Response to Major Incidents and Disasters: An Important Part of Trauma Management

4

Sten Lennquist

4.1 Definitions

Ever since disaster medicine was established as an academic discipline, many attempts have been made to define the term *disaster* from a medical point of view. A wide range of definitions have been proposed and discussed, but many of these proposals have been only constructions of words and do not entail any practical function, neither as a basis for decision making in the process of alert nor as a basis for evaluating and comparing various incidents.

In order to achieve this, more practical and useful terminology originating from the term *Major Incident (MI)*, defined as *any situation where available resources are insufficient for the immediate need of medical care*, has been developed during recent years for the health care sector. MI is not related to any specific number of critically ill or injured patients, or to any specific level of resources, but rather to the balance between resources and need. The term is used only in the acute situation where lack of resources can cause immediate loss of life or severe impairment of health – a "chronic" discrepancy between recourses and need that might be present within an increasing part of the present health care system is not classified as MI.

The text in this chapter is to a part based on the textbook Lennquist S. (Ed): Medical Response to Major Incidents and disasters, Springer 2012, with permission from the publisher.

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The impact on the health care system is related to the *MI level*.

1. *MI Level 1*: By adjusting organization and methodology, we can attain the level of expectation of our medical care and rescue all patients who can be saved. Alternative definitions are *Major Incidents* or *Major Accidents*, *Major Emergencies*, and *Compensated Incidents*.
2. *MI Level 2*: The number of casualties is so high that even with adjusting organization and methodology we cannot attain the level of expectation, meaning that all patients cannot be saved. Alternative definitions are *Mass-Casualty Incidents*, *Disasters*, or *Decompensated Incidents*.
3. *MI Level 3*: The same as level 2, but combined with destruction of the infrastructure in a region. This means even higher demands on triage, as well as demands on other types of support, requiring national assistance from outside the affected region.
4. *MI Level 4*: The same as level 3, but affecting a country where the entire national infrastructure is impaired or where the national resources are insufficient to handle the situation and international assistance is needed. Alternative definitions for levels 3 and 4 are *Complex Emergencies* or *Compound Incidents*.

The advantage of this terminology is that it provides a direct practical base for decisions in response to the alert.

Level 1 means that disaster plans should be activated and the methodology of working adjusted to that, but the goal can still be to save all patients.

Level 2 means upgrading the degree of alert and preparedness, giving a lower priority to casualties with minimal prospects of cure to be able to save patients with a better chance of survival (i.e., use of the triage category "expectant").

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Level 3 means mobilizing national resources from outside the affected region, including support functions for supply of water, electricity, food, and temporary accommodation, and transport facilities both for evacuation of casualties and for delivery of personnel and material resources.

Level 4 has the same meaning as level 3 but on an international basis, indicating activation of international relief organizations.

When this terminology was introduced, levels 3 and 4 were combined into level 3. Recognition of incidents that can be handled nationally in spite of destroyed infrastructure and the need for clear indications for activation of international relief operations has led to the proposal for separating the last level into two separate categories (levels 3 and 4).

Most incidents in high-technology countries, or countries with good health care resources, fall under the category *MI level 1*. From a medical point of view, the World Trade Center terrorist attack of 2001 can be included in this category, even if, in general terminology, it has been classified as a disaster. The primary mortality on the scene was so high that there was an ambulance for every surviving casualty, and the hospital resources were more than adequate.

An example of an *MI level 2* situation is the Estonia Ferry Incident in the Baltic in 1994, where in a storm and cold water the resources were sufficient enough to rescue only a limited number of passengers from the cold water, with a total of 852 casualties; the evacuation of those with signs of life was restricted, leaving hypothermic and "normally" rescuable casualties on the rafts.

Examples of *MI level 3* are the floods after Hurricane Katrina in the United States in 2005 and the earthquake/tsunami disaster in Japan in 2011. Examples of *MI level 4* are the tsunami disaster in the South East Ocean in 2004 and the earthquake in Haiti in 2010.

Even though an internationally uniform terminology is desirable, there will probably be variations in definitions between countries, based on differences in resources, potential scenarios, community structure, culture, and traditions. Regardless of terminology, it is important that the definitions used are not only a theoretical construction of words, but practical and useful for basing decisions and performance in such situations, and they should be well known to health care staff at all levels.

4.2 Risks of MIs in Modern Societies

It has been clearly shown that the possibility of situations where available resources are insufficient for immediate medical care has increased significantly during the past decades and continues to increase in parallel with the development of the community:

- The *global population* has increased from 1.6 to 6 billion people during the past century, and with the current annual increase of 1.33 %, the calculated number for the year 2050 is 8.9 billion, which is a risk factor in itself.
- *Continuing urbanization* means increasing numbers or people in crowded areas, both for permanent living and gathering for different public events. Such areas are also a potential target for terrorist actions.
- *Increasing movement* of people, whether permanent or by travelling. As an example, of the 9 million inhabitants of Sweden, more than 400,000 are in other countries at any given time of the year, in many cases, traveling in areas known to be a focus of natural disasters and/or terrorist activity.
- Production, transport, and use of *hazardous material* has greatly increased over the past decades; only in Sweden, 18 million tons of flammable, explosive, chemical, or toxic agents are transported over roads every year, with an additional 3 million tons transported by rail.
- Hazardous material also includes *radioactive substances* that modern society has been increasingly dependent on for supply of energy, which involves risks that cannot be ignored.
- *Global terrorism* has apparently come to stay, partly replacing armed conflicts. This means that at any time, at any place, regardless of active involvement in any conflict, and without warning, we can be faced with large numbers of severely injured people. The goal of the terrorists is to gain attention for their own interests, with killing being the easiest way and having the biggest effect, regardless of whether innocent people are killed.
- Even if the risk for a global war has decreased temporarily, history speaks for itself, and *armed conflicts* are continuously occurring all over the world and will probably continue to occur, with increasing political tensions, accelerated by increasing divisions between poor and rich populations.

- It is today agreed that the ongoing climatic changes have generated an escalation of so-called *natural disasters* and that the effects of such disasters with regard to loss of health and life have the potential to increase, subsequent to the increased global population and increased concentrations of people in limited areas.

The World Disaster Report 2007 showed a 60 % increase of occurrence of incidents defined as "disasters" during the decade 1997–2006. During that period, the reported deaths from such incidents increased from 600,000 to more than 1,200,000, and the number of affected people increased from 230 to 270 million.

Reviews of MIs occurring in the world during the past few decades clearly show that wherever we live or work in the world and however safe and peaceful the area may seem, we can at any time face a situation requiring all the knowledge and preparedness described below to be able to reduce loss of health and life, as well as suffering, of people who depend on and trust the competence of experts in this field.

For a review of recent MIs, experiences, and lessons learned, the reader is referred to text books on medical response to MIs.

4.3 Demands on Health Care in Major Incidents

Parallel to the increasing risk for MIs wherever we live in the world, we can – as a paradox – identify an *increased vulnerability of our health care system* to these kinds of situations.

- Reduced reserve capacity because of increasing demands on efficiency, with continuous optimal utilization of all available resources
- Increased dependence on advanced technology
- Increased specialization, with reduced ability to deal with conditions outside one's own specialty

The goal of the health care system during MIs is to *reduce* (*as far as possible*) *or eliminate loss of life and health and physical and psychological suffering as consequences of the incident*.

The following are required to achieve this goal:

- Relocating of available resources to where they are most needed and rapid mobilization of additional resources (personnel and material).
- Optimal utilization of available resources by accurately prioritizing between patients and diagnostic and therapeutic measures and the use of simplified methods for diagnosis and treatment.

Relocation and mobilization of resources require *planning and preparedness*, including a prepared structure for coordination and command, defining the positions responsible for decisions on different levels.

Optimal utilization of available resources requires *education and training* for all the staff involved in responding to the incident, possibly the most important part of preparedness.

Planning, education, and training require *development and research* within this field, as in all other fields of medicine.

4.4 Prehospital Response

4.4.1 Demands on Prehospital Response in MIs

This situation is different from the "normal accident" where an ambulance (at least within a short time) can be expected to be available for every patient needing transport, with a varying number of patients now having to wait for transport. Evacuation may be delayed by time-consuming extrication, difficulties in obtaining access to the scene, and/or lack of rescue staff in relation to the need. All these points generate a need for *additional medical functions* at the scene:

- Leading and coordinating the medical activities at scene in conjunction with other organizations (rescue service, police);
- Continuous communication with the medical coordination center (the alarm center, ambulance dispatch center, or regional medical command center, depending on local organization), reporting expected need for care, and requesting resources according to needs;
- Triage on the scene (i.e., deciding in what order the patients should be treated and evacuated);
- Treatment at the scene because evacuation is delayed, but also because treatment may permit lower priority for some casualties, saving ambulances for those requiring immediate hospitalization;

- Transport to hospitals, with estimation of available hospital resources, which requires communication with a coordinating medical center.

These demands result in an immediate need for medical staff at the scene who (1) can lead and coordinate the work according to the above and (2) can start triage as a basis for transport priority.

Regardless of organization, these tasks are always primarily performed by the crew of the first ambulance at the scene.

Incidents with many casualties and/or delay in evacuation require additional medical staff at the scene for the tasks described above. Planning for MIs must include preparedness for them. It is important for the medical officer in command at the scene to identify such needs at an early stage so that prehospital teams can be mobilized for this function and ambulance crews can instead be utilized for transport.

4.4.2 Structural Variations Among Countries

The type of organization on the scene naturally varies among countries depending on structural differences among communities with regard to involved participants and their responsibilities, national traditions, geography and culture, economy, and political system. However, the basic principles are the same and will be described based on what is common practice in at least most European countries, but also with emphasis on where alternative ways of organization may exist. Some basic rules that are important to follow regardless of type of organization will be particularly emphasized, as well as the most common mistakes.

A concept that will be referred to, because it is frequently used in European courses in this field, is the Major Incident Medical Management and Support (MIMMS) concept, originating from the United Kingdom. It is influenced by British organization, which differs somewhat from the organization in Central Europe, but parts of it are valid for any organization and it is educationally well presented, using acronym-based poems to support memory in critical situations.

It is important that all medical personnel who might be deployed for work at the scene of MIs are familiar with their own local organization, have postgraduate education and training in the positions they may be expected to have in a MI.

4.4.3 Terminology

As the organization at the scene varies on some points between countries, there are also variations in terminology. With the aim of avoiding continuous repetition of alternative terminology, which can cause confusion, only one form of terminology will be used in the following text, explained below with mention of alternatives. Regarding organization, it is important for all medical personnel to learn and use the terminology adopted in their own country; hopefully it will be possible sometime in the future to come to an agreement on an internationally uniform terminology.

MIC Medical Incident Commander. Leads and coordinates the medical work at the scene. Alternative term: *Ambulance Incident Officer*.

RIC Rescue Incident Commander. Leads and coordinates the rescue work at the scene. Alternative term: *Fire Incident Officer*.

PIC Police Incident Commander. Leads the police work at the scene.

TRO Triage Officer. Medical officer responsible for the primary triage. The term is not used in all organizations.

ALO Ambulance Loading Officer. Leads and coordinates transport of casualties from the scene. Alternative terms: *Transport Officer*, *Transport Leader*, *Chief of Transport*.

RMC Regional Medical Command Center. Leads and coordinates the whole medical response to the incident. In some countries, this is a specially prepared function staffed by medical and administrative officers. In other countries, this function is covered by other organizations: *Alarm Center*, *Ambulance Dispatch Center*, or a defined hospital in the area, and in some countries it does not exist.

RVP Rendezvous Point. Point where all incoming units in the rescue action are directed to stand by for access to the scene. Alternative terms: *Check Point*, *Break Point*.

4.4.4 First Unit at the Scene

4.4.4.1 The First Report

The first unit at the scene always has an important role, even more so in MIs. Regardless of what type of information has already been relayed to the coordinating center, this will be the first report from medical staff,

which is of critical importance for further activation of the entire medical response chain: Mobilizing transport facilities, equipment and prehospital teams, and alerting hospitals. Delay in this report will cause a delay in the response that can have fatal consequences for the victims of the incident.

The first report is commonly referred to as "Window report"–*it should* ***not*** *try to be complete*, but is *only a primary indication of how great the need for medical care is expected to be*, and therefore in many cases can be based on what can be seen through the window of an arriving vehicle. Possible information at this stage may be restricted to "*Many injured, probably many dead, need both medical support at scene and transport facilities*"–enough to pull the trigger for MI and start activation of the medical response.

According to the MIMMS concept, the acronym-based word for the first report is *METHANE*:
*M*ajor incident declared (or standby)
*E*xact location
*T*ype of incident
*H*azards
*A*ccess
*N*umber of casualties
*E*xtra resources

This concept is used as standard in some countries, but is not always easy to translate into other languages. It is based on the British system where the first ambulance crew may declare a Major Incident, whereas in many countries this is the responsibility of a coordinating medical center. The difference may be of theoretical interest; the probability is that no coordinating center would object if the first arriving ambulance evaluates the situation as a MI. However, *it is important that it is clearly stated in the disaster plan to which position the authority* (*and responsibility*) *to declare a MI is connected*, *so that confusion on this point does not delay the decision and thereby the alerting of resources*.

If an MI is apparent and immediate contact cannot be established with the coordinating center, the first ambulance crew at the scene should act according to the action cards for MI (see Table 4.1) until contact has been established.

Table 4.1 Action card for medical incident commander (example)

Action card MIC
1. *Deliver window report* to alarm center (rough estimation of number of casualties, estimated need of transport and medical care on scene)[a]
2. *Confirm MI*. If MI is not already declared but apparent on arrival, inform alarm center, act according to MI until contact from *RMC*[b]
3. *Park ambulance*, take on *tabards* for *MIC* and (other crew member) *TRO*
4. *Contact RIC* (if arrived) direct or by Channel X
Request information about:
Estimated number of injured and dead
Risk zones(hot, warm) and other risks at the scene
The most urgent need of care
Required and expected resources from rescue service
Decide together with RIC location of casualty-clearing and ambulance-loading zones
5. *Decide* if incoming ambulance crews should be retained at the scene for medical support, and if so how may and for which tasks
6. *Dispatch* TRO to start primary triage according to action card
7. *Make quick survey* of the scene and:
Estimate again number and severity of casualties
Need of support in injury zone (trapped). Identify urgent needs
8. *Decide Level of MI* as guideline for medical work, inform all staff and re-evaluate this level continuously
9. *Contact RMC* Channel X (if no contact with RMC, Alarm center or ADC) and:
Deliver second report based on the information above
Request prehospital teams to scene if needed
Request helicopters if needed and not already alerted
Request distribution key for transports to hospital
10. *Start transport* of patients triaged by TRO. Until distribution key given, start to send severely injured according to:
Six to Major City University Hospital
Four to Small Town Regional Hospital
Two to Small Town County Hospital

(continued)

Table 4.1 (continued)

Action card MIC
11. *Organize casualty-clearing and ambulance-loading zones* for primary and secondary triage and dispatch teams according to that, and also teams to injury zone when needed (to risk zone = not without communication with RIC)
12. *Appoint ALO* for transport coordination
13. *Repeat contacts with RMC*, update reports from scene, request updated distribution keys, request additional support and equipment when needed
14. *Maintain contact with RIC and PIC*, in big incidents establish Command Place
15. *Decide* "*MI* Stand Down" on scene in agreement with RMC when all injured are evacuated. Inform RIC, PIC, and all medical staff at the scene. Lead *debriefing* for all medical staff before departure from scene

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[a]If "METHANE" is used as guideline for this report, insert it here
[b]In some countries, MI is declared by the first arriving ambulance at the scene

Fig. 4.1 The crew in the first ambulance at the scene in a major incident takes the roles of Medical Incident Commander (MIC) and Triage Officer (TRO). They wear tabards with these markings, available in all ambulances, unload medical equipment needed on the scene, and follow the action cards for these positions, also available in all ambulances (Table 4.1). Their ambulance is not used for transport but stays on the scene as a *command ambulance*, in some countries indicated by keeping the blue light on (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012, with permission)

4.4.4.2 Taking Command

When an MI is declared, the first arriving ambulance will not be involved in transport of casualties, but will stay at the scene. One of the officers will take the role of *Medical Incident Commander* (*MIC*) and the other, the primary role of *Triage Officer* (*TRO*) and immediately prepare the ambulance loading zone and triage the first casualties for transport to the first available ambulances.

In some organizations with very good access to ambulances, both officers in the first ambulance take administrative roles, but with such an urgent need of medical care at this stage, it is often difficult to have two administrators.

In most organizations, the ambulances are equipped with tabards labeled with the positions referred to above (Fig. 4.1). The labeling may vary between countries, but the most generally internationally accepted colors for medical staff are green and yellow. The figure also illustrates the need of personal protection clothes and is valid for all medical staff working in the field.

The MIC should have a prepared *action card for MIC* telling what steps to take, and in which order (see Table 4.1). Such action cards should also be included in the equipment of all ambulances.

The acronym-based word used in the MIMMS concept to summarize the contents of the action card is *CSCATTT*, standing for "*C*ommand, *S*afety, *C*ommunication, *A*ssessment, *T*riage, *T*reatment, *T*ransport". This can be good support for memory if the action card is lost or not found.

Fig. 4.2 Police Incident Commander (*left*), Rescue Incident Commander (*middle*) and Medical Incident Commander (*right*). These officers constitute the Command group at the scene and stay in continuous communication during the response, and a command place is usually established that can be at a vehicle or, in extensive incidents, in a special command wagon (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012, with permission)

4.4.4.3 Coordination with Collaborating Agencies

The leader of the rescue operation in most countries is the officer in charge of the first fire brigade that arrives, the *Rescue Incident Commander* (*RIC*), and in some countries the officer in charge of the first police unit to arrive, the *Police Incident Commander* (*PIC*). In some countries, the rescue leader has overall command of rescue operations, whereas in others, every organization involved is on its own. This difference is mainly theoretical because no chief of rescue or police would give orders with regard to medical care, and medical staff naturally respect the advice of police and fire brigade with regard to security matters.

Regardless of organization, the *RIC* has authority to request any type of resource needed for the rescue work, including private property (even if he/she has to answer for it afterward).

If the *RIC* (in most places clearly marked with tabard and helmet [see Fig. 4.2]) has arrived at the scene before the first ambulance, one of the first steps is to establish contact, request available information (Table 4.1), request resources for medical care, and agree on location for triage and ambulance loading zones, which should be as close together as possible, but outside potential risk zones.

The *RIC*, *PIC*, and *MIC* normally constitute the *command group on the scene*. In complex incidents, or incidents extended in time, a command center is established from where this command group can coordinate the operation.

4.4.4.4 Safety

The *MIC* is responsible for the safety of the medical staff, and a dead or injured medical officer is of no benefit to the victims. Communication with the *RIC* with regard to possible risks in the area (Table 4.1) is mandatory as a basis for dispatching medical staff onto the scene.

The rescue service commonly uses the terminology *hot*, *warm*, and *cold* zones:

Hot zone = risks for life and health so high that only rescue staff with special equipment and training should go in (fire, smoke, or high concentrations of hazardous material).

Warm zone = medical staff can go in, but only if they are wearing protective equipment and are trained for it (smoke or hazardous material in concentrations so low that simple protection equipment is sufficient).

Cold zone = no risks requiring special equipment or training (not excluding other risks).

In some countries, the *RIC* decides who is allowed to enter warm or hot zones; in other countries the *MIC* decides on medical staff, but should nevertheless respect the advice of the *RIC*.

In incidents caused by, or involving, criminal activities such as terrorist attacks, riots, or gunfire, the police are also responsible for security and making decisions

with regard to which zones can be entered by rescue and health-care staff without risk of being injured from such activities.

4.4.4.5 Overview of the Scene

Before delivering the next report, the *MIC* should make a *quick scene reconnaissance* (1–3 min) to get the first medical overview of the scene and identify urgent needs of care such as need for medical support for extrication of trapped, and make a preliminary estimation of the number of severely injured. This offers a personal knowledge of the conditions at the scene, valuable as a basis for leading the work and for dispatching medical staff within the area.

In bigger incidents, the *RIC* usually organizes the scene in *sectors* (part of a building, one or more wagons in a train) with a rescue officer responsible for each sector. If there is a need for medical support at the scene, it would be wise to dispatch medical staff to make contact with the responsible rescue sector officers to obtain information and establish collaboration.

4.4.4.6 Second Report

The second report is the *confirming report*, coming after the first "window report". *It is important that this report come as soon as possible*. At this stage, the whole medical organization, triggered by the first alert, is awaiting more information as a basis for a decision regarding the level of alert and steps to be taken within every unit. Therefore, again, there should be no details, no attempts to give the anatomical distribution of injuries, just the information that can be extracted from communicating with other units at the scene, and from the rapid reconnaissance of the area.

4.4.4.7 Decision of Strategy for the Medical Work

At this stage, the *MIC* should be able to estimate the relation (or discrepancy) between the need for medical care at the scene and available resources. Based on this estimate a decision about strategy must be made: Is this a situation where the normal level of medical care can be maintained with the steps:

- taken as above (= *MI Level 1*: all potentially rescuable can be saved, what is called a *compensated incident*), *or*
- Is the load of casualties so high that the standard of care must be lowered to be able to save as many as possible (= *MI Level 2*: *decompensated incident*)?

It is difficult for medical staff at the scene to obtain the overview needed to make such judgments and this is therefore the task of the MIC. Decisions with regard to strategy should be clearly communicated to all the staff involved as a guideline for triage and can be changed, depending on incoming resources or initially undiscovered needs.

4.4.4.8 Establishing Continuous Contact with the Regional Medical Coordinating Center (RMC)

After following these first steps on the action card, the *MIC* should take a position where he/she is not involved in medical care or decisions with regard to triage and establish repeated contacts with the RMC to:

- Request information on hospital capacity
- Request additional support at the scene if needed (transport resources, equipment, staff)
- Report casualty load at the scene and departed transports

4.4.5 Building up the Structure at the Scene

4.4.5.1 The Need for Simplicity

As stated in Chap. 1, *simplicity is the key to successful management of MIs* and that is valid also for the operations at the scene. It should be remembered that the majority of MIs occur in densely populated areas with good access to ambulances and short distances to hospitals. The first ambulance is often at the scene within 5–15 min after the alarm and then the medical work begins, and with many ambulances within close range, the evacuation from the scene can (and should) start a few minutes later.

This does not allow time for building up a complex organization. Schedules of organization that are too complex with too many boxes, too many levels of command and decision, and too many ranks and titles, will involve a risk that "the war is over" before the organization is built up.

It is an understandable temptation to transfer experiences from a military organization to a civilian one because military personnel are (and must be) good organizers, using a clear and strict hierarchy. However, there are significant differences between the civilian MI and the combat situation with regard to (1) time for preparation, (2) demands on endurance:

- A war rarely commences without warning, which allows for a long preparation time. However, the organization must have the ability to run on a high

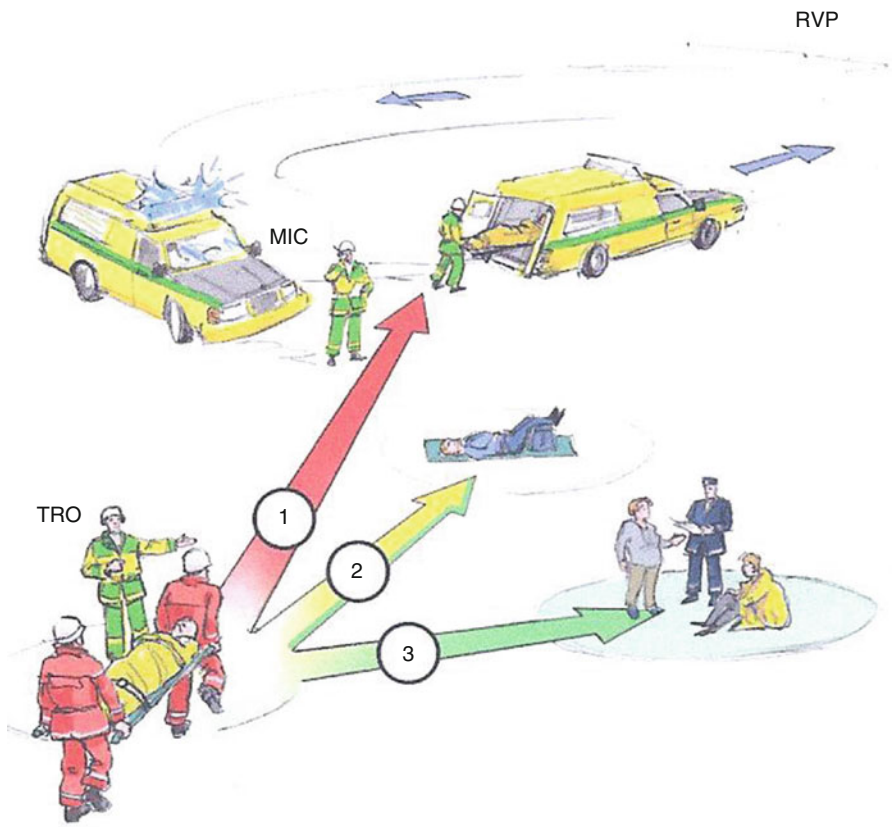


Fig. 4.3 The organization on scene is built up step by step, the first step when the first ambulance arrives. The Triage Officer (*TRO*) makes only a simple primary triage and sorts the patients according to three routes: (*1*) Severely injured, can go with available ambulance, necessary resuscitation done by ambulance crew. (*2*) Need ambulance transport, but can wait. (*3*) Do not need ambulance transport. The Medical Incident Commander (*MIC*) at this stage has the role as transport coordinator and decides the destination for the first patients. *RVP* Rendezvous Point (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012. Artwork Lats-Ake Pettersson, with permission)

capacity for a long time, days, weeks, months, or even years.

- An MI in peace time in a civilian community, on the other hand, occurs at any time, without any warning at all, and within a few minutes, an organization fully occupied with routine medical care must have the ability to deal with a number of severely injured, far exceeding available capacity, regardless of whether any of the available staff has any experience of such situations. However, the peak of the casualty load usually passes within a few hours (exceptions exist, of course).

This means higher demands on existing facilities than in the combat situation. There is no time to build up a new organization, only to adapt the existing organization to the specific demands of the MI.

4.4.5.2 The First Step: Starting Triage and Transport

The tasks of the first medical unit at the scene have already been described, illustrating that one of the officers in the first unit will be fully occupied with the important role of *MIC*.

At the same time, it is of critical importance that the transports to hospitals begin as soon as possible – "*no fully staffed ambulance should be standing waiting*", and the sooner they get moving, the sooner they come back.

Therefore, the triage process must start as soon as there are ambulances at the scene, and this is the reason to use the second officer in the first ambulance as primary triage officer = *TRO*.

The first step in organizing relief work, based on the presence of only one ambulance staff, is illustrated in Fig. 4.3. The *TRO* sorts the patients into three routes of evacuation: (1) Should go with the first available ambulance, (2) needs ambulance but can wait, and (3) injured but without need of ambulance transport. A very simple system should be used for this *primary triage*, for example *Triage Sieve* (see below under triage).

In this phase, the *MIC* may also have the role of transport coordinator and direct available (staffed) ambulances to hospitals. The principles for the distribution between hospitals are described below under "Transport".

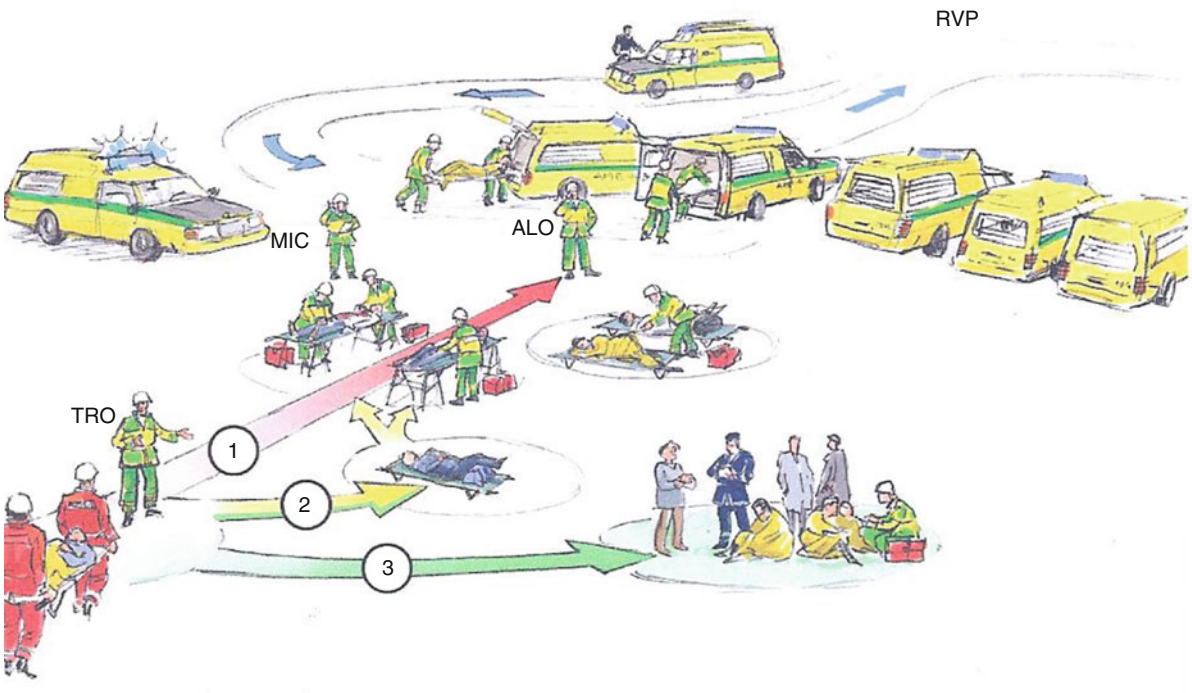


Fig. 4.4 When it is apparent that there are additional patients needing ambulance transport than there are available ambulances, the organization is extended with a *second step*: Patients who are not ready to depart, or cannot depart because of lack of available ambulance, now follow line (*2*) to teams devoted to necessary resuscitation/treatment and secondary triage before transport. An additional medical officer/team surveys patients waiting for transport, and another is dispatched for secondary triage/survey of patients estimated not to need ambulance transport. The *Medical Incident Commander* is now replaced by another ambulance officer having the role as Ambulance Loading Officer (*ALO*) (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012. Artwork Lats-Ake Pettersson, with permission)

As soon as casualties in route (2) begin to accumulate, or need surveillance, additional medical staff at the scene is mandatory and that is the task of the *MIC*. Thereby the organization is transferred to the next step.

4.4.5.3 The Second Step: Completing Casualty and Ambulance Loading

There is now access to additional medical staff at the scene, either ambulance crews from arrived ambulances or deployed prehospital teams (they usually take longer to arrive on the scene).

This means that the second route of evacuation goes to one or more teams for *secondary triage*, including measures of resuscitation needed before transport (Fig. 4.4). Two staff members in each such team are preferable to, for example, one ambulance crew, or a prehospital team with a physician and a nurse. For this secondary triage a system with better discriminative capacity than Triage Sieve is recommended, for example *Triage Sort* (see below under "Triage").

If there is congestion in the evacuation area and no immediate access to ambulances for high priority patients, staff are needed to attend to and help casualties awaiting transport (Fig. 4.4).

At this stage, evacuation of casualties not needing ambulance transport should also be begun, and they must be examined and re-triaged by medical staff before departure (Fig. 4.4).

The *MIC* should be released to assume the position of transport coordinator as soon as possible and replaced by another ambulance officer (*ALO*, Fig. 4.4).

4.4.5.4 The Third Step: Completing the Organization at the Scene

The Injury Zone

As mentioned above, the need for medical support in MIs is usually not restricted to the casualty-clearing

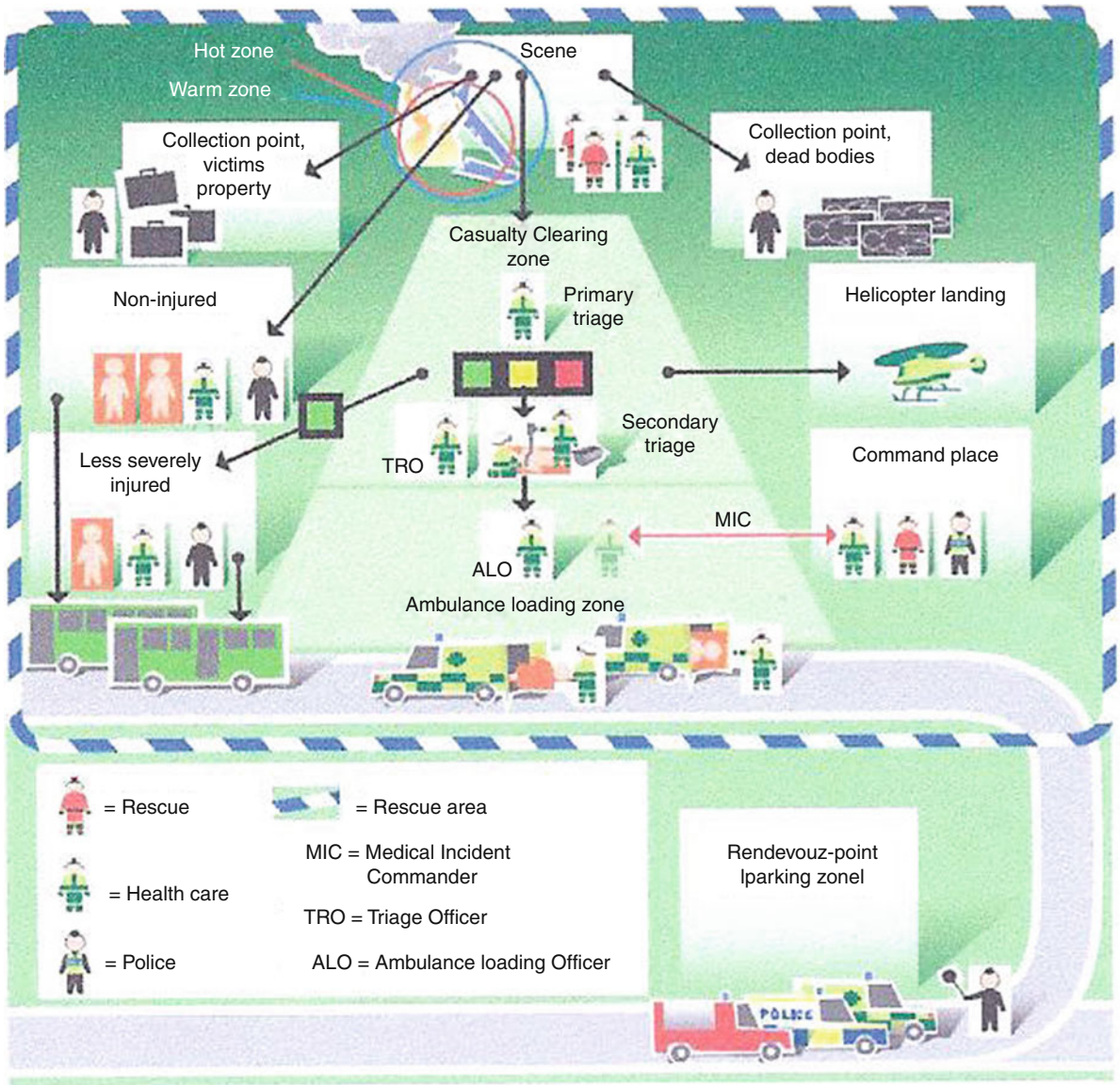


Fig. 4.5 The organization at the scene in a greater incident completely built up (see further the text) (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012, Artwork Typoform, with permission)

and ambulance-loading zones, even if, as a general principle, the work should begin there to have the transport going as soon as possible. There may also be an urgent need for resuscitation and triage where the injured are located, the *injury zone* (Fig. 4.5) and may be in the wreck after an airplane, rail, or bus crash; in a collapsed building; or in an area of explosion. One of the objectives of the rapid overview of the scene performed by the MIC immediately upon arrival is to identify such needs and deploy staff to the location as soon as possible. Note that there can be *risk zones* (see above) within the injury zone; do not deploy staff there without communicating with the *RIC*.

Non-injured People

People who survive an MI without physical injuries are also victims. Exposure to a situation like this is a severe psychological shock for most people, and even if the reactions are not apparent immediately, they may appear later. In addition, many of the non-injured people may have lost contact with friends and relatives,

or seen them killed or injured, and they may have lost their property and/or be far from home. This group of people cannot just be sent away, but need to be taken care of.

Additionally, the same considerations are valid with regard to potential severe injuries here as for the group primarily triaged as "less severely injured" (see below): They should also be examined by a medical officer, if possible, before departing from the scene.

The police have the responsibility of taking care of those who were not injured. They must be registered and taken to a prepared zone where they can be given protection and obtain transport to a location where they can get psychosocial support, information with regard to lost friends and relatives, and help with further transport (Fig. 4.5).

The Dead at the Scene

Management of dead victims on the scene is the responsibility of the police. In most countries, only doctors are allowed to declare patients dead, unless death is apparent: Head separated from the rest of the body or the patient totally crushed or burned. Victims who are apparently dead should be left where they are found to facilitate identification and investigation by the police. For management of the dead, the reader should consult text books on medical response to MIs.

Other casualties without any signs of life should be labeled as low priority patients until they can be examined by a doctor and death confirmed. Note the hazard of differentiating between hypothermia and death: *In a cold environment*, *no one should be declared dead until warm and dead*! For triage and management of hypothermic casualties, the reader should consult text books on medical response to MIs.

Helicopter Landing Area

Helicopters are a useful resource in MIs, not only for evacuation of casualties (see below under "Transport") but also for transport of equipment and staff to the scene. In incidents where the benefit of helicopters is apparent and there is access to them, they should be alerted early for this purpose, and a *helicopter landing area* prepared and clearly marked out. It should be located at such a distance from the casualty-clearing zone that ambulance transport to the helicopters is not necessary, but not so close that it disturbs the work in the casualty-clearing zone (a distance of approximately 50 m is recommended for standard helicopters).

Cordoning Areas Off and Traffic Control

The first task of the police is to cordon off the area to prevent access to all traffic not involved in the rescue action.

If all rescue and transport vehicles arriving at the area should proceed into it, it would soon create a congested and chaotic situation where no vehicle can move. One of the first tasks of the incoming rescue leader is to decide a *check-point* or *rendezvous point* (*RVP*) in conjunction with the police: A place easy to identify on the map, well connected to routes for both entrance and evacuation, and with space enough to park waiting vehicles.

This point is often decided already before arrival of rescue units, based on local knowledge of the area, and information about it should be forwarded to all alerted units. Traffic control at this point should be handled by the police.

Figure 4.5 illustrates the principles for a fully developed organization at the scene of an MI, with many injured and need of medical support both in the injury zone and in the casualty-clearing and ambulance-loading zones. The figure illustrates a scene with immediate access to a road which is the case in most, but not all, MIs. Long distances from the injury zone to a road require off-road transport between casualty-clearing and ambulance-loading zones, which puts even higher demands on the rescue organization.

Inflatable tents can be life-saving measures in severe climatic conditions with delayed evacuation, but also involve a potential risk of congestion: They give the impression of being in a field hospital with a temptation to extend the treatment to more than is absolutely necessary before transport, which may create a congestion of waiting patients and also non-utilized ambulances (Fig. 4.6). *If tents are used*, *it is of vital importance that the structure and principles of working as described above are maintained*.

4.4.6 Triage

4.4.6.1 General Principles

Triage in MI situations must meet the following requirements:

- Triage is, and must be, *a dynamic process*, which means that it can and should be reevaluated at every stage in the chain of response and adjusted to:
  - The patient's condition
  - Effects of performed treatment

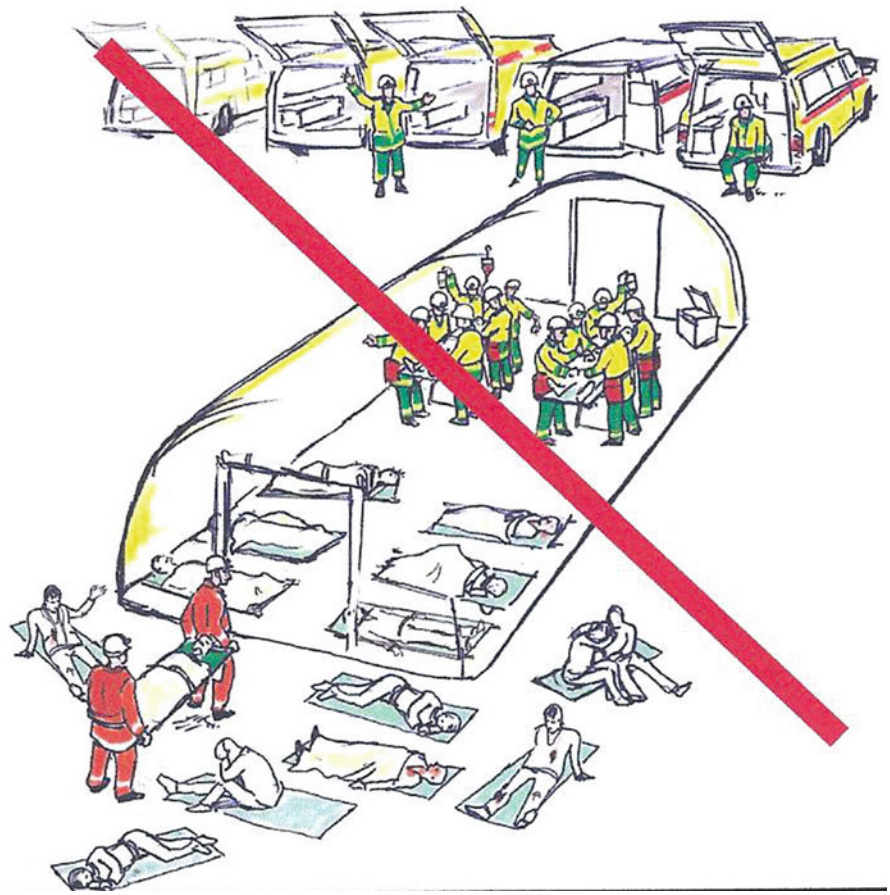


Fig. 4.6 The use of inflatable tents for protection of casualties and staff may be necessary in extreme climatic conditions and delayed evacuation. Even if such tents are used, it is important to maintain the simplicity of the structure and not fall for the temptation to overdo treatment with the feeling of being in a field hospital. What, as seen in this figure, could also be the effect of exercises performed without real times, giving the impression that everything can be done without consuming any time (From Lennquist S (ed) (2012) Medical response to major incidents. Springer, Artwork Lats Ake Pettersson with permission)

  - Position in the chain of response (prehospital, transport, different levels in the hospital response).

This means that a patient may be at different priorities at different levels of the chain of management.

- *Standardized systems* for triage, based on simple physiological criteria, make the triage more independent of the level of competence of the staff performing it, and may thereby be the method of choice in the front line of the response, where senior experience in most cases is not available.
- The *system used must be adapted* to
  - The level in the chain of management at which it is done
  - The competence of the responder doing it

This means that different systems may be used at different levels of the response.

- The *categories of priority must be clearly defined and a uniform terminology used* by all staff involved in the same incident. Internationally uniform terminology is desirable.
- The priority given to a patient must be *clearly marked* though it is *possible to change it rapidly and simply* according to the demand that triage must be a dynamic process.

4.4.6.2 Categories of Priority

The categories used today in most European countries, introduced by the North Atlantic Treaty Organization (NATO), are described in Table 4.2. Two different systems are used, depending on the MI level: The P-system in incidents corresponding to level MI 1, and the T-system in incidents corresponding to levels MI 2 – MI 4.

The *P-system* includes three categories:

- P 1 = Immediate treatment is required to save life
- P 2 = Severely injured, but can wait for a limited time (30–60 min)
- P 3 = Can wait without risk for life and health

The *T- system* includes five categories of priority:

- T 1 = As P 1 above, with the difference that patients with possibilities of survival considered very limited, are now referred to as category T 4 (see below)

Table 4.2 Triage classifications used by NATO

		Label	
Priority	Color	P-system	T-system
Immediate	Red	P 1	T 1
Urgent	Yellow	P 2	T 2
Delayed	Green	P 3	T 3
Expectant	Black/green	T 4	
Dead	White/black	T 0	

The P-system is used in incidents corresponding to MI Level 1 and the T-system in incidents corresponding to MI Levels 2–4

- T 2 = As P 2 above
- T 3 = As P 3 above
- T 4 = Can wait ("expectant"); Patients with very severe injuries where the possibility of survival is considered so limited that the resources they would consume for treatment should instead be used for those who can be saved.
- T 0 = Dead

4.4.6.3 Indication of Priority

There is currently a lack of agreement on an internationally uniform system and a wide variety of colors and symbols are used. This can be dangerous because the same color can have different meanings in different countries. For example, black is used for the category "expectant" as mentioned above in some countries, whereas in other countries it is used only for casualties declared dead by a doctor, and the consequences of misinterpretation are easy to understand.

Triage is a dynamic process, which means that the priority must be reevaluated – and changed when justified – at all stages in the chain of response. The system for indicating priority must then have the possibility to change in both directions: Upgraded or downgraded. There are still systems in use in Europe in which this is not possible and as a result, the triage process cannot be dynamic, which interferes with optimal utilization of resources.

Most systems for indicating priority are based on colors. At a workshop held already during the First Congress of the World Association for Disaster and Emergency Medicine (WADEM) in Mainz, Germany in 1977, the following colors were agreed upon:
Red: Immediate
Yellow: Urgent but can wait
Green: Shall wait
Black: Dead

Since that time, the need of a fourth category has been increasingly recognized, particularly in MI levels 2–4: Casualties with such small possibilities of survival that the resources they would consume for treatment should be used for those who can be saved, as described above. In the NATO system they are categorized as "T4" and are labeled with black and green. In the British system, they are categorized as "Expectant" and labeled with blue color. Most European countries have adopted the British color system, in part influenced by the MIMMS courses, but also by the fact that the color blue offers a better contrast to the other colors.

The introduction of this fourth category is not without controversies and many countries have still not introduced it but it has gained an increasing support in recent years and has been considered justified, particularly in MI levels 2–3. A reasonable European standard would therefore be to add this fourth category:
Blue: Expectant (= shall wait, as long as resources do not permit curative treatment of all casualties)

How these color indicators are applied to casualties also widely varies among countries and among regions; therefore, an internationally uniform standard would be desirable. As already mentioned, it should be a system that permits easy change of priority in both upgrading and downgrading, and disqualifies many systems used today. For different examples of priority markings the reader is referred to text books on medical response to MIs.

4.4.6.4 Triage in Incidents of Physical Trauma

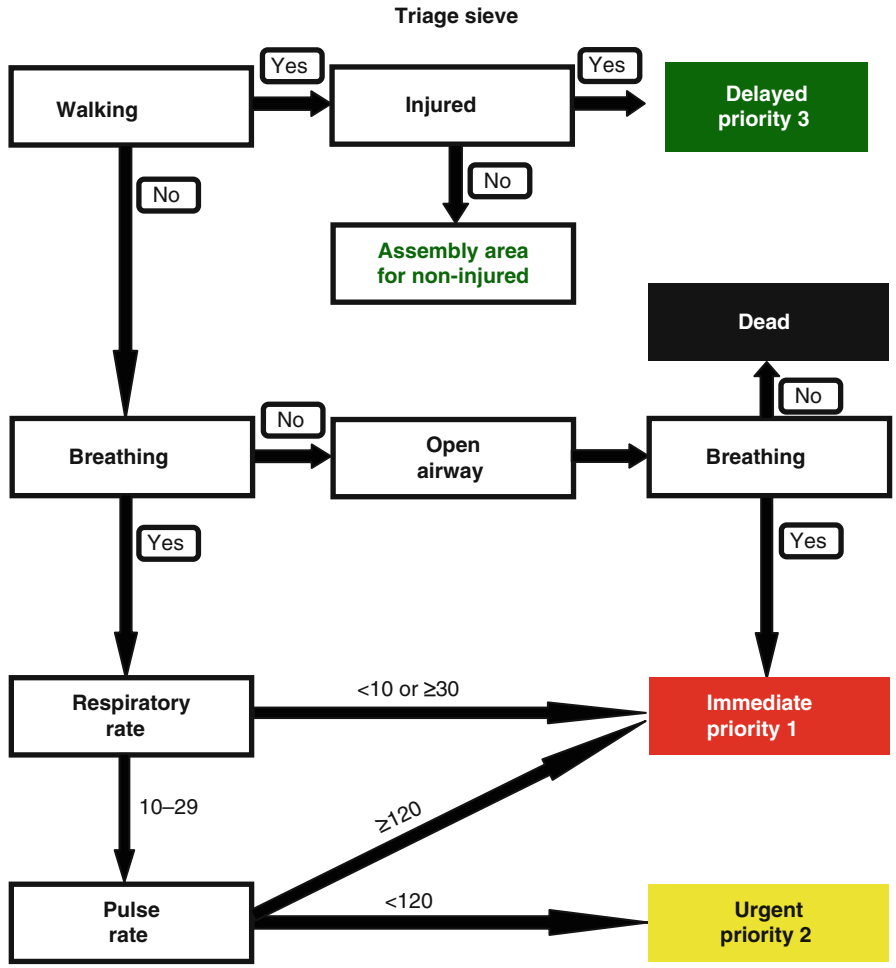
Triage at the scene of MIs caused by physical trauma is typically done in different steps according to the structure illustrated in Figs. 4.3, 4.4, and 4.5.

Primary triage by the primary TRO (or team) with the aim of

- Sorting out those who do *not* need ambulance transport
- Give those who *need* ambulance transport priority for either
  - resuscitation at the scene and secondary triage, or
  - resuscitation and departure in immediately available ambulances.

This primary triage can be based on very simple criteria such as sorting those able to walk from those who are not, or by using a system based on simple criteria

Table 4.3 Algorithm for triage sieve. This method is based on simple physiological criteria and is suitable for primary triage. The original version was based on capillary refill, not always easy to determine under field conditions; the figure illustrates a modified version based on pulse rate



From TG Associates, with permission

of the patients' condition ("physiological triage"), for example *Triage Sieve* (Table 4.3). This can be done quickly and also by a person with limited medical experience, if no experienced staff is available. However, it must be emphasized that this is only a first rough categorization and *those given low priorities in this primary triage must be re-evaluated before evacuation*: Even a patient with dangerous internal bleeding can primarily be walking.

Secondary triage, by the next triage teams, with the aim of:

- Performing a secondary and more thorough examination and evaluation of the victims' condition
- Perform resuscitation and the treatment necessary before transport
- Confirm or adjust priority, based on the results of the above steps, also considering access to transport facilities and estimated time to hospitals.

At this level, a triage system with a higher discriminative capacity is preferred, for example *Triage Sort*, a physiological triage system based on the Revised Trauma Score (Table 4.4), and, if possible, combined with "anatomical triage" (see below).

In incidents with many casualties and/or limited access to transport resources, it may be necessary to *re-evaluate priorities before transporting*, as a basis for the order in which patients should be evacuated. If possible, this triage should be *anatomical* (i.e., based on injuries possible to diagnose at this level and consideration of the potential clinical course of the

Table 4.4 Algorithm for triage sort, based on revised trauma score

TRIAGE SORT

Physiological Variable	Value	Score
Respiratory rate	10-29	4
	>29	3
	6-9	2
	1-5	1
	0	0
Systolic blood pressure	>90	4
	76-89	3
	50-75	2
	1-49	1
	0	0
Glascow coma scale	13-15	4
	9-12	3
	6-8	2
	4-5	1
	3	0

A total score of	12	indicates	T3
	11		T2
	10-1		T1

After Champion et al. (1989)

injuries). This requires clinical competence and experience in trauma. Recently published comparisons between anatomical and physiological triage have shown that anatomical triage performed by staff with such competence gains a better outcome, which emphasizes the importance of bringing such staff to the scene in incidents where delay in evacuation can be expected.

For the principles of anatomical triage for different injuries on different levels in the chain of management, the reader is referred to text books on medical response to MIs.

4.4.6.5 Triage in Scenarios Other than Those Caused by Physical Trauma

For triage in incidents caused by fire or toxic gases, cold and wet climate, hazardous material, irradiation, nature and climate, and infectious diseases, the reader is referred to text books on medical response to MIs.

4.4.7 Indications for Treatment at the Scene

How much medical treatment should be offered on the scene? Is it not a better option to get the injured to the hospitals as soon as possible, where the facilities for diagnosis and treatment are always far better than in the field?

There is an old, and still on-going, debate with regard to which is the best strategy in MIs:

- *Load and go* (*or* "Scope and run") = Transport the patient from the scene without any delay caused by treatment that not is immediately necessary to save a life
- *Stay and stabilize* (*or* "Stay and play") = Not only life-saving, but also more advanced procedures on scene with the goal to
  - Get the patient in the best possible condition before transport
  - Make it possible to give lower priority to some patients, saving transport facilities for those with more urgent need.

As in other fields of medicine, the truth is not black and white: Selection of a strategy must be adapted to the situation, and what is right in one situation might be totally wrong in another. Factors influencing the strategy in MIOs are (in addition to the patient's condition):

- Time to hospital
- Access to transport facilities
- Access to resources on scene

The need of simple, life-saving procedures before transport is apparent and not controversial: Clearing and securing of airway, stopping major external bleeding, simple shock prevention, immobilization of fractures. The controversies apply to more time-consuming procedures such as intravenous lines, intravenous fluids, and tracheal intubation. Such procedures can however be both justified and of critical importance when:

- Expected transport time to hospital is extensive (>30 min as a guide-line)
- Delayed evacuation form the scene (trapped patients and/or many injured)
- Limited access to transport facilities (waiting time for ambulance/helicopter)

When the transport time is <30 min, prehospital intravenous fluid hardly has any effect, then it is better to get the patient to the hospital quickly. Overuse of fluids such as crystalloid solutions can also have negative affects. In case of extensive internal bleeding, the only possibility to save a life may be to get rapid surgical control of the bleeding in the hospital, and any delay might be fatal.

However, as stated above, in the "normal" accident there are also situations where more advanced

prehospital treatment is justified. Increasing ambulance crew competence and having them be better equipped has made that possible. Equally important as the skills for performing treatment in these situations is the ability to make accurate decisions with regard to what to do, and not to do. A good rule to follow is: "The hospital is always the best place for the severely injured patient, and if you stay out there to do things before transport, you must have a very good reason for it".

In *MIs* on the other hand, many of the indications for the more extensive prehospital treatments listed above may be present:

- The transport times to hospital are longer because it may be necessary to send patients to hospitals of longer distance from the scene for capacity reasons
- The evacuation from the scene is delayed because of trapping, limited access, or a high number of casualties in relation to available staff
- The available transport facilities are insufficient in relation to the need

Therefore, preparedness for MIs should include preparedness for treatment of casualties on scene, both with regard to competence and equipment. Good medical competence is also of critical importance for triage of casualties for the most effective utilization of available resources.

For indications and principles for prehospital treatment of different injuries in MIs, the reader is referred to consult text books on medical response to MIs.

4.4.8 Transport of Casualties

With regard to evacuation of casualties from the scene in an MI situation, there is an old misconception that the only important thing is to get all the patients evacuated as soon as possible and when all the patients are in hospital, all the problems are solved. This kind of thinking does in fact still exist. One reason for it is that MI-exercises often stops at the hospital entrance because of practical problems in bringing casualty-actors into the hospital. This means that no one knows what would have happened to all these patients if they really had been brought to hospitals according to the information in the records.

Another reason is that the development within the health care system during the last decades has not been recognized by the prehospital organization. Going back 20–25 years, the situation in the hospitals with regard to capacity for unexpected high loads of casualties was different: It was much easier to find available room and ventilators, and many patients in the wards were in such a condition that they could be sent home earlier if needed. The increasing demands on efficiency (parallel to increased costs for health care) have led to every resource being optimally utilized: During office hours every room in a big hospital is occupied, often for time-consuming heavy surgery, every ventilator in the ICU is in use, and hospital beds are used only for those needing advanced care or surveillance.

If a patient needing immediate surgery or ventilator use arrives at a hospital with no room or ventilator available, the patient may be lost – even in a big hospital – because there is neither time, nor immediately available resources for secondary transport to another hospital.

This can never be understood if rescue exercises are limited to the prehospital part of the response. Every exercise should illustrate the whole chain of management, which can never be achieved without using simulation systems, which is the only effective way to illustrate the hospital response. Live field exercises might be justified, but should always include simulation of transport and hospital response in real times and with real resources.

To summarize, as a consequence of the current development within the health care system, it is of critical importance that the patient be directed to the appropriate hospital facility from the beginning, meaning a hospital where immediately needed resources are immediately available.

Figure 4.7 illustrates what can happen if this is not properly facilitated. An incident has occurred in an area with four hospitals within a relatively close range; all hospitals are alerted and activate their plans. The ALO wants to use the ambulances in the most efficient way and sends all of them to the nearest hospital, thereby getting them back quickly, and the scene can be evacuated in a relatively short time – with the problem over for the transport officer.

However, the nearest hospital in this case does not have enough ORs or ventilators for all patients needing them, patients are lost, while all ambulances are circulating between this hospital and the scene, and the other hospitals are not utilized.

Such a "maldistribution" of patients is one of the most common recently reported errors of MIs.

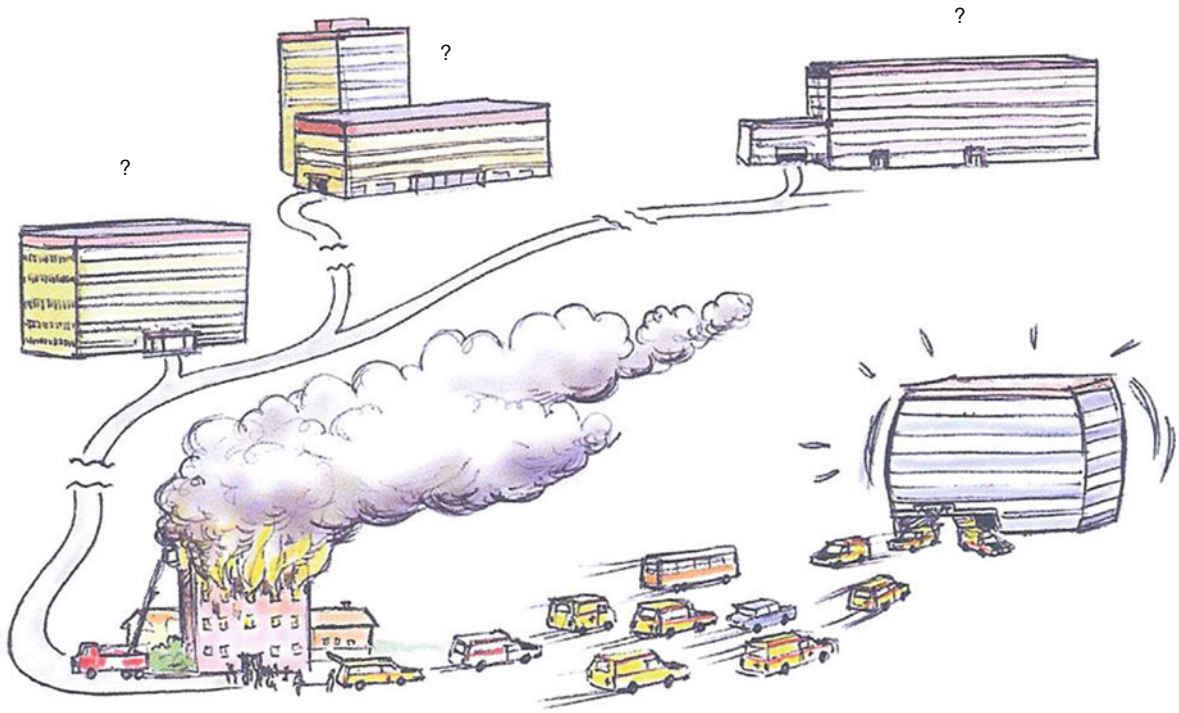


Fig. 4.7 An example of "maldistribution" of patients between hospitals. Instead of distributing the patients between the hospitals in the area of the incident considering hospital capacity, all ambulances are sent to the nearest hospitals to get them back quickly. Because "reserve capacity" for sudden high loads of casualties in hospitals today is limited, this will lead to mortality that could have been avoided (see text) (From Lennquist S (ed): Medical response to major incidents. Springer 2012, with permission)

To achieve an accurate distribution of patients among available hospitals with regard to their immediate capacity requires establishment of communication between the scene and the receiving hospitals as quickly as possible. Communication between the scene and every hospital is not realistic, considering the well-known difficulties of establishing a functioning communication under these circumstances. The communication must be mediated through a coordinating center that is well-equipped with communication lines and staffed by competent medical personnel. It is easier to establish communication with the command groups of involved hospitals from this coordinating center. This coordination is schematically illustrated in Fig. 4.8.

4.4.9 Registration on Scene

4.4.9.1 Medical Documentation

In most countries there is a legal obligation within the health care system to document treatment and decisions made by medical staff outside the hospital, and this is also an important part of patient management. There is still no internationally uniform system, and many countries do not even have a nationally uniform system.

The medical registration is a balance between the need to evacuate the patient from the scene as soon as possible and document as much as possible. As a principle, registration should not cause any unnecessary delay in evacuation; many of the cards used for documentation have space for a lot of information, and it must not be an end in itself. However, medication administered to the patient, including analgesia, must always be documented, and certain data are important for diagnosis and decision making later in the chain (i.e., level of consciousness in head injuries), but everything need not be filled in if it delays transport.

4.4.9.2 Identification and Destination

A part of the medical registration card that should always be filled in is the destination of the patient,

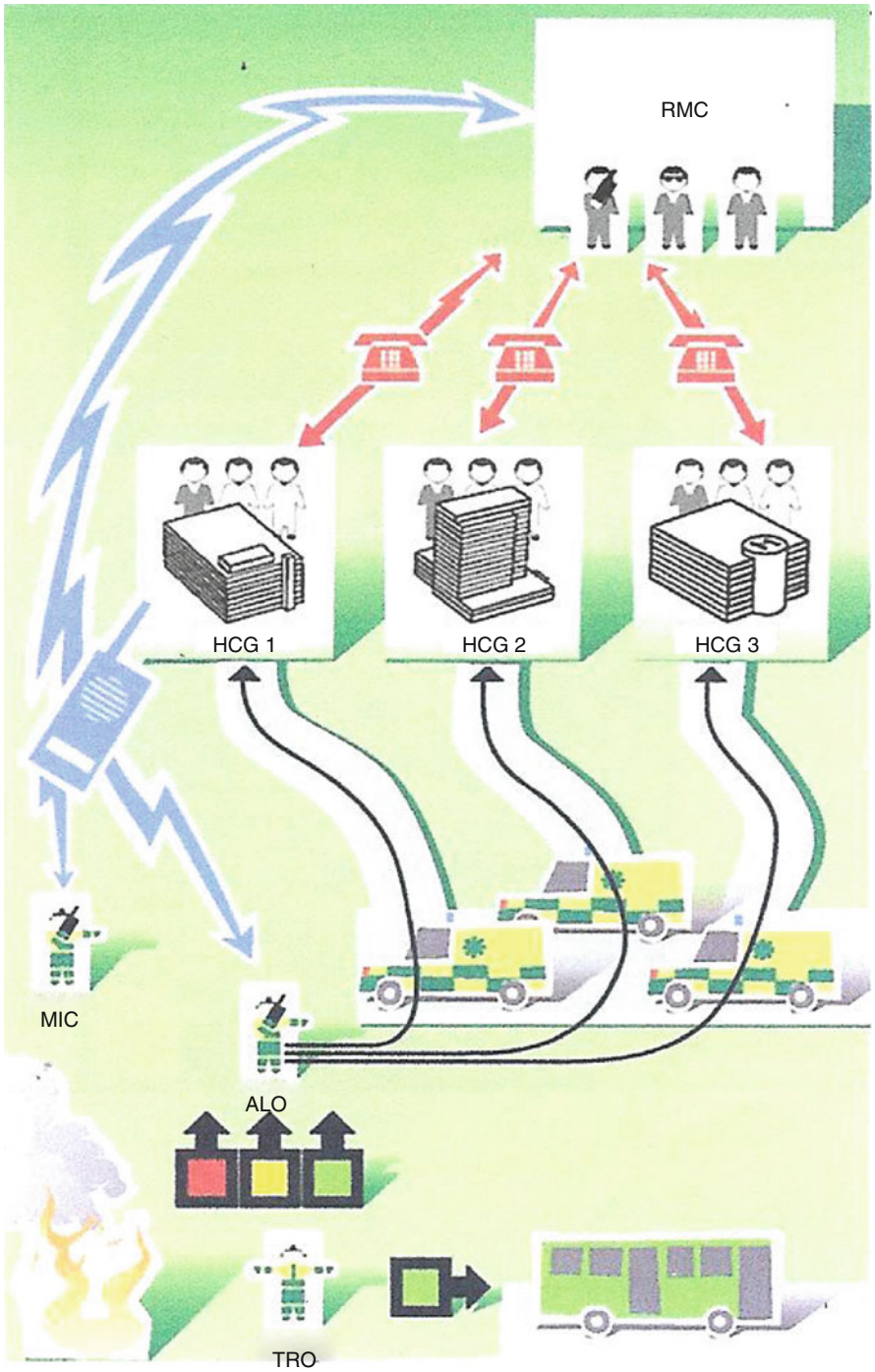


Fig. 4.8 Schematic illustration of the medical "command structure" and coordination of transports to hospitals. The Ambulance Loading Officer (*ALO*) has radio communication with the Regional Medical Coordination Center (*RMC*), which in its turn has telecommunication with the Hospital Command Groups (*HCG*). One of the tasks of the HCG is to report capacity for immediate treatment (room, intensive care unit) at latest 15 min after alert and then continuously after activating disaster plan. Based on this, *RMC* gives a "distribution key" for distribution of casualties between hospitals. A prerequisite for this is that both the *RMC* and *HCG* are based on medical staff on duty or on call (From Lennquist S (ed): Medical response to major incidents. Springer 2012, Artwork Typoform, with permission)

which is also the basic information to relatives. Every card usually has a registration number so if the name cannot be identified or given, the destination can be connected to the registration number.

It is desirable for many reasons that as many patients as possible are identified by name before departing, so that information with regard to which patient goes to which hospital (or another destination) is available as soon as possible. In a heavy load of casualties, it is not practical to assign this task to medical staff. In most countries, this is done by the police. A common registration system for police and medical staff should be a natural goal, but has so far been possible to achieve in very few countries. The police also have the task of

registering non-injured victims and those dead on the scene.

Whichever system is used, it is of critical importance that the registration does not delay the evacuation from the scene; the organization responsible for this must devote sufficient resources to avoid congestion at departure.

4.4.10 Communication

A functioning communication is an absolute prerequisite for a successful MI response and this is valid for all organizations involved in the response. At the same time, the most commonly reported problems in the evaluation of MI response are failures in communication. These failures are of three different types:

1. Deficient functioning of available communication systems, for example, insufficient covering, overload of systems, or technical failures
2. Deficiencies in handling of these systems (human factor), for example, lack of training of medical staff in the use of communication devices or charging of batteries
3. Deficiencies in communication technique: Forget to report (common), unnecessary or unnecessarily long communication, deficiencies in verbal technique

As a golden rule, no organization should be dependent on one single system; alternative systems must be established and available and the involved staff must be trained to use them, which means that communication techniques must be included in the training of medical staff for these situations. For a description of the different available communication systems, and when and how to use them, the reader is referred to text books on medical response to MIs.

4.4.11 Special Considerations in Terrorist Actions in Areas of Violence

In civilian incidents caused by terrorist actions in regions with political tensions and continuous violence, there may be remaining threats on the scene immediately following the incident: Casualties, rescue staff, and medical staff may be exposed to threats even during the response (shooting, explosions). In such cases, safety must take priority and casualties must be evacuated as quickly as possible, even without triage and with minimal resuscitation at the scene.

For the special organization and considerations required for such situations, the reader is referred to text books on medical response to MIs.

4.5 The Hospital Response

4.5.1 Functions of Critical Importance for the Capacity of the Hospital

The capacity of the hospital to receive casualties from an MI is often referred to as the *surge capacity*, the capacity to receive a certain number of injured or critically ill per time unit. Which are then the most common factors limiting this capacity?

The continuously reduced number of *beds* available in hospitals, because of more and more efficient use of available beds, is often referred to as a limiting factor for this capacity. However, all available data show that *the number of beds is rarely or never the limiting factor*, there is always space, there are often supplies of extra beds and patients can even sleep on the floor on mattresses if necessary. Alerting staff not on duty will in most cases bring a sufficient number of staff to take care of a high load of extra patients needing in-patient care for a limited time.

The *emergency department* (ED) a not a limiting factor either. For the severely injured or ill, the ED is just a transfer station through which the casualties should pass as quickly as possible on their way to surgery, ICU, or other wards. The triage and primary treatment at this time should be led by staff with the highest possible level of clinical competence within the actual field; for example, in trauma, by specialists within the surgical and anesthesiologic disciplines; for less severely injured patients on the other hand, the ED is in many cases the final destination, but this category is less resource demanding and not a critical capacity-limiting factor.

Factors of critical importance for the capacity of the hospital are, *actually*, *surgical and ICU capacity*; *the number of available ORs and ventilators*, *and staff to handle them*. As already mentioned, every available OR-theatre is occupied during office hours in a big hospital by (often time consuming) surgery, and it can be very difficult to find a single ventilator for a patient needing it unexpectedly. If these resources are not

available for an injured patient needing them urgently, the patient may die.

Planning and preparing the hospital response must be based on the awareness about which functions are critical in reality, and staff representing these functions must have a major role in the process of planning as well as in the leading of the hospital response.

4.5.2 The Disaster Plan: Goals and Structure

4.5.2.1 Demands on a Functioning Plan

In most countries, there currently is a legal obligation for all hospitals responsible for and authorized to receive patients in the fields of trauma and emergency surgery and medicine to have a functioning disaster plan. A "functioning plan" means not only that there should be a written plan somewhere in an office, but a plan that is continuously updated and tested, and known by all staff potentially involved in the response to MIs.

To meet the demands of a functioning plan requires:

- A responsible committee within the hospital with authorization to request the involvement and contributions needed from all units in the hospital with regard to planning, preparedness, and education
- Informing all staff about the plan as a part of the employment process
- Systematic and repeated training of staff who have important functions in MI response

4.5.2.2 The Need for Simplicity

Equally important is to have a plan to avoid "overplanning": The goal should *not* be to build up a new organization, only to make necessary adjustments to the already existing organization to divert resources to where they by definition are insufficient (i.e., to the treatment of victims). The plan created must be one that can be activated in a few minutes, at any day of the year, and at any time of the day, regardless of who is on duty, and it must be simple:

Simplicity is the key to accurate and realistic planning!

A disaster plan should *not* be a "monument of words" built up through administrative ambitions. There are unfortunately many examples of plans that have been so extensive and complex that no one has taken time to read them, and so they cannot work. At evaluations after MIs, it can sometimes be heard: "Yes we had a plan, but we did not use it," and when you see the plan, you easily realize why.

4.5.2.3 The Content of the Disaster Plan

Plans may look different for various hospitals depending on variations in hospital size and capacity, geographic conditions, and local traditions and there is not, and probably should not be, any uniform "standard plan". However, the structure of the plan should be as uniform as possible, at least within the same country, both for educational reasons (staff is moving between hospitals) and to facilitate collaboration between hospitals during a response – everyone should use the same terminology. Involvement of many hospitals, possibly from different regions, in a response has also been increasingly necessary because of the reduced reserve capacity mentioned above. The following structure is recommended:

I. *General information*

This part should be read and known by all staff and therefore should be restricted to a maximum of five to ten pages. It should include:

- *Alerting the hospital*
  - How the hospital is alerted
  - What to do when receiving the alarm
  - Where to go when alerted
  - What to do when alerted
  - Cancelling of the alert
- *Levels of alert*
  Definitions and indications – when to use a particular level
- *Coordination and command*
  - Overall (regional) command of the response
  - Hospital command:

Who is responsible for a particular decision?

II. *Action cards*

Action cards should be created and available for all staff involved in the response. Every staff member must know the information on his/her own action card, but all action cards can be attached to the plan for information purposes.

III. *Information about special types of incidents, or those involving only specific categories of staff*

- Incidents involving hazardous material
- Incidents involving irradiation

- Incidents involving infectious diseases of biological agents
- Incidents involving large numbers of burns
- Incidents primarily involving the hospital
  - Threats
  - Fire
  - Technical disturbances

4.5.2.4 What Every Staff Member Should Know

As previously mentioned, *Part* (*I*) = "General information" should be known by every staff member and it is recommended that this part be included in the introduction at the time of employment. It is therefore important that this part not be burdened with information that is not absolutely necessary for all staff.

The next part that every staff member should know is his/her own *action card* (see below for examples). The action card for a certain position can be put in a visible place in the office, or as some hospitals do, given out laminated in "pocket format" to staff members in key positions.

All staff should also know where to find information about special types of incidents, including those primarily involving the hospital.

Some categories of staff need specific training:

- Those included in the hospital command group
- Those who might be deployed to prehospital teams (see Chap. 3)
- Those responsible for decontamination of victims from incidents with hazardous material or irradiation

4.5.2.5 The "All-Hazard" Concept

Even if the plan must include certain information about specific types of incidents, this does not mean that there should be specific plans for these types of incidents – this would make the planning much too complex. Instead, *the same structure of plan should be used in every kind of incident*: alert process, levels of alert, coordination, and command. However, staff with special functions in specific types of incidents (for example, decontamination) need special action cards for those types of incidents.

4.5.3 The Alert Process

4.5.3.1 Receiving the Alarm

An incoming alarm should immediately be connected to a defined position in the hospital, clearly described in the plan, usually the senior nurse on duty in the Emergency Department, who is always available. Her/his task is to:

- Collect and register information
- Transfer this information to the person (position) responsible to make decisions with regard to level of alert and to take primary command

In this situation it is easy to miss information of critical importance. The person receiving the alarm therefore should have a *check list for receiving alarm*, listing information important to record. If the receiver is the senior nurse on duty in the Emergency Department, the check list should be on the wall in her/his office along with the action card for this position.

In the MIMMS concept, the same acronym as used at the scene, METHANE, is recommended. It can be used instead of a check list, but is not entirely adapted to the need for information in the hospital; that is why a check list according to the above is recommended.

4.5.3.2 Decision of Level of Alert

It must be clearly stated in the plan which person (= position) has the authorization/responsibility to decide the *level of alert for the hospital* (see below).

In some countries, the alerting organization (RMC or Alarm Center) has this responsibility and if so, it should be included in the message of alert, and thereby also included in the check list of the receiving person.

In other countries, this decision is made by the medical officer primarily in charge in the hospital. This model is recommended, because this is the person who has immediate overview of the present situation in the hospital. For example, if an MI occurs during office hours when all staff are in the hospital and a number of room and ventilators happen to be available, a lower level of alert may be sufficient; in another situation outside office hours and with all available rooms and ventilators occupied, the same incident may require a higher level of alert.

Regardless of which position this responsibility/authorization is connected to, it must be clearly stated in the plan, and included on the action card for that position.

4.5.3.3 Further Processing of the Alarm

An alarm is spread within the hospital according to the principle of "rings-on-the water": The primarily alerted staff alerts other staff/positions, ending up by all alerted units alerting or calling in their own staff. For this purpose, regularly updated files with home telephone

numbers and alternative numbers should be available in all units. To avoid misuse of such lists, they can be kept safe (sealed envelope) until they are needed for this purpose.

To make processing of the alarm possible, it must be clearly stated on the action card for each position as to whom to alert further, with given paging and telephone numbers (see Tables 4.5 and 4.6). *An absolute prerequisite is that everyone should know where to find his/her action card, and that is a keystone in preparedness and education*.

4.5.4 Levels of Alert

To have just one level of alert (which still is the case in some countries) might appear as the most simple. However, this would mean that many steps would need to be taken as soon as there was a suspicion of an MI. The consequences of this would be either a number of "overalerts" (i.e., initiating many procedures that would turn out to be not needed) or absence of alert when it really is needed because of fear of overalert.

Avoiding this requires a system based on different levels of alert. There is still no internationally uniform standard. The system presented here is an example, originally developed by the author, and for many years used as the national system in Sweden and introduced in an increasing number of countries. It is used as a model in the Medical Response to Major Incidents (MRMI) courses organized by the European Society for Trauma and Emergency Surgery (ESTES).

This system is based on three levels of alert:

Green alert = "Stand by"
Yellow alert = "Partial mobilization"
Red alert = "Full mobilization"

4.5.4.1 Green Alert ("Stand by")

Used when:

An accident has occurred or a threat has come up, but it is not yet known whether or to what extent the hospital will accept casualties

Means:

- Activation of the Hospital Command Group (HCG)
- Information of critical functions in the hospital, simultaneous investigation of present capacity
- Report of present capacity of the RMC
- *Considering* "freezing" of planned treatments that can wait (done if something has happened, not in threats)

= *Green alert is minimally resource-consuming but increases the preparedness significantly and should be used with wide indications*

4.5.4.2 Yellow Alert ("Partial Mobilization")

Used when:

It is confirmed that the hospital will receive casualties, but within a limit that does not request full response.

Means:

As above plus:

- "Freezing" of all non-started treatments that can wait
- Alert of a (in the plan defined, and limited) number of emergency room nurses, emergency physicians, surgeons, orthopedic surgeons, anesthesiology teams (physician + nurse), and operating room nurses
- Alert of HCG support group (see below under "command & coordination")

Point (2) above depends on the size and location of the hospital and should be clearly defined in the plan. Example from a medium-sized hospital without emergency physicians in the organization (as in many places in Europe):

> 6 emergency room nurses, 4 surgeons, 2 orthopedic surgeons, 6 anesthesiology teams, and 6 OR nurses

Yellow alert is sufficient to cope with the majority of MIs during peace time (additional staff in key functions can be mobilized later, within this level, by decision of the HCG).

4.5.4.3 Red Alert ("Full Mobilization")

Used when:

It is confirmed or suspected that the hospital will receive a large number of casualties within a short time, requiring its full capacity.

Means:

As above, plus automatic alert of all available staff within emergency and supporting disciplines according to a prepared alarm schedule ("rings-on-the-water" system).

Red alert in a major hospital is a level to be used only on rare occasions = with a very high load of casualties expected and short distance to the scene.

4.5.4.4 The Need for Three Levels

Green alert is needed as a level to activate on very wide indications, as soon as there is even a small suspicion of an MI, and therefore it should remain as a level consuming minimal resources. A common mistake is to "burden" this level with additional steps, but that might create a hesitation to activate it and then the intention is lost. Just the steps included above significantly increase the preparedness for response by having:

- The HCG group in place and activated
- Critical functions (Emergency Department, OR, ICU) informed
- Capacity of critical functions investigated, ready to report to RMC

Yellow alert is clearly justified as being enough to cope with the vast majority of MIs during peace time.

Red alert, even if indicated only on rare occasions in a major hospital, is needed in situations where the hospital is expected to be flooded by casualties within a very short time; there is no time to think of what to alert or not, and *red alert* means automatic mobilization of large numbers of staff and other resources. It must be considered, however, that taking care of all incoming staff also consumes resources, and preparedness for this should be reflected in the action cards for *red alert*.

4.5.5 Coordination and Command

4.5.5.1 Demands on a Clear Command Structure

Most MIs occur in rural or densely populated areas with short distances to hospitals and good access to ambulances. The first ambulances are at the scene often 10–15 min after the alarm and the transport of casualties to hospitals can begin. The importance of getting the patient primarily to a hospital where requested resources are immediately available has already been emphasized. This means that transport of patients as soon as possible must be based on capacity reports from the hospitals. The HCG collects and delivers these reports. *The demand on the HCG should be that it is in action not later than 15 min after the alarm has reached the hospital*.

This means that the hospital response to MIs requires a well-prepared leadership structure based on staff who:

- Are immediately available during non-office hours
- Have a clearly defined responsibility as well as authorization to make the necessary decisions in the initial phase of the response
- Are trained specifically for this difficult task

4.5.5.2 The Medical Officer in Charge in the Hospital

Immediately available on a 24-h basis at a senior level are the senior physicians on call within surgical specialties, anesthesiology, or ED (if the hospital has emergency physicians). Who of these should be the primary Medical Officer in Charge (*MOC*) is not important; however, it is important that:

- It is clearly stated in the disaster plan to which position this task is connected
- Everyone holding this position should have special training for this difficult and important task

Many hospitals use the senior surgeon on call for this task for several reasons:

- He/she automatically has an immediate overview of the critical functions = OR and ICU
- The senior anesthesiologist is needed to prioritize the ICU and the senior emergency physician to prepare the Emergency Department, and the senior orthopedic surgeon is more likely to immediately be involved in patient management.

This is valid for the initial (primary) phase of the response. When more staff are called in, a more senior physician with more experience and also more training for this purpose often takes over the difficult role as *MOC*, especially if the response is extended in time.

4.5.5.3 The Hospital Command Group (HCG)

The *MOC should be the operative leader* of the HCG. The HCG should include administrative staff for support and for decisions with regard to economy and hospital security. Usually this *administrative officer in charge* (*AOC*) is a senior administrative officer available on call, who later may be replaced by the ordinary director/manager of the hospital. However, to make pure administrative staff responsible for the primary operative decisions is not realistic, considering the usually much longer response times for this category of staff.

Because of the many tasks connected to the HCG during the initial critical 15–30 min of the response, it is preferable to dispatch more medical staff to this group whenever possible. They can be senior medical officers on call in other specialties and the details vary among hospitals but, again, it should be clearly stated in the plan.

Fig. 4.9 Hospital command room (example). The room should be located centrally in the hospital, close to the Emergency Department, and always be prepared for action. The equipment should include telephones (internal lines + direct external lines), radio for communication with the ambulance services and, in case of failure in telephone communication, with the regional command center, computers, radio and television receiver to record media broadcasts, plotting boards with maps and disaster plans for the region and the hospital (see further the text) (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012, with permission, Photo University Hospital, Lin Köping)

Secretarial staff specially trained for this purpose should also be working with this group as soon as possible.

Because staff in this position should have special training for this task, for a more detailed description of the coordinating functions in the hospital, the reader is referred to text books on MI response.

4.5.5.4 The Major Incident Command Room

It is mandatory that the HCG has a specially prepared room to go to, which is equipped with:

- Telephones for each staff member, both internal and direct external lines
- Communication – radio with channels for communication with the RMC, the MIC at the scene, and the ambulance service (see Chap. 3)
- Radio and TV sets for following information in the media
- Maps
- Disaster plans for hospitals in the region
- Prepared whiteboards for continuous documentation of information
- Computers

For an example of such a room, see Fig. 4.9.

It is important that the HCG staff go to this room immediately after the alarm. A lot of questions come up in the hospital, there is a need for somewhere to call, and many calls will come to the HCG room within the first minutes after the alarm. That emphasizes the immediate need for secretarial staff.

4.5.5.5 Medical Staff in Charge in Different Functions

During the MI response, it must be clear who has the coordinating responsibility for all critical functions in the hospital. It is one of the initial tasks of the HCG to define or appoint the leaders for different functions, in some cases a nurse, and in some cases a physician and a nurse. Such staff should be clearly labeled with tabards or arm badges.

Table 4.5 Action card for surgeon on duty (example)

Surgeon on duty
Alarm received by: senior nurse ED
When receiving alarm:
Contact senior surgeon on call, report the content of the alarm and the present situation in the hospital with regard to surgery, anesthesiology, and ICU. Senior Surgeon on call makes decision with regard to level of alert
If the Senior Surgeon on call is not immediately available, the surgeon on duty can make this decision
Green alert 1. Inform senior nurse ED (beeper/telephone….) that "green alert" is activated 2. Inform Senior Anesthesiologist on duty (beeper/telephone….) that "green alert" is activated 3. Inform hospital telephone board that "green alert" is activated 4. Inform Senior Nurse OR (beeper/telephone….) that green alert is activated. Simultaneously, investigate the present situation in OR: Theatres available for surgery? Occupied until when? 5. Inform Senior Orthopedic surgeon on duty (beeper/telephone….) that green alert is activated 6. If the senior surgeon on call is not in the hospital or not immediately available, go to hospital command center and follow action card for HCG until senior surgeon on call is available for this position. When and if senior surgeon on call is available, go to ED and accelerate treatment and evacuation of surgical patients
Yellow alert As under "green alert" 1–5 with addition of: 7. Request senior nurse OR to: "Freeze" all non-started surgery that can wait Call 4 OR teams from staff not on duty Call 4 surgeons from staff not on duty according to alarm list
Red alert As under "yellow alert" with addition of: 8. Request Senior Nurse OR to alert all surgeons and all OR staff not on duty according to alarm list

From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012, with permission

4.5.6 Action Cards

As already emphasized, the most important components in hospital preparedness for MIs are the action cards for all positions involved in the response.

What you need to know as a staff member is

- Which level of alert is activated – green, yellow, or red?
- Where is my action card?

Then you can put your index finger in the left margin of the card and follow it step by step, in chronologic order. The telephone and pager numbers you need should be there. *Following this procedure*, *you cannot fail to fulfill your task in the alert and preparatory phase of the response* (= *simplicity is the key to a functioning disaster plan*).

An example of an action card for staff in the "front line" is given in Table 4.5. It is a recommended policy to print the action cards separately, put them on the wall in offices and laminate them in pocket-format for key staff.

4.5.7 Preparing the Hospital

Transferring from a structure designed for ordinary patient care to a structure designed to receive a large number of casualties from MIs is a process that must progress quickly and therefore must be prepared and trained. The action cards, telling all staff members what to do and in what order, is a help in this process. However, other forms of preparation are equally necessary:

- Rooms in the ED where patients should be received, triaged, and primarily treated, must be prepared and all equipment needed for this stored in places known to everyone and with easy access.
- Special material needed, such as cards/records for registration of victims and triage tags and tabards/arm-badges for staff in charge and in key functions, must be prepared and easily available.
- Signs for identification of different zones and pathways in the hospital must be prepared to be set up according to a prepared schedule, usually a task for porters.

- Extra supplies for fluid, disposable material, and beds must be prepared and easily available.
- A room for the HCG must be prepared (see above)
- A room and organization for the hospital information center (see below) must be prepared

All these points are examples of things that must be prepared *before* the incident occurs; otherwise it will not work.

4.5.8 Receiving of Casualties

4.5.8.1 Primary Triage

As a general rule, all casualties should enter the hospital at the same place, a prerequisite for accurate registration. This is usually the ambulance entrance of the Emergency Department. It is important that the hospital is constructed so that there is a wide open area available adjacent to this entrance, used for other purposes under normal conditions but possible to rapidly evacuate on alert (Fig. 4.9). That area will function as the *zone for primary triage*, supplied with:

- Experienced staff responsible for the first triage, with the goal to:
  - Separate the less severely injured who are transferred to the zone for this, usually waiting rooms and offices for ambulatory care of emergency patients
  - Set priority for the severely injured to be taken care of by prepared teams (see below) for primary treatment and secondary triage
- Staff responsible for registration of all arriving casualties

In MI levels 2 and 3, a big entrance hall may be too small for all casualties waiting for triage. This should be considered in the planning and an adjacent area prepared. In countries with a warm climate, this can be an outdoor area; in countries with harsher climates, some sort of indoor facility should be prepared for this (dotted line, Fig. 4.10).

A "must" in all major hospitals receiving emergency and trauma patients is a *decontamination unit in the hospital* for decontamination of patients exposed to hazardous material or irradiation. Theoretically, all such decontamination should be done at the scene before evacuating the casualties for transport to hospitals. In practice, however, there is no guarantee that this is always done. Patients may evacuate themselves spontaneously before rescue and healthcare staff arrive and take control of the scene (this has occurred in MIs during recent years). To bring in one single contaminated patient into the ED may paralyze not only the ED, but many other critical functions in the hospital. Therefore, a decontamination unit should be prepared in connection to, but ventilatorily separated from, the hospital (Fig. 4.11), and the staff should be trained to perform decontamination and work in protective clothes (Fig. 4.11).

4.5.8.2 Severely Injured

The management of the severely injured must run through several *parallel lines*; otherwise the ED will be a keyhole creating congestion. For this purpose, the staff must be organized in teams, working parallel in areas prepared for this (Fig. 4.10).

It is important that these teams are well staffed. Normally, severely injured patients are taken care of by *Trauma Teams*; such a team usually consists of two to three physicians and three to four nurses, all responsible for different functions. With a heavy load of casualties and need of many parallel teams, it may be difficult to afford that many staff in every team. On the other hand, a single physician and nurse are not enough for this task. A recommended model is special *Major Incident Resuscitation* (*MIR*) *teams* for severely injured or critically ill victims with a minimum staff of four persons that includes two physicians and two nurses. In MIs caused by trauma, at least one of the physicians should have clinical experience of trauma and at least one of the nurses should have trauma experience. The rest of the team may in this situation be available physicians and nurses from any specialty.

The first task of the staff in charge of this position is to recruit staff to these MIR teams and appoint *team leaders* according to the principles mentioned above. Some hospitals label these teams with arm badges with numbers so they can be easily identified.

The areas/rooms where these teams can work should be defined as a part of the planning process and supplied with necessary equipment: suction, oxygen, sufficient illumination, and trays with necessary instruments and material. A bigger hospital should have prepared space for at least 6–8 such parallel teams, including the regular trauma bays that of course are suitable for this purpose.

The task of the MIR teams is to make a complete survey of the patient according to the Advanced

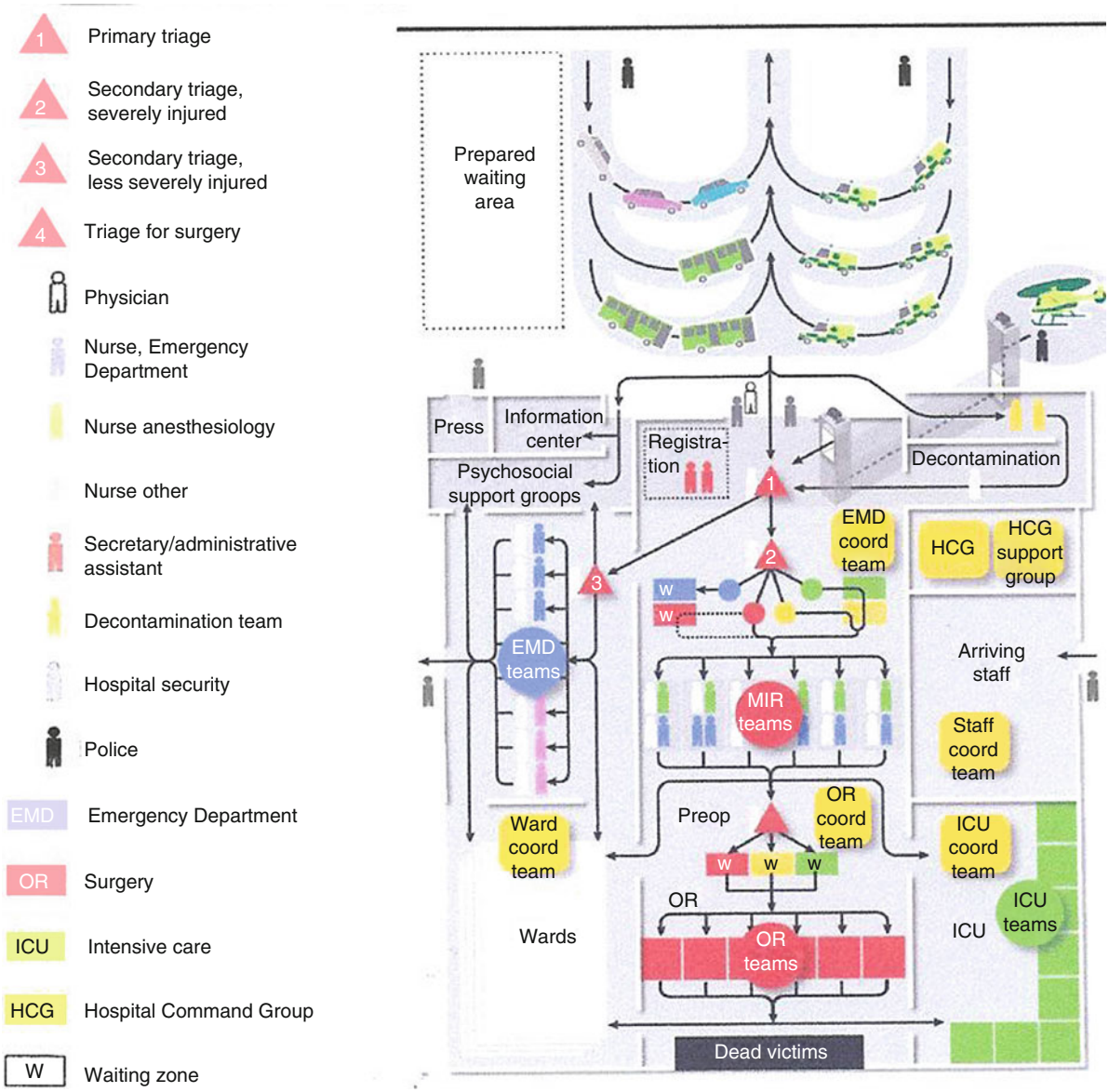


Fig. 4.10 Schematic illustration of the organization of the hospital during an MI response. Areas normally used as entrance hall. (**a**) Emergency Department (**b**) and Postoperative unit (**c**) are now according to a prepared plan rapidly transferred to areas for receiving and triage of casualties (**a**) management of severely + less severely injured casualties (**b**) and preoperative zone with triage/waiting for surgery (**c**). Offices and meeting rooms (**d**, **e**) are in the same way transferred to command rooms and area for arriving staff (**d**) and information-and media center and psychosocial support functions (**e**). Coordinating staff are appointed for all these functions, responsible also for their preparation and staffing. The *red triangles* indicate primary triage on arrival (*1*), secondary triage of severely injured (*2*), secondary triage of less severely injured (*3*) and triage for surgery (*4*). The *arrows* indicate the flow of casualties. See further the text (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012, Artwork Typoform, with permission)

Trauma Life Support (ATLS) principles, perform necessary resuscitation, perform investigations necessary for decisions and immediately necessary treatment, re-evaluate priority (= secondary triage) and then transfer the patient to the next destination as soon as possible, which might be the preoperative zone, the ICU, or in some cases, a ward (Fig. 4.10).

Fig. 4.11 The figure shows a decontamination unit in a major hospital. The unit should be located in connection to, but ventilatorily separated from, the rest of the hospital, with special evacuation routes for decontaminated air and water. The staff who may have to work here must be specially trained in how to perform decontamination and how to use the special protection equipment for this, based on over-pressure of air into the suites (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012, Photo Södersjukhuset, Stockholm with permission)

Radiograph examinations should in this situation be used very restrictively. Even if CT is available in the ED, it cannot be used for all patients and in many cases needs to be replaced by simpler examinations. Plain radiographs of fractures can be done at a later time with mobile units in the preoperative zone or in wards.

4.5.8.3 Less Severely Injured

Those categorized as less severely injured must also be carefully and systematically examined; even a walking patient can have internal bleeding. The staff assigned to this should have trauma experience and can be consulted when needed.

Some of these patients may be transferred to wards for observation or later surgery (for example, fractures that can wait after temporary reduction and stabilization). Others may be ready to be dismissed after treatment. However, it must be considered that these patients, even if they have minor injuries, have gone through a shocking experience and cannot just be sent home. They must have the opportunity to meet with psychosocial support staff (see below) where contact for future needs can be established. These patients can also have lost relatives or friends, they may have relatives among the severely injured, and they may be far from home and have lost their personal property or clothes. An organization to take care of them must therefore be prepared (Fig. 4.10).

Patients who have received some form of treatment must also have a plan for follow up in their home hospital if they are away from home.

4.5.8.4 Non-Injured

Non-injured victims may also come to the hospital, either accompanying injured relatives or friends, or

psychologically shocked, or just because they are far from home and have nowhere else to go. A special area must be prepared for this category of victims, away from the ED and with access to psychosocial support staff as well as access to information to search for relatives and friends (Fig. 4.10). Voluntary organizations such as the Red Cross often play an important role in the support of this category of victims.

4.5.8.5 Dead

Patients who have died during transport or after arrival to the hospital should be transferred to a prepared area for deceased victims, usually in connection with the department of pathology (Fig. 4.10). It is important that this area has rooms where relatives can see their dead in a calm and harmonious atmosphere, and with access to staff from the psychosocial support group.

For information about management and identification of dead casualties, the reader is referred to text books on medical response to MIs.

4.5.9 Registration of Patients

To avoid congestion when a high number of casualties arrive at the hospital within a very short time, *a simple and rapid system for registration and documentation is needed*. This is best achieved by using prepared "fill-in" documents. Many hospitals use the same registration as for trauma patients which works well for incidents caused by physical trauma but not for other types of incidents (hazardous material, irradiation). Other hospitals have a special registration system for MIs covering all types of incidents, including additional information valuable for evaluation of the response. From a scientific point of view, an internationally uniform system should be a goal to work toward.

Regardless of which system is used, it must be a system that meets the demands of simplicity and speed, all staff involved in registration must be familiar with it, and it must be prepared so that the needed documents are available in sufficient number.

It is important that the registration *documents from the scene* are kept together with the hospital registration documents. They may contain valuable information, and as medical documents they must be preserved for medico-legal reasons.

4.5.10 Psychosocial Support

The need for psychosocial support is important both during and after the response to an MI, and many different categories may need such support:

- Injured patients
- Non-injured hit by the incident
- Relatives/friends of injured patients
- Relative/friends of dead victims
- Staff of all categories

Such support therefore must be available at many positions in the chain of management:

- In the assembly area for patients who have been treated and are ambulatory and are ready to be dismissed
- In the assembly area for non-injured, but psychologically shocked victims
- In wards where casualties from the incident are treated
- At the ICU (waiting room for relatives)
- In the area for management of dead for support to relatives/friends
- In the hospital information center

Staff from all categories should have the opportunity to receive psychological support, but the primary support should always be given within their own unit. Persons in charge should have the responsibility of gathering all staff before following a response to discuss what occurred, what was bad and what was good in the response, and what has been learned for the future. This *primary debriefing* is not a task for only psychologists; everyone should be made aware that reactions and feelings are natural and not pathologic. However, it is also important to identify whether any staff member requires psychological support at this point, and if so, to see that it is provided. All staff should be aware that such support can be obtained later if necessary, and whom to contact about it.

The *coordinator of psychosocial support*, who can be a psychiatrist or a psychologist, is responsible for the psychosocial support functions in the hospital. Staff involved in this work can be:

- Psychiatrists
- Psychologists
- Social workers
- Priests

For methodology of psychosocial support in MIs, the reader is referred to text books on medical response to MIs.

4.5.11 Hospital Information Center

After an MI, there is need for information to relatives and friends of people who have been involved, or may have been involved, in the incident. Many call just because they believe that their relatives have been in the area of the incident, others know that their relatives were on the plane, or in the train, that crashed. The total number of calls is too great to be handled by the hospitals and another organization is needed to sort out questions about those who are registered as casualties and to which hospital they have been taken, so that these calls can be transfered to the appropriate hospital.

In most countries, the dissemination of primary information is handled by the police, who immediately after the incident open a *police information center* well staffed with people who can take all the calls (hundreds, sometimes even several thousand) within a short period of time following the incident. This requires a well-prepared organization. The number(s) to call are usually given in the media at an early stage after the incident.

When such calls come to the hospitals, the operator should confirm that the person making the inquiry has been in contact with the police information center and if not, refer them there.

If contact has been made with the police information center and it has been confirmed that the person being inquired about has been taken to the hospital, the operator should forward the call to the *hospital information center*, which is a necessary function in the hospital and must be prepared as an important part of the planning process.

This unit should be located in a place well supplied with telephones and staffed by persons who have received special training for this purpose. A common way to staff this center is by using secretaries working together with nurses from out-patient clinics who are not medically involved in the incident; this staff works in teams of two, one answering the call and one searching for the patient, following the files continuously delivered from registration.

4.5.12 Contact with Media

There are many reasons to establish a constructive collaboration between health care and media in these situations. The health care staff are interested in getting information delivered, for example, request for staff of certain categories to go to the hospital, request for blood – donors, request to people not absolutely needing to go to the hospital to wait, or go to primary care stations. Representatives of the media should, like all other categories in the community, see it as their task to give support in this difficult situation; they also have a responsibility to disseminate the correct information.

Unfortunately, this collaboration is sometimes ruined by "hunting a scope", in order to obtain sensational photograph ps of wounded casualties or crying relatives. However, it is the responsibility of the health care staff to protect patients and relatives in this situation. Even if they agree to be photographed, it is a well-known fact that this can cause considerable psychological harm in the aftermath. This creates a potential conflict between health care staff and media.

The best ways to cope with this is to have:

- Discussions with representatives of the media *before* an incident occurs so that both sides understand each other. Some hospitals organize regular seminars with their local media representatives concerning matters as a daily routine, including MI response and problems associated with that. This is an effort that usually pays well in the long run.
- A senior person (*Information officer*) responsible for media contact, who takes an active role in informing the media representatives, showing them around in an organized way, and giving them the facilities needed, for example, a press room with access to telephones where they can also be continuously informed.

Staff who are in the position of obtaining a role as Information Officers should go through special training in media management.

A good strategy in the initial phase after the alarm is to give a *press release to the hospital telephone operator*. It might appear strange that this measure is given such a high priority in the critical phase immediately after the alarm. However, as soon as information about the incident reaches the media (which occurs quickly today), they will call the nearest hospital and ask for information, and it is not only one call, it is dozens of calls within a few minutes. The hospital operator has to transfer these calls to the HCG – *unless* he/she has a short written message to read, for example: "The hospital has at 10:25 am received an alarm

informing about a train crash between A and B city, many injured. We have activated the plan for MIs and are preparing the hospital according to that, but casualties have not yet arrived. Next press release will occur at 11:00 am." This simple step "protects" the HCG group from a flood of incoming calls, and later the Information Officer can handle this.

4.5.13 Supplies

Most hospitals are currently working with very limited supplies because it is considered an economic advantage not to have big stores of supplies in the hospital and some of the material also has expiry dates. With the current technology, it is relatively easy to continuously refill supplies according to expected needs.

However, this creates new problems during MIs, where the need for specific types of supplies can reach high volumes within a few hours, possibly during non-office hours. Especially sensitive areas are disposable material, fluids, and drugs. For disposable material, many hospitals have supplies only for a few days of routine activity that will run out quickly during an MI.

Preparedness for this must include:

- Reserve supplies of certain materials of critical importance (fluids and certain drugs), even if it is means additional costs
- Agreements with suppliers of material (fluids, drugs, disposables) to have access to supplies in case of emergency within a short time frame, even after business hours
- Certain stock of non-disposable material that can be sterilized and re-used, for example syringes, scalpel blades, linen

4.5.14 Technical Functions

Hospitals today are highly dependent on technology, and the more advanced the technology is, the more sensitive it is to disturbances. Unfortunately, such disturbances are very likely to occur in connection with MIs, either because of simultaneous damage to the infrastructure of the community, or just by overloading. Preparedness for this is therefore an important part of the process of planning and preparedness.

4.5.14.1 Electrical Power

Every hospital today has reserve power systems that automatically take over if the supply by the ordinary net is interrupted. However, it is important that:

- These systems are regularly tested.
- They really cover all functions necessary for an MI response, such as the areas prepared for receiving casualties in the ED, and also administrative functions such as the HCG command room and the information center. During an MI, the interruption of power supply can be long.

Supplies of flashlights and battery head lights in designated areas are also part of the preparedness for this.

4.5.14.2 Water

Very few hospitals have reserves of water supply and because this is dependent on electrical power, long-lasting disturbances are a serious threat. Generally, this is something that should be looked at more precisely. A simple step is having reserve tanks for storing water for a threatening long-lasting interruption of electric supply.

4.5.14.3 Computer Support

Most medical staff have probably experienced a failure of the hospital's central computer system and know what happens: the hospital becomes totally paralyzed. It is suddenly not possible to obtain laboratory test results, in some cases not even possible to request fluids or blood, or diagnostic procedures such as radiographs. Additionally, the entire system of patient registration fails. In routine medical care, such failures are often corrected within a few hours, but in MIs, they can last long and prove fatal for the hospital's ability to respond.

Back-up and reserve systems are mandatory as a part of the process of MI planning and preparedness. This may be the weakest point of current planning, and very few hospitals have such systems, possibly because the consequences of failures are not yet completely understood (the technical development within this field has proceeded quickly).

4.5.14.4 Communication

A well-functioning line of communication is of vital importance for a hospital's MI response. Historically, the old hospital switch boards were sensitive to overloading and could collapse because of a heavy inflow of calls. Following some incidents where this occurred, this could be solved technically and the problem was

forgotten, until the new digital, computer-based systems were introduced a few years ago and the same problem appeared again, this time on a central level and outside the control of the hospitals. This is still not solved and has been reported following a number of recent MIs. The hospital is suddenly isolated from telephone contact both to and from the world outside.

This is also something that must be included in the process of planning and preparedness. Access to cell phones for all key staff is pertinent as long as it works, but this system can also collapse because of the overloading in these situations. One possibility is to secure certain cell phones for key functions (see Chap. 3), but this must be done during the planning stage.

For communication within the hospital, internal lines can be used as well as runners transferring information in written or oral form (something voluntary organizations can be used for if it is planned in advance).

For external communication, the HCG group must have access to radios and be trained in their use (see Chap. 3). Another solution for external communication is runners who can deliver messages between the scene and the hospital and also to the RMC, depending on distance.

4.5.15 Incidents Primarily Involving the Hospital

In the description of the contents of the disaster plan above, a separate part dealing with incidents primarily involving the hospital was also included. This can be:

- Fires, accidental or intentional
- Threats
- Collapsed buildings, as in earthquakes
- Incidents with hazardous material or irradiation
- Floods
- Terrorist actions
- Armed conflicts, exposing the hospital to gun fire

Several *fires* in hospitals have been reported over the past years. It is mandatory that hospitals have special plans for this, including evacuation lines, and everyone knows where to find them, but it also should be regularly tested with the fire department; the staff has a big responsibility to save not only themselves, but the patients, including those severely ill and with ongoing treatment.

Threats to hospitals, for example bomb threats by terrorists, have been reported with increasing frequency and should always be taken seriously. A special action card for dealing with threats should be included in the plan.

4.5.16 The Recovery Phase

A hospital's response to an MI involves many functions in the hospital and sometimes means maximum utilization of all available resources during a (during peace time) usually limited period. However, the response is not over because all patients have left the ED. Primary surgery may continue for many days for casualties who initially were given low priority. Primary surgery is often Damage Control – surgery = temporary life-saving procedures, followed later by definitive surgical repair. This "secondary surgery" is done one or several days after primary surgery, unless the patient is transferred to another hospital. This means that the surgical activity, with all that is connected to it, may fully occupy available OR facilities several days after the incident. During this period, everything in the normal routine that had to be postponed during the incident must also be dealt with. It also takes time to restore supplies, and the staff need rest.

During this phase, it is also extremely important to start the *evaluation process*, which is a part of the debriefing with the staff on all levels. It is important to have the opportunity to discuss how the response fulfilled its goals and what could be planned better for the future. This is also the golden occasion to put together a report of the response from which others will benefit. To make possible scientific evaluation and comparison of such reports, they should be standardized as far as possible, that is, follow the same protocol, and efforts to come to an agreement on such protocols are currently going on, for example in the Section of Disaster & Military Surgery within ESTES.

4.6 Treatment Principles in MIs

Triage, diagnosis, and treatment under these conditions have in common for all scenarios that it often must be done

- Under time pressure
- With limited or no access to specialists
- With limited or no access to advanced technology
- With impaired technical support functions

- With limited supplies
- With long intervals between injury and treatment
- With limited possibilities of follow-up

In addition, the mechanisms of injury are often different from those seen in routine medical care. This puts demands on:

- Simplified methods with emphasis on safety
- Knowledge among medical staff about the principles for triage and primary management of injuries/diseases outside their own specialty
- Knowledge about the principles of treatment of injuries/conditions common in MIs (high-energy trauma, blast injuries, burns, hypothermia, injuries caused by hazardous material, irradiation or biologic agents).

This should also be a part of education and training in disaster medicine (see below).

For the principles of triage, diagnosis, and treatment of different types of injuries at various levels of the chain of management in different scenarios of MIs, the reader is referred to text books on medical response to MIs.

4.7 Education and Training

4.7.1 The Need for Training

To cope with such situations, it is not enough that we as medical staff can do our ordinary job, and continue to do it as efficiently as possible. Additional knowledge and skills of different kinds are needed to accurately respond to the specific demands in these situations. We must be able to:

- Use simplified methods for diagnosis and treatment.
- Primarily treat emergencies outside our own specialty, at least those commonly occurring in these situations.
- Perform triage (i.e., make rapid and accurate decisions with regard to priority between patients and between diagnostic and therapeutic measures, also in a heavy load of casualties).
- Work as an integrated part of an organization where resources rapidly must be redistributed depending on needs, which requires knowledge about the organization.
- Work with limited supplies.
- Use reserve systems if computer or telecommunication systems, or other advanced technical systems, fail.

In addition, specific types of incidents require special knowledge: management of patients contaminated by hazardous material, biological agents or irradiation, or with specific injuries more rarely occurring in our daily care such as high-energy missile fragment injuries, blast injuries, and severely contaminated injuries.

4.7.2 Who Should Be Trained?

Because any medical staff, regardless of specialty, any day at any time, can be faced with a large number of severely injured or critically ill patients with no specialists or expertise available, the basic principles for working during MIs must be taught through special courses during the basic training of doctors and nurses, which is the case today in Europe, with very few exceptions. This is the responsibility of universities and nursing academies and is a prerequisite for a good standard of training.

Staff specializing in emergency disciplines need additional training in their positions that usually is the responsibility of the hospitals, or in some countries, counties or regions, often with government support because this is a matter of security for the population. Staff expected to be given leading or coordinating roles need even further training in these difficult tasks, training that usually is given by a few regional training centers in every country.

Working under austere conditions in areas with highly limited resources or in "chronic" disaster zones with severe public health problems, requires specific knowledge in fields such as nutrition, infectious diseases, and management of refugees and displaced populations. All this requires specific education and training for those deployed to serve in such areas.

4.7.3 Methodology of Training

Education and training in this field is very demanding. Being different from other parts of medicine, the problems and the methods to deal with them can only to a very limited extent be demonstrated on patients, and the real incident is not the place for education or training. This requires simulation models of different kinds. Practical field field exercises are the most common way of teaching and training, but they have had a tendency to become more spectacular events, possibly filling the purpose to illustrate chaotic situations, but giving limited feedback to the trainee: *What would my decision and performance have led to in reality*?

The key element in education and training in Disaster Medicine is decision making:

Correct decisions must be made under time pressure on all levels, from coordination and command: "Which resources to alert? How to use them best?" to individual patient management: "What to do with this patient in this particular situation, when and how to do it, and in what priority?"

Characteristic for this field is that the patient may not get another chance if the wrong decision is made once.

We act as computers, we receive a large amount of information, analyze it and deliver the decision, which leads to a result. To train and evaluate decision making requires that:

- All information on which the decision should be based is available.
- All consequences of the decision are illustrated.

This requires advanced simulation models in which all components in the chain of management (scene, transport, hospital, coordination, and command) are simultaneously handled because they are linked to each other in determining the outcome. It is also the coordination between these components that often fails in reality, illustrating the importance that this be included in the training. The need for such models has been recognized during recent years and they are to an increasing extent replacing the old fashioned form of training with field exercises, which was also more expensive.

An example of a course model meeting the demands described above, is the MRMI course developed by ESTES. The courses are based on a simulation system originally developed for scientific evaluation of methodology, MACSIM (www.macsim.se). They are totally interactive (Fig. 4.12a, b) and include simultaneous training of the whole chain of response, and they also give a measurable outcome of the response that can be used as a basis for improvement with further training, or by adjusting methodology or organization.

Fig. 4.12 Pictures from a Medical Response to Major Incidents (MRMI) course. The course is totally interactive with all participants working in their normal positions. The simulation system is based on injuries from real incidents and everything is run with real consumption of time and resources. The whole chain of response is trained simultaneously. (**a**) A hospital set up with (from the *left* to the *right*) area for arrival and primary triage, ED, preoperative zone, surgery and intensive care. Wards indicated with plastic pouches along the bottom of the boards. The instructor (*yellow arm-badge*) records every decision for later evaluation. (**b**) The coordinating centers are built up on distance from the hospitals. The picture illustrates the Regional Command Center, communicating by radio to the scene and by telephone to the hospital command groups (From Lennquist S (ed): Medical Response to Major Incidents, Springer 2012, with permission)

Fig. 4.12 (continued)

For a further description of different educational methods, the reader is referred to text books on MI Response.

4.8 Development and Research

Development and evaluation of methodology is as necessary in this field as in all other fields of medicine. Examples of important scientific areas are:

- Analysis of risks for MIs and disasters as a basis for planning and preparedness
- Continuous and consequent collection and analysis of experiences and results from MIs and disasters as a basis for development and evaluation of methodology
- Development and evaluation of simplified methods for diagnosis and treatment to be used in these situations
- Development and evaluation of a reserve system for technical support, communication, and information technology
- Development and evaluation of criteria on good preparedness for quality assurance
- Development, evaluation, and validation of educational methods

For a further review of the different areas for development and research, the reader is referred to text books on MI Response.

Further Reading

Overview Literature

Hodgetts T, Mackway-Jones K (eds) (2002) Major incident management and support – the practical approach. BMJ Publishing Group, London

Hogan DE, Burstein JL (2007) Basic perspectives of disasters. In: Hogan DE, Burstein JL (eds) Disaster medicine, 2nd edn. Lippincott, Williams & Wilkins, Philadelphia

Lennquist S (ed) (2012a) Medical response to MIs and disaster – a practical guide for all medical staff. Springer, Berlin

Mac Swain NE, Frame S, Salome JF (eds) (2006) Basic and advanced prehospital trauma life support, 5th edn. Mosby, St. Louis

Powers R, Daily E (eds) (2010) International disaster nursing. Cambridge University Press, Cambridge
Shapira SC, Hammond J, Cole LA (eds) (2009) Essentials of terror medicine. Springer, New York

Literature Covering Specific Areas

Adini B, Goldberg A, Lace D et al (2006) Assessing levels of hospital preparedness for emergencies. Prehosp Disaster Med 21:451–457
Arnold JL, Demby LM, Tsai MC et al (2005) Recommended modifications and applications of the hospital emergency incident command system for hospital emergency management. Prehosp Disaster Med 20:290–300
Aylwin CJ (2006) Reduction in mortality in urban mass casualty incidents – analysis of triage, surgery and resources use after the London bombings on July 7, 2005. Lancet 368: 2219–2225
Berg-Johannesson K, Michel PM, Lundin T (2012) Psychological crisis support in MIs. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 17:363–378
Champion HR, Leitch RA (2012) Combat casualty management. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 14:321–335
Champion HR, Sacco WJ, Copes WS et al (1989) A revision of the trauma score. J Trauma 29:623–629
Concenti P, Azima C (2003) Computer vulnerability, consequences and preparedness – experiences from the World Trade Center disaster. Int J Disaster Med 1:69–75
Cushman JG, Pachter HL, Beaton HL (2003) The New York City hospital's surgical response to the September 11, 2001, terrorist attack in New York City. J Trauma 54:147–154
Davis DP, Poste JC, Hicks T et al (2005) Hospital bed surge capacity in the event of a mass-casualty incident. Prehosp Disaster Med 20:169–176
Frykberg ER (2002) Medical management of disasters and mass-casualties from terrorist bombings – how can we cope? J Trauma 53:201–212
Hirschberg A, Holcomb JB, Mattox KL (2001) Hospital trauma care in multiple casualty injuries – a critical review. Ann Emerg Med 37:647–654
Hirschberg A, Bradford SG, Granchi T et al (2005) How does casualty load affect trauma care in urban bombing incidents? J Trauma 58:686–695
Hreckovski B, Dobson R (2012) Terrorist attacks on the civilian community. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 15:337–352
Hülse E, Oestern HJ (1999) Die ICE – Katastrophe von Eschede 1998. Springer, Berlin
Joussineau S (2012) Incidents cause by irradiation. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 11:275–292
Klyman Y, Kouppari N, Mukhier M (2007) World disaster report 2007. International Federation of red cross and red crescent societies, Geneva, 2007
Lam D (2006) How to collect and transmit data from the site to hospitals during a disaster response. Int J Disaster Med 4:144–151
Lennquist S (2003a) Promotion of disaster medicine to a scientific discipline – a slow and painful, but necessary process. Int J Disaster Med 2:95–99
Lennquist S (2003b) Education and training in disaster medicine – time for a scientific approach. Int J Disaster Med 1:9–15
Lennquist S (2004) The importance of maintaining simplicity in planning and preparation for MIs and disasters. Int J Disaster Med 2003:5–9
Lennquist S (2005) Education and training in disaster medicine. Scand J Surg 94:300–310
Lennquist S (2007) Management of major accidents and disasters – an important responsibility for the trauma surgeon. J Trauma 62(6):1321–1329
Lennquist S (2008) Protocol for reports from MIs and disasters. Eur J Trauma Emerg Surg 5:486–492
Lennquist S (2012a) Major incidents-examples and experiences. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 2:9–32
Lennquist S (2012b) Incidents caused by physical trauma. In: Lennquist S (ed) Medical response to MIs and disaster, Springer, Berlin, 7:111–210
Lennquist S (2012c) Incidents caused by cold and wet environments. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 9:211–228
Lennquist S, Hodgetts T (2008) Evaluation of the response of the Swedish health care system to the tsunami disaster in South East Asia. Eur J Trauma Emerg Surg 5:465–485
Lennquist-Montán K (2012) Triage. In: Lennquist S (ed) Medical response to MIs and disasters, vol 4. Springer, pp 63–76
Lennquist-Montán K, Khorram-Manesh A, Ortenwall P et al (2011) Comparative study of physiological and anatomical triage in MIs using a news simulation model. Am J Disaster Med 6:289–298
Liberman M, Branas CC, Mulder DS et al (2004) Advanced versus basic life support in the prehospital setting – the controversy between the "scope and run" and the "stay and play" approach to the care of the injured patient. Int J Disaster Med 2:9–17
Lindblom B, Rammer L (2012) Management and identification of dead victims. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 6:99–110
Marres G, Bemelman M, van der Eijk J et al (2009) Major incident hospital: development of a permanent facility for management of incident casualties. Eur J Trauma Emerge Surg 3:203–211
O'Neill PA (2005) The ABC's of the disaster response. Scand J Surg 4:259–266
Pryor JP (2009) The 2001 World Trade Center disaster – summary and evaluation of experiences. Eur J Trauma Emerg Surg 3:212–224
Riddez L, von Schreeb J (2012) Incidents caused by changes in nature and climate. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 13:305–318
Sarc L (2012) Incidents caused by hazardous material. In: Lennquist S (ed) Medical response to MIs, Springer, Berlin,10:229–274
Sjöberg F (2012) Incidents caused by fire and toxic gas. In: Lennquist S (ed) Medical response to MIs and disasters, Springer, Berlin, 10:197–210

Smith E, Waisak J, Archer F (2009) Three decades of disasters – a review of disaster – specific literature from 1777–2009. Prehosp Disaster Med 24:306–311

Sundness KO, Birnbaum ML (2003) Health disaster management guidelines for evaluation and research in the Utstein style. Prehosp Disaster Med 17(Suppl 3):1–177

Turegano F, Perez-Diaz D, Sans-Sanchez M et al (2008) Overall assessment of the response to the terrorist bombings in trains in Madrid, March 11 2004. Eur J Trauma Emerg Surg 34:433–441

Websites

World Health Organisation. International strategy for disaster reduction report, 2008–2009 world disaster reduction campaign. www.unisdr.org/eng/public_aware/world_camp/2008-2009world_health_day_20090407/enindex.html