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Considerations in Mass Casualty and Disaster Management

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1. Introduction

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

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

The aim of this chapter is to:

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

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

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

2. Definitions

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

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

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

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

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

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

Fig. 1. Examples of Disaster Definitions.

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

3. Epidemiology of disasters

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

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

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

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

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

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

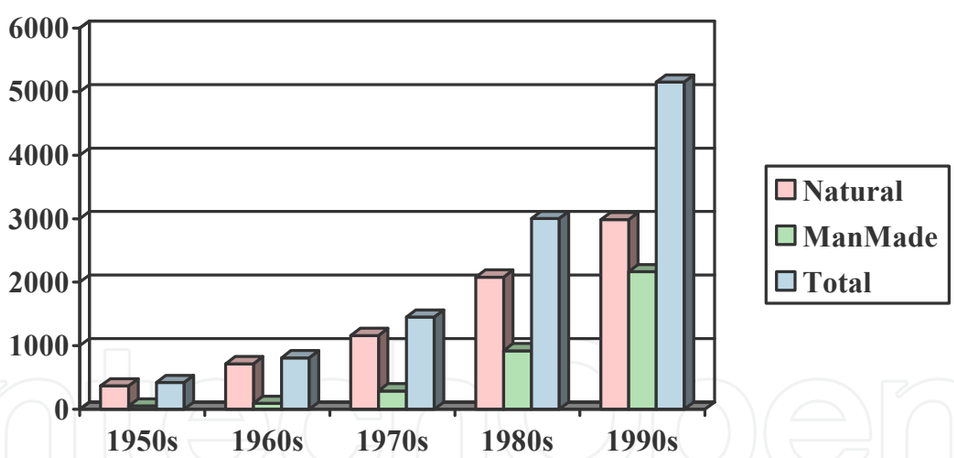

Fig. 2. Frequency of Disasters Each Decade.

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

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

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

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

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

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

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

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

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

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

Table 5. Basic Societal Functions as Defined by WADEM.

4. Major principles of care

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

4.1 Disaster models

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

4.2 Comprehensive approach

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

4.2.1 Prevention and mitigation

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

4.2.2 Preparedness

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

4.2.3 Response

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

4.2.4 Recovery

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

4.3 All agencies

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

4.4 All hazards

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

4.5 Prepared community

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

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

4.6 Risk management

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

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

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

Fig. 3. Risk Management using Risk Tables.

4.7 Resilience

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

5. Common problems

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

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

5.1 Communication

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

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

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

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

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

5.2 Command, control, coordination

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

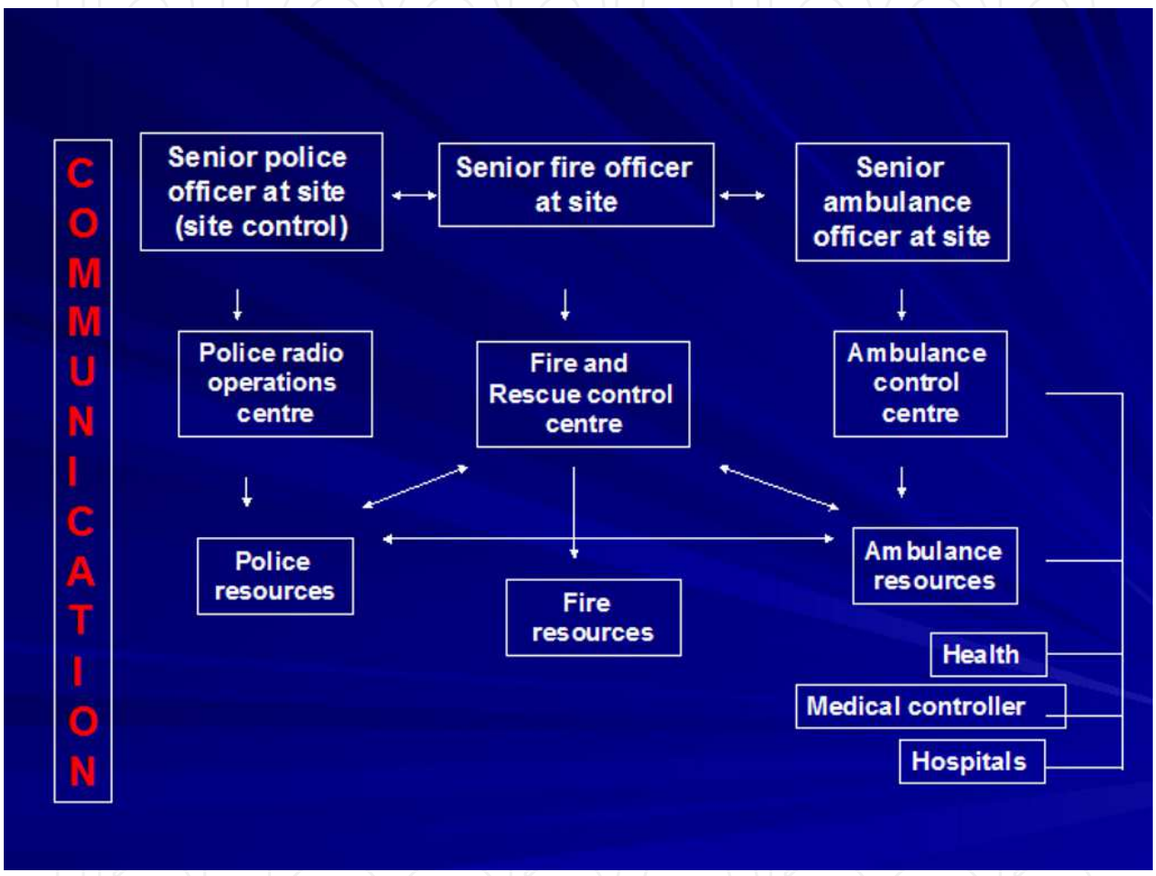

Fig. 4. Command, Control and Coordination.

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

- It operates vertically within an organisation.

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

- It operates horizontally across organisations.

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

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

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

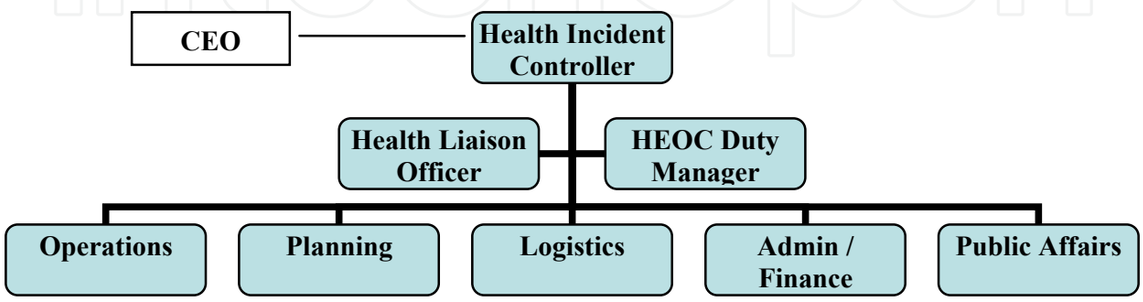

Fig. 5. Typical ICS Structure.

5.3 Activation procedures

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

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

5.4 Surge management

Health systems need to be able to expand their capability as part of disaster response. This can be thought of in terms of "space", "staff", "stuff" and the "system" (Kaji et al., 2006). Table 6 summarises a number of suggested approaches to surge management across this spectrum. Each facility is different however and strategies need to be developed that recognise local issues including barriers and potential solutions. Staff action cards should

include some of these tasks as key prompts. Expert working groups have also developed 'surge cards' that summarise key emergency department actions to facilitate surge management both before and during an incident (Bradt et al., 2009).

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

Table 6. Surge Management Strategies.

5.5 Vulnerable groups

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

5.5.1 General community

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

5.5.2 Vulnerable groups likely to impact on directly on the ED

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

5.5.2.1 Those who are dependent on power supplies

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

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

5.5.2.2 Those dependant on home support

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

5.5.2.3 Those with chronic disease

Many chronic diseases may be exacerbated by the stress of involvement in a disaster. This may include increased presentation rates of patients with ischaemic heart disease or unstable diabetes for example. The other 'chronic disease' worth noting is drug use. In the early stages of large disasters there may be increased presentation of patients with acute drug withdrawal as supply lines are interrupted. The logistic supply chains of drug supply

are remarkably effective and ingenious however and this phase is usually short lived. It may in fact be replaced by presentations with overdose due to either overly enthusiastic use patterns or the introduction of stronger substances from different suppliers filling the market gap.

5.5.3 Vulnerable staff

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

5.6 Recovery

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

5.7 Post incident review and debrief

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

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

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

5.8 Planning

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

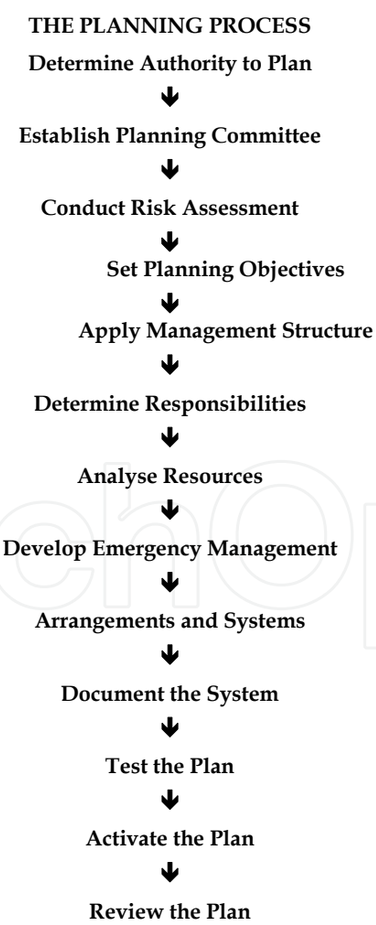

Fig. 6. Approach to Planning (based on EMA approach).

5.9 Education, training and exercises

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

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

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

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

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

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

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

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

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

5.10 Research, evidence and standards

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

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

5.11 Media management

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

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

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

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

6. Mass casualty management

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

6.1 Site management

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

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

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

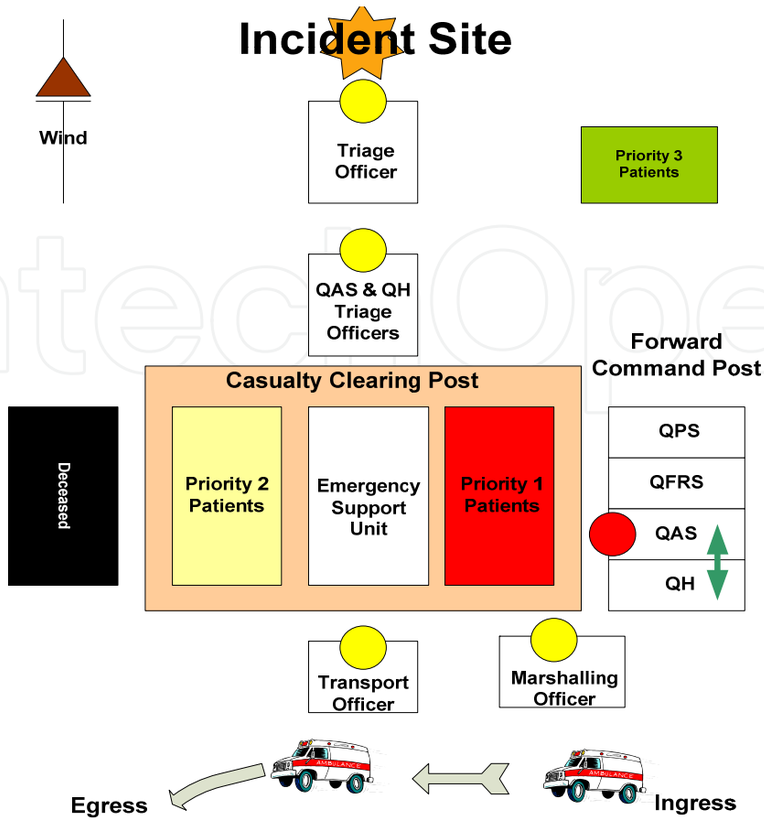

Fig. 7. Site Structure. Legend: QAS = Ambulance; QFRS = Fire and Rescue; QH = Health; QPS = Police (Source: Queensland Health, 2011).

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

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

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

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

6.2 Triage

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

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

Fig. 10. Summary of Triage Systems.

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

6.3 Care on site and casualty clearing post

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

Safety of treatment site and Personal Protective Equipment (PPE)

Simple and restricted clinical procedures

Maintenance of cardiorespiratory functions

Haemorrhage control – prevention of shock

Specific antidotes as indicated or available

Splinting fractures

Dressing wounds/burns

Adequate analgesia

Fig. 11. Elements of care on site.

6.4 Transport

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

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

6.5 Disposition

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

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

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

6.6 Care in the emergency department and the hospital

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

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

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

Whole of hospital activities include:

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

Myths to be aware of include the following examples:

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

6.7 Volunteers

Volunteers may be a useful resource or a minefield of regret if not managed properly. Consideration should be given in advance to how best to manage these arrangements. This can include pre-event credentialing of local medical and nursing practitioners as well as

standing arrangements to grant emergency credentialing powers to individuals under and approved process. The reasons for ensuring this occurs includes:

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

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

6.8 Predictors of numbers

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

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

A special consideration is the potential for patients to be involved in chemical, biological or radiological

Incidents (CBR). This may occur as a discrete incident in its own right (e.g. chemical spill, nuclear reactor incident) where the causative agent is easily identified or as part of a more complex scenario involving a 'dirty bomb'. In this scenario biological or radiological material is mixed in with a standard explosive device.

A CBR scenario poses a series of new, and different, concerns. These include:

- The ability to ensure decontamination prior to entry to ED
- Who provides decontamination – is this hospital staff or fire services?
- What happens to any residual run off? Is simple dilution sufficient for all substances?
- The provision of PPE to ED staff – and ensuring they are trained in use of equipment
- The ability to offer antidotes to staff and patients if exposure has occurred

The level of preparedness of most ED, for a CBR event has been questioned (Caldicott et al., 2008).

7. International humanitarian response

Emergency physicians may play a role in international response. Key considerations include:

7.1 International diplomacy and politics

The affected country must, first invite international teams that deploy overseas. Failure to wait for this, despite good intentions, may result in diplomatic incidents and can even considered being invasion. The process for securing diplomatic approval may take days, and while clinical staff may feel frustrated by this delay, failure to do this prior to arrival, may result in teams being refused entry, spend hours or days at airports or ports or even returned home. Similarly, their equipment may not be allowed entry with significant effects on the team's effectiveness.

It is also likely there will be increased calls for disaster medical assistance from developing countries. (McEntire, 1998; Lennquist 2004; Burkle 2001). This is underpinned by the precept that health and security are a basic human right (Judd, 1992; WHO, 2005). There have also been changes in how disasters are viewed by the world community with disaster relief being seen not as a magnanimous gesture but as a humanitarian obligation and claimed as a right by affected countries (Gunn, 2005).

While cost effective mitigation is seen as the key to natural disasters (Iwan, 1999), most governments provide little assistance for mitigation in comparison to response. While disaster aid should be seen as part of long-term development (Gunn, 2005), "silent", long term investments in mitigation are rarely viewed with favour by politicians (Stephenson et al., 2005).

7.2 Epidemiology of aid

The timeline of injury must be understood when planning to deploy teams and the selection of the team should reflect the injuries or illnesses likely to be present. Different disasters produce different injury patterns, which helps estimate needs and timelines (Milsten, 2000; Noji, 2000; Van Rooyen, 2001). There is also at tri-modal distribution of medical issues post sudden onset disasters (Maegele et al., 2005, Taylor et al., 1998). Phase 1 occurs in seconds to minutes and has a high mortality, phase 2 occurs in minutes to hours and consists of medical care with a focus on trauma management, and phase 3 occurs days to weeks afterwards and consist of complications such as sepsis, multi-organ failure and mental health issues; the care of displaced persons and a lack resources and trauma from the clean up and recovery.

Three phases of care have been described for deployment of foreign field hospitals, in a guideline document developed by WHO and PAHO (2003). These are outlined in Table 7 and are based on an appreciation of the following key issues:

- The timeline of survival
- Types of injury can be predicted for different types of disasters
- Chronic disease is often exacerbated by the disaster due to stress, loss of access to usual care (e.g. dialysis or home oxygen) or loss of usual medications
- Women and children still have babies
- Disruption of water and sewage may have significant impact on infectious disease, as may power loss and refrigeration failure
- Vector control may be problematic with disasters caused by flooding or rainfall

Unfortunately international medical assistance teams are rarely on site soon enough to deal with the acutely injured (Judd, 1992; Hsu, 2002; Asari, 2000; Noji, 2000; Redmond, 2005;

Wallace, 2002). Following the Gujarat earthquake, outside help arrived only after local health services had provided emergency assistance and immediate care with specialised field hospitals arriving too late to reduce mortality and morbidity (Bremer, 2003, Roy, 2002). Similarly following the Chi Chi earthquake of the 104 teams that responded, 80% needed more than 24 hours to be able to provide care (Hsu, 2002).

7.3 Type of aid

International assistance is often best supplied by means other than through deployment of an international health team, in fact this should be a provider of last resort. Cash rather than goods, is often more appropriate (Campbell 2005; de Ville de Goyet 2000; Martone 2005; Redmond 2005b). Money is often the most useful resource as it allows:

- Increased local control of resource allocation and how the money is spent.
- Purchase of goods, and personnel locally, which helps stimulate the local disaster affected economy (Martone 2005, Redmond 2005b).
- Purchase of local goods, and use of local personnel, often at a significantly lower cost
- Use of local staff, familiar with local health care standards as well as language and culture

Phase	PHASE 1 EARLY EMERGENCY CARE	PHASE 2 FOLLOW UP TRAUMA AND MEDICAL CARE	PHASE 3 TEMPORARY HEALTH FACILITY
Primary Role	Provide early emergency medical care, including ATLS.	Temporarily fill the gaps in emergency medical assistance during the period when health services are progressively overwhelmed by the need for ongoing secondary care of trauma victims and routine medical care.	To substitute for damaged installations pending repair or reconstruction.
Timeline	Initial 48 hours following the onset of an event.	From day 3 to day 15, and should not exceed 15 days.	From second month to two or more years.
Essential Requirements	Be operational on site within 24 hours of event Be entirely self sufficient Offer similar or higher standards of medical care than were available in the affected country prior to the precipitating event.	Be fully operational within 3-5 days of event Minimal need for support from local communities Basic knowledge of health situation, language and respect for culture Availability of selected specialties. e.g. general surgery, anaesthetics, internal medicine, obstetrics / gynaecology, paediatrics with appropriate paramedic and support staff. Equipment should allow treatment of all patients regardless of age / gender. Sustainability Evaluation of the cost effectiveness and cost benefit associated with use of foreign field hospital	Lack of other cost effective alternatives Appropriate standards for patients and staff Designed for use by final reconstruction Installation and maintenance support provided at no cost to affected country

Table 7. WHO / PAHO Guidelines.

Donated goods may create a problem in their own right. Common problems include:

- Being unusable (Rubin et al 2000) due to expiry dates, (particularly for medications and food) and the language that instructions are written in (particularly for medications or technical equipment)
- The appropriateness of donated goods, such as revealing swim wear to cold climates or Muslim countries
- Consume personnel and space for storage, cataloguing and transport or destruction (Frisch 2005; Noji 2000; Rubin et al 2000).
- Undermining local practice rather than supporting it (Redmond 2005b).
- Technical support, and consumables, for medical equipment. Power sources and plug configuration should also be considered.
- Ability to actually enter the country through posts and customs

The 1988 Armenia Earthquake is an example of this. More than 5000 tons of drugs were donated, which occupied more than 30 warehouses and took 50 people 6 months to sort through. Of these only 30% were relevant and useful with 8% expired. There are also concerns about how donations are used and the risk of corruption with donations of money. This should not prevent donations. Donations should instead be based on assessed needs and the requests of the affected community

7.4 Based on needs

Any assistance offered should be based on the needs of the affected community. As Redmond notes "if aid is to do the most good for the most people it must be targeted" (Redmond, 2005b). Rapid needs assessments have thus become the norm for gathering information about the status of an affected population (Keim et al., 2001; Malilay, 2000; Redmond, 2005 Asari et al., 2000; Chen et al, 2003).

The United Nations use Disaster Assessment and Coordination teams (UNDAC), which are a 2-6 person team drawn from member countries that travels quickly to a disaster scene to report the immediate needs to the international community (Redmond, 2005). Needs assessment is a specialised area of expertise, and without use of personnel with appropriate experience and training multiple problems may occur. These include:

- May be inaccurate (Asari et al, 2000; Birnbaum, 2005; Braham et al., 2001; Malilay, 2000; Maury et al., 2004; McEntire, 1998; 1999; Rubin, 2000).
- May be incomplete (Asari et al., 2000; Mallilay, 2000; Maury et al., 2004).
- May be delayed (Asari et al., 2000; Braham, 2001; Malilay, 2000; Maury, 2004; McEntire, 1998; 1999).
- May be repeated multiple times by different agencies leading to assessment fatigue (Malilay, 2000; Nabarro, 2005; PAHO, 1999; Redmond, 2005).
- Need for a validated tool (Malilay, 2000)
- Need for standardisation of the content (Bradt, 2003; Malilay, 2000).
- Need for timeline to determine what information is needed from assessments at various times post disaster (Malilay, 2000).
- Level of experience of those performing the needs assessment (Redmond, 2005b).
- Assessment may not involve local population (Redmond, 2005b).

7.5 Integration with existing services

Deployed teams need to integrate with local services. It is the local services who will have provided the initial care and it is the local services who will continue to provide care after the deployed team has left. The local population should ideally be involved in all phases of relief operations as it enhances capacity building, empowers local communities and helps regain control over their lives (Brennan et al., 2001; Leus et al., 2001). Failure to do so can lead to mistrust, resentment, lack of cooperation (Brennan et al., 2001) and undermine the capacity of local people to solve their own problems (Judd, 1992). It may also lead to undermining of the local health system or problems with on going care for those treated by deployed teams.

Common problems are:

- Different standards used by deployed team to local health services
  - This may undermine local health services by raising expectations of care to a level that is unable to be continued locally due to resource or funding issues
  - This may leave patients with no adequate follow up post procedure, with risk of complications
- Free care and impact on economic recovery and livelihood of health workers

7.6 Self sufficiency

Deployed teams must be self sufficient (Nabarro, 2005; Redmond, 2005; Roschin, 2002) to ensure they do not pose an additional burden on affected communities. This applies not just to medical equipment but also to their ability to support themselves. All teams should have a basic self-sufficiency capability, which should include shelter, sleep gear, food and water at a minimum. Ideally teams should be self-sufficient for the duration of their stay but this will depend on the context of the disaster and the ability to provide re-supply. It may actually provide assistance to the affected community to contribute to the local economy by purchasing local products, including accommodation, if these are not in short supply.

7.7 Language and culture

Communication is a cornerstone of health care unfortunately language barriers are common with international deployment. This may occur between the team and the affected population or between responding teams. Solutions include bilingual staff, language training and interpreters. Use of bilingual staff is the optimal arrangement but difficult to achieve, while few deployments have time to arrange language lessons in time to be more effective than the basics of 'please' and 'thank you'. Interpreters are the most common option for most NGOs (Moresky, 2001). The use of interpreters from the local community may also assist integration with local services, provide local knowledge and local cultural advice and, if paid, stimulate the local economy (Redmond, 1991; McCurdy, 1999). While the most efficient solution is use of interpreters, this needs to be approached with caution. Payment well above local rates may result in loss of staff from local essential functions, including health services. Care also needs to be taken with selection of interpreters that isolation of cultural groups does not inadvertently occur. This may result in other groups not wishing to seek care or perceived favouritism.

Culture is unfortunately often over looked as a potential issue (Moresky, 2001). Cultural factors must be addressed in order to appreciate the context of disasters for a population (Keim et al., 2001). Common problems include dress codes of international responders, especially for women, the ability of men to examine or treat women (Roshchin et al., 2002) and the cultural appropriateness of donated goods. All team members should be aware of cultural issues before deploying as failure to do this may compromise the personal safety of team members and effectiveness of the mission.

7.8 Safety and security

Safety and security is becoming an increasing problem (Brennan, 2001; Burkle, 1995; Holland, 2004; Schull, 2001; VanRooyen, 2001). The major cause of death and injury in the 1970s was MVA (Birch. 2005; Brennan, 2001), while the major cause of death in the 1990s was violent trauma (Brennan, 2001). Sheik (2000) looked at the deaths of 382 aid workers and found 67% were from intentional violence, with the number of deaths from hostile acts increasing. Unfortunately combatants in complex humanitarian emergencies (CHE) increasingly regard medical workers as targets (Bricknell, 2005). Deployed teams need to be cognisant of their own safety and security. All deployed teams should have safety and security training and have considered the elements in Table 8 as a minimum.

Grouping	**Details**
Vehicle safety and travel	Vehicle inspection Vehicle safety Convoy planning and driving Driver training Basic mechanics Trip planning (routes, access points, petrol, what to carry)
Basic Navigation Skills	Map reading Use of GPS Use of compass
Basic Communications Skills	Use of radios including radio protocols Use of specific team communications equipment
Camp Safety	Perimeters Guards Lighting Curfews Equipment security
Personal Safety	Grab bags Avoiding being out alone (especially after dark) Identification
Team Safety	Buddy strategies and monitor systems Rendezvous points Team musters and regular team meetings
Critical Incident Safety	Actions on Evacuation plans Hostage negotiation Weapons awareness

Table 8. Essential Safety and Security Training.

7.9 Health and welfare of deployed team

The health and welfare of deployed teams is important. Team members becoming ill or injured may compromise the mission by altering the level of care able to be provided. It may also increase the workload for other members as yet one more patient is added to the load, and the morale of team members may be adversely affected. The sponsoring organisation may also be adversely affected either by reputation, or through costs of evacuation, care and rehabilitation of the unwell team member(s), which may be prolonged and even possibly litigation.

The health and welfare of deployed teams involves a systematic approach that recognises the need for pre and post health support; health support during deployment and appropriate team selection, education and training and logistic support (Aitken et al., 2009a; 2009b; 2011).

Processes should be in place to ensure that all team members who deploy:

- Are in good physical health and have had a recent medical and dental check up
- Have access to regular personal medications (if appropriate to deploy with these) and have a spare set of eyeglasses if needed
- Have received appropriate vaccinations prior to deployment and access to any chemoprophylaxis necessary
- Have an appropriate degree of physical fitness
- Ideally have acclimatisation schedules considered, especially for any deployment from temperate to hot environments
- Have access to medical care while deployed, including a team medical kit
- Have access to clean water and safe food supply while deployed
- Have access to uniforms appropriate to both climate and work environment
- Have task appropriate personal protective equipment
- Are protected from vector borne diseases by an appropriate combination of vector control, prophylactic measures and access to treatment
- Have access to post deployment follow up health care, with both physical and mental health issues addressed

7.10 Coordination

Deployed teams should not only integrate with local health services but also coordinate their activities with other deployed teams. This is to ensure that all needs are addressed and that there is appropriate coverage of aid needs to all geographical areas. Otherwise, both task omission and task duplication can easily occur. This is especially important in large-scale disasters where coordination and logistics issues can be immense. As an example consider the problems faced in Haiti. At one stage there were over 1000 NGO on ground, in a country with virtually all infrastructures (including government) destroyed and the native language was different to nearly all deployed teams.

Efforts to improve global coordination of disasters have led to the development of the Cluster approach, which is now an essential component of international humanitarian work. The clusters are open to all contributing agencies with each of the nine clusters (Protection, Camp Coordination and Management, Water Sanitation and Hygiene, Health, Emergency Shelter, Nutrition, Emergency Telecommunications, Logistics, and Early Recovery) led by a

designated agency. Two additional clusters, Education and Agriculture, were later added. For the Health Cluster the lead agency is the World Health Organisation. There are also efforts currently to ensure only appropriately trained and prepared teams deploy internationally with development of an international register of accredited teams.

8. Pandemics

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

8.1 ED design

Emergency Departments, as a rule, are not designed to manage large numbers of patients with infectious disease. Open plan design, which meets the need to maintain the visibility of patients with acute presentations, sacrifices not only privacy but also offers little ability to isolate patients. As FitzGerald et al (2010) note, "curtains make poor barriers to the spread of disease". Few ED have designs well suited to management of infectious patients with ability to isolate from time of presentation to triage and through their ED 'journey'.

8.2 Identification of index cases

This can only happen as a result of raised awareness and heightened suspicion. EDs need to recognise that they are part of the broader health system as well as the front door of the hospital. There should be strong links with local public health and communicable disease networks. This allows ED staff to be aware of communicable disease alerts and have a clear reporting structure if cases are identified.

8.3 Alternative care sites

The use of "flu clinics" is intended to divert patients from Emergency Departments and preserve ED capacity. The establishment of 'flu clinics' needs careful planning for it to be successful:

- It is important to avoid using ED staff for this role or ED capacity may be actually reduced;
- There must be an ability to provide immediate care for those with more severe illness at flu clinics as well as the ability to transfer to higher levels of care
- There must be clear case definitions and protocols in place to ensure standardised and consistent care across the community
- The community must be informed of where to attend to seek care.

8.4 Controlling entry to ED

Patients with flu, or any infectious disease, should not enter EDs and mingle freely with other patients and staff. Pathways should be established so that patients with suspected infectious diseases are diverted to alternative care sites (flu clinics) or if unwell have a clear route to areas capable of isolation or ideally negative pressure rooms.

8.5 Integrated care

It is imperative that EDs have established links with the public health system, primary health care and the full hospital system. Planning needs to ensure that this is a 'whole of health' response. This enables early notice of emerging infectious diseases, clear reporting lines, support for alternative care sites and consistent care pathways with in the hospital for admitted patients to both the ward and Intensive Care. It is also essential that microbiology and laboratory services as well as hospital administration are included in this.

8.6 The workforce

Staff welfare is an essential element of pandemic management. This not only protects the health and safety of health personnel but also ensures the on going ability of the ED to provide care. This needs to include access to PPE, vaccination and antiviral medications. Staff in high-risk groups may also need to be re-deployed from their primary place of employment. While this may differ for specific disease processes, for H1N1 this included pregnancy, immunosuppression and chronic disease. There is a need for clear processes to be in place for sick leave and staff absence as carers during the pandemic (Considine et al., 2011). The latter is particularly important when schools are closed, or staff quarantined as the primary carers of those with confirmed illness.

The willingness of staff to present for work also needs to be considered. Conflicting opinions have been presented, however the severity of the disease and levels of personal risk are probably the best guide. Health workers are altruistic by nature, however personal and family risk may limit this. The personal risk for health workers when caring for patients in an environment similar to the 1918 pandemic (see Figure 12) should not be under estimated.

9. Emerging issues

Disaster health does not stand still. As the world changes and new technology is developed, different threats emerge. Risk assessment is a continuous process and needs to recognise new hazards as they emerge. Some of these are discussed briefly below.

Fig. 12. Patient care during the 1918 Flu Pandemic.

9.1 Climate change

It has been proposed that climate change will bring with it an increased number of severe storms, cyclones and hurricanes. Additionally global warming may cause the endemic regions for vector borne disease to expand. The most serious concern is the spread of malaria while other diseases such as dengue fever are also of concern. The exposure of disease naive populations increases the potential to cause significant morbidity and mortality.

9.2 Heatwave

Heatwaves are generally an under recognised disaster and have caused significant mortality. Most of this occurs in populations in which buildings have been adapted for the cold and keep heat in. Buildings reliant on air conditioning to keep cool, including hospitals, are particularly at risk with power failures. Recent work has identified standard definitions, the influence of biometeorological influences (Vaneckova et al 2011) and population susceptibility (Wang et al 2011). Local temperature, and the variation from this, is one of the most important factors with the elderly and those with chronic disease particularly ischaemic heart disease and diabetes, at risk.

9.3 Pandemics and emerging infectious disease

The advent of cheap global travel and expansion of international trade has its own risks, with the spread of disease able to occur much more readily as a result of this. Emerging infectious diseases have the potential to be spread quickly with transcontinental flight and may not be noticed initially if diseases have a longer incubation period allowing disembarkation before onset of symptoms and negating the effectiveness of pre-flight screening. This is particularly relevant given that the majority of travellers would not postpone their travel, even if they exhibited flu-like symptoms (Leggat et al., 2010). Pandemics occur regularly and while Pandemic (H1N1) 2009 was not the disease initially feared, diseases with higher case fatality rates such as SARS and 'Bird Flu' and emergence of novel viruses associated with animal reservoirs continues to pose concerns. Fortunately, almost everyone reported that they would comply with physician's advice to stay at home for seven days if they were diagnosed with Pandemic (H1N1) 2009 (Brown et al., 2010). Interestingly, most of these people also indicated that they would have sufficient food supplies to cope with isolation for a period of three days, although they would cope less well if there was a disruption in utilities (Aitken et al., 2010).

9.4 Conflict and war

War is not included as a disaster in many databases. However both war and complex health emergencies have accounted for millions of deaths in the past century. This is not just as a result of direct violence but occurs due to disruption of the health system, loss of access to basic food and water, loss of immunisation programs and general loss of infrastructure including transport systems. The crisis in the Democratic Republic of the Congo (DCR) resulted in the deaths of ten million people over a two year period with more than 50% dying as a result of infectious disease. Of the 15% who died from battlefield injuries many of these occurred in inaccessible places away from help (Brennan & Nandy, 2001).

9.5 Information technology

The development of information technology has enhanced our ability to respond and manage disasters (Arnold et al., 2004). However many of our systems, including health systems, are so reliant on computers that a major disruption of the information technology infrastructure may result in complete system failures. This may range from patient data systems, refrigeration and cooling of medical and blood-stocks to digital radiology systems. Indirect effects include the impact on public transport, economic breakdown and other components of critical infrastructure.

9.6 Standards of care

An emerging, and necessary, discussion is the concept of standards of care during a disaster. The modern community has an expectation that care will continue, at the same standard, during a disaster. Depending on both the imbalance between supply and demand and the level of infrastructure damage this may not be possible.

10. The future

The ability to predict the future is in the realm of crystal balls and Nostradamus. Novel disasters will occur, or 'traditional' disasters in less likely locations. However it is likely that future developments will include work on the emerging issues described above with a focus on:

- standards of care (and altered standards of care),
- accountability and credentialing of disaster health care providers and managers,
- the integration of health care into the disaster 'system',
- improved communication with improved visibility of communication and sharing of information,
- the impact of ED overcrowding on surge capacity
- the implications of an aging population on disaster response in the developed world.

11. Conclusion

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

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

innovations are formally assessed to determine effectiveness and whether outcomes are improved.

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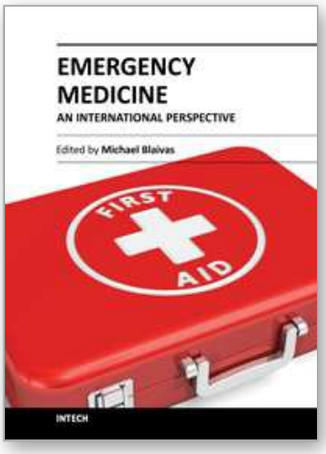

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