2005b)?

1.3.2 Needs of the Affected Community and Assessment Fatigue

Generally, it is accepted that the principal task of the disaster response is a rapid assessment of the needs of the affected community (Bricknell & MacCormack 2005; Frisch 2005; Nabarro 2005; PAHO/WHO 1999; Russbach 1990). Efficient matching of resources to needs will mitigate against further adverse health effects (Brennan & Nandy 2001; Noji et al. 2001; Noji 2000), and limited resources must be allocated in a way that provides the greatest good for the greatest number of people (Brennan et al. 2001). 'If aid is to do the most good for the most people it must be targeted' (Redmond 2005b).

There is a temptation to send relief before being asked for it. Local authorities must immediately give potential donors some indication as to the actual needs of the

affected communiy (Russbach 1990). However, assistance should always attempt to meet some defined needs or it has little or even detrimental value for the affected population (Rubin et al. 2000).

Failure to explicitly articulate both the domains of responsibility and the geographic areas to which they apply leads to service gaps and duplication, and denying responsibility for problems. This information is essential to newly arrived teams seeking a niche in the disaster relief efforts (Bradt & Drummond 2003).

Rapid needs assessments have thus become the modus operandi for gathering information about the status of an affected population (Keim & Rhyne 2001; Malilay 2000; Redmond 2005b) with results forming the basis for directing relief efforts (Asari et al. 2000; Chen et al, 2003).

United Nations (UN) Disaster Assessment and Coordination teams now try to establish an onsite operations and coordination centre early after a disaster, consisting of a 2 to 6-person team, drawn from member countries, that travels quickly to a disaster scene to report the immediate needs to the international community (Redmond 2005b).

Problems still exist with rapid needs assessments as they are often limited by a lack of time, money and the use of mono-disciplinary analyses (Maury & Russbach 2004). Only a moderate number of relief organisations were able to identify victims' needs with little or no problem (McEntire 1998). In a review of the disaster preparedness of Oceania nations, only 20% of public health plans had any reference to rapid health assessments (Keim & Rhyne 2001). This forces a reliance on external reviews with their associated delays.

The destruction of communication systems may result in slow and inaccurate estimations of the extent of the damage (Braham et al. 2001; McEntire 1998; McEntire 1999). Time may not improve this; the Japanese review of needs on day 7 after the Aitape tsunami found that information was often still inaccurate or incomplete (Asari et al. 2000).

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

- being inaccurate (Asari et al. 2000; Birnbaum 2005; Braham et al. 2001; Malilay 2000; Maury & Russbach 2004; McEntire 1998; 1999), and/or self-serving (Rubin & Heuvelmans 2000).
- being incomplete (Asari et al. 2000; Mallilay 2000; Maury et al. 2004). Malilay (2000) found that assessments commonly addressed range of needs but the magnitude was often neglected. If magnitude is known, estimates can be derived for response actions such as the resources required to restore electricity to a certain number of households.
- being delayed (Asari et al.2000; Braham et al. 2001; Malilay 2000; Maury & Russback 2004; McEntire 1998, 1999). Malilay (2000) reviewed a number of disaster assessments from the Centers for Disease Control and Prevention's (CDC) Morbidity and Mortality Report and found most were conducted more than 3 days after the disaster. She suggests that if logistical constraints prevent arrival of a team, then an earlier review by local authorities trained in the process may be of benefit if it does not impact on the ability to provide immediate care

to the victims. Medical outreach teams have been suggested, but the time of their arrival after the disaster raises questions about their usefulness (Leonard, Spangler & Stringer 1997).

- being duplicated by different agencies leading to assessment fatigue, time wasting, duplicating effort and frustrating the local community (Malilay 2000; Nabarro, 2005; PAHO/WHO 1999; Redmond 2005b). After hurricane Georges, it was noted that groups in the public, not-for-profit and private arenas were doing their own assessments of the disaster (McEntire 1998). Sharing information not only prevents duplication but allows a clearer and more consistent picture to emerge, and smaller agencies can improve the speed and relevance of their response by use of reports from large international agencies (Redmond 2005b).
- the need for a validated tool for needs assessment (Malilay,2000) and standardisation of the content of needs assessment to minimise subjective analysis and provide consistency (Bradt & Drummond 2003; Malilay 2000). A timeline to determine what information is required from assessments occurring within 3 days, between 3 to 10 days, after 10 days, and after 1 month is also needed (Malilay 2000).
- the level of experience of those performing the needs assessment (Redmond 2005b).
- Not involving the local population (Redmond 2005b).

Newer, less fragmentary approaches, using epidemiological study designs and sampling approaches have been developed (Malilay 2000). Bradt and Drummond (2002) propose improvements to health needs assessments by refining the criteria in the protocol evaluation. The development, acceptance and use of standardised Minimum Essential Data Sets will improve the practice of disaster health coordination including:

- serially pre-emptive information priorities to enhance attention to critical issues
- sector specific metadata to enhance follow-up contact with key informants
- fixed data layout to enhance data entry
- South Manchester Accident Rescue Team (SMART) performance indicators with co-located benchmarks to enhance interpretation
- length limits of 2 pages to enhance portability
- completion time of under 2 hours (for a trained investigator in a population of 10,000 with knowledgeable parties available for interview) to enhance utility (Bradt & Drumond 2002).

Bradt, Abraham & Franks (2003) also envision technicians with laptops, GIS software and plotters appearing at the disaster site as information first responders.

1.3.3 Roles: Field Hospitals versus Primary Care & Public Health

There is a need for improving field operations (VanRooyen et al. 2001a) with the humanitarian response occurring in accordance with the needs of the affected population (de Ville de Goyet 2000) and based on an appropriate needs assessment (Malilay 2000; Schull & Shanks, 2001).

Many authors note that, although the medical needs of the affected population may be great, the lack of non-medical necessities is usually the most immediate threat to life.

These include:

- **Drinking water.** An adequate amount of reasonably safe water is preferable to a lesser amount of pure water.
- **Sanitation.** One latrine seat per 20 people, each dwelling no more than 1 minute walk from a toilet, and a communal refuse pit measuring 2m x 5m x 2m for every 500 people.
- **Food.** Locally prepared food with local ingredients is best received and also supports the local economy. The minimum level is 2,100 kcal/day.
- **Shelter.** Temporary housing should be avoided and permanent shelter established as soon as possible. Minimum floor area is 3.5 metres squared per person.
- **Medical needs.** Primary care needs are paramount. WHO emergency health kits are available for primary health care workers to assist a population of 10,000 for 3 months, which fit on the back of a pick up truck. Supplementary units are also available for health professionals but do not duplicate the primary kit and cannot be used alone. Measles immunisation should also be considered, especially with displaced persons and refugee camps (Brennan et al. 2001; Loretti, Leus & Hosteijn 2001; Redmond 2005b; Schull & Shanks 2001).

Each disaster is different, and priorities should be based on the context of the local community, and the ability and timeliness of the response. For example, after the Asian tsunami, the first priority was treating injuries, then access to safe water, monitoring of disease outbreaks, mental health, and then reconstruction (Campbell 2005).

Resuscitation and medical care are glamorous, but not the only life saving activities. These can include sanitation programs, water distribution, building of shelters and food distribution (Russbach 1990). Medical assistance should respond to primary heath care needs in the affected countries rather than to the perceptions of a far away, well intentioned yet misinformed public (de Ville de Goyet 2000). Foreign Field Hospitals (FFHs) often place a logistical and technical support load on the affected country with debatable efficiency (Bar Dayan et al. 2005a; Noji 2000; PAHO/WHO 1999).

For example, the field hospital capacity after the Gujarat earthquake exceeded the need for surgery while other medical needs were neglected. When the acute phase was over and the foreign staff had left, the local health personnel who had died in the earthquake were still not replaced, so remaining staff were overstretched and exhausted, and the workload had still not returned to normal (Bremer 2003).

The cost-efficiency of an advanced surgical centre that handles minimal cases is also questionable if other needs are left unmet. The Canadian Advanced Surgical Centre handled 109 surgical cases in 39 months in Bosnia (Braham et al. 2001), while the Norwegian Red Cross field hospital in Banda Aceh had seen 100 patients and admitted 40 by 2nd February (Riddez 2005). In contrast, 251 patients were seen by the ADF team responding to the Aitape tsunami, with 209 surgical procedures performed (Taylor, Emonson & Schlimmer 1998).

It is also important to remember the special needs of the more vulnerable members of society such as women and children, along with the elderly, disabled, chronically ill and those who have been displaced (Abbott 2000; Bremer 2003; Brennan et al. 2001; Burkle et al. 1995; Leus, Wallace & Loretti 2001 ; Mudur 2005; Redmond 2005a; Seamen & Maguire 2005).

Traditionally, field hospitals are of military origin and pay little attention to the needs of women and children (Bremer 2003). When medical and public health services have been disorganised by a disaster, life and 'Indigenous' disease processes go on. Pregnant women still have babies, diabetics still need insulin and mental health needs remain (Leus, Wallace & Loretti 2001).

In the Norwegian Medical Aid System (NorAid), maternity modules with personnel and equipment were developed in 1992. The UN High Commission for Refugees introduced the Minimum Initial Service Package in 1999 focusing on maternity, sexually transmitted infections and family planning.

After the Gujarat earthquake, paediatricians came from other parts of India, but the international community was not prepared to assist with paediatric drugs and equipment. Only the Israeli field hospital brought equipment for infants and children, with maternity services having been provided by an Israeli unit for the last few years (Bremer 2003).

Weiss et al. (1999) describe the experiences of mobile clinic staff during the Northridge earthquake relief operation who found a high prevalence of acute conditions including stress and anxiety reactions, and large numbers of children. It was recommended that staff trained in primary care, mental health and paediatrics should be considered for relief missions that begin several days after a disaster.

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

The interventions that produce the greatest health benefit are based on models of public health and primary care (Brennan et al. 2001), often utilising non-government organisations (NGOs), although this approach is not immune to problems:

- The South Florida DMAT responding to Hurricane Charley was assigned to assist and relieve staff nurses at the Charlotte Regional Medical centre. Most of the nurses had been on duty for over 40 hours straight because relief staff could not make it to the hospital; their DMAT had not anticipated the needs of the community. A number of people living in the Florida area were on home antibiotic therapy or home oxygen (Cohen & Mulvaney 2004).
- Transient clinical programs rarely are sound medically. Mobile health clinics and transient curative programs can quickly undermine the local health care system.

Individuals are encouraged to bypass local personnel in favour of expatriates, who may not be trained appropriately to handle the affected population (VanRooyen et al. 2001b).

- Mass vaccination programs are usually not needed; if the organism is not present before the disaster and not introduced after the event, there is no threat, regardless of the conditions. Vaccination for childhood diseases may be needed for unimmunised children in mass care settings, and tetanus boosters needed for those with open wounds or penetrating injuries (Abbott, 2000).
- Standard relief packages designed for refugee situations in poor, tropical countries and dominated by infectious disease patterns were found to be inadequate in Kosovo (Leus et al. 2001), again emphasising the importance of local context.

1.3.4 WHO/PAHO guidelines

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

They also state that FFHs should only be deployed:

- following an appropriate declaration of an emergency and a request from the health authorities of the affected country
- when they are integrated into the local health system
- when the respective roles and responsibilities for their installation and operational sustainment have been clearly defined.

There are also guidelines for the donation of a FFH without staff, which PAHO advises should be considered cautiously given issues with cost, installation and maintenance, and other more cost effective options.

The 3 distinct purposes for FFHs defined by the WHO/PAHO are outlined below.

1.3.4.1 Early Emergency Care

Provide early emergency medical care, including Advanced Trauma Life Support (ATLS).

This period only lasts up to 48 hours following the onset of an event. The essential requirements are to:

- be operational on site within 24 hours after the impact of the event
- be entirely self-sufficient
- offer similar or higher standards of medical care than were available in the affected country prior to the precipitating event
- be familiar with the health situation and culture of the affected country (optional).

1.3.4.2 Follow Up Trauma And Medical Care

This stage provides follow up care for trauma cases, emergencies, routine health care, and routine emergencies during the period when health services are progressively overwhelmed by the need for ongoing, secondary care of trauma victims and routine medical care. The health facilities may not be fully operational and local staff may urgently need time to rest and care for possible personal losses.

If local health structures and systems remain functional, this need is better met by in-country resources or from culturally compatible neighbours.

The primary role of the FFH is to temporarily fill the gaps in emergency medical assistance. This period lasts from day 3 to day 15, and should not exceed 15 days.

The essential requirements are to:

- be fully operational within 3 to 5 days
- require minimal need for support from the local communities
- have a basic knowledge of the health situation and language, and respect for the culture
- ensure the availability of selected specialties. This must include areas such as general surgery, anaesthetics, internal medicine, obstetrics and gynaecology, and paediatrics, with appropriate paramedical and support staff. Equipment should allow treatment of all patients regardless of age or gender.
- be sustainable
- be able to evaluate of the cost effectiveness and cost benefit associated with the use of the FFH.

Optional requirements include:

- cultural similarity
- a broad range of medical disciplines including clinicians and public health professionals. Epidemiologists, hygiene/sanitation experts and mental health experts have proven to be valuable assets.

1.3.4.3 Temporary Health Facility

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

1.3.5 Integration with Existing Services

Integration with existing services is an essential component of the goal of disaster medicine. Birch and Miller (2005) noted that 'life didn't start for anyone when you got off the plane…Your intervention needs to fit into the local response to the crisis'. It is critical to work closely with local government, organisations and other sectors (Campbell 2005; Robertson, Dwyer & Leclerq 2005).

All agencies involved in relief and development activities share a responsibility to include local populations in all phases of projects from design through to delivery and evaluation. This inclusive process also helps to establish a learning process that enhances capacity building, empowering local communities to regain control over their lives. Failure to do so can lead to mistrust, resentment and a lack of cooperation, or

undermine the capacity of local people to solve their own problems (Brennan et al. 2001; Judd 1992; Leus et al. 2001).

It is too easy for outsiders to ignore, if not trample over, national and local health systems, bringing immediate and valuable relief at the expense of sustainable, long-term health care (Loretti, Leus & Van Hosteijn 2001). In a review of the Mozambique floods in 2000, measures of network centrality are far higher for international than for local NGOs, suggesting that local NGOs tend to remain peripheral to the coordination process. Local civil society capacity for responding to future disasters may not have been developed, which can result in increased dependence on international NGOs (Moore & Blasser 1991). Organisations must 'rise above their independent and individualistic perspectives to work with local governments and communities' (VanRooyen & Leaning 2005).

A number of issues have been raised by various authors:

1.3.5.1 Coordination

The local community should be encouraged to run a coordination centre for international relief agencies (PAHO/WHO 1999; Redmond 2005b). Delays in actually locating a site required assistance by teams responding to the Chi Chi earthquake (Hsu et al. 2002), while an Israeli mission in Sri Lanka, after the Asian tsunami, was faced with a delay of 2 days in finding where to station the medical teams because local coordinators were not from the medical community. Their decision to leave was made on the basis of mutual understanding with the local medical officer and the Sri Lankan Ministry of Health, and only occurred once the local medical system was able to serve the community (Feigenberg 2005).

1.3.5.2 Dependency

McEntire (1999) and Reade (2000) note issues with creating dependency, while Palmer (2005) states that teams are there to 'help local people help themselves, not to create dependency'.

1.3.5.3 Use of Local Workers

It is important to manage the situation through local providers rather than imposing preconceived solutions on an already traumatised community (Grantham 2005). International aid can be detrimental by hiring away local workers and duplicating services (Leus, Wallace & Loretti 2001; Reade 2000). This may be more difficult on occasions when there is complete devastation such as after the Aitape tsunami or the Bam earthquake, where none of the health care facilities were functional, and local health care workers unavailable (Abdaliha 2005, Taylor, Emonson & Schlimmer 1998). However, there is often more capability present than expected; Auf der Heide et al. (2001) noted a resilience of the medical system in Albania despite a decade of violent political conflict.

1.3.5.4 Level of Care

The presence of a foreign military hospital may raise the expectations of the community to an impossibly high level (Reade 2000). If life-saving priorities are addressed through an integrated, primary health care approach, the local health care system can be preserved and strengthened (Loretti, Leus & Hosteijn 2001).

1.3.6 Cultural Acceptance

Cultural factors must be addressed in order to appreciate the context of disasters for a population (Keim & Rhyne 2001). There is a need to be 'sensitive to cross cultural nuances' both in provision of services, and analysis of program goals and performance (Ha-Redeye 2005).

Community interaction is another method of achieving cultural acceptance. For example, the Canadian Disaster Assistance Response Team (DART) personally distributed water on the streets as a form of community outreach to connect with the local population (Braham et al. 2001).

After his experiences in Aceh, Ha-Redeye (2005) stated that a model of providing care during a disaster by people respectful of local traditions is one which should be replicated in the future. This was reaffirmed by Grantham (2005), who stated that one of the most important lessons from the tsunami was the value of accepting cultural differences.

Amital et al. (2003) also describes how team members from the Israeli deployment to Kosovo learnt caution when asking about relatives who were probably missing, and the interplay between physical illness and grief. The Ukrainian team to Gujarat found that patient examinations had to be undertaken in the presence of relatives, and women could only be examined by female physicians with no males present (Roshchin & Mazurenko 2002).

1.3.7 Communication and Information

Communication and information management is one of the most consistent challenges and problems in disaster response (Arnold et al. 2004; Braham et al. 2001; Chan et al. 2004; Gerace 1979; McEntire 1998). Valid information is critical to enable decision making and resource prioritisation (Chen et al. 2003).

While information is acknowledged as needing wider distribution in a disaster situation (McEntire, 1999), communication issues, both technical and organisational, are important considerations in coordinating the medical health response (Noji et al. 2001). For example, normal communication networks could not be relied upon after the Chi Chi and Kobe earthquakes (Chen et al. 2001).

Poor coordination between agencies and limited evidence of organisational learning are two common criticisms (Sondorp, Kaiser & Zwi 2001). Often medical and health teams are too insular, and although self-sufficiency is important, it should not be at the expense of exchanging vital information (Noji et al. 2001).

A lack of clearly defined roles and responsibilities can also lead to confusion, misunderstandings, conflict and delays in response (Brennan et al. 2001). The importance of a pre-planned, independent and dedicated communication system to effectively coordinate and manage disasters is seen as one of the most critical areas needing attention (Hickson et al. 2001).

1.3.8 Leadership

Good leadership is essential in disaster teams, although leadership is generally a learned skill (Campbell 2005; Cuny 2000a). Maintaining effective team welfare and

dynamics in a physically and psychologically challenging post-tsunami environment requires a considerable conscious effort in terms of leadership (Grantham 2005).

An Israeli study of the response of the Thai medical system to the tsunami disaster found that leadership was crucial for effective function (BarDayan et al. 2005c), while performance standards are noted to suffer, at least in part, due to mismanagement (Burkle et al. 2001). Problems in coordination may arise due to poor leadership as, without a strong chain of command and proper protocols in place, confusion is inevitable (Hickson et al. 2001).

No single set of characteristics guarantee good leadership. The leadership characteristics required in situations of extreme adversity will be very different to those needed in a time of stability (McCormick & Wardrope 2003). A management style that emphasises cooperation, participation and fairness, and based on personal example, is the best way for a disaster manager to influence others. Good leaders get subordinates to buy into the vision and share it. They must be familiar with different styles of leadership (directive, supportive, participative and achievement oriented), and know how to use them and when. These styles may vary with the phase of the disaster, the environment, the staff involved, and the interpersonal relationships established; professional relationships normally require a participative leadership role whereas a directive style is more appropriate in crisis situations (Cuny 2000a).

Research after the Rwanda crisis showed that aid workers saw organisational and management issues as prime stressors in their work. The 'People in Aid' code was subsequently developed, focusing on organisational issues such as human resources in plans and budgets, risk management, and communication with staff (Birch & Miller 2005). There is also a need for team leaders to have an awareness of the issues associated with conflict. This may be individual or group, local or national (Anderson 2005).

1.3.9 Global Coordination of Needs, Responding Agencies and Donors

Coordination of disaster assistance is a major priority for effective humanitarian aid operations (Bradt & Drummond 2003b; Moore & Blasser 1991). Disasters require a multi-organisational approach, with coordination and cooperation the key to success (Burkle et al. 2001; Kipor & Goncharov 1999; Libman et al. 1997; Nnoaham 2005). The capacity to deploy international, 'neutral' experts through external assistance remains critical (Loretti, Leus & Van Holsteijn 2001).

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

A sobering lesson from the Asian tsunami is the demand for a multidisciplinary national infrastructure to support patients within, or project care outside, our borders (Dries & Perry 2005). This was a problem after the Bali bombings, especially the coordination of assistance and the flow of information (Health Emergency Management New Zealand

2002). Again, after the Asian tsunami, coordination and logistic support were major challenges, worsening as more agencies arrived (VanRooyen & Leaning 2005). The WHO Interagency Rapid Health Assessment Team (34 people from local Indonesian governments, US Military, CDC, UN, WHO, NGOs) stated that better coordination is needed among all agencies dispensing aid (Kennedy & Roush, 2005).

A centralised authority to coordinate international assistance appears to be essential (Hickson et al. 2001), with more, and better, linkages between civil society, military, government institutions and NGOs (Cruz Vega et al. 2001; Kipor & Goncharov 1997). Global coordination of the disaster response remains a problem, however, despite numerous calls for improved global coordination and attempts by international agencies to develop this. A World Disaster Coordinating Centre was proposed as far back as 1983 (Cuny 1983), while Bremer (2003) repeated the call after the Gujarat earthquake.

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

While clearly defined roles and responsibilities enable effective collaboration, there is a need for greater standardisation of language, including terms and definitions, and use of colour coding and symbols for personnel and materials (Noji et al. 2001). Effective exchange of information and international decision making in disaster management requires a high degree of inter-operability between a large number of organisations through common infrastructures (Anderson et al. 2001).

1.3.9.1 Models

A retired director of Oxfam believes there needs to be a UN Unit for Emergency Operations, headed by a Deputy Secretary General, to coordinate relief efforts, with a rapid reaction force of experts and specially appointed field coordinators to ensure effective coordination in the field between UN agencies, NGOs, donors and host governments, and a clear division of labour, to prevent duplication and rivalry (Judd, 1992).

The UN first institutionalised responsibility for coordination in 1971 in the Office of the UN Disaster Relief Coordinator who headed the UN Disaster Relief Organization (UNDRO). Hobbled by funding, staffing and consensus issues, this was never able to live up to expectations (Bradt and Drummond, 2003; McEntire, 1998). The UN Department of Humanitarian Affairs (DHA) was created in 1991 to supersede UNDRO. The WHO is also exploring the feasibility of memoranda of understanding with major donors by which human and material resources would be available ‘at 24 hours notice’ (Loretti, Leus & Van Holsteijn 2001).

The 'SPHERE' project encourages intergovernmental organisations to provide an overall coordinating framework for international and local disaster relief. However, present practice is variable and recognised minimum standards for such coordination do not exist. Bradt and Drummond (2003) and Libman et al. (1997) suggest that the establishment of a global information network that is in place before a disaster occurs, which could link all the relief communication efforts. A Global Health Unit for Disaster and Relief Coordination could be set up as part of the Global Health Network, utilising the Internet as its backbone.

A number of authors have advocated the use of a World Wide Web site for disaster management and humanitarian assistance, with the ability to act as a database of accredited experts with contact details, searchable database of disaster related materials, and on-line simulation and training (Arnold et al. 2004; Piper, Burkle & Murray 1997). Mathew (2005) has proposed a 'Health and Disaster Information Network' in the South Asian/India region; a network of experts and organisations able to provide and share information and support during all phases of disaster management, and assist in providing rescue and medical resources during the very early phases of a disaster.

Bradt and Drummond (2003) propose a coordination tool kit comprising:

- binding principles of engagement which acknowledge humanitarian values, group commitment to international best practice, and ascendancy of the host country
- protocols for assumption of responsibilities
- standardised essential minimum data sets
- health sector component summaries.

1.3.9.2 Examples

SUMA (Supply Management Software)

SUMA has been used for tracking and registering all incoming humanitarian health supplies received in disasters. It is also able to describe gaps between drugs required and actually donated. It was used in the Bangladesh floods, where effective coordination helped prevent the entry of many unnecessary donations (Rahman, Aldis & Huda 2000). The basic components of the SUMA Global Project are considered part of a universal management system for humanitarian support during disasters (Kipor 2005; Leus, Wallace & Loretti 2001). This may also be applicable to DMATs.

INSARAG (International Search and Rescue Advisory Group)

According to Beech (1991), the need for rapidly deployable search and rescue teams will only increase, and that there needs to be international agreement on the principles governing a rapid international response. The INSARAG has formed a network consisting of a Steering Group and 3 regional groups for Africa/Europe, the Americas and Asia /Pacific. In the event of a major earthquake, the officially recognised search and rescue (SAR) teams are immediately alerted by DHA in Geneva. Once deployed, their work at the disaster site is coordinated by the UNDAC team in conjunction with local authorities from an On Site Operations Coordination Centre (DHA 1994a).

The 'Directory of International Search and Rescue Teams' is a register of 23 officially recognised SAR teams and the response capabilities of 215 countries, as well as a

list of donor countries and assets of various American states which may be deployed for international relief operations (DHA 1994b). The INSARAG has also developed standards including composition of teams, self-sufficiency, familiarity with the concept of international on site coordination, an understanding of the principles of a needs driven response, the use of standardised marking systems, and the levels of equipment carried (Holland & Wilson-North, 2005).

1.4 Factors Guiding DMAT Reviews

1.4.1 Economic Costs

Little has been done to study the cost-effectiveness of various disaster relief activities (VanRooyen et al. 2001b). The sending of specialist medical teams to foreign countries must be well targeted, efficient and effective aid, and have adequate funding to improve preparedness and to speed dispatch (Redmond, Watson & Nightingale 1991). Often, a great concern in domestic response is the official declaration of disaster as this dictates who pays; in USA, hospitals are guaranteed federal reimbursement for National Disaster Medical System (NDMS) patient care (Stopford 2005).

1.4.2 Standards and Laws

The effectiveness of emergency interventions may be difficult to measure (VanRooyen & Leaning 2005). This is exacerbated by the lack of available standards, benchmarks and indices which makes assessment and the ability to learn from experience more difficult. For example, the 100,000 avoidable deaths in the Rwanda crisis were attributed to poor performance on the part of relief agencies (Hickson et al. 2001; Relief and Rehabilitation Network 1996).

Methodologies for quality management have been slowly developed (Sondorp, Kaiser & Zwi 2001), but there is still a need for agencies and governments to agree to benchmarks, standards and codes of practice for health disaster preparedness and response, and also to guide recovery. There needs to be honest and transparent accountability, responsibility and evaluation against agreed standards of performance (Nabarro 2005).

An evidence-based grading system incorporating indicators to measure the effectiveness of a humanitarian response is required. Different methodologies may be needed to assess indicators in countries without access to data (Bradt & Drummond 2003; Burkle 2001a).

The military has found that ‘measures of effectiveness’ (MOE) have proven to be an effective way to define goals in the accomplishment of mission objectives (Sharp et al. 2001). If MOE are to be developed to predict the value or measure of a system or organisation, they need to:

- be operationally credible
- have predictive values
- be sensitive to factors influencing outcome
- be measurable
- support decision making

- be able to complement the operating system
- be easily understood
- be universally accepted
- improve, not worsen, efficiency, communication and coordination.

MOE also need to be measured more than once to be meaningful and show progress, or lack of it, toward mission accomplishment (Burkle et al. 1995).

The 1994 wide-scale mismanagement of cholera by inexperienced relief workers in Zaire led to a recognition of the need to improve professional standards and the effectiveness of the response (Salama, Buzard & Speigel 2001). The SPHERE Project has been one of the first systematic efforts to improve accountability. Reluctance in accepting these standards has arisen due to concerns about levels of flexibility and the potential use of minimum standards as a punitive tool, despite these being a collective expert opinion recognising context and constraints (Dufour et al. 2004; Salama, Buzard & Speigel 2001). The debate should shift from potential threats to NGOs, to the rights of people affected by disasters, and 'ultimately, all humanitarian organizations should be held accountable when they do not meet minimum standards when there is a reasonable expectation of doing so' (Salama, Buzard & Speigel 2001).

SPHERE addresses key indicators for 5 sectors; water supply and sanitation, nutrition, food aid, shelter and site management, and health services (Sondorp, Kaiser & Zwi 2001). It also has clearly defined guidelines and minimum standards (Brennan et al. 2001). The SPHERE standards are also used by both NGOs and the military in humanitarian aid, so may be seen as a common link between the two (Dufour et al. 2004).

Other standards developed include 'People in Aid' aimed at organisational practice (Birch 2005), the 'Quality Compass' (Maury & Russbach 2004), the 'Ombudsman' project (VanRooyen et al. 2001b) and the 'Active Learning Network for Accountability and Performance' (Campbell 2005; Leus 2000).

In contrast, the international law of humanitarian response in peacetime is remarkably undeveloped (Hoffman, 2003). Hoffman (2003) also notes that the establishment of international rules and standards does not mean people will comply. Compliance and adherence to standards also requires funding; quality control through supervision is indispensable but expensive (Sondorp, Kaiser & Zwi 2001).

There is also a lack of standards available to train personnel or to judge competence, and no way to assess the abilities and competencies of the organisations and people who volunteer to help an affected population (Birnbaum 2005).

1.5 Incident and Team Reports, and Lessons Learned

There are many anecdotal reports of experiences in disaster relief, with few providing any standardised review of effectiveness or in-depth analyses of lessons learned (Lewis-Rakestraw 1991; Tryon 1997).

Robertson, Dwyer and Leclerq (2005) led one of the first international, civilian-based, DMATs to the Maldives after the Asian tsunami. Several lessons were learnt from the experience. As one of the few Australian reports of the actions of a DMAT, they are reproduced in entirety below.

- Health intelligence
  - Accurate health information needs to be provided to the teams before deployment.
- Team selection
- Military, developing country and/or rural and remote medical experience and disaster medicine training is useful
  - Team member flexibility is critical, especially being able to improvise and adapt to constantly changing circumstances.
  - Interpreters, or team members who speak the local language, are highly desirable.
- Equipment
  - National modular checklists of both self-sufficiency and medical stores need to be further developed, incorporating sections on primary care, paediatrics, chronic care and public health (including vaccines).
  - There is a need for team-identifying clothing, principally vests and headgear.
- Communication
  - A clear command and control structure is essential.
  - Satellite phones with international coverage, and international roaming mobile phones are critical.
- Logistics
  - Funding, insurance and indemnity issues should be resolved before deployment, including cash advances (US dollars were widely accepted) and credit cards.
  - Guidelines on what will be funded on deployment (e.g. mobile phone use, purchase of clothing) are necessary.
- Transport
  - Agreements with commercial airline companies to rapidly deploy team members should be explored further.

There were unfortunate examples of well intentioned, but misguided attempts by some international medical teams to take over the local health system or provide services, such as trauma surgery, that were not needed, placing extra strain on Ministry of Health staff (Robertson, Dwyer & Leclerq 2005).

Many other DMATs have also described the lessons learnt from their experiences. A selection of treatment outcomes and identified problems are outlined below.

1.5.1.1 Australian Defence Force (ADF)

The ADF sent a 58-member team of medical and other personnel to Papua New Guinea after the Aitape tsunami. The initial team consisted of 25 health personnel (6 doctors, 6 nurses, 2 operating theatre technicians, 10 medical assistants, and a preventive medicine officer) supported by logistics, movements and communications staff. They were later reinforced by other surgical teams from the ADF, and the New Zealand and US Military. They arrived on day 3, and treated 251 patients in the health facility, performed 209 surgical procedures, and saw hundreds of other patients in the healthcare clinics. Public health teams, engineers and aircrew reviewed water and sanitation needs (Taylor, Emonson & Schlimmer 1998).

1.5.1.2 Israel

The Israelis have described a number of lessons from their experiences. They use Israeli Defence Force staff and reservists, modifiable field hospitals and transport aircraft. They also use 'forward teams' to assess needs and tailor teams accordingly.

Mombassa: The forward team was able to send a detailed account of the number and type of casualties to the transport team, as well as organise the transport of patients to the hospital. One intensivist was used for every 2 multiple trauma or ventilated patients, and 1 trauma surgeon for every 6 mild-moderate injured patients. Repatriation teams use an equal number of nurses and paramedics. All team members need to be trained in aero-medical evacuation (Marmor et al. 2005).

Kosovo: The Israeli Defence Forces provided specialised care using a field hospital. They sent 76 personnel including 15 physicians, 7 nurses, 2 paramedics, a pharmacist, X-ray and pathology technicians, a medical engineer, and a skilled logistic team including a carpenter, plumber, mechanic and electricians. Most of the 1,560 patients, a quarter of whom were children, were seen for medical purposes. They realised the importance of assessing the situation prior to deployment, and equipping and fitting teams to the expected needs, as well as the requirement for a high degree of logistic independence and cooperation with local authorities (Amital et al. 2003).

Turkey: The mission to Duzce began treating patients 63 hours after the earthquake. They were deployed as a substitute for local health services as hospitals had been abandoned after the earthquake, rather than to treat patients injured from the earthquake. They saw 2,230 patients, with 90% suffering non-traumatic illnesses. Of these, 37% were paediatric and 32% general medical. Only 39 patients needed an operation. They assembled their team to include the most appropriate personnel, including logistics and communication staff (Bar-Dayan et al. 2005).

1.5.1.3 IMSuRT

The experiences of the International Medical Surgical Response Team (IMSuRT) from Boston are worth examining. This is a highly specialised team, capable of establishing a free-standing, field surgical facility anywhere in the world. It deploys with medical supplies, pharmaceuticals, surgical equipment and a Deployable Rapid Assembly Shelter/Surgical Hospital (DRASH), a self-contained field hospital complete with triage, operating theatres and an intensive care unit (Forgione et al. 2003; Gaudette et al. 2002; Owens, Forgione & Briggs 2005; Schnitzer & Briggs 2004).

In responding to the World Trade Centre bombing in New York, it quickly became apparent that they were not going to be treating survivors, so IMSuRT assumed the mantle of looking after rescue workers instead. Approximately 500 rescue-related injuries were treated each day; 90% of the patients treated represented relatively minor injuries such as sprains, minor puncture wounds, abrasions and eye injuries. Those needing more acute treatment included a myocardial infarction, chest pain, a variety of respiratory illnesses, some crush injuries and a burns patient (Gaudette et al. 2002). All patients with acute illness were initially assessed, then transferred to hospital for ongoing investigation and management (Forgione et al. 2003).

The team consisted of surgeons, anaesthetists and perioperative nurses. As no significant surgery was performed, the nurses took on the role of bedside clinicians instead (Forgione et al. 2003).

The lessons learned were:

- standard instrument kits were too heavy for one person to carry, especially in an austere environment
- a modular instrument kit needed to be developed for specialties and to reduce weight
- an ability to perform cauterisation and sterilisation without electricity was necessary
- a need to determine essential surgical supplies
- a need for patient documentation (Forgione et al. 2003).

They had initially deployed with no suction or cauterisation facilities, and subsequently used generator power for 2 small units. Sterilisation was achieved by a 2% glutaraldehyde solution soak for 20 minutes. Specialty instrument sets were developed for orthopaedics, thoracic and vascular surgery. Smaller kits were developed for cut downs, laceration and chest tube insertion. They also estimated that 15 to 20 major surgical procedures could be performed satisfactorily (Forgione et al. 2003).

The IMSuRT responded to the Bam earthquake with 57 staff including 2 paediatric surgeons, 1 orthopaedic surgeon, 1 cardiac surgeon, 1 general surgeon, 1 trauma surgeon,1 gynaecologist, 1 anaesthetist, 1 perioperative nurse, and 1 licensed nurse in theatre. The theatre was set up to accommodate 2 cases at once. They saw 727 patients and completed 6 surgical procedures, with non-surgical patients including medical problems, anxiety, and paediatric and obstetric complaints (Owens, Forgione & Briggs 2005; Schnitzer & Briggs, 2004).

The team encountered a number of problems:

- They had not anticipated the need to clean the floor between cases so had limited cleaning supplies.
- Sterile gowns were too bulky so aprons were worn over street clothes and boots covered with disposable covers.
- The instrument cleaning area was located outside of the tent and a sand storm on the second night coated the instruments with sand, which were then unable to be cleaned properly.
- Irrigating open fractures was difficult without standard equipment and drains.
- The team had not taken any instruments for caesarean sections, although it was the most common operation performed, as they replaced these for instruments that they thought would use more frequently.
- They had no neonatal incubators for neonates, with night time temperatures of 6 °C.

They still concluded that it was a successful model to use in the immediate post-earthquake environment (Owens, Forgione & Briggs 2005).

1.5.1.4 Taiwan

After the Chi Chi earthquake, relatively few teams saw many critically injured patients; fewer than 16% of EMATs encountered more than 10 triage category 1 patients, and fewer than 28% of teams treated more than 10 triage category 2 patients. Low level acuity dominated with over 48% of teams treating more than 50 triage category 3 patients, and 10% more than 250 level 3 patients. Over 54% of teams attended more than 50 level 4 patients, and 4% of teams treated 500 to 1,000 level 4 patients, involving minor lacerations, contusions and non-trauma complaints such as viral illnesses. This is in contrast with what was anticipated, and evident on review of equipment brought versus equipment used (Hsu et al. 2002).

1.5.1.5 Japan Disaster Relief Team

The Japanese Disaster Relief team in Nicaragua, following hurricane Mitch, arrived 17 days after the event and stayed for 9 days. The team consisted of 3 doctors, 6 nurses, and 3 medical and 3 administrative coordinators. Of the 1,120 patients seen, 63% were female and 55% under 14 years of age. Infectious diseases were the main problems encountered, with very little trauma (Kondo et al. 1999).

After the Asian tsunami, 95 health personnel were sent to 4 countries (Maldives, Indonesia, Sri Lanka and Thailand). Over 6,000 patients were seen, with approximately half having upper respiratory tract infection or minor trauma. The trauma case load was less than experienced in the Papua New Guinea tsunami (Koido 2005).

1.5.1.6 DMAT Hawaii

The experiences of 3 DMAT clinics in Hawaii after hurricane Iniki demonstrate the need for basic medical services and primary health care. They arrived on day 5 post-event and stayed for 4 days. They saw 614 people of whom 60% were male. The largest treatment categories were injury (40%), illness (39%) and preventive services (9%). Most of these were minor, with 99% of patients being ambulatory (Henderson et al. 1994).

1.5.1.6 EMEDS Houston

An Expeditionary Medical Support unit (EMEDS) was sent to Houston, Texas as part of the response to tropical storm Alison. An EMEDS is designed to treat injuries associated with deploying 3,000 to 5,000 troops in a low threat environment (D'Amore & Hardin 2005).

They treated 1,036 patients with a casemix which was mainly medical (507) and trauma (232), but included animal and insect bites, sexually transmitted infections, acute respiratory tract infections, viraemia, fungal infections and occupational illness.

Sixty patients were transferred, with 48 admitted to a ward and 33 to ICU. Over 1,000 X-rays were taken in 326 patients, and about 2,000 laboratory tests, 33 dental procedures and 16 operations were performed, mainly soft tissue infections and orthopaedics.

A number of problems emerged, inherent to a different style of medicine than the team were equipped and trained for; the disaster victims were older or younger, and sicker, and they needed more beds, expanding to 10, and later to 12, rather than the

normal 2 bays. A government supply purchase card was used, which worked well for local purchases, but much of the standard 10-day supply was not useful in the civilian setting. They also found communication difficult, and command and control across 2 accommodation sites and the treatment area cumbersome. Media management took a lot of time, while reporting and tracking took half of one administration officer's time.

A summary of the problems is shown below:

- The equipment arrived packed in no apparent order rather than according to functional area.
- There was a need for operating support; in this case, food, housing, a 10,000-pound forklift and hospitals to receive patients.
- The civilian truck transport was tardy, and military personnel were upset at seeing trucks at rest stops while they waited.
- The laboratory function was delayed for 6 days awaiting perishable supplies.
- The pharmacy did not have medications to treat chronic diseases.
- The local area network was cumbersome, time consuming and provided no value.
- A public affairs officer was needed immediately; attending to the needs of the press took up the Commanding Officer's valuable time.
- A more robust radiology package was needed, and possibly a CT scanner.

A summary of the lessons learned is shown below:

- Early contact with an on-scene civilian and federal consortium is vital to determine the role of EMEDS.
- Flexibility in configuration is essential.
- Early determination and monitoring of an exit strategy is important.
- A plan for long-term follow up of complex medical and surgical cases must be determined and arranged by supporting agency early on.
- Suitable billeting and reliable provision of meals is essential.
- The operations tempo in support of civilian disaster relief is much higher than that in a military deployment setting.
- Local evacuation of patients after stabilisation may not be available through civilian facilities; evacuation routes must be well established early on.
- Two weeks at the highest sustained in-operations tempo (12-hour shifts and 7-day weeks) is the maximum tolerance for deployed troops. A working rotation policy should begin at deployment.
- Supplies are consumed at a higher rate than in a military support operation.
- Use of combat supply packages may result in the transport of unneeded supplies, while these also may not have pharmacy and other required resources.
- Placing an EMEDS on the grounds of a local hospital may allow integration.
- A portable CT should also be deployed.
- A doctrinal combat configuration of 2 beds may be inadequate, and needs to populate 25 inpatient beds. (D'Amore & Hardin 2005).

Some of this information is summarised in Tables 3 and 4.

Table 3 : Roles and activity of DMATs in various disasters

TEAM (MODEL)	INCIDENT	TIME PERIOD	ROLE	PATIENTS	PROBLEMS
Israel (Miitary) Amital et al. 2003	Kosovo	Operational 20 hrs after arrival	Field hospital	1560 pts 446 <15 mainly medical 76 patients admitted for 161 bed days 12 deliveries	Limited questioning of patients (refugees) Exit strategy
Israel (Military) Marmor et al. 2005	Mombassa	Departure 12 hrs post incident. Return 30.5 hours post incident	Repatriation and retrieval of injured nationals	13 pts 1 ventilated 7 moderate injury needing IV fluids 5 minor injuries with supervision only	Training in aeromedical work needed as untrained staff misused equipment. Forward team able to do needs assessment and organise early treatment and transport to airport but lacked equipment
Israel (Military) (Bar-Dayan et al. 2005b)	Turkey	Operational day 3	Provide primary and secondary medical care, inc ICU and surgery	2230 pts 37% paeds 90% non trauma 84 admitted 39 operation	Lack of other medical services as hospitals abandoned
Japanese Disaster Relief Team (Koido 2005)	Tsunami Indonesia, Maldives, Sri Lanka, Thailand)	Arrive day 5 Operational 23 days	Primary care services	6,288 pts 22% paeds 23% URTI 22 % minor trauma	Disease patterns differed from tsunami in PNG where trauma was more common
Australian ECHO Team (Civil) (Grantham 2005)	Tsunami Banda Aceh		Plastic surgery Infectious Diseases	130 reconst operation 50 medical cases	Logistics Communication Team welfare/ dynamics
Australia ALPHA/BRAVO Teams (Civil) (Cooper 2005)	Tsunami Banda Aceh	Request Day 3 Operational 17 hours after request	Medical and Surgical Care	300 pt/day 70 inpts/day 90 surgical operation	Self-sustainment Lack of water. Only intermittent power. No laboratory support Difficult to sterilise
Australia ADF Team (Military) (Taylor, Emonson & Schlimmer 1998)	Aitape Tsunami	Request 12 hrs after wave. Arrived 52 hrs after wave Operational for 10 days	Surgical care Primary health care Public Health	251 pts 209 operations Hundreds other primary care	Planning with unknown details. Different casemix to normal role Complete local destruction
USA IMSuRT (Civil) (Schnitzer, & Briggs 2004) (Owens, Forgione & Briggs 2005)	Bam earthquake	Request 18 hrs Deploy 18 hrs Operational for 4 days	Field Hospital	727 pts, 6 operation, 2 LSCS, 1 appendix, 1 shooting, 1 I&D hand abscess, 1 amputation toe 1 degloving injury foot	Lack of running water Lack of sewage. Near freezing temps. Loss infrastructure. Electricity demand exceed generator supply

Ukraine (Roshchin et al. 2000)	Gujarat earthquake	Arrived day 6 Operational 30 days	Field hospital	5558 pts 1,053 children 216 operation 13 deliveries	Heat Lack food, water, supplies, transport. Non compliance pts. Cultural and gender issues. Change of caseload from trauma (often delayed and infected) to mainly medical
USA EMEDS (Military) (D'Amore & Hardin 2005)	Tropical Storm Allison	Operational 11 days	Field Hospital augment local services	1036 pts mainly medical (507). Transfer 60, admit 48 ward, 33 ICU 16 operation	Equipment packing. Lack of food, housing, forklift and hospitals. Transport difficult. Laboratory function. Inadequate medications Local area network not useful Media management. Radiology access.

Table 4: Summary of lessons learned from deployment

LESSON	AUSTRALIA Tsunami (Robertson, Dwyer & Leclerq 2005)	ISRAEL Kosovo (Amital et al. 2003)	AUSTRALIA Tsunami (Grantham 2005)	UKRAINE Gujarat (Roshchin et al. 2000)	USA EMEDS (D'Amore & Hardin 2005)
INTELLIGENCE	Info predeployment	Info predeployment - local resources - previously deployed teams - forward team (last resort)		Lack of local staff prior to arrival	Early contact with on scene coordination vital to determine the role of EMEDS.
TEAM SELECTION	Experience Flexibility Interpreters				Flexibility in configuration is essential.
EQUIPMENT	Modular checklists Team ID clothing	Equipped for expected requirements		Shortage of equipment and supplies Inadequate analgesia	Supplies used at higher rate than military operation. Combat supply package has inappropriate and inadequate materials. Portable CT should also be deployed. 2 bed combat configuration inadequate Improved packing
COMMUNICATIONS	Command/ control Satellite phones		International teams and local communication		Difficult use of local area network

LOGISTICS	Funding Insurance Indemnity	Independence - energy - food/water - medical supplies	Scale of response	Food and water needs could not be met Local medical infrastructure destroyed by quake	Accommodation and food needs
TRANSPORT	Agreements with commercial airlines			Unable to transport victims	Evacuation routes must be well established early on. Difficulties using local transport
SECURITY		Essential and often means military involvement			
COMMAND AND CONTROL		Cooperation with local authorities essential Coordination multiple teams essential	Leadership to maintain team harmony Collaboration between locals & international aid providers	Coordination multiple teams and local authorities	Exit strategy is important Operations tempo in disaster relief is much higher than a military deployment
DATA AND PROCEDURE		Use medical records Collect data			
LOCAL		Limited questioning about missing relatives.	Accepting cultural differences	Need info about social, medical and sanitary conditions to function	Placing an EMEDS on the grounds of a local hospital for integration. Plan for long term local follow up of complex cases
PATIENT CASEMIX		Mainly medical, paediatric, obstetric.		Trauma replaced by ID/ medical illness within 14 days	Mainly medical
RISK				Heath risk increased by lack sanitation, water	Two weeks at high tempo is max tolerance for staff. A rotation policy should begin at deployment.

1.6 External Reviews of DMATs

The immediate reporting of a crisis often provokes cries of 'something must be done' (Redmond 2005b). After the Asian tsunami, Frist (2005), the majority leader of the US Senate, noted that 'individual contributions of medical assistance can rank among the world's most precious and meaningful currencies'.

Unfortunately, if that something is not what is needed, its uninvited dispatch may do more harm than good. There is no longer a role for 'good intentions' and the overriding message is that the 'well intentioned amateur' needs to be replaced by a more 'professional' approach to disaster medical assistance. Instead, a highly technical approach based on strict prioritisation of tasks is necessary (Gunn 2005; Lamberg 2005; Leus 2000; Schull & Schanks 2001).

There are numerous reasons for this, apart from a humanitarian desire to provide the best possible care, which include donor and political interests, and the accountability of providers. Griekspoor & Sondorp (2001) describe a tenfold increase in the amount given by donor governments from 1980 to 1994 (US$3.5 billion), partly as a response to humanitarian need, and partly as a realisation that aid could be used as a political tool. This increased financial and political interest is another reason to pay more attention to quality, impact and accountability. Donors demand value for money and evidence based interventions, although many of these efforts have been ineffective (Griekspoor & Sondorp 2001; VanRooyen et al. 2001a).

Disaster stricken countries appreciate external assistance when directed to real problems. Unfortunately, too much assistance is misdirected. The myth that 'any kind of assistance is needed, and that it is needed immediately' is contrary to the WHO experience, in which 'a hasty response that is not based on familiarity with local conditions and meant to complement national efforts only contributes to the chaos…It is better to wait until genuine needs have been assessed and to accept that international intervention can raise artificial expectations at an extraordinary cost to the local provision' (de Ville de Goyet 2000).

This is not a new problem. In 1972, Western wrote that:

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

Cuny (1983) wrote that the primary responsibility for disaster response remains with the host government, that international aid has limited effects and that intervention is not totally positive, while Birnbaum (2005) asked, 'why do we not learn from our experiences'?

Excessive and unwanted personnel may arrive at a disaster site too late, be unable to contribute to the efforts or to speak the language, require maintenance by the already stressed and affected population, and tend to operate outside of 'Command and Control', rapidly exacerbating the problem rather than alleviating it (Birnbaum 2005; Burkle et al. 1995; Campbell 2005; PAHO/WHO, 1999; Rubin et al. 2000; Tyron 1997). This was seen in India when relief teams of foreign doctors arrived in Gujarat in hordes on the 6th day after the earthquake. Most were in a hurry to lend their surgical expertise, but could not stay long. Without knowledge of the local culture and language, they consumed spare resources and manpower, reducing the ability to provide postoperative care and rehabilitation (Bremer 2003; Roy et al. 2002).

Reasons why this pattern persists may be related to the demands of public opinion and the perceptions of both the public and the relief workers from donor countries. A common myth in disaster management is that the 'affected local population is helplessly waiting for the western world to save it', often perpetuated by press coverage (de Ville

de Goyet 2000). The WHO's de Ville de Goyet (2000) notes that most survivors are saved by their neighbours or local authorities, and that western medical teams are not necessarily the best equipped to deal with local conditions. He also raises concerns that foreign assistance is sponsored by donor countries responding to the pressure and expectations of public opinion rather than to the real needs of the affected country, and questions who is really benefiting; less developed countries have come to realise that funding for highly visible teams comes from the same budget as other, more valuable and productive forms of assistance.

Rubin & Heuvelmans (2000) reviewed the perceived effectiveness of health related disaster relief in the former Yugoslavia, finding significant differences between those providing and receiving international assistance. International organisations and workers appeared to believe their efforts were more effective than the recipients did. All groups believed that approximately half the needs were being met, but international organisations believed that a higher proportion were being met by their assistance (73.4%) than did the locals (52.1%, $p<0.001$). Interestingly, 87% of the international interviewees believed the affected population was requesting more than it actually needed. Two thirds of the international participants, compared to 20% of the recipients and local authorities, believed that 25% of the demands for assistance could not be justified. Twenty-seven per cent of the international participants compared to 80% of the recipients felt that a quarter of what was provided was unusable (Rubin & Heuvelmans 2000).

Some of this may be acknowledged subconsciously although there is no evidence to support this; after the Chi Chi earthquake, Hsu et al. (2002) found that the level of morale declined in the 104 responding EMATs, although it was unclear why.

External relief requires time for mobilisation and is likely to arrive after the second day. Therefore training and equipment should not target a profile dominated by trauma as teams will arrive after the period dominated by traumatic injury. Disaster assistance teams should focus on traumatic injuries during the immediate post-impact period, and then on primary care illnesses (Kazzi et al. 2000). For example, Gillet (2005) notes that the Asian tsunami worsened the already poor sanitary conditions; rundown health facilities, poorly trained health care personnel, tropical disease and poor hygiene.

Teams that present with unrealistic expectations or missions may either cause interference, feel disappointed or both. As an example the CDC (2005) has developed a 'mass casualties predictor' which state that 'within 90 minutes 50 to 80% of the acute casualties will likely arrive at the closest medical facilities'. These guidelines are used in major US hospitals, but there still seems to be a belief by some that sending trauma surgeons on day 6 or 7 will be useful without a needs assessment or discussion and negotiation with local staff. This may indicate either a belief that there are no facilities in the affected country or that transport mechanisms to hospital are very slow.

1.6.1 External reviews

1.6.1.1 Moore & Blasser (1991).

- Rather than a rigid, hierarchical structure, a DMAT should be flexible to fit the situation as required. It is important to include 4 groups:
  - treatment group composed of doctors and other health professionals
  - environmental health group made up of sanitarians, engineers and vets
  - mental health group including psychiatrists, psychologists and social workers
  - professional support group including scientists, medical records specialists, administrators, IT specialists, and medical laboratory staff.
- The function, role and use of technicians and non-professional support staff is less clearly defined than in the basic model.
- DMATs serve 2 different functions. They act as a local resource to the institution sponsoring them, and can also be activated as a federal reserve.
- DMATs can effectively supply and manage very little in terms of supplies and equipment; some may be accumulated for use in local emergencies but would be hard to transport when deployed outside their locality.
- Teams may not arrive on scene until after 12 or more hours, so may not be needed to manage trauma but instead to support local health service recovering from the disaster. In these instances, primary care providers, environmental health and mental health staff may be more important than acute trauma personnel.
- The multiple functions of professional in a team changes over time. It is preferable that administrative staff be health professionals who can serve 2 or more roles in a deployment.
- The fact that DMATs can be more than just trauma teams needs promoting.
- The concept of partial or specialised mobilisation also needs consideration where groups of skilled professionals from various teams may come together to meet unique needs.

1.6.1.2 Campbell (2005)

- Clearly differentiate between the immediate life saving needs of search and rescue and emergency medical care, and the type of health assistance required for longer term rehabilitation.
- Determine whether the outside medical team can become operational in the first 24 hours, in time to save lives. Lack of medical attention is often caused by logistical problems such as access to site, transport and weather rather than a lack of volunteers.
- When a lack of human resources is the problems, target requests for assistance to neighbouring countries or other states in the same region.
- Offer or accept only teams that meet the following criteria:
  - are sponsored by a well known agency
  - are familiar with the language and culture
  - have technology appropriate to the situation
  - are self-supported and able to work without sophisticated support
  - are willing and able to remain for a reasonable period of time.

- Do not rush to request, accept or send aid in sudden impact natural disasters. This often arrives too late to address the immediate life threatening medical consequences.
- Target requests to suitable neighbouring countries rather than blanket global appeals.
- Do not let media coverage and eagerness of external groups dictate policy.
- Do not send indiscriminate help as it often hampers rather than helps the situation.

1.6.1.3 Aghababian (2000)

- Team leaders must be concerned with:
  - team composition
  - transportation
  - communication
  - re-supply
  - safety of team members.
- Team members must be prepared to:
  - be self-sufficient
  - respect the cultural sensitivities and ethnic convictions of victims.
- The extent of victim field stabilisation and available triage options should be constantly re-evaluated by team leaders and communicated to field personnel.
- Disasters such as earthquakes, severe hurricanes, trans-border conflict and certain acts of terrorism are likely to result in requests for international medical assistance.
- Delayed complications of disasters, such as epidemics of communicable diseases, substance abuse and psychiatric illness may affect the victims and rescuers alike.
- Those who are responsible for public policy relating to disasters should remember:
  - How well a society survives a disaster is directly related to the skills possessed by its leaders and the advanced preparations they have made.
  - International disaster assistance reflects a sophisticated level of human compassion and intra-cultural respect.

1.6.1.4 Kizer (2000)

- Planning pays, and plans should be simple and flexible, focus on the basic interventions required, and be as close as possible to the respondents' usual daily duties.
- A bad situation can be made worse by inappropriate responses.
- Most life-saving interventions will occur before the disaster happens and immediately after by local action. Because of the inherent delays in state and federal responses (48 to 72 hours) external assistance is primarily post-disaster help in recovery and remediation.
- Public health emergency management is not a democratic process. It is essential that one person is in charge of the emergency response and everyone knows the chain of command. The incident leader must be able to make appropriate decisions quickly, and often on the basis of incomplete or uncertain data. This

autocratic style of leadership is more customary in law enforcement, military and fire fighting, and is different to the more group focussed approach used in health. Therefore leadership and management roles among the potentially responding entities need to be clearly established and understood in advance.

- Psychological factors are usually greater than anticipated.
- Communications and information management are vital, but are often the weakest link in the response chain.
- Collaboration and partnerships are essential. These may take the form of predetermined, mutual aid agreements which may hasten the arrival of aid.
- Unsolicited volunteers and aid are inevitable and must be planned for and managed. Disaster relief personnel should respond only when invited, and should plan on being self-sufficient for at least the first few days, otherwise they also need to be housed, fed and watered, adding to the local burden. Unsolicited relief materials are often unusable (out of date, unnecessary etc) and either consume staff and resources to catalogue and store, or are simply wasted or burnt (see also Lennquist 2004).
- Never assume anything, and always expect the unexpected.
- Post event evaluation is important and must be coordinated.

1.6.1.5 Lennquist

Lennquist (2004), the first academic Professor of Disaster Medicine, noted some differences with the Asian tsunami that need the relearning of old lessons in disaster management:

- Local Response: 'the quality of the immediate local response that is one of the most important factors determining the outcome with regard to preservation of life and health'.
- Preparedness verses Response: Developed countries should support countries with fewer resources to improve local preparedness and competence. 'It may even be more important than dramatic relief actions' although these appear 'more glamorous and rewarding for "goodwill"'.
- Coordination of Response: There is a 'need for coordination between both supporting countries, and between supporting and supported' with 'increased international coordination and collaboration…done already at the planning and preparatory stages'.
- Patterns of Injuries and Needs Assessment: Response needs to be based not only on a full understanding of the type of disaster and expected injury patterns, but local information specific to the disaster.
- Global Tourism: Increased world travel has increased the likelihood that foreign nationals will be involved in disasters and their governments need to anticipate this.

He also describes the following lessons concerning the development of models of disaster medical assistance:

- It is the responsibility of a country with many citizens in a potential disaster area to have a preparedness to deal with such situations, both for the benefit of their own citizens and to support the affected country.

- Such preparedness cannot be based on individuals without an obligation to be available, but should, exactly as in a hospital disaster plan, be based on an 'on call' system.
- The preparedness organisation must include representatives from key stakeholders with authorisation to make decisions, such as rescue services, medical care, military defence and police.

He advocates the formation of a 'National Crisis Group' along these lines, that also trains together.

1.6.1.5 Griekspoor & Sondorp

Griekspoor & Sondorp (2001) from the WHO describe a number of ways to improve the quality of care delivered in humanitarian assistance.

- Use systematic epidemiological approaches to guide interventions.
- Develop internal training programs and guidelines.
- Apply the 1994 voluntary Code of Conduct, with 10 underpinning principles which promote the impartial character of aid, respect of local cultures, building on local capacities, involvement of beneficiaries, and respect for local dignity.
- Apply logical framework planning methods with measurable indicators to quantify and qualify results. The Active Learning Network on Accountability and Performance maintains a database of evaluation reports and related publications, and initiates studies itself. The SPHERE handbook contains a humanitarian charter and minimum standards accompanied by indicators.

Despite these developments there is still:

- no mechanism in the humanitarian system to assure or improve quality during the response. A quality management model may provide solutions.
- no form of self-regulation
- no mechanism for addressing system or sector-wide performance
- no systematic joint planning based upon situation and multi-sectoral needs analysis, with coordination often limited to sharing of information
- no official accreditation system for humanitarian workers entrusted with considerable budgets and far reaching responsibilities
- no consideration of the role of the donors
- strong resistance by some NGOs toward the standardisation principles as promoted by SPHERE.

1.6.2 Criticisms

Many authors have been critical of disaster relief teams.

- Too often, untrained people, coming with a lot of good will but no professional skills, have disrupted relief operations by mobilising already overworked local people, and overloading logistic means for their own purposes, while not efficiently helping to meet the priority needs (Russbach 1990).
- Those responsible for disaster relief and rescue operations often repeat the mistakes of previous incidents and assume that the local staff are both sufficient in numbers and experience to cope with the event (Redmond, Watson & Nightingale 1991).

The effectiveness of teams must be assessed against the objectives:

- If preservation of life or number of survivors found is the yardstick, then foreign disaster assistance teams are an effective utilisation of manpower and resources.
- In general they arrive at the scene too late and can be an administrative hindrance for the host government attempting.
- They may be seen as a sign that the system has been unable to cope, and are critical of the efforts of the host government.
- If the effectiveness is measured as a humanitarian gesture, they are tremendously effective from a media/public relations viewpoint (Abrams, 1990).
- Cuny (1983) maintains that relief simply maintains the 'status quo', while others feel that the effects are largely palliative or can even make matters worse (McEntire 1998).
- Emergency work is often regarded as too short-term and cowboy-like, creating a dependence in potential beneficiaries, not sufficiently developmental, and lacking in accountability (Sondorp, Kaiser & Zwi 2001).
- Not all relief efforts are useful. According to Frisch (2005), the coordinator of the Swiss Government's aid response to the Asian tsunami, 'again, many well doers and uncoordinated, brainless 'helpers' arrived and were a burden for the country. This is not professional humanitarian aid'. This identifies the issue of 'disaster tourism' as described after the Gujarat earthquake (Roy et al. 2002).
- The coalition-led, unilateral approach to humanitarian intervention fell gravely short in meeting expectations (Burkle 2005).

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

However, aid is often effective, although much of the response to emergencies is poorly evaluated. (Sondorp, Kaiser & Zwi 2001). The most recent example of a major aid effort which has been evaluated was the Asian tsunami. The Tsunami Evaluation Coalition (Cosgrave 2005) found that most aid delivered was appropriate, with very few examples of inappropriate assistance. It is worth noting however the use of field hospitals is the subject of a separate report, so not yet evaluated.

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

1.7 Summary

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

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

2 PREFERRED DMAT FORMATS

2.1 History of DMATs and Overview of Models

One of the earliest documented efforts of international disaster relief occurred after an earthquake devastated Lisbon in 1755. England's King George II requested that Parliament quickly send sufficient and suitable relief to meet the victims of the emergency (McEntire 1998).

Modern disaster medical assistance teams date back to the efforts of Henry Dunant, who mobilised local assistance after witnessing the carnage from the 1859 Battle of Solferino which left 40,000 dead and severely wounded. Moved by this, he called for the formation of national relief societies to render assistance in emergencies, 10 years later founding the Red Cross (Dara 2005; Domres et al. 2003).

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

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

While the practice of basing disaster relief teams around major hospitals has been questioned since the 1997 Thredbo disaster (Robertson, Dwyer & Leclerq 2005), the ADF has had the primary agency responsibility for recent team deployments such as for the 1998 Aitape tsunami and the 2002 Bali bombing. Following the Asian tsunami, civilian teams were deployed under AUSASSISTPLAN (Cooper, 2005).

DMATs will be discussed under a number of headings according to nationality, role and sponsoring agency. A summary of these is presented in Table 5.

Table 5: Summary of role and sponsoring agency

	MILITARY	CIVILIAN	MIXED
RETRIEVAL	German MedEvac, USA CCAT		
IMMEDIATE CARE		DMAT Strike Team Cincinatti, MATS (USA), Accident Flying Squad (UK)	
FIELD HOSPITALS		SMART (UK), IMSuRT (USA)	
ASSESSMENT	EMEDS Forward Team (USA)	UNDAC Teams, SDC Teams (Swiss)	
MIXED MODELS	DART (Canada), IDF (Israel)	DMAT (USA), JDR (Japan), HUREX (Japan), DMAT (Japan)	IDF with reservists (Israel)
SPECIFIC ASPECTS ONLY		Local CBR Teams, (USA) RDRTF (Renal), DMORT (USA), VMAT (USA), NNRT (USA), NPRT (USA), NMRT-WMD (USA)	

2.2 Civil-Military Issues

Civil and military integration and collaboration is important and productive, particularly in the area of humanitarian aid (Anderson et al. 2001). However, the civilian-military interface and the promotion of closer ties between civilian and military units needs further development (Hampson, Cook & Frederiksen 2002; Moore & Blasser 1991; Nabarro 2005; Palmer et al. 2003; Read & Ashford 2004).

'Many of the problems inherent in disaster management are solved when the military combine with specialist civilian teams' (Redmond, Watson & Nightingale. 1991). There are a variety of reasons for civil military collaboration in disasters, with military and relief organisations being mutually dependant on each other for a successful outcome (Burkle et al. 1995).

Availability*:* Military medical forces may be the only medical services available and have a long history of providing assistance after disasters (Bidari et al. 2005; Bricknell & MacCormack 2005).

Security*:* The military may be the only organisation capable of providing the required security and logistical infrastructure in time to deal effectively with the crisis, particularly with a complex health emergency (Braham et al. 2001; Haddow & Bullock 2003; Judd 1992; Pretto & Safar 1991; Sharp et al. 2001).

Response Time and Self-Sufficiency*:* The military is well suited for an efficient, rapid response under harsh conditions, and being self-contained, their response does not impose a burden on the affected areas (Braham et al. 2001; Haddow & Bullock 2003; Judd 1992; Pretto & Safar 1991).

The military response to disasters includes (Braham et al. 2001; Haddow & Bullock 2003; Judd 1992; Pretto & Safar 1991; Sharp et al. 2001):

- rapid needs assessment
- transport of personnel and supplies
- organisation including communications, logistics, supply management
- intelligence including weather, population movements
- engineering including food, water, infrastructure repair, building works
- self-sufficiency
- medical and surgical services including acute care, preventive medicine and deployable laboratories, public health and sanitation
- speciality services such as chemical, biological and radiological, (CBR), and hazardous materials management.

Specifically, the military also has technical facilities such as the cold chain for measles immunisations, preventive medicine investigative laboratories and reverse osmosis water purification devices (Burkle et al. 1995) and is the only organisation with large airlift capability and the ability to deploy temporary tent hospitals close to disaster sites in remote areas (Palmer et al. 2003). In the Asian tsunami, only the lift and transport capacity of the US Military came close to meeting the need for reconnaissance, evacuation and supply (VanRooyen & Leaning 2005).

However, military retrieval teams have little exposure to critical care transport during peacetime, their equipment is lacking (Hampson, Cook & Frederiksen 2002; Tran et

al. 2003), and military medical personnel have little peacetime opportunity to practice trauma skills as military medical centres do not routinely receive trauma patients. In contrast, civilian trauma centre staff care for injured trauma patients regularly (Johannigman 2005; Pretto & Safar 1991). The ADF also has less medical infrastructure than the civilian system (Hampson, Cook & Frederiksen 2002; Read & Ashford 2004). Deployed military medical teams are oriented towards highly advanced battlefield trauma care, primarily for young men. The services needed during humanitarian intervention are different, with a primary care focus consisting primarily of women and children (Sharp et al. 2001; Taylor, Emonson & Schlimmer 1998).

Similarly, although many relief organisations work in war zones, their work focuses on population based health interventions such immunisation, food and water and primary care. Few have the equipment for, or skills in, wound management, orthopaedics or amputation (VanRooyen & Leaning 2005). This remains the domain of the civilian hospital or the active duty, military medical staff.

2.2.1.1 Conflict

Whether military forces used for humanitarian assistance can be truly impartial and neutral is controversial (Sharp et al. 2001). The inherent political and security agendas characteristic of military models require consideration in a humanitarian response (Haddow & Bullock 2003; Noji et al. 2001).

NGOs and multinational armed forces often have to work closely together in humanitarian operations, making it difficult to distance a military operation from a humanitarian one (Hickson Schukk & Arias 2001). The military of developed nations have been increasingly seen as important participants in response to complex health emergencies after successful cooperation with humanitarian agencies, such as in resolving the Kurdish crisis (Sharp et al. 2001). Although many NGOs prefer to maintain operational separation from the military to maintain perceptions of impartiality, the size and scope of the Asian tsunami disaster made cooperation with military a practical imperative (VanRooyen & Leaning 2005).

Both civilian and military agencies need to educate themselves about each others' culture, mission and methods of operation (PAHO/WHO 1999). The bilateral use of SPHERE may be a start towards common ground.

This collaboration is not just needed at the response level but also for data collection and surveillance. After hurricane Andrew, data from the civilian and military systems had to be analysed separately because of different case definitions and data collection methods (Redmond 2005a). When attempting to identify 'measures of effectiveness' for humanitarian operations the priority focus varies among military, government and NGO representatives (Burkle et al. 1995).

2.2.1.2 Models and Solutions

Gunn (2005) has noted that Armed forces are being 'recycled' from traditional combat duties to peace keeping and peace making functions. This is not a new concept; Safar (1985) was an advocate for humanitarian service for the military in disasters as far back as 1985. Civil-military cooperation has since been fostered by the UN and military initiatives (Bradt & Drummond 2003), while individual countries have made efforts to formalise collaboration:

- In the Czech Republic, a specific law exactly defines the roles of both civil and military involved in the response to mass casualty situations (Klein & Storek, 2005).
- Israel has a policy of civil-military collaboration. Army Medical Corps and civil medical services cooperated to establish shared national protocols for medical care due to mass casualty incidents (MCIs). This collaboration is evident from national committees to local training exercises. Israel has found that shared resources and a collaborative approach has resulted in larger combined forces with a faster response (Benin-Goren & Blumenfeld, 2005)
- After the Chi Chi earthquake in Taiwan, a National Institute of Disaster Management was established. This agency has the responsibility of disaster coordination including ability to activate military resources and maintaining volunteer lists. A mutual aid network has been developed between the 17 service regions. Two DMATs have also been established to respond to future disasters. These are based in the northern and southern parts of the country (Hsu et al. 2002).
- Civil-military cooperation has also been described in Russia in response to the Beslan tragedy (Goncharev, 2005).
- The evacuation of injured Australians following the Bali bombings was a combined civilian-military operation, with international retrieval performed by military resources and interstate distribution within Australia done by civilian retrieval teams (Tran et al. 2003). This was a 'one off', however, and a national retrieval network has been proposed to improve coordination between the ADF and the civilian retrieval services (Tran et al. 2003).
- A joint civil-military response was needed by South Africa when sending a team to the Algeria earthquake in 2003. To be able to send a team with both search and rescue, and primary health care and post disaster relief activities, the military health service, although multidisciplinary, had to be reinforced by civilian counterparts with high speciality skills. A team of 96 members was deployed with 12 hours notice, using a joint command and control (Ligthelm 2005).

2.2.1.3 Training

There are currently 5 recognised joint civilian-military training centres in the USA, 3 air force, 1 army and 1 navy. These Centres for Sustainment of Trauma and Readiness Skills each have slightly different focus:

- Expeditionary Medical Support Teams, are small lightweight mobile hospitals that provide immediate capability for up to 10 laparotomies or limb salvage procedures, and are staffed by 10 medical personnel.
- CCATT provide en-route care for critically ill patients during the evacuation phase of care, and consist of a critical care physician, critical care nurse and a respiratory therapist, who can provide self-sustained critical care for up to 3 ventilated patients.
- Battlefield skills for pre-hospital care providers on the battlefield.

Each of the courses runs for 12 to 28 days and has a formal curriculum validated by the Air Forces School of Aerospace Medicine, combined with specific training exercises and clinical experiences. The programs also offer the chance for the various

medical teams to function in an integrated manner. In exchange for the training the civilian trauma centre gains a much needed infusion of manpower to help care for injured patients (Johannigman 2005).

The Boston-based IMSuRT has also trained with the US Air Force (Gaudette et al. 2002).

It is also important to remember that humanitarian aid does not only benefit the recipient. The military benefit by the opportunity to exercise skills, a sense of achievement, and fostering positive public relations at home and abroad (Reade 2000).

2.2.1.4 Example Military Models

The Iranian military was able to offer a significant and timely response to the earthquake in Bam. They started search and rescue operations in the first hour after the disaster, set up 2 field hospitals, 23 field emergency and 13 field assistance centres, transported 937 assistance personnel to the disaster site in the first day, ran 8 post hospital care centres, and transported more than 12,000 casualties around the country. The abilities of the military should be recognised and a defined role for the them should be considered when developing a disaster plan, particularly in developing countries with a lack of well developed and resourced relief organisations (Hassan & Radfar 2005).

The Canadian DART is 200 member Canadian military force, bridging the gap until the arrival of members of the international community to provide longer term help (McCurdy,1999). It is an airborne medical emergency team with a 48 hour readiness capability, and a mandate to provide assistance for up to 40 days. The team has a wider focus than curative medicine alone. DART focuses on 4 main areas; potable water, engineering, communication and medical care, and its reverse osmosis water purification can provide clean water for thousands of people (Braham et al. 2001; McCurdy 1999).

2.3 Mitigation as a Component of the DMAT model

Disasters and development are intertwined (Loretti, Leus & Van Hosteijn 2001) and any response to disasters must be part of a wider development strategy (Judd 1992). Mitigation has emerged as a major strategy for reducing losses caused by natural disasters. Recommendations from the Board on Natural Disasters of the US National Research Council include that disaster prone developing nations should be given technical and scientific assistance in developing mitigation programs (Iwan et al. 1999).

This needs to occur at all levels; government, NGOs and military. Most governments provide little assistance for mitigation in comparison to response. Iwan et al (1999) cite the Office of Foreign Disaster Assistance in the USA as an example, with only 11% of its budget devoted to mitigation.

De Ville de Goyet (2000) feels that donor agencies and private contributors should allow and encourage humanitarian organisations to use part of their relief funds to support medium term rehabilitation. The World Bank decision in 2000 to assign 15% of its emergency relief grants to the reduction of vulnerability to future disasters should be emulated by other donors.

Less developed countries are increasingly requesting assistance to develop programs that improve disaster preparedness, prevention and mitigation (Burkle 2001a). Relatively small investments in preparedness and mitigation can reduce the losses caused by catastrophic events (Stephenson & DuFrane 2005). This may have other cost benefits as a more disaster resistant community promotes increased earnings, export opportunities and political stability, regardless of mortality and morbidity figures (Iwan et al. 1999). The Federal Emergency Management Agency (FEMA) has developed collaborative, inclusive programs through Project Impact to improve standards of preparedness and mitigation, thereby saving costs and businesses, building partnerships and making communities disaster resistant (Burkle et al. 2001). However, 'silent', long term investments in mitigation are rarely viewed with much favour by politicians, and they do not have the perceived benefit of 'putting on a show' of large scale relief (Stephenson & DuFrane 2005).

Rather than simply providing training and equipment, the establishment of partnerships may offer benefits to both developing nations and collaborating partners (Iwan et al. 1999). This is not clear cut, however, and McEntire (1999) argues that, despite the current emphasis on mitigation, the number of disaster related deaths has not fallen and that perhaps the pendulum has swung too far (McEntire 1998).

2.4 Descriptions of Key Models by Role

2.4.1 International Rescue as part of International Disaster Assistance

Consideration needs to be given to the needs of foreign nationals involved in disasters and the obligation of governments to their care. This may be as a result of both disasters and terrorist incidents. The Bali bombings, Asian tsunami and bombings in Kenya are examples of this, some of which are described briefly, with outlines of models and lessons learned.

Critical care at a distance as demanded by remote disasters is hardly 'business as usual'. Sophisticated care requirements may be greater than anticipated due to the volume and complexity of injuries, and distances involved. Skill requirements must include management skills and support of multi-organ failure (Dries & Perry 2005). For example, Australian military retrieval teams have little exposure to critical care transport during peacetime and their equipment is lacking (Hampson, Cook & Frederiksen 2002; Tran et al. 2003). The Royal Australian Air Force (RAAF) is well suited to for the evacuation of ADF personnel, generally fit young individuals, but future situations could involve children or the elderly (Read & Ashford 2004). The civilian air medical transport industry is a well developed international resource which has worked in conjunction with military agencies in some countries to develop technology, teaching programs and techniques to provide critical-care support to victims of disasters at a distance, with ultimate safe return home (Dries et al. 2005).

2.4.1.1 Bali

The Australian government evacuated all foreign victims of the bombings, the majority of whom were Australian, to Australia for ongoing care, and, within 36 hours, all were flown out of Bali (Health Emergency Management New Zealand 2002). The

most severely injured patients were flown to Royal Darwin Hospital on 5 military transport aircraft; of these 65, 53 were listed as serious or critical (Hampson, Cook & Frederiksen 2002; Tran et al. 2003). Staffing was provided by the military, with reservists in specialist positions (surgeon and anaesthetist), and military staffing of 2 aero-medical evacuation (AME) doctors, 4 nurses and 3 medical assistants (Hampson, Cook & Frederiksen 2002; Palmer et al. 2003; Read & Ashford 2004). The uncertain security situation meant that only ADF personnel were utilised for the international component (Read & Ashford 2004). The evacuation was still a combined civilian-military operation, with international retrieval performed by military resources, and interstate distribution within Australia by civilian retrieval teams (Hampson, Cook & Frederiksen 2002; Tran et al. 2003).

Coordination between ADF and multiple civilian retrieval teams was difficult at times (Palmer et al. 2003; Tran et al. 2003). A national retrieval network has been proposed to improve coordination between the ADF and the civilian retrieval services, as well as the use of smaller, faster civilian jet aircraft and retrieval teams that could be rapidly mobilised and perform intelligence gathering, as well beginning resuscitation of patients prior to arrival of the larger, slower military transport aircraft for events outside Australia where security is not in doubt (Tran et al. 2003). Civil aviation companies were not willing to fly in to the uninsured environment of Bali immediately after the bombings, and ground clearance was also difficult to obtain. The first RAAF Hercules only obtained ground clearance as it approached Denpasar (Palmer et al. 2003).

2.4.1.2 Asian Tsunami

A number of European countries acted quickly to evacuate their citizens from Asia after the tsunami (Maegele et al. 2005).

Sweden sent a Medevac team of 18 staff, 84 hours after the tsunami, with patients repatriated over the next 72 hours. They identified availability of ICU beds as a bottleneck, and concluded that there needs to be training of medical teams to take part in complex international operations as well as a system for performing needs assessments to guide allocation of resources (Holst and Ljungquist, 2005).

Germany sent a team of 30 emergency physicians and paramedics under the auspices of the Department of Foreign Affairs, coordinated by representatives from the German military forces, air ambulance services and the national airline (Maegele et al. 2005).

Finland sent an initial reconnaissance team of 8 members the day after the tsunami, followed by a 31-member team 2 days later. The main team used a converted Boeing B-757 transformed into a 22-bed hospital, with 7 ICU and 15 regular beds, ventilators, monitoring equipment and a point of care testing lab. The team consisted of 13 doctors and 24 ICU and OT nurses (Pajarinen et al. 2004).

2.4.1.3 Kenya

Those involved in the USA response to the Embassy bombing in Kenya found the characteristics and requirements for this event differed from domestic disaster emergency responses, and had to adjust their operating procedures accordingly (Macintyre, Weir & Barbera 1999).

2.4.1.4 Egypt

Following the Tabba/Ras el Satan bombing in Egypt, Israel used a forward team with 23 doctors, 35 paramedics, 12 nurses and senior Israeli Defence Force (IDF) medical personnel, with 150 units of blood, transported by the Israeli Air Force. Twenty holidaying physicians from Israel also arrived to help. A total of 185 wounded Israelis were evacuated to Israel by ambulance and helicopters. This was a combined operation between Israeli Defence Force, IDF Medical Corps, Israeli Air Force rescue teams, and civilian ambulance and hospitals (Bar-Dayan et al. 2005a).

2.4.1.5 Example of Models

The German Air Force maintains 2 medically-equipped Airbus A310 MRT MedEvac aircraft for providing quick, worldwide medical care and transport. The aircraft is outfitted with 6 ICU stations each equipped with computers, monitoring, diagnostics, ventilators and infusion pumps, and sufficient bottled gas to provide 8 hours of ventilation on 100% oxygen. The aircraft also has capacity for transporting up to 38 less severely injured patients in standard hospital beds. The aircraft and its crew of 25 specialists can be mobilised anywhere in the world in 3 hours (Maegele et al. 2005).

The US Air Force CCATT were developed in 1994 in response to an unmet military need for long range transport of critically ill and injured patients. These teams consist of an intensivist or emergency physician, critical care nurse and a respiratory therapist, and carry all necessary medical devices, equipment and supplies to care for 3 ICU patients per team. They have the ability to care not just for young victims of trauma, but also older patients with chronic diseases. The same scalable modular response may be well suited to disaster response (Grissom & Farmer, 2005).

2.4.2 Immediate Care

Pretto and Safar (1991) have proposed an altered model based on an awareness of the timeliness to response with its inherent delays and the need for immediate care. They note that the NDMS does not initiate the life-support chain from the disaster site, via transportation, to the most appropriate hospital rapidly enough. It does not provide life saving first aid by uninjured bystanders, the crucial first link, nor is it flexible enough to bring ATLS to the disaster scene within a few hours. The DMATs cannot be expected to provide ATLS at the scene within 24 hours of being called. The mobile surgical units would require 48 to 72 hours to be ready for resuscitative surgery.

They also propose a smaller model to provide earlier immediate Advanced Life Support (ALS) care. This would consist of, at least, an emergency physician, anaesthetist, trauma surgeon, several nurses and paramedics. Nearby teams could arrive within 2 hours. They could be transported from everyday civilian trauma hospitals by civilian emergency transport aircraft and US Air National Guard units, which are already deployed on a regional basis. The Critical Care volunteer teams which operated as part of Operation Desert Storm should become part of the NDMS. Funding, training and leadership are obviously important components of the ability to proceed (Pretto & Safar, 1991).

Some areas and countries have used this immediate care model and found that, as well as providing local care, they have been deployed on a wider, regional basis:

- The Accident Flying Squad based at the ED at Edinburgh's Royal Infirmary is a mobile medical team designed to make a rapid response (mean time from call to mobilisation 3.7 min) and usually consists of 1 or 2 experienced nurses and 1 or 2 senior doctors. Although designed to provide a local service only, they have also responded to disasters further afield, such as the Lockerbie plane crash (Steedman et al. 1991).
- Singapore has local teams that respond to disasters. Each First Aid Post at the scene consists of 3 to 10 field medical teams sent from local hospitals (Lee et al. 2000).
- Local CBR teams have also been developed in the USA, such as that at Robert Wood Johnson University Hospital which, once formed, have found a larger, county-wide role in both response and planning (Zavotsky, Valendo & Torres 2004).
- Cincinatti organised Medical Assistance Teams (MATS) in the 1970s made up of volunteer physicians, nurses, paramedics and rescue squad members to respond to disasters in the local area (Gates et al. 1979).

Local site disaster teams coming from hospitals vary but usually consist of 3 or more physicians from surgery, anaesthesia and emergency medicine, a nurse and a respiratory technician. There were fears that this would leave hospitals short staffed, but these fears seem unwarranted (Gerace, 1979). Pretto & Safar (1991) also suggest that medical resuscitation teams should be sent from the initial receiving hospital, with backup, replenishment staff called in.

However, after the Thredbo disaster, Garner and Nocera (1999) noted that the continued focus on hospital medical teams as the primary source of on-site medical services is inappropriate, as suitably trained and experience doctors are unlikely to be available from within the hospital system.

Roth and Gaffre (1996) also note the need for mini-DMATs for rapid response in the early phases with immediate care. DMAT 'strike' teams have also been used during the Olympics in which 5 or 6 people make up a small highly mobile unit with the capability to move quickly into the affected area (Wallace 2002). The US Air Force CCAT have also been suggested as a scalable modular response, well suited to disaster response as they are small, mobile, carry all their equipment themselves in back packs, and are able to provide critical care (Grissom & Farmer 2005).

2.4.3 Field Hospital

2.4.3.1 South Manchester Accident Rescue Team (SMART)

The policy for SMART was to send a 10-person team to work for 5 days continuously on site, excluding rest and travel, with equipment for treating up to 100 patients. The team is self-sufficient in food, water, surgical equipment, dressings and drugs. Travel to the scene is tiring and the work stressful, so after 5 days on the scene team members are physically and mentally exhausted. This reduces the effectiveness of the team and increases the risk to the patients. On this basis, prior to departure, team

members must agree to disengage after 5 days. A series of teams from across the UK could extend the period of aid. Operative intervention was limited to those who might die without surgery, and withheld from those who would live without surgery or who would probably die even with surgery. They also note that anaesthetists must be prepared to work in very different conditions to that in Britain (Redmond, Watson & Nightingale 1991).

2.4.3.2 International Medical Surgical Response Team (IMSuRT)

The IMSuRT was first deployed 2 years after its inception. It is a specialised medical/surgical support team, formed after the terrorist bombings in Kenya, consisting of a 20 member advance team plus a 30-member follow-up team. Each team member carries their own personal equipment and helps carry a full load of specialty equipment with 48 hours of supplies. In addition, the team is accompanied by a DRASH tent, operating equipment, pharamaceuticals, ventilators, and anything else needed to be a fully self-contained, emergency medical facility. Both teams are tasked with triage, definitive care and evacuation (Forgione et al. 2003; Gaudette et al. 2002; Lhowe & Briggs, 2004).

The advance team can be deployed within 4 hours of activation. Care provided in field hospitals is likely to consist of simple amputations, fracture and dislocation manipulation, debridement, fasciotomy and application of simple external fixation. The logistical challenges posed by long-range deployment to another country means that most victims will have been initially treated to some degree, and there may be political difficulties in assuming the care of victims already hospitalised (Lhowe & Briggs, 2004).

2.4.4 Specific Functions

2.4.4.1 Renal Disaster Relief Task Force (RDRTF)

This organisation was formed in 1989 by the International Society of Nephrology after the Armenian earthquake. It consists of a dialysis advance team, which assesses the needs and possibilities of dialysis treatment, followed by supportive manpower and supplies. Stocks of hardware and lists of volunteers (nurses and nephrologists) are based on 3 principal areas (Americas, Asia, and Europe/North Africa). A global coordinator is based at the European headquarters in Belgium with local coordinators on ground (Vanholder et al. 2001).

2.4.4.2 DMAT Logistical Support Group

The Bethesda DMAT has developed a Logistical Support Group (LSG) responsible for providing all dietary, engineering, sanitation, communication and supply needs for a DMAT and its patients. During deployment, the LSG will consist of 5 to 7 personnel, also cross-trained in first aid so they can assist the medical team in providing patient care if needed.

The LSG members include:

- Dieticians to evaluate the dietary needs of the team and patients, and food preparation procedures.
- A HAM radio operator responsible for maintaining a communication network.

- Engineers to help select the operational site, inspect any building being considered for use, and provide power, heat, water, and waste disposal in concert with sanitarians.
- Sanitarians for vector control along with quality control of water and food.

Both sanitarians and engineers must be competent in hazardous materials identification and safe handling; although not the main mission of a DMAT, potential exposure may occur during disaster response.

In reality these functions should be part of all disaster medical teams; just as there are concerns about the medical operations only being part of the response, these also need to be part of an integrated unit rather than a stand alone team (Rodenbeck 1990).

2.4.4.3 Rapid Response Assessment Teams

Under the auspices of the Swiss Humanitarian Aid Unit (SDC), Switzerland uses rapid response teams as part of their program in conjunction with UNDAC. These teams consist of a team leader, communication, water and sanitation specialists, and a doctor (Frisch 2005).

Several FEMA Emergency Support teams have developed rapidly deployable assessment and evaluation teams (Roth et al. 1996). EMEDS often utilises a small forward party to perform a pre-deployment site survey (D'Amore & Hardin 2005).

The US Office of Foreign Disaster Assistance has developed a DART which can carry out sustained response activities during international disasters and includes specialists trained in a variety of skills. The activities vary depending on the type, size and complexity of the disaster. During fast onset disasters the focus of the team is to:

- coordinate the assessment of the situation and report on the needs
- recommend US Government response actions
- manage US Government on-site relief activities
- manage the receipt, distribution and monitoring of US Government-provided relief supplies (Campbell, 2005).

2.4.4.4 NDMS Specialty Teams

The NDMS consist of the following specialty teams in addition to standard DMATS and local developments such as the logistics group at Bethesda:

- **Specialty DMATs** providing burn care and mental health.
- **Disaster Mortuary Teams** (DMORTs) providing portable morgue units, forensic professionals and victim identification services.
- **Veterinary Medical Assistance Teams** (VMATs) providing vet care to rescue dogs on duty, care to abandoned animals in the disaster area, animal disease surveillance, and animal decontamination.
- **IMSuRTs** are highly specialised surgical teams trained and equipped to establish free-standing, fully functioning field surgical facilities anywhere in the world. MSRTs can deploy to international disaster sites and foreign hospitals to provide health, medical and evacuation services. They are a cooperative effort between the NDMS and the Department of State.

- **National Nurse and National Pharmacist Response Teams** (NNRTs, NPRTs) to assist in mass vaccination and medication dispensing programs.
- **National Medical Response Teams – Weapons of Mass Destruction** (NMRT-WMD) who provide rapidly deployable mass casualty decontamination and speciality medication administration in the event of a WMD or hazardous materials event. They deploy with detection devices, personal protective equipment, specialised pharmaceuticals and antidotes. NRMT-WMD are often pre-deployed to high risk events.
- **Joint Management Team** (JMT) who deploy early in every NDMS event to provide command and control for NDMS response assets, and serve as a liaison to the requesting local and state authorities (Stopford 2005).

2.4.4.5 Chemical, Biological, Radiological (CBR) Teams

Teams trained and prepared for radiation disasters and other hazardous materials need to be considered (Abbott 2000; Koscheyev, Leon & Greaves 1997). A number of these exist in the USA. The Public Health Service Hazmat team in the USA (the Metro Medical Strike team) is designed to deal specifically with CBR terrorism (Deal et al. 1997).

COBRA (Chemical Ordinance Biological Radiological Antiterrorism) is the name for the Atlanta CBR team. The team has 100 members and includes paramedics, emergency medical technicians, physicians, nurses, toxicologists, public health officers and law enforcement officers, all of who receive specialised training (Deal et al. 1997). Local CBR teams have also been developed that have found a larger county-wide role in both response and planning, such as the Robert Wood Johnson University Hospital team (Zavotsky, Valendo & Torres 2004).

2.5 National Models of Importance

2.5.1 USA

The USA has developed a number of different formats for disaster medical assistance. These are a mix of civil and military.

2.5.1.1 National Disaster Medical System (NDMS)

The USA formed FEMA after massive disasters in the 1960s and 1970s. The NDMS, created in about 1987, is a section of FEMA (Dara et al. 2005).

Congressional funding has been in place since 1987. The NDMS is the congressionally mandated disaster response system for the USA, a partnership between public and private agencies to provide emergency health care and services during disasters (Born & deLong 2004).

Initially, the NDMS represented a cooperative alliance of 4 government departments and agencies (the Departments of Health and Human Services, Defense, and Veterans Affairs, and the Federal Emergency Management Agency) (Born & deLong 2004; Pretto & Safar 1991; Roth & Gaffney 1996; Stopford 2005). It has since expanded to include local and state governments, and the private sector. In March 2003, these were reorganised by the Bush administration with the creation of the Department of

Homeland Security (Born & deLong 2004; NDMS 2006; Stopford 2005).

The NDMS does not replace state and local planning efforts, but is designed to supplement and assist in the event of state and local medical services being overwhelmed. (Born & deLong 2004; Pretto & Safar,1991; Roth & Gaffney 1996). The NDMS can be activated when a US disaster overwhelms the capability of local and state jurisdictions, necessitating the transfer of disaster patients out of the affected area of the country (Koenig, 2003). Implementation is by Presidential declaration (Born & deLong 2004).

There are 3 key elements of the NDMS:

- rapid medical response
- patient evacuation
- definitive medical care (Pretto & Safar 1991).

The NDMS's 108 response teams are comprised of over 8000 personnel, both civilians and service health and medical professionals who serve as part-time federal employees, while training or deployed (Stopford, 2005). For a breakdown of the teams, see 2.4.4.4 on page 58.

The historical basis for the development of the DMAT concept was the medical hierarchical structure of the US Army's Medical Clearing Company. Three DMATs were often organised into a clearing and staging unit with a total of about 105 personnel to operate 240 beds (Pretto & Safar 1991; Moore & Blasser 1991).

Today, the NDMS develops and maintains DMATs as groups of professional and paraprofessional medical personnel, supported by logistic and administrative staff trained to provide medical care during a disaster (Dara et al. 2005; Deal et al. 1997; NDMS 2006).

Each team has a sponsoring organisation, such as a major medical centre that signs a memorandum of understanding with the Department of Homeland Security. The DMAT sponsor organises the team, recruits the members, and arranges training and coordinated dispatch of the team. The roles and responsibilities of the DMAT, the sponsoring agency, the US Public Health Service and NDMS are all clearly defined (NDMS 2006; Wallace, 2002).

Supplies and equipment are stored and ready for deployment to the sites of hurricanes, floods, earthquakes or civil disturbances. Being accepted as a DMAT also entitles teams to federal surplus and stores (NDMS 2006).

DMATs deploy to disaster sites with sufficient equipment to sustain themselves for a minimum of 72 hours, while providing medical care at a fixed or temporary medical care site (Koenig 2003; Wallace 2002), providing 4 main functions:

- search and rescue
- triage and initial stabilisation/emergent or primary medical care
- provision of definitive medical care and augmentation of overloaded local health facilities
- evacuation (Gaudette et al. 2002; NDMS 2006).

There are 80 DMATs in the USA, of which 25 are capable of supplying Level 1 trauma readiness (Morrissey 2001, Roth et al. 1996).

DMAT levels are:

- **Level 1:** The highest level of readiness, fully deployable within 8 hours of notification and self-sufficient for 72 hours, with standardised equipment and supply sets to treat up to 250 patients a day.
- **Level 2:** Lack enough equipment to be self-sufficient but are able to deploy and replace a Level 1 team, utilising and supplementing equipment left on site.
- **Level 3:** Local response capability only and in an early stage of development.
- **Level 4:** Memorandum of understanding executed in some stage of development but have no response capacity yet (Cohen & Mulvaney 2004; Morrissey 2001, NDMS 2006; Roth et al. 1996).

DMATs consist of volunteer physicians and other medical professionals who are required to maintain appropriate certification and licensing within their discipline (Born & DeLong 2000; NDMS 2006), although training is usually voluntary (Deal et al. 1997). They are treated as Federal employees for the duration of duty, so their expenses are met, and they are paid or have their normal salaries reimbursed by the US Public Health Office (Born & DeLong 2000; NDMS 2006). This also means they have the protection of the Federal Tort Claims Act in which the Federal Government becomes the defendant in the event of an interstate malpractice claim (NDMS 2006).

To be operable, a DMAT must be able to provide approximately 35 members including physicians, nurses and other allied health care personnel. To ensure a complete team is always available, at least 2 people should be identified for each position. Team numbers on the roster vary from 20 (level 3 team) to 250 members (Wallace, 2002; NDMS 2006).

A DMAT's composition is quite varied, typically containing physicians, physician assistants, nurses, nurse practitioners, pharmacists, mental health specialists, dentists, environmental and laboratory specialists, and emergency medical technicians. Technical or non medical team members may include engineers, radio operators, and administrative, logistic, security, mechanics and computer specialists (Wallace 2002).

A typical team has 34 personnel as shown below:

- 7 non medical
  - 2 DMAT leaders (may be medical or non medical)
  - 1 safety officer
  - 1 administrative or finance chief
  - 1 administrative assistant
  - 1 logistics chief
  - 1 communications officer
- 26 medical
  - 3 medical officers
  - 1 pharmacist
  - 1 pharmacy assistant
  - 2 supervisory nurses

- 6 staff nurses
- 4 advanced paediatric nurses or physician assistants
- 4 paramedics
- 5 positions determined by DMAT

- 1 home base (non deployed) support position (Wallace 2002; Morrissey 2001).

Therefore, there are 3 basic requirements for DMATs to function effectively:

- If not adequately trained, equipped and staffed they will not be able to provide quality medical care
- They must be able to take care of themselves if a site becomes hazardous and evacuation is not available or delayed.
- They must be fully prepared going into the disaster site so as not to add a burden to the local community (Gaudette et al. 2002; Roth & Gaffney 1996).

2.5.2 Canada

The Candaian DART is a 200-member military force under the Department of National Defence which bridges the gap until the arrival of members of the international community to provide long-term help (McCurdy 1999). It is an airborne medical emergency team with a 48-hour readiness capability and a mandate to provide assistance for up to 40 days (Braham et al. 2001; McCurdy 1999). DART was developed by the Canadian Government in 1996, based on a identified, short-term need for rapid response intervention to provide immediate and humanitarian medical relief aid in disaster zones at home and abroad (McCurdy 1999). DART is mobilised after a formal request has come from another country or the UN, based on advice from the Departments of Foreign Affairs and Trade, and of National Defence, and the Canadian International Development Agency (McCurdy 1999).

DART focuses on 4 main areas; potable water, engineering, communication and medical care (McCurdy 1999) and can provide clean water for thousands of people with its reverse osmosis water purification (Braham et al. 2001). It is composed of headquarters, logistics, engineering, security and medical sections.

- The medical team has 44 people to provide daily care for up to 35 inpatients and 500 outpatients. There is no capacity to perform surgery. On-site sections include a laboratory, pharmacy, dehydration and preventive medicine.
- The 40-member engineering unit provides the camp with electricity, showers and toilets, as well as analysing water, inspecting roads and providing 100,000 litres of potable water daily.
- The 34-member defence and security team guards the camp perimeter and provides general labour.
- The 20-member logistics team is responsible for maintenance, transport and supply to maintain self-sustainability.
- The 114-member tactical team is responsible for overall command, control, liaison and communications.(McCurdy 1999).

DART preparation includes training, education, immunisation, flora and fauna, communication, nutrition, and critical incident stress debriefing (McCurdy 1999).

2.5.3 Japan

In 1987, the Japanese Government formed the Japan Disaster Relief (JDR) Team under the Japan International Co-operation Agency to expand and strengthen international cooperation. It can promptly dispatch experienced disaster relief teams overseas, especially to developing countries, as and when a government requests it via UNDRO. There are about 300 doctors, nurses and medical engineers registered as volunteers. Between 1987 and 1989, the JDR was involved in operations in about 30 disaster affected countries (UNDRO 1989).

Humanitarian Relief Experts (HUREX) commenced in Japan in 1998. It is designed to be a system of personnel for humanitarian teams that the Government of Japan organises and sends to disaster areas after requests from international humanitarian organisations. HUREX aims to arrive and be engaged in medical activities in the acute and transition phases of complex emergencies within 45 and 60 days, staying, on average, for 3 months. The initial size of the roster was to be 80 experts (medical and logistics) with the secretariat in the Prime Minister's Office (Ninomiya et al. 1999).

DMATs were established in Tokyo in August 2004, and are expected to expand into other areas in the future (Ukai 2005).

2.5.4 Israel

Israel has sent teams to a number of international disasters, using a model based on military involvement with civilian support (reservists). Examples include Kosovo (Amital et al. 2003), the Tabba/Ras el Satan bombing in Egypt (Bar-Dayan et al. 2005a), the earthquake in Turkey (Bar-Dayan et al. 2005b) and the international retrieval of injured Israeli tourists from Mombassa (Marmor et al, 2005).

The Israelis have the capacity to mount either retrieval-based missions (Bar-Dayan et al. 2005a; Marmor et al, 2005), or field hospitals acting as immediate care providers or replacement facilities in the event of infrastructure loss (Amital et al. 2003; Bar-Dayan et al. 2005b). They have used forward teams to assess needs when necessary (Marmor et al, 2005), but have also acted on local information if available, depending on the speed of response needed (Bar-Dayan et al. 2005a; Bar-Dayan et al. 2005b). They make all efforts to tailor the response to needs and mission objectives (Bar-Dayan et al. 2005b; Marmor et al, 2005).

The IDF Hospital consists of both active service and medical corps reservists (Bar Dayan et al. 2005a). Through a policy of civil-military cooperation, they are able to integrate the civilian and military agencies at all levels, from shared national protocols through to training and response, resluting in larger combined forces with a faster response (Benin-Goren & Blumenfeld 2005).

An example of an integrated rapid response followed the Tabba/Ras el Satan bombing in Egypt. Israel used a forward team with 23 doctors, 35 paramedics, 12 nurses and senior IDF medical personnel, with 150 units of blood transported by the Israeli Air Force. Twenty holidaying physicians from Israel also arrived to help. A total of 185 wounded Israelis were evacuated to Israel by ambulance and helicopters. This was a combined operation between the IDF, the IDF Medical Corps, Israeli Air Force rescue teams, and civilian ambulance and hospitals (Bar-Dayan et al. 2005b).

3 SELECTION OF TEAM MEMBERS

3.1 Overview of Selection Process

The selection of the right person for a specific job is crucial in both normal and emergency situations (Cuny 2000c). Bar-Dayan Rami et al. (2005c) found that those who had volunteered were more supportive than those who had been asked to work with the team. The success of a team will very much depend on the selection of the right members. Selection should not be based entirely on skills; fitting into a team and being able to carry out the work required in the field is more desirable (Holland & Wooster, 2004).

To be effective, medical and health teams need to be multidisciplinary, have the appropriate training, and have predefined strategies for how to carry out these tasks. Understanding both the physical and mental problems that accompany relief work will help to predict problems, and properly prepare for and mitigate against these (Noji et al. 2001).

DeVita, Simmonds and Strub (2005) describe principles for implementing a Rapid Response team in a hospital, some of which are applicable to DMATs:

- determine the best structure for the team, for example a general emergency team as well as specific stroke, chest pain and trauma teams
- establish criteria for when the team is called
- provide education and training
- create a data collection tool
- measure effectiveness.

People wishing to become NDMS team members in the USA need to complete a federal application, submit to background checks, maintain their professional credentials, be able to physically perform their assigned job, and comply with training requirements. Basic training requirements include completion of an in-depth web based training program as well as successful participation in team-specific field training and exercises (NDMS 2006).

In the process of selection for the international search and rescue team Rapid-UK, applicants and their partner attend an introduction day where they learn about the organisation, and gain an understanding of the commitment and dangers. They are then asked to send in a CV and complete a questionnaire about themselves and why they wish to become involved in humanitarian work, which eliminates about 50% of applicants. The next phase is an induction weekend involving a series of tests oriented around teamwork, problem solving, and individual strengths and weaknesses, finishing with an oral interview (Holland & Wooster 2004).

Potential volunteers should ask themselves a number of screening questions before travelling to an international disaster area, which could also be used to screen of applicants in a recruitment program:

- effects on them
- effects on their home life
- effects on their career

- conditions of work of the agency they propose to work with, and its support and funding operations
- any issues of conscience to consider
- talking to colleagues in the field
- what it will be like returning home (Campbell 2005).

3.2 Selection verses Anticipated Roles

The skills required at a disaster scene are dependant on the type of disaster (Abrams 1990; McEntire 1998), and personnel assistance must be tailored to meet the specific needs of the affected community (VanRooyen et al. 2001a). Each disaster situation is different and a response appropriate to local circumstances has to be found (Redmond, Watson & Nightingale 1991; Russbach 1990).

The program objectives must be based following a realistic assessment not only of needs, but also of the resources available to meet those needs (Brennan et al. 2001). The response also has to be part of an overall approach; medical needs should not be considered as a special entity outside of the general context (Russbach 1990).

Some aspects of the disaster response are constant, such as food, water, clothing and shelter. Teams must be adaptable, self-sufficient and trained to work in the environment (Redmond, Watson & Nightingale 1991). Critical to a successful medical response are important non-medical elements such as communication, sanitation, safety and security (Schnitzer & Briggs 2004), and logistics, supply systems, administration and finance (Brennan et al. 2001; Moore & Blasser 1991; Nabarro 2005). Water engineers, sanitary workers and hygiene specialists should be involved at an early stage (Bremer 2003) and each organisation needs to develop its own logistics capacity (VanRooyen & Leaning 2005).

DMAT composition typically contains physicians, physician assistants, nurses, nurse practitioners, pharmacists, mental health specialists, dentists, environmental and laboratory specialists, and emergency medical technicians. Technical or non-medical team members may include engineers, radio operators, and administrative, logistic, security, mechanics and computer specialists (Wallace 2002).

A typical size for a deployment is 33 to 35 medical, technical and support personnel. To ensure a complete team is always available at least 2 people should be identified for each position. Team numbers on the roster vary from 20 (level 3 team) to 250 members (Wallace, 2002), and a typical team make up is shown on page 61.

The composition of a number of international teams is shown in Table 6.

Table 6: Composition of selected international teams

Country	Model	Medical Staff	Other Clinical Health Staff	Health Support Staff	Logistic Support Staff
Israel Kosovo (Amital et al. 2003)	Military IDF Medical Corps (76 members)	2 surgeons 1 anaesth 1 ortho 2 gynae 4 internists (ID) 3 paeds 2 Albanian physicians (interpreters)	2 paramedics 7 nurses army medics	1 medical engineer 1 preventive medical specialist 1 pharmacist Xray techs Lab techs	1 carpenter 1 plumber 1 mechanic 2 electricians
Israel Mombassa (Marmor et al. 2005)	Military 54 IDF medical 5 Forward medical team 14 Air Force AME 33 medical corps 4 rescue squad	10 surgeon 6 anaesth 5 medical 1 haem 1 ICU 1 Paed ICU 1 Emerg med	13 ALS/BLS officers 2 nurses	5 command team 4 healthcare officers	3 organisation officer 2 social workers
Israel Turkey (Bar Dayan et al. 2005)	Military 100 IDF medical corps	21 physicians	13 nurses 2 paramed 17 medics	Support personnel	Technicians Logistics
Japanese Disaster Relief Team Tsunami (Koido 2005)	Civil (95 health staff) 4 teams	24 doctors 15 Emerg Phys 2 Internal med 3 paed 4 public health	44 nurses 21 medical assistants	6 pharmacists	+ Logistics communication transport
Australia Tsunami (Cooper, 2005)	Civil Alpha 14 Bravo 14	Ortho Surgery Emerg Med ID Public Health	Nursing Paramedical		Logistics (Fire)
Australia Tsunami Maldives (Robertson, Dwyer & Leclerq 2005)	Civil 17 people	1Team leader 3 GP 2 PH physicians 3 Emerg med 1 ID physician 1 anaesthetist	3 nurses 1 paramedic	1 EHO	1 logistics officer
USA IMSuRT Bam earthquake (Owens, Forgione & Briggs 2005)	Civilian 57	Trauma surgery O&G Anaesthetics Primary care Paediatrics Emerg Med	Physician assistants ER Nurses OR Nurses ICU Nurses Paramedics	Pharmacists Resp therapists Xray technicians	logistics
Ukraine Gujarat earthquake (Roshchin et al. 2002)	56	20 physicians	14 nurses	2 lab techs	20 SAR

3.3 Personal Characteristics

3.3.1 Experience and Availability

The growing need for disaster relief work and a rapid response has led many organisations to place inexperienced or inadequately trained personnel in the field. Such inexperienced but enthusiastic workers may be of limited or decreasing usefulness (Campbell, 2005; Moresky et al. 2001), and may even have a negative impact as such personnel can threaten the success of a program, frustrate beneficiaries and donors, and damage the credibility of the agency (Brennan & Nandy 2001a).

Unfortunately, the majority of responding people are novices who volunteer for short periods then return to their normal occupations without passing on their experiences (Birnbaum 2005). In a study conducted by Moresky et al. (2001), only 18 out of 53 (34%) NGOs surveyed required that personnel had previous international experience, although Birch and Miller (2005) note that many humanitarian aid agencies now require 2 years' post-qualification and overseas experience before considering a candidate. People selected to respond should also have as broad a base of experience and expertise as possible to increase their value and ability to work in a variety of situations (Abrams 1990).

Staff also need to be aware of the 'on call' arrangements of the team. For example DMAT members rotate being on call for 1 month periods (Hogan, Rega & Forkapa 1990).

3.3.2 Personality, Motivation and Psychological Profile

Psychological stress in the aftermath of a disaster and its long-term effects are only beginning to be understood (VanRooyen & Leaning 2005). There is a need for better training and preparation in stress management for responders (Auf der Heide et al. 2001). Larkin (1998) comments that the actions of UK emergency service teams after major disasters are often seen as 'insensitive and unsympathetic', which raises concerns about the mental health of individuals concerned. Workshops have been organised in the UK to help address this. He quotes the experience of a social worker, called in to help family members identify victims after a plane crash in the UK, who felt that she was 'dropped in at the deep end', and that it took her a year to sort things through (Larkin 1998). Many of the younger, inexperienced members of the various services involved at Lockerbie were also clearly unable to control their emotions (Steedman et al. 1991).

Individuals under stress from a disaster do not generally seek mental health treatment, particularly outside their own community. The most important function of a disaster team may be a 'ministry of presence' (North, Weaver & Hong 2001). 'The mental health response should not be segregated from the others'; it becomes harder for field staff to respond if they are struggling to cope themselves (Lamberg, 2005).

According to Nocera (2000) 'disaster planning to support the physical and mental needs of medical and emergency service responders during an incident, especially when they themselves are victims of the disaster, has the potential to improve the overall efficiency of an incident response'. More attention needs to be given to the psychosocial impacts of disasters, teams need to be prepared both physically and psychologically for their task, and counselling should be made available for team members (Cruz Vega et al, 2001).

Palmer (2005) notes that 'all those involved in catastrophes will be changed by the experience' and suggests that people should only deploy if they are in good physical and mental health. However, lasting friendships can be created by DMAT deployment (both within the team and with those in the affected country), and a sense of accomplishment and achievement develop (Lewis-Rakestraw 1991).

Team members need to be flexible, willing to deal with ambiguity, and have an ability to innovate (Gaudette et al. 2002; Palmer 2005).

3.3.3 Physical Health

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

3.3.4 Group work

One of the defining experiences of the Royal Darwin Hospital's response to the Bali bombings was the level of teamwork between organisations, departments, professional groups and individuals; it was an environment completely stripped of hidden agendas and professional boundaries (Palmer, 2005).

Each team member needs to prepare with the rest of the team so it acts and adapts as a single organism. The team has to be truly a team and not a collection of 'talented renegades' (Gaudette et al. 2002). Job identification and responsibility are essential for staff morale. Team cohesiveness makes them better able to withstand prolonged exposure to the stresses generated by the disaster (Bar-Dayan et al. 2005c). There should also be a clear understanding of team members' roles and responsibilities, and how they contribute to the overall objectives (Birch & Miller 2005).

The success of a team strongly depends on the selection of the right members. Selection should not be based entirely on skills; fitting into a team and being able to carry out the work required in the field is more desirable (Holland & Wooster 2004). A study by Bar-Dayan et al (2005c) found that those who had volunteered for the disaster team were found to be more supportive than those who had been invited to work with the team.

Palmer (2005) also notes that working as part of an international assistance team is much like expatriate communities with personality issues, the endemic nature of gossip and how corrosive it is to group function, and the temptation to relieve stress through alcohol, drugs and sex. Support for those away from home should also be made available through communication with friends and family.

Understanding group dynamics is thus essential for disaster managers and team leaders (Cuny 2000c). Group unity is positively affected by smaller groups, achievement of goals, higher status in an organisation and the individual member's dependence upon the group. Some individuals cannot adapt to group work and conflict arises (Cuny 2000b).

Once conflict has arisen, potential solutions, depending on the situation, include changing leadership, removing a member, reducing the group size and dissolving the group altogether (Cuny 2000b).

4 POLICY CONSIDERATIONS FOR TEAM DEPLOYMENT

4.1 Policy Issues for Deployment and Withdrawal

4.1.1 International Policy

Normally in international politics, assistance is only offered if formally requested by the affected country. Territorial boundaries need to be respected despite a disaster occurring. The request for aid travels through pre-established diplomatic channels once the affected country has determined that its own resources have been overwhelmed or destroyed (Abrams 1990; Haddow & Bullock 2003).

Unfortunately, this procedure takes time, but 'shortcutting' this procedure may have unwanted consequences including perceived invasion, incarceration of relief staff, and political 'nightmares' (Abrams 1990). Teams and individuals who respond to disasters without authority or accreditation will only add to the problems of the affected country, further draining their resources (Holland & Wilson-North 2005; PAHO/WHO 1999).

International humanitarian aid is increasingly treated as part of foreign policy. This trend also explains the growing involvement of the military in operations (Dufour et al. 2004). As an example, the USA position stated by the Office of Foreign Disaster Assistance is that, following a request for aid, an assessment of value is made; if sending of aid is to the 'advantage' of the USA an authorisation is given, otherwise the answer is 'no' (Abrams 1990).

Thus, it is worth noting that the threshold to intervene and supply aid depends not only on when the victim nation's capacity to respond is overwhelmed (Dara et al. 2005), but the victim nation actually requesting aid. Some governments may not want international assistance given the politics of aid (McEntire 1999), which may either confuse other governments (Roy 2005) or be misunderstood as refusing international help can be a very sensitive matter (Russbach 1990). An example of a country refusing aid was India, following the Asian tsunami (Frisch 2005).

4.1.2 Australian Situation

The peak national body for emergency management policy coordination is the Australian Emergency Management Committee. The peak national body for emergency management health issues is the Australian Health Disaster Management Policy Committee. The peak operational Commonwealth body for emergency management is Emergency Management Australia (EMA) (Bradt, Abraham & Franks 2003).

The primary role of the Commonwealth is to assist states in developing their own capabilities, coordination of resources, and for issues relating to international responses. The Commonwealth has no ground resources of its own apart from the ADF, as police, fire, ambulance, State Emergency Services and hospital services are all state-based (Abrahams 2001; Bradt, Abraham & Franks 2003).

State requests for Commonwealth assistance can only be made by designated authorities when the state cannot meet requirements. During disasters, EMA coordinates the provision of technical and material assistance to states from its National Emergency Management Coordination Centre in Canberra. This is usually provided at no cost (Abrahams 2001; Bradt, Abraham & Franks 2003).

The response to the Asian tsunami illustrates the mechanisms involved. The Australian Government received requests for medical assistance from the governments of Indonesia, Sri Lanka and the Maldives, and through EMA and the Australian Government Overseas Aid Program (AusAID), in consultation with the Department of Health and Ageing, organised for the deployment of 4 disaster medical teams. The national disaster plan for overseas assistance (AUSASSISTPLAN) was activated (Cooper 2005).

4.1.3 Improving Deployment Policy

Mutual aid agreements may help with communication between hospitals, and state and federal relief personnel (Milsten 2000), and countries with bilateral agreements may include disaster relief as part of the cooperation (Bremer, 2003). In 'Global Crises – Global Solutions', the WHO states an obligation to rapidly assist member nations who need external assistance through deployment of a WHO operational response team working closely with the affected nation (WHO 2002).

An example of rapid, cross-border international assistance is the Israeli response to the Tabba/Ras el Satan bombing in Egypt. Optimal international collaboration was established immediately, with the opening of borders and a rapid, combined medical response (Bar-Dayan et al. 2004).

4.1.4 Actual Deployment

The reasons for sending a team should be carefully evaluated (Abrams 1990), particularly in assessing the likely efficacy of the response. Once a decision has been made to deploy, however, organisation according to a rapid response plan is important (Noji et al. 2001). Issues with deployment can be characterised as:

- a need for a clear mandate
- self-sufficiency
- well-defined protocols between different levels of government regarding deployment.
- funding mechanisms must be in place (Noji et al. 2001).

Military models are instructive examples of strong pre-planning. They also have clearly defined mission statements, roles and objectives and a strong chain of command (Noji et al. 2001), coupled with measures of effectiveness and end-points (Sharp et al. 2001). Rules of humanitarian engagement should be defined as clearly as are the rules of military engagement (PAHO/WHO 1999).

Bricknell and MacCormack (2005) describe a 5-step military approach of a 'mission estimate':

1. mission analysis based on information from headquarters
2. evaluation of factors
3. consideration of courses of action based on task lists
4. commander's decision
5. development of the plan with communication to all involved.

The factors in step 2 include an evaluation of the environment, hostile forces, friendly forces and the population at risk, casualty estimates, security, medical force protection, time, medical capabilities and logistics, medical command and control, communications and computers, humanitarian factors and assessment of tasks. These are often designed as a series of checklists to determine 'how to do it' (Bricknell & MacCormack 2005).

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

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

Members of the team should be fully briefed on what to expect on arrival (Abrams 1990). There also needs to be a clear exit strategy consistent with a military approach to operation planning to keep to the initial mandate and to maintain efficiency of the operation, avoiding overload or fatigue of deployed staff. Redmond, Watson and Nightingale (1991) note that, after 5 days on the scene, both mental and physical exhaustion can set in, reducing the effectiveness of the team and increasing the risk to patients. As it is hard to turn your back on suffering, a strict rule to disengage after 5 days must be accepted by the team before departing .

4.1.5 Funding

The amount of funding and the way it is provided has a great influence on the scope of the project (Birch & Mullar 2005). A major challenge for the Italian response to hurricane Mitch was to ensure a balanced sheet of budgeted priorities, taking into account the emergency requirements of multiple countries. They used the magnitude of the event's impact on the population, and the main needs of each affected country as the key criteria (Guglielmetti & Miozzo 2000).

The actual cost of a medically dedicated response team is multidimensional and includes:

- Wages (or lost wages)
- Backfill cost of replacing the deployed staff at their normal place of work
- Food and accommodation costs
- Transport costs
- Inventory costs in terms of personal items, disposable equipment, donated equipment, and the cost of items that are lost, broken, stolen or irretrievable.
- Training costs
- Team administration costs
- Insurance.

Significant expenditure can be anticipated and will vary according to the type, extent and magnitude of the disaster, the number of people sent, the type and amount of equipment, and the length of time deployed (Abrams 1990).

When a state of emergency is declared in the USA, funding for NDMS assets may occur via the Stafford Act to avoid causing an undue financial burden on the local community (Roth & Gaffney 1996; Stopford 2005). Similarly in Australia, if state requests for assistance are met, this is usually provided at no cost (Bradt, Abraham & Franks 2003). In a review of operation following hurricanes Hugo and Andrew, 'out of channel pathways' normally utilised in the warning and emergency phase of the response remained operational after more formal, civilian–military communications pathways and local assessment capability had been established (Weddle & Prado-Monje 1999). This is important because if 'unofficial' channels are utilised and a team sent on this basis, funding may not be forthcoming (D'Amore & Hardin 2005).

4.2 Deployment Process

4.2.1 Time to Deployment

The reality of most disasters is that local people provide the first response and outside help may come hours or days later.

There is a need to respond quickly once activated (Abrams, 1990), with deployments required in hours rather than days (Holland & Wilson-North 2005). Crucial time is lost when relief workers are not placed quickly and appropriately (Hickson et al. 2001), so teams need to have response structure and strategy in place that can be activated immediately (Holland & Wilson-North 2005). Ideally, a response team must operate within a 24 hour radius of its home base, and all team members have current passports (Abrams, 1990).

Holland and Wilson-North (2005) describe a structured breakdown of the components of a response strategy and information gathering process based on the policies of the British based Search and Rescue team RAPID-UK:

- Availability of operational personnel
- Selecting a balanced team and placing it on stand-by
- Flights to nearest main airport
- Onward movement from airport to disaster area
- Details of equipment and its weight forwarded to the airline
- Movement to airport
- Mobilisation of the operational support team
- All personal details of team to airline and authorities
- Maps of the area
- Cultural awareness information
- Information pack on disaster and pre-deployment briefings for team members
- Packing equipment (should be pre-packed)
- Liaison with various authorities
- Liaison with in country contacts.

4.2.2 Transport to Site

Transportation is a key issue as it can severely restrict operations and response. Air transport support is critical in times of disaster (Hickson et al. 2001), but all avenues of transport may be affected depending on the disaster and local conditions. Transport was a major problem in Asia after the tsunami (Frisch 2005; Maegele et al. 2005; Van Rooyen & Leaning 2005). The Japanese found that the use of land routes was extremely difficult following the Hanshin earthquake in Kobe so the Japanese Maritime Self Defence Force has developed a ship with high level medical facilities for use in disaster relief (Shiozaki 1999). Transport difficulties are also exacerbated by communication problems (Braham et al. 2001).

An advantage of national or military affiliation is often improved access to transport vehicles with transportation to and from the disaster area able to be arranged by the federal government (Hogan, Rega & Forkapa 1990). The IMSuRT, as a federal team, was transported by US Government arrangements, with a C-17 cargo/transport plane used to fly team and supplies. The importance of a logistics function is the ability to secure other means of transport such as buses (Cohen & Mulvaney 2004).

To avoid delays, pre-event simplification of bureaucracy is essential. A Japanese field hospital was only released after 2 days in customs because equipment lists were lacking (Bremer 2003). The UN has attempted to ensure application of simplified customs procedures in order to speed up the delivery of international humanitarian assistance, including military and civil assets. This includes advance submission of documents, waiving of economic restrictions, duties and taxes, expeditious processing without examination, and simplified inspection procedures (Balabanov 1996).

4.3 Training

4.3.1 Training and Preparation

Relief teams coming from abroad must be well qualified and professionally trained, know their equipment and be flexible (Gaudette et al. 2002; Russbach 1990).

Marmor et al. (2005) describe difficulty with untrained staff during the aero-medical repatriation of injured Israelis from Mombassa. The IDF now only include trained members (Marmor et al. 2005). A lack of needed skills is a major cause of poor employee morale, which may be a reason for the high turnover of staff (VanRooyen et al. 2001b).

There is general acknowledgment that training needs to be improved.

- There is an urgent need for intensive and focused training of relief workers (Campbell 2005).
- Basic training in disaster management should be strengthened at all levels of education (PAHO/WHO 1999).
- The military acknowledge that it is unacceptable for military medical staff and military forces simply to send units trained and prepared for combat and hope they quickly adjust to emergency relief practices. These staff find that they do not have the training, equipment and supplies necessary for humanitarian assistance (Sharp et al. 2001).

- 'UK training as a nurse or doctor is unlikely to prepare health workers adequately' for work in complex emergencies or disasters (Birch & Miller 2005).
- After the Thredbo disaster, the continued focus on hospital medical teams as the primary source of on-site medical services has been seen to be ineffective, as appropriately trained and experience doctors are unlikely to be available from within the hospital system (Garner & Nocera 1999).
- Galvin (2000) found his experiences in East Timor 'a great challenge', and that the lack of radiological and laboratory support sharpened his clinical skills and emphasised the importance of improvisation as a core skill.

International emergency and disaster medicine increasingly requires a strong knowledge base in health and human rights, logistics, international humanitarian law, international organisational management, negotiation and mediation (Burkle et al. 2001).

4.3.1.1 Current Training

Staff trained in basic principles will make more appropriate decisions and fewer mistakes (Moresky et al. 2001; VanRooyen et al. 2001b).

In a review of the 104 EMATs that responded to Taiwan's Chi Chi earthquake, 93% of team leaders had advanced cardiac life support training (ACLS) and 87% in advanced trauma life support (ATLS), but fewer than 25% had prior disaster training or experience (Hsu et al. 2002). Fewer than half the NGOs surveyed by Moresky et al (2001) provided pre-field training in health care, with areas covered including HIV, nutrition/dehydration, disaster relief, tropical medicine, ACLS/ATLS/APLS (advanced paediatric life support), women's health, family planning, and water/sanitation training. Only 34% offered classroom teaching or orientation prior to departure, varying from 2 days to 2 weeks, and only half required medical or nursing board certification (Moresky et al. 2001).

4.3.1.2 Training Problems

Emergency response training poses a number of unique problems:

- Need to retain material learned in training over a long period of time between emergencies.
- Need to apply information learned from the training conditions to the unforeseen conditions during the emergency.
- Need to develop effective mechanisms for teamwork (Ford & Schmidt 2000).

Adopting mastery, rather than a performance oriented learning strategy, may assist retention, while a number of other strategies may assist in the transfer of learning (Ford & Schmidt 2000).

Training involving multidisciplinary groups with inter-agency cooperation can be a challenging process (Brunet 2000). Multidisciplinary teams of healthcare professionals are the norm in clinical care, yet teaching and rehearsing team skills is rare in healthcare education. DeVita et al. (2004) suggests that training improves team efficiency and effectiveness of completing key tasks in a crisis situation. Teamwork skills need to be specifically addressed during training (Ford & Schmidt 2000).

It is imperative that realistic training is carried out, and training standards and minimum training requirements are established before training commences (Holland & Wooster 2004).

The 3 key areas identified by the Swiss that warrant further training and development are rapid assessment, flexibility in assistance and rapid decision making (Frisch, 2005).

4.3.1.3 Courses

There has been a recent increase in the number of training courses available for health workers considering disaster response (Campbell 2005):

- The New York College of Osteopathic Medicine has developed a Disaster Reserve Partner Group composed of undergraduate students. Team members undertake a 2-day training program in conjunction with the American Red Cross, consisting of an orientation so that learning occurs in context, followed by sessions on disasters, mass care and shelter operations, and a simulation including the construction of a mock shelter. Red Cross certifications have the advantages of being free and recognised nationwide (Vohra & Meyler 2003).
- The Canadian DART is comprised of professional soldiers dually trained in military response and civilian mass casualty medical relief aid. They augment their normal military training with sessions on the treatment of women, children and elderly (McCurdy, 1999).
- To facilitate international coordination, health and relief workers must be provided with professional training before becoming involved in an emergency situation. The WHO's month-long Health Emergencies in Large Populations (HELP) course covers various topics such as epidemiology, communicable disease, planning, nutrition, environmental health, war victims protection and disaster response teaching methods, and is designed to prepare future medical coordinators in disasters with this multidisciplinary approach (Russbach 1990; VanRooyen et al. 2001b).
- Other courses include the Combined Humanitarian Assistance Response Training and the courses offered by the International Rescue Committee and the Office of Foreign Disaster Assistance (Moresky et al. 2001; VanRooyen et al. 2001b).
- A number of websites and databases list training and/or employment opportunities with humanitarian agencies, including Relief Web, InterAction and the International Health Exchange (International Health Exchange 2006; Campbell 2005; Moresky et al. 2001).
- The Australian Aid Resource and Training Guide lists training opportunities in humanitarian work related areas across the country and is accessible through the Australian Development Gateway (2006). Australian courses include a Post-graduate Certificate in Disaster and Refugee Health through James Cook University as well as courses offered through EMA, Deakin University and the Burnett Institute.
- The 2-day 'Medical Response to Terrorism' is run by the American Public Health Association and the National Association of Emergency Medical Services (EMS) Physicians, and endorsed by the American College of Surgeons, and core, basic and advanced Disaster Life Support courses are endorsed by the AMA (Johannigman 2005).

- The National Emergency Response and Rescue Training Centre (NERRTC) was established to train emergency responders in Texas. They have a physical 'Disaster City' that allows participants to experience scenario-based training in true-to-scale settings. The NERRTC also exports courses to other locations (Johannigman 2005).
- The British search and rescue team, RAPID-UK, makes each new team member undergo a minimum of 18 months training, equivalent to 45 days, carried out over weekends, culminating in a 5-day assessment before acceptance onto the operational register for deployment in the UK or overseas. They specifically aim to develop a range of attributes in their members through a curriculum based on more than just technical skills (Holland & Wooster 2004).

  The following attributes are developed by RAPID-UK during training :

  - Development of teamwork
  - Contributor to the team
  - Dedication
  - Determination
  - Strength of character
  - Good awareness
  - Reasonable fitness level
  - Mentally alert at all times
  - Able to work with stress and pressure
  - Able to work with heights and confined spaces
  - Common sense
  - Self-discipline
  - Good listener
  - Likeable character
  - Logical thinker
  - Sense of humour
  - Able to pace themselves
  - Able to adapt to change
  - Good communication skills
  - Compassionate
  - Focussed
  - Technical ability
  - Individual skills
  - Cultural awareness (overseas)
  - Trust
  - Sense of urgency when required
  - Able to work alone when required
  - Passion to help
  - Patience
  - Non confrontational
  - Stamina
  - Hygienic
  - Pride in the team
  - Well motivated
  - Calm in stressful situations
  - Organised
  - Enthusiastic
  - Professional approach
  - Able to follow instructions
  - Able to take constructive criticism

  Plus personal considerations; financial, family, physical and mental (Holland & Wooster 2004).

  The following modules are used for training RAPID-UK members:

  - Module A – Core elements of training
  - Module B – Base Camp procedures
  - Module C – Support equipment
  - Module D – Hygiene, food and cooking
  - Module E – Communications
  - Module F – Introduction to rescue work
  - Module G – Search procedures
  - Module H – Basic rescue

- Module I – Technical search and rescue aids
- Module J – Specialist courses and sections (Holland & Wooster 2004).

Members also carry training on working in conflict zones, the SPHERE standards, Red Cross code of conduct and the UN basic security in the field program. Modules consist of both theory and practical components. Each operational member attends monthly training, regardless of how many overseas deployments they have been on (Holland & Wooster 2004).

A more medically-based educational program for disaster relief workers has been developed by the US-based DMATs. Ongoing training must occur for the DMATs to function as a team once deployed. Team members also need to be familiar with the equipment and basic load supply, as well as their job function. Training consists of classroom programs and field training, and an annual conference that offers workshops and training courses for members. A national training program for DMATs has been proposed and is shown below (Wallace, 2002):

- Module 1
  - Orientation to federal disaster medical response programs
  - History of various federal departments that pertain to federal disaster medical response programs.
  - Orientation to the DMAT structure, function, organisation, operations and team standards
  - Federal personnel guidelines
  - Physical fitness standards
  - Criteria for DMAT levels 1, 2 and 3
  - Team table of organisation and equipment
- Module 2
  - Team field skills
  - Command and control
  - Field stations
  - Aircraft safety
  - Litter obstacle course
  - Rapid shelter deployment
  - Cache lists
  - Equipment and supply storage and management
  - Call down roster
  - Alert, deployment and demobilisation procedures
  - Aircraft cargo guidelines
  - Equipment maintenance
  - Medical compound configuration (include special missions)
- Module 3
  - Personal deployment preparation
  - Field living skills
  - Skills to live under austere conditions using standard personal/team equipment
- Module 4
  - Disaster medical and traumatic emergencies

- How to make tough decisions about triage categories, treatment priorities and transport
- Patient reporting activities

- Module 5
  - Integration of field medical and non medical skills
  - Certain selected support applications reviewed with DMAT members for their own safety, and the safety and treatment of patients
- Module 6
  - Comprehensive deployment exercise, including logistics and safety operations
  - Hands on experience with specialised equipment and supplies including an overnight deployment, irrespective of weather conditions, to simulate austere disaster experiences to test the DMAT members' readiness (Wallace, 2002).

A number of other issues are raised by various authors with respect to training:

- Field program managers also need training in management skills such as project assessment and planning, finance and personnel management, and quality assurance and reporting (VanRooyen et al. 2001b).
- A number of NGOs now offer staff training in security (VanRooyen et al. 2001b).
- Teams should also be trained in field deployment and living, aero-medical conditions, equipment use and maintenance, casualty collection and regional evacuation point operations, command and control, NDMS organisation, and structure and administrative requirements (NDMS 2006).
- The Operational Room is vital to any team deployed overseas and should be staffed 24 hours a day until the team returns home. Training is needed for the staff, who run the operational room which addresses desk top exercises, experiences, media training, IT skills, telephone skills, report log training, press releases, dealing with next of kin and handling specific requests (Holland & Wooster 2004).

Many organisations, however, lack the capacity to train field personnel in areas such as security, management, standardised programs, field educational methods and cultural sensitivity (Moresky et al. 2001).

The care and maintenance of teams is important, and the following are needed, and apply to education, standards and group function:

- The development of training standards, opportunities to receive training, development of module-based training packages, and joint team training sessions.
- The development of performance-based training standards so teams are known for their capabilities rather than just enthusiasm and availability.
- The provision of direction and technical assistance to teams in the area of team development and management.
- The encouragement of inter-team activity and communications.
- The sharing of known or developed knowledge (Moore & Blasser 1991).

4.4 Equipment

'The responding agency must be prepared to provide the equipment and supplies needed to carry on their operations. These need to be easily transportable, durable, adaptable and plentiful. The team must also be totally self-sufficient so as not to become a burden on the affected population. This includes food, water, accommodation, clothing, security, finances, communications and possibly transportation' (Abrams 1990).

4.4.1 Self-Sufficiency

Teams must be self-sufficient (Nabarro 2005; Redmond 2005a; Roschin & Mazurenko 2002; Russbach 1990). They need to be equipped to make the individuals safe, relatively comfortable and, very importantly, self-sufficient for an initial period of at least 10 days, but ideally for the duration of their stay or the victim country is then forced to find food, water and shelter for extra people from already limited resources (Holland & Wilson-North 2005; Roschin & Mazurenko 2002).

There is a major need for self-sustainability in austere environments such as after the tsunami in Banda Aceh (Cooper 2005), while after the Bam earthquake, no water or electricity was available for the first 2 days (Abdaliha 2005).

The US DMATs deploy to disaster sites with sufficient equipment to sustain themselves for a minimum of 72 hours while providing medical care at a fixed or temporary medical care site (NDMS 2006; Hogan, Rega & Forkapa 1992). The Israeli response to Kosovo brought hospital supplies, kitchens, hygiene facilities, energy, accommodation and heavy vehicles, rendering the entire project self-sufficient with maximal logistic independence (Amital et al. 2003).

4.4.2 Base Camp

Base camp equipment needs the following as a minimum:

- large, 'quick erect' tents
- generators, lighting and cooking facilities
- water supplies and/or filtration unit
- food in the form of 24-hour, hygienically sealed rations able to be eaten hot or cold
- waterless toilet system
- solar shower that can provide hot water
- anti-bacterial hand wipes and team medical needs (Holland & Wilson-North 2005; Roschin & Mazurenko 2002).

General equipment includes fuel cans, duct tape, spare bulbs, batteries and fuses, toolkit, tarpaulins and tools.

Teams using tents need to have alternative methods of securing to pegs alone. After September 11th, the Boston IMSuRT had to improvise with use of sandbags after setting up camp in a concrete schoolyard (Gaudette et al. 2002).

4.4.3 Field Hospital

Most international aid teams use field hospitals that are able to be quickly erected, including tents or inflatables. The field hospital should be constructed beforehand according to local data but must be adaptable to the needs of the local population, remembering that most of the medical activity is non urgent treatment (Bar-Dayan et al. 2000). Examples of some field hospital descriptions are included in Table 7.

Table 7 : Examples of field hospital formats

Ukraine Gujurat (Roschin & Mazurenko 2002)	Israel Kosovo (Amital et al. 2003)	Israel Turkey (Bar-Dayan et al. 2005b)
8 inflatable sections • Emergency • Operating Theatre • ICU • ID • Obstetric/ Paediatric • Pharmacy • Technical • Staff Also a large tent for the management for 100 inpatients.	4 medical wings that composed the hospital plus a services area and ED/OT • Emergency • Operating Theatre • Internal medicine (30 beds) • Surgical ward (30 beds) • Paediatrics (30 beds) plus paediatric ICU and neonatology • Obstetrics ward, (and operating theatre) Service areas with laboratory and imaging (xray and ultrasound), pharmacy and medical supplies and logistic support.	7 sections • Emergency • Operating Theatre • Surgical ICU • Internal medicine • Orthopaedics • Paediatrics • Obstetrics

4.4.4 Medical

Teams must bring their own equipment, including shelter for patients, based on its role and anticipated patient numbers. Given the space and weight considerations, drugs and fluids need to be chosen carefully but still offer the ability to provide analgesia, treat toxicities, stabilise circulation and respiratory function, and abolish seizures (Grissom & Farmer 2005). For example, plaster is more versatile, takes up less space and weighs less than external splinting devices (Lhowe & Briggs 2004). The most frequently transported supplies by the 104 EMATs at the Chi Chi earthquake were first aid kits (90%), IV fluids (87%), suture materials (77%), airway/intubation equipment (70%), and splints (70%). Only 13% of teams brought emergency power generators with them (Hsu et al. 2002).

Detailed planning is needed for the supply of individual items such as oxygen, clinical waste disposal, and blood and blood products. The storage and distribution chain also needs to be considered to ensure medical material is kept within specified temperatures (Bricknell & MacCormack 2005). Equipment selection needs to consider function in the working environment such as noise, vibration, altitude, decompression and whether they will work in conjunction with radiofrequency transmitting equipment. Power supply and battery life needs to be considered (Grissom & Farmer 2005).

Primary care needs are paramount, and WHO emergency health kits for primary health care workers are available to assist a population of 10,000 for 3 months, and designed to fit on the back of a pick-up truck. Supplementary units are also available for use by health professionals, but do not duplicate the primary kit and cannot be used alone (Redmond 2005).

DMATs have an anticipated load of 250 patients per day along with medical operations, pharmacy, supplies and medical equipment. The field set up is quiet similar to a small ED with adjacent clinic responsibilities (Hogan, Rega & Forkapa 1992).

The vast majority of the patients seen by EMATs following the Chi Chi earthquake were triage category 3 and 4 patients (4 point scale) involving minor lacerations, contusions and non-trauma complaints such as viral illnesses, with few critically injured patients. This appeared to be in contrast with what was anticipated and evident on review of equipment brought verses equipment used (Hsu et al. 2002).

Equipment for the critical care components, especially retrieval, should include monitoring technologies that overcome the limitations of noise. This must include automated blood pressure monitors, oxygen saturations, end tidal carbon dioxide, limited electrocardiography, and ventilators with variable minute volumes over a wide range of barometric pressures. Infusion devices must be robust with extended battery life and compact size. Point of care laboratory testing is needed. Drugs must include analgesia, sedation, vasoconstriction, inotropic support, vasodilation and neuromuscular blockade (Dries & Perry 2005).

The diagnostic equipment consists of a small ultrasound device, point of care laboratory testing and portable bronchoscopy. Other equipment includes monitoring devices, infusion pumps and ventilators (Grissom & Farmer 2005). Kubota et al. (2003) compare the use of point-of-care testing systems in disasters with hospital based analysers. This is more applicable as a backup for a hospital based response but may bear consideration for international assistance teams (Grissom & Farmer 2005).

The Bali bombing retrieval team found that their stocks were exhausted quickly on arrival in Bali. They had initially taken 11 units of blood and 90 litres of crystalloid, lasting 20 minutes and 3 hours respectively. All types of drugs including antibiotics, tetanus vaccines, narcotics and ketamine ran out (Read & Ashford 2004).

An important role of the pharmacist is to develop a cache of drugs to be used (Gaudette et al. 2002). The WHO's emergency health kit contains basic drugs (Bremer 2003), and other resources include the Pharmaceutical and Medical Equipment List for Disasters which details the drugs and medical supplies necessary for 500 persons for 3 days in a disaster affected population of 50,000 (Abrahams 2001), and the Australian Pharmaceutical and Medical Equipment List for Disasters (Australian Medical Disaster Coordination Group 1998).

Refrigeration for special drugs needs to be considered as does security of controlled substances (Gaudette et al. 2002). Tetanus immunisation needs to be available for workers during the phase of debris removal. However, vaccines that are not part of the affected countries basic immunisation scheme should not be sent without prior approval from the national coordinating institution (PAHO/WHO 1999).

Effective pain management is one of the benchmarks for doctors'in a crisis, disaster or war, and must be simple, effective and inexpensive. Centrally acting analgesics should be the minimum available in a disaster (Domres et al. 2003). Narcotic analgesia is always in short supply and may be impossible to obtain locally (Roshchin et al. 2002). Emergency workers also need to take care if such drugs are imported and used in a crisis (Domres et al. 2003). Ketamine was seen as an ideal anaesthetic agent during the Bali bombing retrievals (Read & Ashford 2004) because it had easy administration (intravenous, intramuscular or subcutaneous), a wide margin of safety, gave both analgesia and anaesthesia, and allowed the anaesthetist to delegate care to the surgeon and an unqualified carer while they looked after other patients (Read & Ashford 2004; Taylor, Emonson & Schlimmer 1998).

Commercial polyethylene 'clingfilm' was seen as the ideal dressing after the Bali bombings as it was compact, allowed easy surveillance of the burns and made recall of burns patterns in different patients easy to recall (Read & Ashford 2004).

Medical records were difficult to maintain in Bali. Writing on patients with indelible markers was the only reliable method but these became difficult to use because of humidity and sweat. Waxed and waterproof ADF 'Casvac' cards were used when possible, but not understood by civilian staff (Read & Ashford 2004).

4.4.5 Support

Although the medical needs of the affected population may be great, the lack of non-medical necessities is usually the most immediate threat to life.

4.4.5.1 Drinking water

An adequate amount of reasonably safe water is generally preferable to a lesser amount of pure water (Redmond, 2005a). A minimum of 3 to 5 litres/person/day is needed for survival, with 15 to 20 litres for fluid replacement, personal hygiene, cooking and sanitation (Abbott 2000).

Water supplies for both team members and patients need to be included in plans for self-sufficiency. Basic water safety methods include boiling for at least a minute, however in many disasters fuel supplies may be limited, and chemical disinfection of water using sodium hypochlorite solution, iodine or halogen tablets (Abbott 2000). The Canadian DART can provide clean water for thousands of people with its reverse osmosis water purification (Braham et al. 2001).

4.4.5.2 Sanitation.

Sanitary disposal of human waste is essential to prevent the contamination of water supplies and the spread of communicable disease by insect or rodent vectors (Abbott 2000). As a basic guide, this should consist of one latrine seat per 20 people, with each dwelling no more than 1 minute's walk from a toilet, and a communal refuse pit measuring 2 x 5 x 2 metres for every 500 people (Redmond, 2005a). Chemical toilets (1/20 to 25 people) or pit toilets are alternatives (Abbott 2000).

Medical and other biohazard waste must be handled and disposed of carefully (Abbott 2000).

4.4.5.3 Food

Locally prepared food with local ingredients is best received by patients and also supports the local economy. The minimum level is 2100 kcal/day (Redmond 2005a).

4.4.5.4 Shelter

Temporary housing should be avoided, and permanent shelter established as soon as possible. The minimum floor area is 3.5 meters squared per person (Redmond 2005a).

4.4.6 Logistics and Cost

The Israelis have found that with aero-medical repatriation of injured nationals, the type and amount of equipment needs to be tailored to the specific needs of the assignment. A basic key has been calculated and presetting can be done with final fit-out based on information from the forward team (Marmor et al. 2005). Sullivan et al. (1999) in analysing over 6 years experience of providing medical coverage at an air show, found that comprehensive care can be offered if existing equipment resources are supplemented by expendable supplies from a pre-determined list.

Pre-determined lists have multiple benefits:

- It prevents material being left behind: one quarter of the teams responding to the Chi Chi earthquake left for the disaster sites without a prior designated disaster cache. Although they consisted of emergency medicine and surgical specialists, teams were often unable to perform procedures due to a lack of supporting equipment or power (Hsu et al. 2002).
- The value of pre-loading supplies has been previously learned from other disaster response teams and deployments, and is a good way to get all the equipment loaded in a timely manner. Pallets can be wrapped with shrink wrap cellophane to secure the contents (Cohen & Mulvaney 2004).
- Pre-packaging also means equipment manifests can be prepared in advance to help smooth international travel and customs procedures (Holland & Wooster 2004).

Given the need for large volumes of supplies and the low likelihood of use, there are cost considerations. A loan arrangement with a supplier, with the return of unused supplies, is particularly convenient and economical (Sullivan et al. 1999).

SMART has identified essential equipment and quantities required from experience. They maintain storage and requisition lists within the South Manchester Health Authority, and one phone call to the duty stores manager activates the mobilisation of equipment. A similar process secures the personal medical kits and drugs from pharmacy. This system ensures that equipment and drugs are part of district supplies, and so are constantly turned minimising wastage (Redmond, Watson & Nightingale 1991). This equipment system is important as there is no ‘up front’ funding as, unless the British Foreign Office agrees and refunds all costs in full, funding comes from within existing resources (Redmond, Watson & Nightingale 1991).

MATS from Cincinatti maintain their supplies separately for a more rapid response, but drugs and supplies are rotated every 6 months by Red Cross nursing personnel

(Gates et al. 1979). The provider must expect that not all of the equipment will be returned, especially equipment sent ahead of the response team (Abrams 1990).

Stock rotation is not just important from a cost perspective, but also for functionality and product expiry. The SDMAT tasked to hurricane Charley found that their equipment had been in storage for a number of years and had begun to deteriorate. Equipment and supplies had not been routinely rotated or recycled. Plastic and rubber materials had begun to deteriorate, and some stock has expired. Some federally issued equipment did not meet changes in safety standards, such as needleless intravenous lines (Cohen & Mulvaney 2004).

All equipment should be drained of fuels and oils and pre-packed in air transportable crates. Having equipment pre-packed in cases that can be carried by hand allows aircraft to be loaded and unloaded without the need for machinery, and the team to go in and out of the disaster zone in small vehicles. The IMSuRT transported equipment in wheeled, hard sided case ('pelicans') which were easy to transport but still need manpower to move. They also transported multiple pallets of bottled spring water, a waterless cleaner, generators and portable hands-free battery-powered headlights. The hospital used latrines and a small tent for a toilet. Biohazard bags were used and individuals were responsible for disposal. The DRASH used oxygen concentrators to save space rather than bulky oxygen cylinders. The surgical table was a cot-like stretcher placed over metal saw horses. The hard sided pelican boxes were used as a back table during surgery. An anaesthetic machine and monitoring equipment along with drainage bags, chest drains were all stored in theatre as well. The IMSuRT kept drugs and equipment in roll-out nylon hanging bags of their own design (Gaudette et al. 2002).

Lists and pre-packing also prevents the problems that faced a US EMEDS team when they arrived to find their equipment in no apparent order. Equipment should be packaged according to functional area to make operational set-up faster and easier (D'Amore & Hardin 2005; Owens, Forgione & Briggs 2005).

The logistical challenge is evident when the size of the load is reviewed. There was a major need for self-sustainability after the tsunami in Banda Aceh. The task force deployment included 17 tons of medical and logistics equipment on 16 pallets, including pharmaceuticals, generators, lighting, tents, water and ration packs, completely filling an RAAF 707 (Cooper 2005).

4.4.7 Specific Items

Each team member must be able to use all the equipment (Holland & Wooster 2004). Galvin (2000), from his experiences in East Timor, describes his two most important pieces of equipment as his 'Leatherman'® tool and his headlight (with spare batteries).

4.4.8 Example of DMAT Cargo

The basic load for DMATs can occupy at least 6 military pallets on a cargo aircraft. Included in this load are the following:

- General equipment
  - large commercial or general purpose military canvas tents
  - generators and associated power distribution systems
  - lighting
  - water purification systems
  - water
  - fuel
  - food (normally ready-to eat meals)
  - latrines
  - shower and sinks
  - safety, communications, and computer equipment
- Medical equipment
  - monitor/defibrillators
  - ventilators
  - portable ECG machines
  - pulse oximeters
  - small point of service laboratory analysers
  - minor surgical kits
  - wound and orthopaedic stations
  - intravenous set ups
  - minor care stations
  - observation unit supplies
  - large cache of medical disposable supplies
  - associated housekeeping equipment (Hogan, Rega & Forkapa 1992; Moore & Blasser 1991).

4.4.9 Communication and Information Technology

Information technology is playing an increasingly important role in information sharing during disasters, which is not surprising given the frequency that communication and coordination are cited as major problems during disasters (Arnold et al. 2004; Bradt, Abraham & Franks 2003; Chan et al. 2004; Mathew, 2005), including both technical and organisational considerations (Noji et al. 2001).

Team members need to have the equipment to reliably communicate with coordination centres locally and at home, with other team members (Holland & Wilson-North 2005), and with family in the outside world, which greatly aids morale (Cohen & Mulvaney 2004). As an example, Rapid-UK carries radios with the ability to change frequencies or operate underground, satellite phones, laptop computers and printers, a fax machine, GPS and general office stationary (Holland & Wilson-North 2005).

Arnold et al. (2004) suggest the use of needs assessment applications, database, messaging, localisation and directional geographical information, and event logging systems as future directions. A successful example was the use of SUMA (see page 29) to track donated supplies in disasters (Arnold et al. 2004).

Personal Digital Assistants (PDA) have been used in support of information sharing in out-of-hospital activities including routine EMS and public health use, and database

access for chemical disasters (Arnold et al. 2004). A PDA-based drug information program and database was found to be useful for determining replacement drugs for those who had lost their supplies and for their own stocks (Gaudette et al. 2002).

The development of wireless and satellite communications systems is helping to overcome the problems of access to communication technologies in developing countries without telecommunications infrastructure. Satellite communications has been used for telehealth in India and disaster management in large remote areas (Anderson et al. 2001; Mathews 2005). The further development of wireless technology and peer networks may offer increasing solutions (Arnold et al. 2004; Bradt, Abraham & Franks 2003).

Mobile phones were used as the main source of information following the Chi Chi earthquake, but once batteries failed there was a communication vacuum. Satellite phones should be considered (Hsu et al. 2002). A DMAT had difficulties communicating with the 'outside world' while still in the USA. Only a few team members had mobile phone capacity or portable radios to receive news reports. Batteries and recharging were also problematic (Cohen & Mulvaney 2004).

It is worth noting that there are applications, communications and security challenges with the use of any technology (Arnold et al. 2004). Confidentiality can be a problem with non-secure networks, as a UK team found when CNN listened in on their mobile phone conversations (Braham et al. 2001)

To achieve a broadly-based, proficient handling of communications technology, it must be appropriate, easy to use, meaningful to the user, and capable of overcoming language and cultural barriers (Anderson et al. 2001; Chan et al. 2004).

4.5 Security

Security is an increasing concern for humanitarian aid and disaster relief teams. There is a clear perception amongst relief workers that safety and security are becoming worse (Brennan et al. 2001; Burkle et al. 1995; Holland & Wooster 2004; Schull et al. 2001; VanRooyen et al. 2001b).

The major cause of death and injury among humanitarian staff was reportedly motor vehicle accidents during the 1970s and 1980s (Birch & Miller 2005; Brennan et al. 2001), but the commonest cause of death in the most recent study was violent trauma including gun shot, shrapnel and land mine wounds (Brennan et al. 2001). In an analysis of 382 deaths, Sheik et al (2000) found that death from intentional violence accounted for 67% of all humanitarian workers deaths with the number of deaths due to hostile acts increasing.

Some types of disaster are becoming increasingly hostile (Birch & Miller 2005). The breakdown of local structures and security problems make relief activities in armed conflicts very different to those following a natural disaster (Russbach 1990). Combatants in complex humanitarian emergencies increasingly regard the medical workers as targets (Bricknell & MacCormack 2005).

It is vital that the security of the humanitarian community be given a high priority (Bricknell & MacCormack 2005). There needs to be a clear understanding of who

is responsible for security issues, and organisations need to brief staff appropriately (Birch & Miller 2005).

Security courses are available and should be considered (Birch & Miller 2005). The WHO advocates that health workers who are often on the front lines of assistance to internally displaced persons have the knowledge and skills needed to ensure not only their health, but the right to security and protection as well. Moresky et al. (2001) found that only half the NGOs surveyed provided training or resources for security preparedness.

Other security measures include:

- **Curfews:** After the Iran earthquake SMART members were not allowed to stay in the local hospital overnight (Redmond, Watson & Nightingale 1991).
- **Driver training:** Rules about who should drive and when may be difficult to follow (Birch & Miller 2005).
- **Negotiation:** The 'Health as a Bridge for Peace' program focuses on training health workers in humanitarian law, political analysis and negotiation (Leus 2000).
- **Security:** Security commonly entails civil military interaction, but defining and obtaining security remain a polarising issue in humanitarian assistance (Bradt, Abraham & Franks 2003). Teams based on military models find the integration of security much easier to achieve. The Canadian DART combines a security force as part of their medical response (McCurdy, 1999), as do the IDF medical teams on international deployment (Amital et al. 2003).

4.6 Language and Culture

4.6.1 Language

Communication is an essential and important part of medicine, and the most common problem identified in the reviews of most disasters, as well as the basis for most complaints in standard clinical medicine (Arnold et al. 2004; Braham et al. 2001; Chan et al. 2004; Gerace, 1979; McEntire, 1998).

Being able to communicate well is important (Gaudette et al. 2002) and teams must be able to communicate with the local population (Russbach, 1990). Language barriers are common in international deployment both with the local population and other international disaster teams (Noji et al. 2001). The language barrier is a cause of stress for responders with the provision of translators alleviating that stress (Bar-Dayan et al. 2005c).

Solutions identified and used by disaster teams include the following:

- **Using bilingual staff:** About half the NGOs surveyed had a language requirement (Moresky et al. 2001), while disaster teams from bilingual countries are at a 'cultural advantage', such as the Canadian DART members who are fluent in both English and French (McCurdy 1999).
- **Offering language training:** In the NGOs surveyed by Moresky et al. (2001) only about a quarter reported teaching the language of the region, mainly due to time constraints (Moresky et al. 2001). US Peace Corps members are required

to undergo 3 months of intensive language, culture and humanitarian operations training before they set out into the field (McEntire 1999).

- **Use of interpreters:** Interpreters are critical assets (Schnitzer & Briggs 2004) and, in the survey by Moresky et al. (2001), 72% of NGOs provided interpreters. Some teams recognise the added advantage of hiring local interpreters (Redmond, Watson & Nightingale 1991), who may act as local cultural advisors, improving integration with local services (McCurdy 1999). The RDRTF couples aid providers with local colleagues, increasing efficiency and minimising organisational conflicts as well as cultural and linguistic misunderstandings (Vanholder et al. 2001).

4.6.2 Cultural Awareness

Cultural sensitivity is an important but often overlooked area which may impact on the ability to integrate team response with local organisations (Moresky et al. 2001), hence a need to incorporate the local culture into plans (Roschin & Mazurenko 2000). Team members need to understand local culture and pre-deployment reading may assist this (Birch & Miller 2005). About two thirds of NGOs surveyed provided information about the region being deployed to, usually only in the form of reference materials, but only half provided any form of cultural sensitivity training (Moresky et al. 2001).

If staff cannot agree with aspects of local culture they must seek advice and ask how it will affect those being assisted (Birch & Miller 2005). The SMART included 4 women on their mission to the 1990 Iran earthquake who wore Islamic dress throughout the stay, from when they boarded the flight in London (Redmond et al,1991). The IMSuRT to Bam ensured separate treatment areas for males, females and children, female team members avoided directly treating any male patients, and women covered their heads (Owens, Forgione & Briggs 2005).

The Ukrainian team to the Gujarat earthquake, however, failed to appreciate some of the cultural differences such as patients needing to be examined in the presence of their family, and female patients only by female physicians with no male present (Roshchin et al. 2002).

4.7 Health Preparation Prior to Deployment

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

- Immunisation, particularly tetanus, needs to be current (Abrams, 1990; Birch & Miller 2005; Bricknell & MacCormack 2005; PAHO/WHO 1999).; suggested immunisations, based on the DART experience in Canada, are diphtheria, pertussis, tetanus, polio, and also immune serum globulin for hepatitis A and B, typhoid, cholera and tuberculosis (McCurdy 1999). This should be considered in light of the deployment location, and guidance sought from specialist areas such as travel clinics (Birch & Miller 2005).
- Measures to prevent insect bites (Bricknell & MacCormack 2005; Wallace, 2002); agencies need to ensure staff have insect repellent, impregnated mosquito nets and suitable clothing (Birch & Miller 2005).
- Sunscreen (Wallace, 2002).

- Chemoprophylaxis against malaria (Birch & Miller 2005; Bricknell & MacCormack 2005).
- Adequate stocks of personal medications (Abrams 1990); a 2-week supply is suggested by DAMTs (Wallace, 2002).
- Advice about what other drugs to take (Birch & Miller 2005).
- Potentially use of body armour in areas with high security risk (Bricknell & MacCormack 2005).
- Security of food and water should also be considered prior to deployment (Bricknell & MacCormack 2005).
- Arrangements for medical care and evacuation if needed (Birch & Miller 2005).

4.8 Recognition, Reward, Insurance and Indemnity

Team members need to have job security and be safe from financial penalty and medico-legal liability, as well as have personal financial protection for themselves and any dependants (Abrams, 1990).

The process of 'federalising' DMAT members for operational deployment eliminates a number of potential problems (NDMS 2006; Roth 1993; Stopford 2005; Wallace, 2002):

- Health care personnel are allowed to practice in areas other than where they are licensed as, when activated, their professional licenses and certifications are recognized in all states.
- Liability issues are covered by the Federal Tort Claims Act in which the Federal Government becomes the defendant in the event of an interstate malpractice claim (NDMS 2006).
- Federal Workers Compensation Insurance coverage is enabled.
- Rostered NDMS personnel are covered by the Uniformed Services Employment and Reemployment Rights Act that protects other uniformed service reservists for job protection (Roth 1993; Stopford 2005).

Team members are also compensated by federal wage guidelines according to their government equivalent pay grade, although local and state activation of DMATs may not be covered by this process, depending on the arrangements with various agencies (Wallace, 2002). In return, DMAT members are required to maintain appropriate certification and licensing within their discipline (NDMS 2006).

Liability is another contentious issue. Trotter (2003) argues, based on Morriem's classification of duty, that it is difficult to hold government powers accountable for their many resource and expertise duties. This difficulty is compounded further by political arrangements that foist under-funded mandates for disaster services on healthcare providers.

5 PERSONAL PROTECTION EQUIPMENT (PPE) AND COMFORT PACKS FOR TEAM MEMBERS

5.1 Personal Equipment

Rapid-UK, a British based international search and rescue team, issues each team member with an individual kit as well as items of personal choice. Each operative must be self-sufficient for 24 to 48 hours and needs to carry a day sack holding items such as safety equipment (helmet, gloves, goggles, dust masks), access equipment (rope, descender and karabiners), torches (head and hand), spare clothing, waterproof clothing, water, food, first aid kit and bivvy bag. In addition each individual has an 80-litre bag to carry larger items such as a personal tent, sleeping bag, sleeping mat, clothing and day sack restock items (Holland & Wilson-North 2005).

This dual bag approach is also used by US DMATs. One bag contains everything the member needs for the first 3 days and can be used in the event the remaining bag is delayed during transport (Cohen & Mulvaney 2004). Each DMAT member is responsible for carrying their own gear with weight limitations of 30 kg for warm weather and 40 kg for cold weather (Wallace 2002).

DMATs provide a minimum suggested personal equipment list including, with local conditions and the nature of the deployment being taken into account when organising equipment:

- uniforms
- long underwear (polypropylene)
- heavy jacket (cold weather type)
- gloves (polypropylene)
- light jacket
- heavy sweater
- rain gear (gortex)
- weather extreme clothing and equipment
- boots (steel shank and toe, water resistant)
- personal safety clothing and equipment
- photo identification and passport
- towel and washcloth
- personal grooming and hygiene kit
- two sets of eyeglasses
- sunglasses
- torch
- watch
- hearing protection earplugs (ANSI S.3.9-1974)
- personal funds and credit card
- bottled water (32 to 64 oz)
- 2-week's supply of personal medications, sunscreen, insect repellent

Plus the following if working in hazardous conditions

- hard hat
- light helmet
- heavy work gloves
- eye protection (ANSI 287.1) (Wallace 2002).

This prior organisation of equipment lists is also an essential part of both wilderness and expedition medicine in order to minimise weight and volume of packs, and to ensure essential items are not forgotten. As an example, not all the IMSuRT members deployed to New York after September 11th had wet weather gear, so had to wear rubbish bags as protection (Gaudette et al. 2002).

5.2 Identification and PPE

To prevent the confusion, the identification of the medical on-site coordinator and other members of medical teams should be simplified using colour-coded hard hats and clothing (Gates et al. 1979; Gerace 1979; Noji et al. 2001). A logo on team clothing acts as an identifier (Noji et al. 2001) and helps 'to promote esprit de corps' (Zavotsky, Valendo & Torres 2004).

If subject to working in hazardous conditions, a hard hat or light helmet, heavy work gloves, eye protection and safety boots that all meet appropriate standards are also needed (Wallace 2002). Flight staff involved in aero-medical disaster work need to have helmets with visors, long sleeved Nomex uniforms, flame retardant gloves, leather high-top boots and hearing protection (Grissom & Farmer 2005). Use of body armour should also be considered in areas with high security risk (Bricknell & MacCormack 2005).

The Accident Flying Squad, a mobile medical team based in Edinburgh, usually responds to local incidents but was deployed to the Lockerbie bombing, after which it was noted that their PPE was inadequate (Steedman et al. 1991). They now have had all-in-one thermal overalls, structurally reinforced and fire resistant helmets instead of 'Bump hats", and gloves and safety boots, all approved to fire and rescue standards.

Tracking devices and clinical sensors have also been proposed and tested for on-scene providers at disasters. Wrist band status devices, which monitor vital signs and position, have been trialled in the military. It has been proposed that these could also incorporate detection devices for chemical or radiological hazards (Chan et al. 2004).

It is important that staff are familiar with all issued equipment; most IMSuRT members deployed to New York after September 11th had never worked in hard hats or masks, and found it difficult (Gaudette et al. 2002).

5.3 Personal Comfort, Hygiene and Health on Deployment

5.3.1 Food and Water

Food and water safety is important. Hazards include lack of hand washing facilities, inadequate refrigeration, use of unsafe ingredients and improper temperature controls. One of the urban search and rescue teams responding to the Oklahoma City bombing all suffered from food poisoning (Abbott 2000).

Water safety methods include boiling for at least a minute (although fuel supplies may be limited) and chemical disinfection of water using sodium hypochlorite solution, iodine or halogen tablets (Abbott 2000). The Canadian DART uses a reverse osmosis water purifier capable of mass water production and maintains chlorination of water to 'home' standards.

They also supply rations airlifted weekly from Canada (McCurdy 1999). Other teams use prepared meals such as the US Military 'Meals Ready to Eat' which can be eaten hot or cold (Owens, Forgione & Briggs 2005).

In larger operations, a self-serve area with food and water can be maintained for staff and workers enabling ready access by staff (Gaudette et al. 2002). Providing catering facilities for responding staff must be complemented by organised and enforced breaks, as staff will be reluctant to ask for rest, food or water while they perceive there are victims in need of assistance (Nocera 2000).

5.3.2 Rest and Fatigue Management

Both physical and mental fatigue are major problems during prolonged rescue and recovery operations, and it is important to develop measures to minimise fatigue (Nocera 2000). Fatigue analysis systems, screening key personnel, have been used in disasters (Scott-Findlay 1975).

Adequate rest is often difficult as teams work in 12-hour shifts at a minimum, and are often exhausted after 5 days. Leisure time activities are also often limited due to safety concerns, power shortages, curfews, transport difficulties and the closure of local businesses (Cohen & Mulvaney 2004).

The temptation is for off duty staff to 'hang around'. This should be discouraged, and sufficient breaks should be taken as they contribute to good relationships in the field, although such breaks may need to be enforced (Birch & Miller 2005; Nocera 2004; Wallace 2002).

5.3.3 Healthcare of Team

Birch stresses the need for taking care of your own health (Birch & Miller 2005), but this is also a responsibility of the team leader and the lead agency. Team leaders must watch for and recognise stress, both environmental and mental, and must monitor for illness and injury among members (Wallace 2002). There should also be limitations on the physical activity of team members, such as not using older team members with bad backs as stretcher bearers (Moore, Eng & Daniel 2003).

Attention to fluid balance, rest breaks and a paced approach may avoid injury and illness early in the mission. As the mission proceeds, lack of sleep, missed meals, long shifts and exposure to infections may result in some members becoming sick, which can be excerbated by environmental and weather extremes (Cohen& Mulvaney 2004; Wallace 2002).

A medical cache specifically for team memebers only should always be available (Wallace 2002); Yoshinaga et al. (2003) found that the Japanese Disaster Relief team members had different health problems to the disaster victims.

Agencies also need to ensure that staff have insect repellent, impregnated mosquito nets and suitable clothing. Clear guidance is available from specialist areas such as travel clinics (Birch & Miller 2005).

5.3.4 Morale Management

Some teams have difficulties communicating with the outside world. Only a few have mobile phone capacity or portable radios to receive news reports, and batteries and recharging can also be problematic (Cohen & Mulvaney 2004). There is also a need

for planning for extended operations in disaster response, including the provision of rest cycles, food, temporary accommodation and rest areas for staff as an aid to management of stress and morale (Lee et al. 2000).

5.3.5 Sanitation

Maintenance of personal hygiene is important with sanitary disposal of human waste essential to prevent contamination of water supplies and the spread of communicable disease by insect or rodent vectors (Abbott 2000). Cohen and Mulvaney (2004) note that DMATs found it difficult to maintain good personal hygiene and find clean toileting areas because fresh water was not available after hurricane Charley. This may need to be organised with enforced breaks rather than merely providing the facilities (Nocera 2000).

The US National Guard has portable hand washing, showers and laundry facilities, and chemical toilets (1:20 to 25 people), though pit toilets are another options. Waterless hand sanitisers may need to be used (Abbott 2000).

5.4 Health and Review After Deployment

'All those involved in catastrophes will be changed by the experience' (Palmer 2005).

Reviews and post-disaster appraisals serve 2 purposes; improving performance and helping transition to normal life. In disaster management, personnel appraisals should occur each time a program makes a transition from one phase of a disaster to another, not just at the end of the operation. Appraisals will need to be more frequent in the post disaster environment (Cuny 2000c).

5.4.1 Performance

Performance during routine events may be significantly different to that during an emergency. Some people who appear well suited may 'fall apart', while others who appear less efficient may rise to the challenge. If the appraisal is to help improve performance, formal feedback should be provided to the worker (Cuny 2000c).

5.4.2 Return to Normal Life

An international medical aid worker providing assistance in an unknown and highly disorganised environment may face a formidable personal and organisational challenge unless backed by experience (Campbell 2005).

Repatriation and the return to normal life may be difficult; it is often easier to take part in relief work than to return home (Campbell 2005). In general, the more problematic the deployment, the more problematic the readjustment (Palmer 2005).

The emotional toll on these workers may be high (VanRooyen et al. 2001b). Approximately 90% of responders experience psychological reactions in response to an event, of whom up to 7% may develop post-traumatic stress disorder (Hodgkinson & Stewart 1992).

Experience and support at the time is also important. For example, many of the younger, inexperienced members of the various services involved at Lockerbie were clearly unable to control their emotions. In these instances, when inexperienced

staff are required, they need to be supported and supervised at all times by senior, experienced personnel. All staff should also have the opportunity to talk through their experiences following the incident (Steedman et al. 1991).

Care and support should be provided to relief workers who are experiencing human tragedy and may be stressed, fatigued and trying to provide services with too few resources in an unsafe environment (Campbell 2005; CruzVega et al. 2001). For example, DART members undergo extensive Critical Incident Stress Debriefing upon return to Canada (McCurdy, 1999).

In the USA, a legal precedent has been set for providing psychological support to fire and police personnel who have been emotionally traumatised in their work. Relief organisations have the same responsibilities to their staff (VanRooyen et al, 2001b).

CONCLUSIONS

1 POTENTIAL USEFULNESS OF DMATS

1.1 Anticipated Need for DMATs

Disasters are increasing in frequency. Developing countries not only have more disasters, but less capacity to prepare and respond. Even within developed countries, most hospitals would be unable to cope with anything more than small number of seriously injured patients without outside assistance. It is likely that calls for both international disaster medical assistance and future state or national responses will continue.

1.2 Epidemiology of Disasters

An understanding of disaster epidemiology is necessary to help estimate likely injury patterns, needs and timeliness of response. For sudden onset disasters this normally involves a trimodal distribution of medical problems. The first phase, seconds to minutes afterwards, is characterised by high mortality. In the second phase, minutes to hours afterwards, medical needs are focused on early trauma management, the 'golden' 24-hour period in which most casualties are recovered and most fatalities occur. In the third phase, occurring days to weeks after, the problems relate to complications such as sepsis, psychological damage, management of displaced persons and the lack of essential services. Primary care and the ongoing health care of the population does not stop, needing to be addresses as soon as 24 hours after impact.

There are inherent delays in mobilising DMATs, with most not arriving at least 3 days or more after the event.

1.3 Factors Affecting Efficiency of DMAT Response

Unilateral donations of goods following disasters are often unneeded or inappropriate, diverting resources, both personnel and space, away from the major priorities. Disaster medical assistance is no different.

Limited resources must be matched to the needs of the affected community to ensure an efficient response. This should be based on a rapid needs assessment. Improvements have occurred in needs assessments due to epidemiological study design and sampling techniques, however, they may still be problematic, given difficulties with lack of infrastructure, communication systems and access to the affected area. It is important that the local population is involved in the needs assessment, and that relief efforts attempt to match the needs.

The role filled by foreign DMATs is a controversial area. Traditionally, field hospitals, despite having usually arrived too late for the trauma load, have been military in origin with a trauma focus, and paid little attention to the needs of women and children, or the ongoing medical and mental health needs of the community. The role of field hospitals may be classified as immediate emergency care, primary care, and follow-up trauma and medical care, and replacing damaged facilities. The WHO and PAHO have developed guidelines regarding the use of FFHs which are worthy of mention.

It is essential that there is integration with the existing, local services. This should include all phases of the response and subsequent evaluation, as it may act as a learning process that enhances capacity building, empowers local communities and helps them regain control over their lives. Cultural factors should be considered and respected both in the context of the disaster and the provision of services.

Communication is a consistent challenge due to infrastructure and the interface between multiple agencies. It needs not only to be timely and accurate, but to be shared. Pre-deployment consideration needs to be given to communication strategies, both technical and organisational.

Good leadership is essential in disaster teams, requiring the ability to use a variety of leadership styles depending on the situation. Leadership is not natural for most people, so training should be provided to team leaders and their deputies.

A central authority to coordinate response to disasters is vital. This needs to occur at the local level and, depending on the scale of the disaster, there may also need to be a national body. There are ongoing calls for a central body to coordinate the international response, but no single body seems equipped to do this given issues with jurisdiction, authority, capacity and competency. Successful models have been used for search and rescue and supply management, and internet based networks have been proposed. If these eventuate, it would be important for DMATs to be aware and involved.

1.4 Factors Guiding DMAT Review

Little has been done to study the cost effectiveness of disaster relief activities, including DMATs.

The effectiveness of emergency interventions is also difficult to measure, exacerbated by a lack of available standards, benchmarks and indices. The SPHERE project has been an early effort to achieve this, but measures of both effectiveness and responder competence need to be developed, validated and accepted.

1.5 Incident and Team Reports, and Lessons Learned

Many individual team reports are anecdotal, and the lack of standards make in-depth evaluation difficult for both the external reviewer and team members.

Common issues identified in selected reports are:

- need for accurate information prior to deployment
- appropriate team and equipment selection based on needs and mission
- most international response not arriving until at least day 3 or 4
- needs are mainly medical for teams deployed days after the event, but individual disasters still have their own differences
- need for flexibility in both staffing and configuration
- need for experience and training of team members
- difficulties of language and cultural barriers, and the importance of interpreters
- importance of self-sufficiency across the operation, and the difficulty in locating essential supplies in the affected area

- equipment packed in functional areas, with inventories and checklists
- team members identifiable by their clothing
- need for a clear command structure
- communication strategies, including back up equipment and batteries
- strong logistics and essential services support, including water, power and sanitation
- difficulties in transport both to the affected area and once on site
- guidelines regarding funding, insurance and indemnity issues should be in place before any deployment.

1.6 External Reviews of DMATs

Numerous external reviewers agree that international DMATs often arrive late, are unable to speak the language, require assistance from the local population, and exacerbate rather than relieve the problem.

Disaster medical assistance should, at a minimum, be based on a full understanding of disaster epidemiology and the timeliness of both this and realistic response times. Teams need to recognise what their capabilities are within this time-frame, basing their response on a needs assessment of the affected area/country. Their efforts should match needs rather than be imposed, whether they be immediate or delayed, which entails prior planning with a clear mission of purpose and duration of stay, and an exit strategy.

The response should therefore be of benefit to the local community rather than the donor country/agency, integrate with local services, be culturally appropriate and consistent with local practice. There should be clear lines of communication between the team and both local coordination and an operations centre at home. This entails adequate equipment, organisational policy and leadership. The response should be self-sufficient with respect to not only the needs of the team, but their ability to provide care. This should be at a minimum of 72 hours, but ideally for the duration of their stay. Team members need to be adequately trained prior to the mission and supported during and after the mission. Most of all, there needs to be meaningful evidence based standards developed, and used by all involved.

If this does not occur, the mistakes of previous incidents will continue to be repeated.

2 PREFERRED DMAT FORMATS

2.1 History of DMATs and Overview of Models

DMATs fill a variety of roles such as immediate emergent care, aero-medical repatriation and retrieval, primary care and public health, field hospitals and replacement services. They also operate under a variety of models, both civil and military.

2.2 Civil-Military Issues

Many of the inherent problems in disaster management can be solved through civil and military cooperation. They have often complementary strengths and weaknesses. The military may lack the clinical skills and medical infrastructure of the civil system

but are able to provide essential logistic, transport and security support. However, more work needs to be done on developing closer ties and an active interface between the two. There are significant cultural differences between the military and NGOs in particular, given the inherent political agendas of security forces and the need for NGOs to be neutral.

2.3 Mitigation as a Component of the DMAT model

Disasters and development are linked, and any response to disasters should also include mitigation for the next as part of a wider development strategy. There is a need for collaborative efforts in improving preparedness, especially for developing nations. DMATs should consider including capacity to respond to calls for help with preparedness programs before the disaster as well as noting means to promote mitigation while responding.

2.4 Descriptions of Key Models by Role

With the increase in global tourism, consideration needs to be given to the needs of foreign nationals involved in disasters and the obligation that governments have to both their care and the load that places on the affected country. Models used are mainly military in origin, given the likely security issues, but there is a need for improved interface between military and civil teams, especially during the redistribution phase, and a potential need for a national retrieval network.

Most of the immediate care following a disaster is provided by local personnel and facilities. It is almost impossible for international teams to be able to assist with this given the inherent time delays in requests for assistance, deployment and travel. Improved local assistance may be able to be used for state and national events and smaller more rapidly deployable teams have been proposed for this, although the use of hospital-based disaster teams is controversial.

FFHs must be used in line with guidelines such as those by the WHO if they are to be useful.

Of the identified options in this literature review, the preferred options would be the Canadian DART for a military model or the US DMAT model as the best developed civilian model. The Israeli system, with its collaborative approach to civil-military involvement and their strategic, flexible and needs approach to disaster medical assistance, is an excellent model, but one which would be harder to implement initially although the lessons learned about deployment are readily adaptable.

Using a civilian structure aimed at deployment both intra and interstate, and internationally, needs a critical analysis of its mandate so that operational policy remains functional. This may entail a modular approach with mini-DMATs or ‘strike teams’ for immediate care intrastate and possibly assessment capacity, as well as core functions for larger deployment. A realistic review of response timeliness would guide the structure of team development as to immediate care versus the option of combined primary care and public health, or function as an alternate health care provider when health care facilities have been rendered inoperable.

3 SELECTION OF TEAM MEMBERS

3.1 Overview of Selection Process

The selection of the right person is crucial. This should not be based entirely on skills but also on their motivation and ability to fit into the team. Potential volunteers should also consider the effects on themselves, their career and their family.

3 .2 Selection verses Anticipated Roles

Final team selection should be based on anticipated roles as the skills required are dependant on the type of disaster, the time and timeframe of deployment, and needs of the affected community. The medical needs should be considered as part of the overall response, and team selection should represent this. Non-medical elements such as water engineers, sanitary workers, hygiene specialists, logistics, security and communications experts and administrators all need to be considered. The size of the team is also important as larger teams make travel and logistics increasingly difficult, so team members need be able to fill multiple roles.

3.3 Personal Characteristics

Team members need to have as broad a range of expertise and experience as possible to increase their value and ability to work in a variety of situations. Enthusiastic but inexperienced workers are often of limited benefit and may actually have a negative impact.

Psychological stress is an unavoidable component of disasters and one which is beginning to be understood. There is a need for better training and preparation in stress management for those responding if they are to be able to help not only themselves but others around them. Counselling services should also be made available.

Team members should only deploy if they are in good physical health.

Good team function is essential for the success of a DMAT. There should be a clear understanding of team roles and responsibilities, and efforts made to maintain morale. Understanding group dynamics, conflict resolution and people management are essential skills for team leaders if team harmony is to be maintained.

4 POLICY CONSIDERATIONS FOR TEAM DEPLOYMENT

4.1 Policy Issues for Deployment and Withdrawal

In international politics, assistance is normally offered only if requested. The request for aid has to travel through the appropriate diplomatic channels. This process takes time and leads to inherent delays in deployment. However, humanitarian aid is increasingly being seen as part of foreign policy and bypassing protocol may have significant political ramifications.

Within Australia, protocol and policy must also be followed with state requests to EMA for federal or other state assistance only able to be made by designated authorities. Mutual aid agreements may help to speed response times at all levels; state, national and international.

Once a decision has been made to deploy, there needs to be a clear mandate, exit

strategy and funding arrangement using well defined protocols. There also needs to be a thorough briefing of team members and a fully maintained operational support centre for the duration of deployment. Military models are instructive examples of strong pre-planning.

Significant expenditures will be incurred, depending on the disaster and the type and magnitude of response, along with period of deployment. Costs are multidimensional and include wages, backfill cost, food and accommodation, transport, equipment, training, team administration and insurance.

4.2 Deployment Process

There is a need to respond quickly once a decision has been made to deploy, so teams need to have a response strategy in place that can be activated immediately.

Transport to the affected area is often difficult, and compounded by the number of team members and large amounts of equipment. Government or military affiliation may improve access to transport vehicles, as may prearranged agreements with civil carriers. Bureaucracy also needs to be considered with cargo manifests and documentation prearranged in an effort to simplify customs transit. The UN is also attempting to simplify customs procedures for international humanitarian assistance.

4.3 Training

All groups acknowledge the need for improved training although, currently, training is generally insufficient. Challenges include retention and application of knowledge and skills a long time after instruction, and the ability to apply this in the field, as well as training involving teams and emerging issues such as security. There has been a recent growth in the number of courses available, but there is still a lack of standards available to accredit either courses or their graduates.

4.4 Equipment

The DMAT needs to be self-sufficient in all aspects of deployment for a minimum of 72 hours, and preferably the full duration of deployment. To do otherwise increases the burden on the affected community. This is a major logistical exercise as self-sufficiency should include not just food, water and shelter for the team members, but also medical and communications equipment, and possibly transport and any other materials needed for patient care.

The base camp needs to be rapidly set up, have generators, lighting and cooking facilities, water supplies or filtration unit, sanitation and hygiene systems and general equipment such as tarpaulins, tools and ‘spares’.

Field hospitals should be constructed beforehand, but be adaptable for the specific disaster; most are inflatable or tents. They need to have separate areas determined by the mission, and may include areas for patient assessment, inpatient care, surgery, support services (X-ray, laboratory, pharmacy, supplies), as well as staff areas and amenities.

The team needs to bring all its own equipment based on its role and estimated patient numbers. Size and weight of equipment needs to be carefully considered along with durability, power supply and battery life. Careful thought needs to go to specific issues

such as storage and distribution of scheduled drugs and drugs with a cold chain requirement, as well as disposal of blood and blood products. Often, simple issues such as analgesia, cleaning and sterilisation, and documentation are forgotten.

Although the medical needs of the affected community may be large, the lack of basic essentials is often the most immediate threat to life. Drinking water, food, sanitation and shelter are priorities, and teams need to ensure access to these for themselves, their patients and as much of the local community as possible. This usually mandates the use of staff experienced in these areas as part of the team.

Rapid deployment with large amounts of equipment is a significant logistical exercise. The BASIC load for the US DMATs occupies at least 6 military pallets on a cargo aircraft. Predetermined lists are helpful to speed this process up as long as the equipment is able to be adapted to the specific needs, and be periodically checked and maintained.

The cost of storing all the equipment for the next disaster is prohibitive and also wasteful for perishables, so arrangements with local health facilities or drug companies should be encouraged for either stock rotation or pre-packed central warehousing. Transport arrangements should also ensure that equipment is packed in containers which are solid enough to prevent damage, but small enough to be easily moved at the destination. Equipment should also be packed in functional areas to speed up operational set up on arrival.

All team members should be able to use any essential equipment.

Communication is a frequent and major problem in disaster management. There needs to be the ability for team members to communicate with each other, the local coordinating centre, operational support at home, and the 'outside world' and family. The minimum suggested is laptop computer and printer, radios, satellite phones and GPS, with power sources/spare batteries for all equipment.

Advances in information technology such as PDA and wireless technology offer potential benefits, but for any system to provide meaningful support it needs to be reliable, and easy to use and maintain. As well as technical issues in communication, teams also need to ensure organisation policy ensures clear lines of communication and sharing of information.

4.5 Security

Security is an increasing concern with international deployment. The major causes of death have changed from vehicle accidents to violent trauma. Security measures considered should include curfews, driver training and security courses, along with initial deployment in the first instance.

4.6 Language and Culture

Teams must be able to communicate with the local population and all efforts must be made to achieve this through the use of training and interpreters.

It is important to understand local culture and integrate this into the response.

4.7 Health Preparation Prior to Deployment

Preventive medical actions are necessary prior to deployment. These include appropriate immunisations, measures to prevent insect bites, sunscreen, malaria prophylaxis if needed, adequate stocks of personal medical equipment, and access to other medical supplies/care and medical evacuation if needed.

4.8 Recognition, Reward, Insurance and Indemnity

Team members need to have financial and job security and be provided with medico-legal cover, and adequate workers compensation cover if injured during deployment.

5 PPE AND COMFORT PACKS FOR TEAM MEMBERS

5.1 Personal Equipment

Team members need to be provided with adequate personal equipment to make them safe and comfortable, and to meet the conditions. Equipment lists are recommended as a guide, but team members should also have the ability to include items of personal choice. They also need to remember the weight restrictions so that they can carry their own pack, and split their packs. One bag containing everything needed for the first 3 days makes team members self-sufficient for this period and guards against complete loss of equipment.

5.2 Identification and PPE

Teams need to have adequate identification based on colour codes, names and/or logos. This assists with identification and safety issues at the disaster scene and team morale. PPE adequate for the nature of the deployment environment and training in its use is essential. Future developments may include tracking devices, and clinical sensors which incorporate both vital signs and CBR detection.

5.3 Personal Comfort, Hygiene and Health on Deployment

Personal comfort is an important component of the DMAT. Key items should include mosquito protection, food and water supply and protection, sanitation and hygiene facilities, rest and fatigue management (which may need to be rostered and enforced), and the healthcare of the team. These all contribute to efficiency and morale management, along with the ability to communicate with family and others from the 'outside world'.

5.4 Health and Review After Deployment

There should be a post-disaster review to help improve performance and assist in the return to normal life. Feedback about performance needs to be given, as well as an opportunity provided by management to hear feedback from the DMAT members. The more difficult the deployment, the more difficult the transition and the emotional toll may be high. Care and support needs to be provided to workers and there is now a legal precedent for this in the USA.

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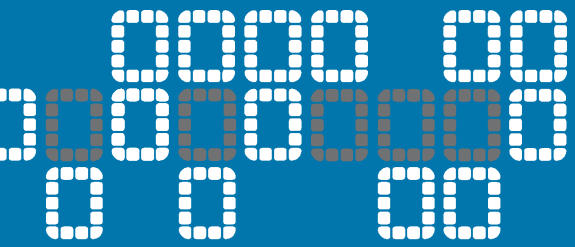

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