DISASTER MEDICINE

An Overview of Major Incidents and Disaster Medicine

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Introduction

Disaster medicine is not generally covered in the undergraduate medical school curriculum; indeed emergency medicine has been reduced to a handful of lectures and some generic skills. A renewed focus in recent decades has followed high-profile terrorist attacks and a succession of natural disasters putting an increased emphasis on hospitals to be ready to cope with large numbers of casualties or extraordinary occurrences. The role of hospitals has been reviewed; particularly as they are viewed as havens of safety within communities and play a wider role than simply treating patients.

Let us first define the subject for this essay. Disasters can cause massive number of casualties and disruption of infrastructure. *Natural disasters* include earthquakes, tsunamis, tornadoes, floods and hurricanes and have been responsible for the loss of 3.5 million lives worldwide over the past 25 years, affecting 1 billion people and causing damages of $50bn. *Man-made* incidents are the result of human intervention or technology such as a transport incident or bomb. A *major incident* is not defined primarily in terms of numbers but by considering the ability of the existing services to cope or: *"any emergency that requires the implementation of special arrangements by one of more of the emergency services, the NHS, or local authority"*. In essence, a disaster occurs when the number of patients presenting cannot be offered even minimal care without external assistance. However, a single case of a potent virus or major figure could similarly disrupt the normal hospital operation – hence, a pre-established hospital protocol should be present to deal with such an event.

A *compound* incident is one of sufficient magnitude to disrupt the structure of a society including its communications, hospitals and the organizations required to mount a response but it is declared a *simple* incident if this is not the case. A *compensated* incident is one that can be managed by mobilizing readily available extra resources such as extra ambulances or the military. A failure to cope is sometimes referred to as a *major disaster* which is an *uncompensated* major incident. In the States, *external disasters* occur outside the hospital whereas *internal disasters* occur within the physical confines of the hospital *e.g.* fire or power failure. The horrific events that took place on 11th September, 2001 at the World Trade Centre and the Pentagon were referred to as *mass casualty events* or *incidents.* Research in the US after these events showed that the Emergency Departments had great difficulty in coping with even moderately increased numbers of patients. They identified a number of problems including:

- Delayed or improper notification
- Poor delineation of command structure
- Overloaded or broken communications networks
- Improper or incomplete identification
- Lack of supplies
- Lack of public relations

They concluded that emergency medicine should assume the primary role in the medical aspects of disaster planning, management and patient care to prevent hospitals from being overwhelmed.

This essay will briefly examine the bewildering variety of possible disasters that hospitals have drawn up plans to manage. It will then look at how disaster medicine might be brought into the medical curriculum in these troubling times by scrutinizing a German team asked to provide a course for German medical students by their government. After this, we will examine in more detail what a hospital plan in the UK involves and finally, we will examine the issues encountered in natural disasters abroad by using the work of the Red Cross as an example.

Types of Disaster (Tintinalli, Kelen and Stapczynski, 2004)

A large number of possible events and catastrophes are covered under the umbrella term "major incident" requiring that any contingency plans must be of both a general nature to ensure flexibility in management but also must cater for specific incidents and fallout, some of which are listed below:

Bioterrorism

Responding to bioterrorism involves coordinating with a variety of groups and sources of information not often encountered such as: public health, police, disease control and online information databases. These substances may be infectious agents or biological toxins (which behave as chemical agents and are considered below). The US federal government has seen the risk of such attacks go from those used in military weapons to those of non-combatants: in the civilian setting they are considered to be low probability but high impact events. Despite this, since 9/11 there has been 22 cases recorded where *Bacillus anthracis* was disseminated via the Postal Service. However, such engendered fear meant many thousands on the East Coast received anthrax prophylaxis *e.g.* ciprofloxacin when the full extent of the attack was unknown.

In the States, the Centers for Disease Control (CDC) attempted to stratify the risk of the many and varied organisms (and their diseases) that could potentially be used as weapons. They used four general criteria to select these agents:

- Potential for public health impact
- Delivery potential measured by ease of development and dissemination and transmission
- Public perception of the agent ("fear factor")
- Special requirements for public health preparedness.

These agents were then ranked into three categories based on their potential for an adverse public health impact. Class A has the most serious potential impact and includes *Variola major* (smallpox), anthrax and *Yersinia pestis* (plague). Class B is less potent and contains more readily encountered organisms such as *Coxiella burnetti* (Q fever) or water safety threats such as *Vibrio cholera*. Class C agents could emerge as future threats as technology improves. This category includes the Hantavirus a cause of the originally named Korean haemorrhagic fever.

Recognition of an event may be difficult to ascertain especially when initial symptoms are often commonly encountered such as fever, body aches and malaise. Hence, detection is often dependent on extraordinary signs, eliciting an unusual history, rapidly available diagnostic test results, multiple patients presenting in a similar manner or a warning from public health surveillance including symptoms and signs that local healthcare facilities should be on the lookout for.

Adequate plans are imperative to produce a rapid, coordinated response. Infection control procedures should be utilised and appropriate external agencies notified such as the local public health departments to minimize outside impact and allow other organizations to prepare themselves. Information can then be passed to all clinicians regarding communitywide patient evaluation and treatment. Identification of the suspected agent and its control guidelines is hugely important in protecting those who have been in contact with the agent and those who may do so *i.e.* hospital staff. Those agents with airborne transmission capability are most troubling, requiring droplet protection and isolation with possible decontamination.

Limiting the impact of an agent is dependent on preventing exposure, providing prophylaxis and immunization (where available) and treating the infected. More specific protocols may be provided following precise diagnosis.

Chemical Agents

Arsenic smoke was first used by the Chinese as long ago as 1000 BC. The First World War saw a number of agents used including: chlorine, cyanide-based agents and the sulphur mustards. Chemical weapons treaties have been drawn up but US intelligence suggests programmes are still in existence in 17 countries. Additionally, agents have been used away from military targets. Sarin, a nerve agent, was released in two Japanese cities in the early 90s killing seven and causing thousands to seek medical attention.

Every emergency department must be capable of receiving unannounced victims and treat them accordingly. This involves planning when it is known that a chemical attack has occurred; rapid identification of the agent including its toxicity and likely spread; protection of those within the hospital; decontamination and triage of victims; treatment and protection of the community from secondary contamination.

In America, the CDC established a list of agents that were likely to pose the greatest threat. They established a collection of agents from those known as chemical agents to toxic agents commonly found in industry. Availability is a key factor along with those likely to cause major morbidity and mortality; those that might cause widespread public panic and those that require special public preparation. Chemical agent categories with examples include: *nerve agents* (sarin); *blood agents* (cyanides, chlorides); *blister agents* (mustards); *heavy metals* (arsenic, lead, mercury); *volatile toxins* (benzene, chloroforms); *pulmonary agents* (phosgene, chlorine); *incapacitating agents; pesticides; dioxins; explosive nitro compounds; flammable industrial chemicals; poisonous industrial gases* (cyanides, nitriles) and *corrosive industrial acids and bases* (nitric and sulphuric acid).

This large list presents many problems for the hospital and means that coordination of the hospital and public agencies are required. Triaged patients should be kept away from the ED until the agent is known. As before, generalized plans should be drawn up and drills practised. This should include a procedure for mass casualty decontamination which may be in an outdoor area away from the main building. The required equipment should be onsite rather than having to wait for external agencies to arrive. Such equipment includes: warning tape to delineate the cordoned-off area; disposable rubber gloves, decontamination stretcher, full-cover chemical resistant jump suits; rubber aprons; cleaning agents; waste bags; wading pools for staff; adsorbent materials; oxygen tanks and privacy barriers.

The aim of decontamination is to decrease the absorbed dose for the victim and prevent secondary contamination. It may involve showering, heated tents or paddling pools. Care is taken that the materials involved don't react with water *e.g.* alkali metals, dry lime or concentrated sulphuric acid. Seriously ill patients may require other measures such as intubation. Clothing should be removed immediately as it contains up to 80% of the contaminant. Ocular exposure and wounds take precedence and the patient is decontaminated from the head downward. Following chemical exposure, nausea and vomiting are common indicating a systemic toxic effect, toxic ingestion or hysteria. Hence, any vomitus should be anticipated and isolated. Also, some materials can react with stomach acid to produce a toxic gas. For example, cyanide salts react to form hydrogen cyanide gas. External suction should be in place around the contaminated zone. The Hazardous Materials Response (HAZMAT) teams in America are trained to provide on-scene chemical decontamination. However, it was found that many hospitals were forced to await their arrival rather than initiating treatment themselves wasting valuable time.

Blast and Crush Injuries

Explosions can often lead to sudden forces and rapid acceleration but small amounts of actual displacement. Crushing injuries are characterized by slower application of force and weaker acceleration but produce a greater surface displacement. Both can cause internal tissue damage which may initially be hidden. *Stress waves* are caused by the brief acceleration of a surface transmitted deep into the body through its fluids. When they encounter tissues of differing density, the differential pressure forces, motion, stretching and tearing causes damage. This is a prime reason for the Primary Blast Injury (PBI) of the ears, lungs and bowel discussed below. *Shear waves* often cause the blunt trauma in crush injuries.

Blast injuries result from the rapid release of energy in expanding gasses which superheat the surrounding water and air to create shock (or blast) waves. The PBI tends to manifest as bleeding or air escape. In the ears, there may be bleeding or rupture of the tympanic membrane and the bones may fracture or dislocate. Pulmonary tissue can tear resulting in blood or air escape and pneumothoraces. Escaping air can lead to pseudocyst formation creating a pneumatocele. Blood that may be leaking from the walls of the gastrointestinal tract can leak into the lumen or peritoneal cavity. Bowel tears can spill its contents resulting in peritonitis. Stretching can lead to ischaemia and eventual perforation. Other injuries are seen in a blast such as penetrating missiles or blunt trauma or injuries resulting from being blown across the ground. A combination of these injuries can lead to a compromised airway, insufficient ventilation, haemorrhages, tension pneumothorax, shock or arterial air embolism all requiring immediate treatment in an emergency department. Pulmonary PBIs are assessed by looking for dyspnoea and chest pain, pharyngeal petechiae or haemoptysis. The main, immediate investigation is often a plain chest X-ray and arterial blood gas. Gastrointestinal PBIs may be discovered via abdominal or testicular pain symptoms, nausea and vomiting and an urge to defecate. Quick investigations such as FAST scans may speed up the diagnosis.

For patients with blast injuries it should be remembered that external haemorrhage is more likely than airway compromise; there is a high risk of pneumothorax and air embolism and the patient may need to be placed on their left hand side; rapid crystalloid infusion may be harmful due to pulmonary contusion; and exertion (such as helping other casualties) may worsen occult lung injuries.

Crush injuries is an umbrella term which may refer to the mechanism (machinery, collapse of buildings, combat and so on), or the sequelae such as compartment syndrome. *Acute traumatic ischaemia (ATI)* offers a method of examining the underlying physiological problem. Here, the trauma is looked at in terms of whether there is macro- or microvascular trauma. Both of these lead to hypoperfusion, haemorrhage and oedema with their own cascading physiology and signs and symptoms from the resultant tissue hypoxia and ischaemia. Hence, it can be seen that these considerations affect management of the patient and should be anticipated from the history. Therefore, the skin should be cleansed and examined for changes in colour including blanching and erythema. The whole body should be palpated for crepitus, swelling or tenderness. This is done in addition to a full neurological and vascular check which needs to be repeated at intervals. All patients with suspected ATI require hydration, monitoring for compartment syndrome and possible treatment for hyperkalaemia, hypercalcaemia, hypophosphataemia and myoglobinuria associated with rhabdomyolysis.

Radiation Injuries

Such injuries may be accidental or intentional and recent events in Japan have led to a renewed global interest from the public. Before the recent earthquake destabilising the Fukushima nuclear power station, in 1986, the Chernobyl accident accounted for 28 deaths and 116,500 injuries in a high-dose, localized incident. Accidents can also occur in a hospital where a patient is given too high a dose or radiotherapy. Abroad, scavengers in countries such as Thailand and Brazil discovered metals later found to be radioactive.

Though quite involved, an appreciation of the forms of radiation can help in assessing the extent of damage caused. A dose-equivalent scale of measurement is calculated by looking at the absorbed dose and other modifying factors to account for the differences in biological effect between the different varieties. *Non-ionizing radiation* includes: ultraviolet, visible, infrared, micro- and radio waves and are typically low-energy and low-frequency. In medicine, they are found in lasers, ultrasound and MRI scanners. A progression through the electromagnetic spectrum leads to short-wavelength, high-frequency, high-energy *ionizing radiation*. It can be in two forms: alpha, beta and neutrons are particulate whereas gamma and

X-rays are waves. They can form highly reactive free radicals damaging DNA and other molecules leading to cell death.

Preparation, as ever, is the key to planning for this sort of disaster. Here, an evacuation plan would be required and practised. Initial responders are responsible for securing the scene and trying to establish the identity of the hazard. Correct equipment including protective apparel and dosimeters are required both at the scene and in the hospital. Triage usually occurs due to any acute medical condition as radioactive contamination is not immediately life-threatening. In this instance, extra precautions are required as the hazardous material can only be detected with monitoring devices and hence are essential in contamination control. *Externally contaminated* patients should be managed first. This is where the material has been deposited on the skin and hence is ripe for spread. Decontamination is necessary in this case. *External irradiation* occurs when the body is exposed to penetrating radiation and may be local or diffuse. *Internal contamination* can occur via ingestion of a source or through absorption through wounds or via the lungs. It can result in *incorporation* where the material is taken up into the cells.

These differing methods of radiation injury means that the presentation and treatment of patients can be quite varied. Most externally contaminated patients are affected through local radiation injuries with partial body effects. These mostly manifest through dose-dependent skin involvement which can appear similar to thermal burns. Patients may be asymptomatic for the first week or experience transient erythema, hyperaesthesia or itching. True erythema and epilation develops during the second week followed by warm, painful, swollen and itchy skin. Treatment is mainly symptom-control based.

Whole-body irradiation typically presents with a collection of symptoms that manifest within 24 hours. *Acute radiation syndrome (ARS)* progresses in a series of phases often beginning within minutes of the exposure. The first system to see changes is the *haematopoietic system* where damage is caused to circulating lymphocytes and stem cells resulting in pancytopenia and immunosuppression *i.e.* an increased risk of haemorrhage and infection. Nausea, vomiting and possible diarrhoea indicates a *gastrointestinal syndrome.* Abdominal pain additionally often follows a latent period of a week or so. It occurs as a result of mucosal damage and fluid losses leading to volume loss, electrolyte disturbance and possible dissemination of gut flora. Increased radiation doses can lead to a *cardiovascular and central nervous system syndrome* that can also demonstrate prostration, nausea, vomiting, diarrhoea and hypotension. Alterations in consciousness might be seen along with lethargy, ataxia, tremors and convulsions. Hypotension is refractory to treatment, leads to a lymphocyte count of near zero and is fatal. Usually, this patient is not radioactive and therefore not able to contaminate others (high-level neutrons are an exception *e.g.* from a nuclear plant accident). High-level doses may damage the pulmonary system leading to pneumonitis, fibrosis and interstitial oedema.

Treatment is mainly through symptom management and would therefore include anti-emetics, analgesia and replacement of blood cells (low cell counts carry with them a poor prognosis). Low cell counts might be expected within a month and therefore the patient and relatives should undergo HLA typing to prepare for a white cell and platelet transfusions. Haematopoietic growth factors and stem cell transplants are other therapies which have been used in the past.

Internally contaminated patients have suffered entry of the radioactive material through inhalation, ingestion or absorption from mucous membranes or abraded skin. It is seen through administration of the wrong dose of radiopharmaceutical within a hospital or if large amounts have been released into the atmosphere from a bomb, nuclear plant accident or volcano. It will irradiate tissues until it decays to a stable isotope. It may disseminate throughout the body or concentrate in a single *critical organ.* In this case, identification of the material is required for adequate treatment and may require laboratory verification of swabs and analysis of sputum, faecal matter and urine.

Treatment is aimed at reducing absorption or increasing elimination. This may require bronchopulmonary lavage, gastric lavage, emetics and purgatives to hasten the body's own physiological mechanisms. *Decorporation* may be required if the material crosses into the extracellular fluid; blocking agents, isotopic dilution, chelation and similar techniques may then be required. Radioiodine is particularly hazardous to the thyroid and indeed, an increase in the incidence of thyroid cancer has been recorded in Chernobyl's heavily contaminated areas. It may be detected in the urine and treatment is most beneficial within 12 hours via oral potassium iodine. This substance can also be used as a prophylactic in the first hours after the incident. Alpha particles require quick treatment with Pu-239 due to their long half life and high energy state. Heavy metals can often be chelated with agents such as DTPA salts. Lastly, the unborn child of a pregnant woman involves further consideration as their cells are mostly undifferentiated and highly proliferative and hence have increased radiosensitivity depending on the gestation age. Data from survivors of the Japanese atomic bombs suggested that the most common *in utero* injuries are related to the CNS especially microcephaly and mental retardation. Whilst most organogenesis is complete by 7 weeks the CNS development continues during the early foetal period. Other malformations including growth retardation and ocular defects have been reported. This damage must be considered for high doses between 8 and 15 weeks gestation and the parents receive adequate counselling should this be the case.

Disaster medicine in medical school education

The aim of including a course in the undergraduate degree is to increase catastrophe preparedness. A recent focus has been placed on exposing students to some form of education following a proliferation of natural disasters (and their coverage in the media) and also a heightened awareness of terrorism following 9/11. In 2003, America recommended that bioterrorism be included as part of the curriculum and Germany also decreed that their students be familiar with such principles. Oddly, in the UK curriculum a set of principles is listed to cover all of the emergency skills but a final year student may only spend a week or two in the department itself (or they may be in another acute setting). Pfenninger and his team were commissioned by the German government to provide a standardized template to fit into the German medical schools' curriculum that would give some experience in such eventualities. They found that the US course was mainly a theoretical, 2nd year, course originally organized by the military and not appropriate for medical intervention. For instance, as a direct response to the event of 9/11 the Texas A&M University System Health Science Center College of Medicine partnered up with military experts from the Defense Institute to create a one-week, non-graded course entitled "Leadership Course in Disaster Response" and designed to respond to bioterrorism among other disasters. It included information such as tracking down the source of the contaminant. The German team used searches and outside experts to ascertain what should be covered in a modern course.

As appropriate for their curriculum, they came up with a course that would be given in the 4th out of 6 years, separated into 14 2-hour modules. It involved liaising with outside experts and collaborating with rescue and disaster response units for drill-type exercises. These modules gave a clear indication of the goals:

Modules 1-3: teaches terminology, law, management, the multidisciplinary team and communication systems. Disaster response strategies are discussed in PBLs.

Modules 4 and 5: covers hospital alarm and preparedness plans. Previous real-world disasters are examined and implementing care in the field is considered.

Modules 6 and 7: contains exercises to learn about triage and evacuation. Small group exercises are taken in noisy, smoke-filled hospital corridors with low-lighting. Students put on full protective gear and use communication devices. They are aware of a short time limit as they search for and triage trained volunteers covering moribund, medical and emotional conditions.

Modules 8 and 9: teaches life-saving and medical care for specific situations including burns, explosions, blasts and warfare and biological illnesses.

Modules 10 and 11: teaches the dangers and management of radiological/nuclear and chemical hazardous materials. This involves didactic training and practical experience of a decontamination procedure in full-gear taught by the fire department.

Modules 12 and 13: covers the challenges of ethical, professional, psychosocial, and quality control criteria of medical disaster management themes.
Module 14: assessment.

This curriculum is currently being taught in nine German medical schools who have reported that they are able to cover such issues in far greater depth than is covered in the emergency medicine component of the medicine course. The course was designed so that the topics covered would not overlap with other sections of the syllabus. This was a 5-year project and it isn't possible to see if early exposure to disaster medicine gives an advantage to medical practitioners in the future during such disasters but, as the authors point out, the learning must begin at some point. However, such a specific course would require refreshing at intervals. Also, the demonstrations place an extra pressure on the school's budget and disaster scenarios can never be absolutely modelled but their feedback suggests that the skills learned here – such as a review of life support medicine, thinking about other agencies such as public health or gaining leadership experience - will be of use in a general hospital setting and are transferable skills from this point of view.

National Response (Driscoll and Skinner, 1998 and Graves and Johnson, 2002)

Adequate preparation requires planning, obtaining equipment and training. In England, "listed hospitals" are those with a 24-hour Emergency Department and all of these require a major incident plan. These plans follow a regional health authority plan, which in turn follow national Department of Health guidelines. Medical plans follow an *all hazard* approach where they provide a broad system of principles that cover all types of incident and provide a systematic framework to be followed, rehearsed and improved upon. Such an approach to management should cover: command, safety, communication, assessment, triage, treatment and transport and each is discussed below. Any plan must also incorporate an *all agency* approach which would involve detailing the roles of individual emergency services and how they are integrated into a response. Local plans are reappraised in the recovery phase showing that planning is a continuous process involving prevention, preparation, response and recovery. A typical general plan would involve:
1. Planning and Equipment – involves coordination of all departments and local emergency services and voluntary agencies. Most hospitals use "action cards" detailing skills and availability of staff. Once a plan is in place, major incident practices are held. These are either "table-top" where staff coordinates around a table, or full-blown practices which can be seen to be disruptive and expensive but give a more realistic impression. Additionally, major incident response should be part of induction days as ongoing education and all equipment located and in date.
2. Command and Control – this varies between hospitals there must be a medical coordinator (usually a Consultant) who works with the triage officer, senior nursing officer and duty senior manager together with external organizations.
3. Triage – a key factor in efficiency and success. It aims to ensure that patients with immediately life threatening injuries (Priority 1, P1) are treated before urgent patients (P2). The "walking wounded" (or the "worried well"), P3 (delayed) patients are initially directed to an area where they may be observed. In urban areas, peak volumes can be expected within 3h. A fully established hospital response will ensure that these patients are then managed simultaneously: P1 patients are treated in the emergency department resuscitation rooms and majors; P2 in the emergency department or similarly equipped and staffed area and P3 are away from the seriously injured but where they can receive full supervision and where transfer is practical should they deteriorate – hence reassessment should not be forgotten.

Triage is usually taken by a senior member of staff: the patient is "sorted" and care taken to label them clearly. Triage sorting would typically involve assessing and scoring the patient's respiratory rate, systolic blood pressure and Glasgow Coma Scale to assign to them a triage category.
4. Treatment – action cards indicate which area a member of staff will work in and staff are assigned according to experience and role. Surgeons (including an orthopaedic surgeon, a

general surgeon and intensivist) and anaesthetists would further prioritize patients who need transferring to theatre or ICU.

5. Dealing with the Dead – a temporary mortuary may be necessary at the scene but the hospital is responsible for those who die *en route* or after arrival. The area should be secure in case potential evidence is tampered with. Numbers of fatalities are only released in official information bulletins and identities only released after the next of kin have been informed.

6. Admissions – this may require designating a ward to admit potentially large numbers of patients. The ward should not contain high-dependency patients as they are difficult to move, and ideally be located close to the emergency departments and theatres. Clearly, a real-time and accurate bed state is required; patients from acute admissions should be moved on quickly (or discharged) and patients awaiting non-essential surgery and discharge sent home. All routine procedures should be cancelled as the consequences of such an event might cause a backlog far beyond the response being formally stood down.

7. Staffing – the switchboard usually informs staff operating a cascade system: senior staff are initially contacted including on-call Consultants and present medical staff, duty manager, senior nurses, senior clerical officer, porter and theatre staff, pharmacist and other support staff. These people are then responsible for getting the required members of their team together. Other staff might also go to the hospital after hearing about the incident through the media. Managers are responsible for coordinating staff should the response be prolonged so that a second shift of responders is available.

8. Dealing with relatives – the hospital will likely become a focus for relatives to find their loved ones or just to find out more information. A specific area should be laid aside and made as comfortable as possible and the assistance of the chaplain, social workers or nurses might be required. The police may also need facilities to gather information.

9. Communications – the usual hospital mechanisms should be used and hence should be kept clear for essential business. Personal radios or similar may be necessary for staff who are moving around constantly. Once a major incident has been declared, the police will issue to the press a telephone number for the public to use to gain further information.

10. Dealing with the media – a media liaison is responsible for providing regular bulletins to the media (where interest is high) to satisfy those searching for further information but also to prevent speculation. Hospital staff must not be caught making speculative remarks in unguarded situations. When the situation has stabilized, it may become possible for designated members of staff (or victims) to be interviewed.

11. Police liaison – the police usually dispatches a documentation team to the hospital to build up a picture of all those involved in the incident. A major incident is a crime scene unless proven otherwise which may necessitate an enquiry. They are in charge of the forensic aspects of the incident such as personal clothing and belongings.

12. Mobile medical teams – these may be part of some major incident plans where a team from the hospital is sent to the scene *e.g.* an amputation.

The scene itself is organized in a structured manner: the first service to arrive becomes the control unit until a dedicated team arrives and is identified by a rotating beacon. It is essential that the later teams to arrive (such as the hospital team) coordinate with this first team. The immediate area containing the incident is the bronze or operational area. Senior officers from each emergency service work in here. These are known as the forward commanders (formerly incident officers). This is surrounded by the inner cordon. The area outside of this area *i.e.* increasing circles, is known as the silver or tactical area comprising the casualty clearing station (organized by the ambulance service) and other response measures. Silver control comprises the police commander, fire commander, ambulance commander and medical commander. These commanders are in overall command and report to gold control. An outer cordon surrounds this layer and the police are responsible for who enters it. In major incidents, a gold control or strategic control area will usually also be established some distance away to allow liaison of the senior members of each team.

International Response Example – the Red Cross

The International Red Cross and Red Crescent Movement is a humanitarian movement which today has a presence in just about every country of the world. Their principles involve protecting human life and health, ensuring respect for all human beings and in preventing and alleviating human suffering without discrimination. Its massive reach - it has around 97 million members in 186 National Services - gives it unparalleled access including an extensive major incident function, both nationally and internationally; of which the latter will be discussed here.

Their work in this area can be summarised into two categories: *preparing for disasters* and *emergency response*. Preparation is the key to saving lives and protecting livelihoods. They provide general tips such as teaching as many people first aid as possible, having nothing heavy or valuable in lower floors in a location prone to flooding or possessing emergency equipment in vulnerable places. Other work they do is tailored towards specific locations. Bangladesh is a developing country with areas of high population density and very rural living conditions. It is susceptible to cyclones and flooding among other disasters. The Red Cross works with 85 community committees to train them in mapping out hazards, analysing risks and developing plans to warn people when this is possible. They raise flags corresponding to increasingly serious low-pressure depressions thus providing time to get to safety. Micro-loans might help people buy or repair fishing boats: the source of many livelihoods. The organization has worked within communities to reach out and include women who are traditionally kept away from such discussions and assistance.

Working within communities has been the basis of their work in Indonesia in combating tsunamis especially after the devastation of 2004. The villagers choose groups who are trained in first aid and search and rescue. They ascertain the risks to their communities and build evacuation routes to higher grounds. Vulnerable members of the society are identified at this stage and precautions taken. An increased awareness of the possible impact of the disaster is communicated by a number of community activities including plays. When the initial work was completed (which took almost 4 years) the day-to-day running was passed to an Australian aid agency: Austcare. The Red Cross is uniquely placed to tackle countries like Syria which is not only susceptible to natural disasters such as earthquakes, drought and flooding but also currently has a very unstable political situation (where human atrocities are said to have been committed), a large influx of refugees from neighbouring countries and also conflicts with the same. It was a challenge to them, but a testament to their reputation internationally, that they are able to call up a team of 3,000 volunteers to modernize Syria's response to natural disasters. Among a large number of programmes, they have been able to teach first-aid in community groups and also within schools. They have been able to provide equipment including sanitation aids, nutrition for emergencies and instruction for how to run camps.

Local recruitment is the cornerstone to the Red Cross's rapidity when responding to a global emergency. The key to the initial action are the *emergency response units* who are always on-call to be deployed anywhere in the world to provide relief items and water and sanitation facilities. A similar plan to that outlined above is used to respond to such disasters and the Red Cross is additionally committed to remaining after the initial assistance to ensure the community is thriving as before.

Emergency response units are usually requested when the local teams might themselves me affected by a disaster and require supplementary assistance. As an example, the British team has a number of specialists: the *logistics* unit is responsible for getting relief to the people who need it. They must arrange for supplies to reach the country they're needed in and accounted for in storage. They then have to identify means of getting the supplies to those who require it. This might be difficult in remote areas or if the infrastructure has been affected. *Mass sanitation* units are hugely important in all disasters to prevent diseases from spreading and maintaining good hygiene. Cholera is a major consideration where sanitation has been impaired and water purification and soap and disinfectants are essential in preventing its spread. The first use of this team was in Pakistan after the floods of 2007. The

Red Cross might provide loans and equipment to families allowing them to replace equipment necessary to live and work. Psychosocial support is provided for any Brits caught abroad. Other teams in other countries can provide assistance in water and sanitation, hospitals, basic health and IT.

Conclusion

The subject of disaster medicine is a vast one and one of the many subjects that there is not enough time to adequately cover in medical school. However, it provides many lessons in good practice that make its study worthwhile apart from the basic fact that any health professional and citizen might be in a position to assist their fellow human beings. The key to a good response is preparation and planning: ensuring that the equipment is available; that people know their roles and, perhaps most importantly is working with people from other disciplines. The topic lends itself to revising emergency medicine and triage. It involves revision of injuries across the board and taking an interest in the public health aspect of medicine.

We examined the work of the Red Cross as an example of an organization able to deal with international disasters. Of course, they are one of a very many similar organizations. Also, such tragedies bring people together with a common goal and show basic humanity. This can often be fostered in a response. Communities crystallize at such times. When the recent earthquakes struck Japan rapidity of response was the key to the initial survival. The government was thought to have dragged their heels. Similar accusations were made after Hurricane Katrina in New Orleans. In the former, it was the Yakuza who were actually the first on the scene providing food, blankets and so on. It took days for other agencies to reach the people who required help. How we respond to natural disasters is an ongoing consideration. We can still get faster, plan and practise more, and coordinate our resources for a more effective action. These are skills that it is never too early to begin learning and honing.

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