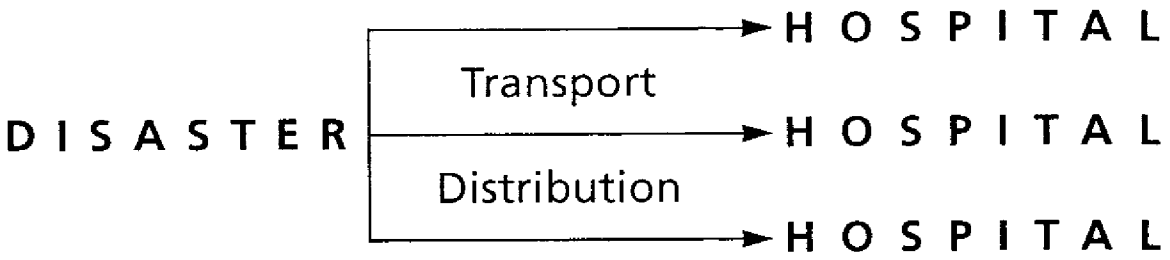
ASSESSMENT OF MEDICAL DISASTER PREPAREDNESS*

*ADAPTED FROM AN ARTICLE IN THE JOURNAL OF PREHOSPITAL AND DISASTER MEDICINE (1997)

Chain of Medical Care



Medical rescue capacity (MRC)	**Medical transport capacity (MTC)**	**Hospital treatment capacity (HTC)**
Methods	Distribution plan	Disaster procedure
Personnel	Personnel	Personnel
Supplies	Ambulances	Supplies
Terrain and weather	Terrain and weather	Accomodation

In an earlier paper an attempt was made to calculate the so called disaster preparedness (dp) in the chain of medical care. Since the capacities in this chain are not only determined by the methods used, but also by personnel and the material to be utilized, the latter aspects should be considered as well.
Personnel and material should therefore also be incorporated in the medical assessment of disaster preparedness.
A more elaborated methodology will be described in the following.

METHODOLOGY

The medical organization for disasters can be divided into three more or less closed organizational systems:

* the medical organization at the site;
* the transportation and distribution of victims to and among neighbouring hospitals;
* the disaster procedures for the hospital themselves.

Along this chain of progressive medical care from the disaster site to the hospital bed, the victim is medically handled and treated. This is not only true for the Dutch situation, but is valid also for any calamity, whether a disaster or an accident, as long as there are victims who have to be treated medically.
Each of the three systems has its capacities:

* the medical rescue capacity (MRC), which could be defined as the number of victims receiving basic and advanced life support at the disaster site per hour. In earlier studies and during exercises it was found that a mobile medical team consisting of a surgeon, an anaesthesiologist and two nursing staff can provide this life support for about 8 seriously and moderately wounded (triage 1 and triage 2) casualties who have to be hospitalized. Well-trained general practioners and paramedics can probably handle the same number of casualties, providing they work as a team or at least in pairs.
* the medical transport capacity (MTC) is defined as the number of victims that could be transported per hour to neighbouring hospitals during the transportation and distribution phase. It is assumed that each ambulance has accomodation for two casualties. Moreover, this capacity is related to the number of ready-to-go ambulances and the average distance within the region where the ambulances are operating. From these figures the MTC could be estimated, for which a formula has been introduced.

$$MRC \approx MTC \approx HTC$$

↓ ↓ ↓

personnel

material

methods

The lowest capacity in the chain will determine the capacity of the whole chain!

* the hospital treatment capacity (HTC) is defined as the number of victims who could be treated per hour in the hospitals. In case of casualties requiring surgery, the HTC is mainly dependent upon the number of surgeons, anaesthesiologists, nursing staff, operating room and intensive care facilities. Usually, these numbers are related to the number of hospital beds, and as a rule the HTC is considered to be 3%, i.e., 3 casualties per 100 beds per hour. This percentage is obtained from a large number of exercises and is valid for The Netherlands.
  For detailed studies of MRC, MTC and HTC see apropriate chapters.

To avoid stagnation in the chain of progressive medical care, synchronization of MRC, MTC, and HTC is imperative, which implies that these capacities should be equal to one another. One could have a situation with a large HTC but a small MTC, then the small MTC is determining the proper functioning of progressive medical care. Thus, the lowest capacity determines the capacity of the whole chain.

Personnel

no personnel available	1
personnel being appointed	2
personnel available	3
personnel available and trained (certified)	4
personnel available, regular drills and upgrading	5

Materials

no materials available	1
materials being purchased	2
materials available	3
materials available and tested	4
materials available, regular drills and upgrading	5

Methods

no plan available	1
plan in preparation	2
plan available	3
plan available and tested	4
plan available, regular drills and upgrading	5

The grading of personnel, materials and methods.

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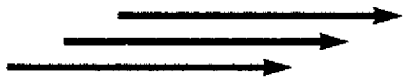
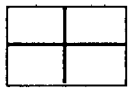
grade	capacity
1	20%
2	40%
3	60%
4	80%
5	100%

Grading correlated to capacity.

The capacities are determined by plans and procedures, which in turn are based on the availability of personnel and materials.
What should be considered are therefore personnel, materials utilized and methods used.
Personnel is defined as doctors, nurses and paramedics who have their duties in the chain of medical care in an organized way, e.g. members of trauma teams, Red Cross personnel, ambulance crew or hospital personnel.
Material is defined as the essential equipment and apparatus necessary, qualitatively and quantitatively, in the chain of medical care for life and limbsaving treatment of triage 1 and triage 2 victims according to current medical standards.
A method is defined as a well thought-out and fixed way of acting in order to reach a certain goal, e.g. a triageprocedure for classifying victims in order to speed-up their transportation and final treatment, a treatmentprotocol for the optimal treatment of mechanically injured victims, a hospital disaster plan for the receipt of large numbers of injured, etc.
Personnel, materials and methods can be graded uniformly from 1 through 5.

In each phase in the chain of medical care personnel, material and methods should be considered.
By adding up the grades for personnel, materials and methods and dividing the sum of each of them by the different kind of medical rescueworkers, the various sorts of equipment and apparatus to be utilized and the number of plans available, a figure, ranging from 1 to 5 for personnel, material and methods can be obtained representing the quality of disaster preparedness for each of them.
So far, this grading only qualifies the determinants of the capacities.
Since the capacities are expressed in quantities e.g., number of patients per hour, the grading should be transformed into a quantification.
Considering the fact that the capacities are based on a 100% output, which means that personnel, materials and methods are available with regular drills and upgrading, the grading itself could be correlated as parts of this 100% performance.

An example may illustrate the methodology described.

Chain of medical care				
personnel	doctors [1]	doctors [1]	doctors [1]	
	nurses [2]	nurses [2]	nurses [2]	
	paramedics [3]	paramedics [3]	paramedics [3]	
subtotal	(1 + 2 + 3) / 3	(1 + 2 + 3) / 3	(1 + 2 + 3) / 3	
material	ventilation [1]	ventilation [1]	ventilation [1]	
	circulation [2]	circulation [2]	circulation [2]	
	other material [3]	other material [3]	other material [3]	
subtotal	(1 + 2 + 3) / 3	(1 + 2 + 3) / 3	(1 + 2 + 3) / 3	
methodes	attack plans [1]	ambulance assistance [1]	disaster procedures [1]	
	triage [2]	patient distribution [2]	triage [2]	
	treatment protocols [3]	patient monitoring [3]	simplification standardization [3]	
subtotal	(1 + 2 + 3) / 3	(1 + 2 + 3) / 3	(1 + 2 + 3) / 3	
total				

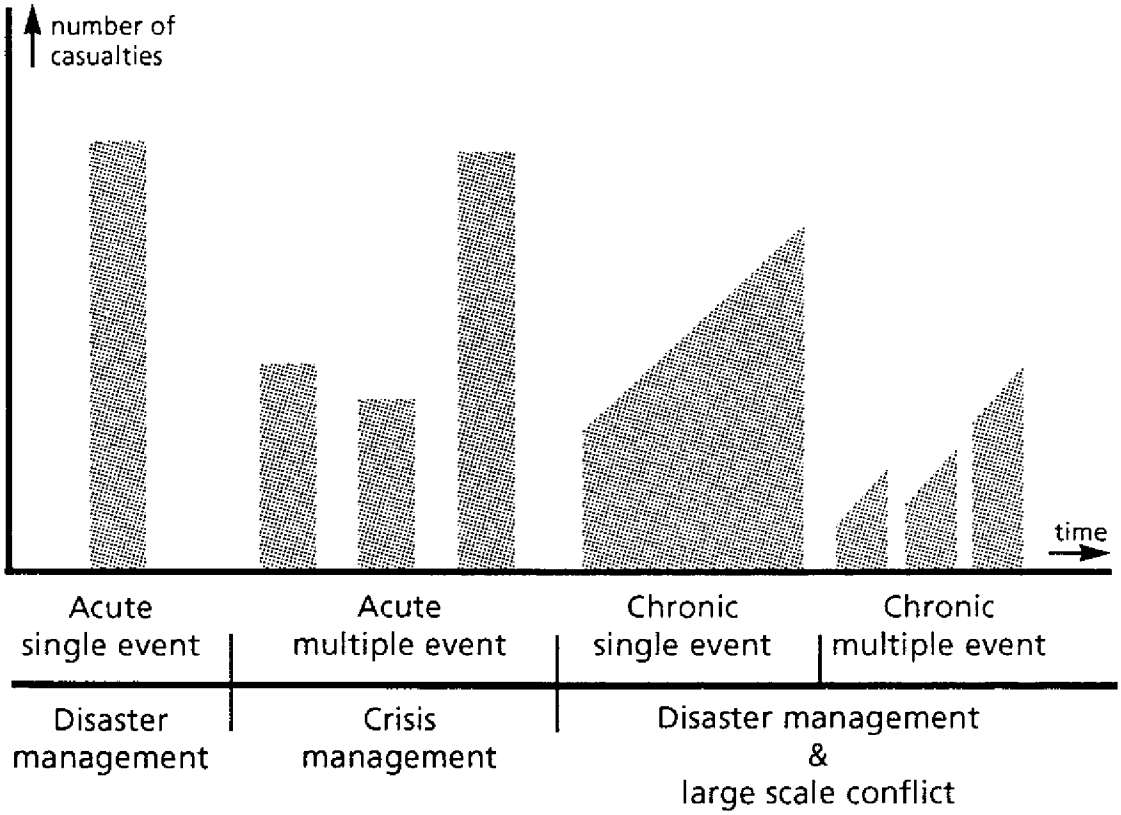
Gross estimate of the medical disaster preparedness in a distinct area.

A large international airport in the vicinity of a capital city will be considered, where a wide-body airplane may crash resulting in many deaths and severety wounded.
In this case the chain of medical care begins at the air-port, where men, working with certain materials and utilizing various protocols are dealing with the medical aspects of this major incident or disaster. Following the extrication of the victims from the wreckage by the fire-brigade the medical rescuers start their work, i.c. a sweeping triage for the triage 1 victims, life- and limbsaving measures, a second triage, first-aid for the triage 2 victims and preparing the victims for transportation.
The doctors, nurses and paramedics involved in the medical rescue activities at the site do not have a certificate in disaster medicine, nor are they well-trained in the use of their equipment and apparatus and in applying the available protocols. This implies a grading of 3 for each of them.
The materials for ventilation, circulation and for other essential purposes the medical rescuers are utilizing are not well tested, qualitatively as well as quantitatively, resulting in a grading of 3 for each of the catagories.
The methods to be applied are protocols: attack plans, triage and treatmentprocedures are available, however, not well tested, leading again to a grading of 3 for each of them. The subtotal for the disaster site, in this case the air-port is 3 + 3 + 3 divided by 3 is 3.
The second part in the chain of medical care is the transport and distribution phase of the ambulances.
Personnel involved in this phase are nurses and paramedics with some education and training in disaster medicine, however, they do not possess a seperate certificate in this field. The grading should therefore be considered again as 3 for each of them. The ambulances utilized in a mass casualty situation are the ones in use already in the daily routine. The material for ventilatory and circulatory support, as well as other relevant material is therefore available and tested. The grading is therefore 4 for each of them. The methods like ambulance assistance, patient-distribution and patientmonitoring for a mass casualty situation are available, but not properly tested, except for the latter, resulting in a grading of 3 for the first two methods and 4 for the latter, resulting in a grading of 3.3 for the methods. The second phase has a subtotal of 3 + 4 + 3.3 divided by 3 is 3.4.
The third part in the chain of medical care is the hospital phase. In the vicinity of this imaginary air-port six hospitals are located with a collective bedcapacity of around 2000 beds, resulting in a hospital treatment capacity of 60 triage 1 and 2 victims per hour provided they have a well trained and up dated hospital disaster procedure. Only the accident and emergency department will be considered. Personnel involved are doctors, nurses and paramedics, without education and training in disaster medicine. On the other hand they are well-trained for the single event and daily routine. The grading could thus be set as 4 for each of them.
The material in use for immediate ventilatory and circulatory support is of course also available, resulting in a grading of 4 for each. The methods, like the hospital disaster procedure, triage, and simplified and standardized treatment protocols are in preparation, yealding a grading of 2 for each of them. The subtotal for the third phase 4 + 4 + 2 divided by 3 is 3.3.
Since the grading determines the capacity and since the lowest capacity determines the capacity of the whole chain of medical care, the overall grading for this airport can be set at 3.

Various possibilities of mass casualty situations

Approach:
1) Top-down
2) Bottom-up

Based upon:
scenario's / industry, traffic
capacities / scaling



Discussion

In the past, managers were satisfied already having some equipment and apparatus ready to cope with disasters. Nowadays disaster managers realize that not only material is essential to solve the complicated medical aspects in a mass casualty situation, but also the personnel involved and methods to be utilized are of paramount importance.
The methodology described for the assessment of the medical disaster preparedness is a gross estimate since only major items were classified. One could imagine that a shortage of infusion needles in the chain of medical care may jeopardize the lifes of many victims, in which case sophisticated ambulances and well-trained doctors do not contribute much to improve overall mortality, morbidity and disability.
In this respect three main groups of materials were differentiated only: equipment for ventilatory and for circulatory support and other essential materials like stretchers, bandages and splints. It is possible, however, to differentiate into more than three items.
The same holds for the methods to be applied. Only three types of methods were mentioned, however, the treatment protocols themselves could also be differentiated into those for the treatment of mechanical lesions, chemical lesions and nuclear lesions. When this is done, the materials should be differentiated in the same way.
Dependant on the number of material items, methods or type of personnel the subtotals and thus the overall total will gain reliability in this respect. The more differentation, the better results and thus a more reliable figure for disaster preparedness.
Since the grading determines the capacity and since the lowest capacity in the chain of medical care determines the capacity of the whole chain, the disaster preparedness of a certain object at risk (air-port, harbour)or any other region is determined by the lowest grading in this chain.

By analysing the medical disaster preparedness (MDP) in the way described, not only a figure could be obtained, but also the weak points in the chain of medical care could be traced immediately.
Various mass casualty situations are possible, which is shown in the illustration. The assessment of the medical disaster preparedness is either top-down by analysing imaginary scenarios, or bottumup by analysing the available capacity in the chain of medical care.

GLOSSARY OF NEW CONCEPTS IN DISASTER MEDICINE

(additional to Gunn's Multilingual Dictionary of Disaster Medicine)

M. Debacker
B. Domres
J. de Boer

Each discipline needs its language. Only then it will be feasable to communicate in a scientific way.
It was William Gunn who recognized this basic thought for which he created the first Multilingual Dictionary of Disaster Medicine in the late eighties. This expertise, however, was focussed mainly on remote and naturally-occurring disasters and not so much on domestic man-made ones. Besides, disaster medicine, a young branche on the old tree of medicine, is growing fast and is developing itself as a science.
New concepts in disaster medicine are being introduced and that is why Gunn's dictionary needs to be supplemented with concepts, which could be found in the literature (see references).
For the same reasons, the European Academy of Disaster Medicine (EURADEM) was founded in 1996. According to its statutes the main aim is to safeguard the academic level of disaster medicine as a specialism in Medicine. One way to achieve this is by issueing a complete glossary of concepts in disaster medicine periodically.
Of course, this is not definite and needs periodic updates. The issueing of this glossary stimulates teachers at the University level to lecture disaster medicine in such a way that at least basic concepts are defined uniformely.
Again this glossary is supplementary to Gunn's dictionary. In the future both efforts should be combined.

GLOSSARY OF NEW CONCEPTS IN DISASTER MEDICINE

Advanced life support
ALARA
Alarm procedure
Ambulance support

Basic life support

Casualty clearing station
Casualty
Central holding area
Chain of medical care
Chemical lesions
Community profile
Contamination
Crash team

Decontamination
Definition, classification and scoring of disaster
Disaster Medicine
Disaster Severity Scale
Disaster site

Epidemiology of disaster

Far field
Filter area
First acts
First-aid post
Forward control point
Friedrich's time

Golden hour

Hospital Treatment Capacity

Hygienic measures

Identification of dead
Intervention levels
Iodine prophylaxis

Maesure zone
Mass casualty
Mechanical lesions
Medical Rescue Capacity
Medical Severity Index
Medical Transport Capacity
Medical Disaster Preparedness
Medical coordination
Mobile medical teams

Near field
Nuclear lesions

Plans, procedures and protocols
Posttraumatic stress syndrome
Prevention
    primary
    secondary
    tertiary

Sheltering
Simplification
Standardisation
Sweeping triage

Victim
Victim distribution

GLOSSARY OF NEW CONCEPTS IN DISASTER MEDICINE

Advanced life support
Those invasive measures as to preserve life of ABC-instable patients like intubation and ventilation, infundation and thoracic drainage.

ALARA
As Low As Reasonably Achievable; concept utilized in relation to intervention levels following the release of dangerous chemical or nuclear materials.

Alarm procedure
Repressive disaster management is preceeded by alerting every party concerned. Various optical and acoustical means of alarm are possible: flags, lights, sirenes, radio and telephone.

Ambulance support
When disaster strikes a certain (ambulance) region, ambulance support is needed from surrounding regions according to a preplanned scheme.

Basic life support
Those non-invasive measures as to preserve life of ABC-instable patients like elimination of airway obstruction, cardio-pulmonary resuscitation, hemorrhage control, woundcare and immobilisation of fractures.

Casualty clearing station
Collecting point for T1 en T2 victims in the immediate vicinity of the disaster site where further triage and basic and advanced life support can be provided.

Casualty
Any person suffering physical and/or psychological damage by outside violence leading to either death, injuries or material losses only.

Central holding area
An ambulance assembly location in the filter area from where ambulances either leave to pick-up patients from the casualty clearing station or to leave for one of the neighbouring hospitals according to a victim distribution plan.

Chain of medical care
The chain of medical care from the disaster site to the hospital bed, along which the patient is medically handled and treated, can be devided into 3 phases: the medical organisation at te site, the distribution of patients among neighbouring hospitals and the organisation in the hospitals.

Chemical lesions
Body lesions caused by chemical substances either through external (skin and mucous membranes) or internal (inhalation and ingestion) contamination or both leading to a variety of reactions from skin irritation and ventilatory problems to systemic effects and even death.

Community profile
Caracteristics of the local environment prone to a chemical or nuclear accident: population density, age distribution, roads, railways, waterways, types of dwellings and buildings and the relief agencies locally available.

Contamination
Accidental release of hazardous chemical or nuclear materials leads to pollution of the environment in which man could be contaminated by these materials, either externally (skin and mucous membranes) or internally (by inhalation or ingestion) or both.

Crash team
Team comprising a doctor and a nurse specialized in advanced trauma life support and meant for stabelising seriously wounded victims.

Decontamination
The removal of hazardous chemical or nuclear substances from the skin and/or mucous membranes by showering or washing with water, or out of wounds by rinsing with sterile solutions.

Definition, Classification and Scoring of Disaster
From a medical point of view a disaster needs only two criteria: victims and a discrepancy between the number and treatment capacity. Disasters can then be classified utilizing various parameters; man-made versus God-made, the radius of the disaster site, the number of dead, the number of wounded, the avarage severity of the injuries sustained, the impacttime and the rescuetime.
By attributing 0, 1 or 2 to each of them, increasing with intensity, number or time a scale can be produced varying between 0 and 13, which is called the Disaster Severity Scale.

Disaster Medicine
The combination of medical and medico-organisational measures undertaken in case of disaster covering the entire range of medical care from the scene of the disaster to the hospital bed.

Disaster Severity Scale
See Definition, Classification and Scoring of Disaster.

Disaster site
Area where the immediate impact of the disaster took place. The first duty of the Police is to seal down this area by an inner cordon. Outside this cordon a second one can be laid: the outer cordon. The area in between both cordons is then called the filter area, through which at one or two points the disaster site can be reached by rescuers.

Epidemiology of disaster
Only with a uniform and standard definition, classification and scoring system for (the medical aspects of) disasters is epidemiologic research feasible.

Far-field
Following a nuclear accident on-site, e.g. a nuclear plant, the immediate vicinity is called near-field with a diameter varying between 2 and 20 kilometers, depending on the source strength. The area outside the near-field is called the far-field, where effects are still noticeble after an accident.

Filter area
The area between the inner and outer cordon around the disaster site. See disaster site.

First acts
The first acts of doctors and nurses at the disaster site are Anticipation, Control, Triage, Treatment and Transport (ACTTT).

First-aid post
Collecting point for T3 victims in the immediate vicinity of the disaster site, however separate from the casualty clearing station, as to divide the T1 and T2 flow of patients from the T3 one.

Forward control point
The point next to the disaster site where the first ambulances to arrive are those to function as a command, coordination and communication post.

Friedrich's time
4-6 hours following sustainment of mechanical injuries T2 victims may become ABC unstable when untreated. It is therefore important to provide first-aid measures within this period of time.

Golden hour
ABC-unstable victims (T1) should be stabilised as soon as possible, at least within one hour following injury, otherwise they will die.

Hospital Treatment Capapcity
The number of T1 and T2 victims, which can be treated in a hospital per hour, according to current medical standards.

Hygienic measures
Those measures as to prevent diseases following a major disaster, because the infrastructure of the stricken area is non- or malfunctioning.

Identification of dead
Disasters with "unknown" dead necessitate identification of the bodies or their remains. This is important for the bereaved, not only from an emotional point of view, but also for judicial and insurance purposes. Various medical disciplines are involved in matching ante-and post-mortem findings.

Intervention levels
Levels of radiation or concentrations of chemicals in the environment. These levels determine the measures to be taken in the measure zone and can be regarded as aids to decision-making.

Iodine prophylaxes
Radioactive iodine is often an important component of radioactive isotopes to be discharged into the atmosphere after a nuclear accident. Stable iodine prevents the absorption of radioactive iodine in the thyroid gland provided it is administered beforehand.

Maesure zone
The zone where measures are to be taken in case of nuclear or chemical accidents. These zones are determined by the community profile and the source strenght.

Mass casualty
The definition of disaster implies a discrepancy between number of victims and its treatment capacity. This does not necessarily means a mass casualty situation, in which case the number of victims is overwhelming.

Mechanical lesions
Mechanical impact on the human body creates injuries like wounds, lacerations, fractures, bleedings (internal and external) and concussions. Mechanical lesions also include burns.

Medical Rescue Capacity
The number of victims which could be rescued and stabilised at the disaster site per hour by doctors, nurses and paramedics.

Medical Severity Index
The ratio between the number of victims times the average severity of the injuries sustained and the treatment capacity in the chain of medical care. When this ratio is larger than 1 the event can be considered a disaster.

Medical transport capacity
The number of victims which could be transported to and distributed between the hospitals surrounding the disaster site, per hour.

Medical disaster preparedness
The medical preparedness in the chain of medical care is determined by personnel, materials and methods. With the aid of this basic concept medical disaster preparedness can be expressed in a figure ranging from 1 to 5.

Medical coordination
In the chain of medical care coordination between its phases and in each phase between doctors, nurses and paramedics, is of paramount importance. Simplification and standardisation of materials and methods utilised is therefore a prerequisite.

Mobile medical teams
In stead of bringing the patient to the hospital, the hospital is coming to the patient for which mobile medical teams are created in order to stabilise the patient on the spot and this could shorten the treatment delay.

Near field
See far field. Concept used after a nuclear accident.

Nuclear lesions
Body lesions caused by external exposure to radiation and internal of external contamination with radioactive material. Radiation exposure can effect part of the body or the whole body. External contamination effects skin and mucous membranes, while internal contamination leads to systemic effects or effects on specific organs (e.g. the thyroid).

Plans, procedures and protocols
A well though-out and fixed way of acting in order to reach a certain goal and written down as plans, procedures and protocols.

Posttraumatic stress syndrome
Following a period of intense stress (like in disaster) a person may encounter psychic disorders on the short or long term varying among other things from auxiety, insomnia, feelings of guilt, irritability and concentration problems.

Prevention
Primary prevention of disaster is possible through technical, organisational and judicial means. Secondary prevention implies the optimal management of disaster itself.

Tertiary prevention combats the complications of disaster. The better secondary prevention, the less tertiary prevention is needed.

Sheltering
The extent to which a shelter can protect potential victims from exposure to ionizing radiation and contamination with radioactive material depends on its location and type. Exposure is at a maximum level in the open air and at a minimum in a cellar of a concrete building with a ventilation filter

Simplification
Simplification of medical procedures saves time so that more attention can be paid to the seriously wounded victims, e.g. large wounds should be disinfected and covered and in a later stage closed with plastic and reconstructive surgery.

Standardisation
Standardisation of medical procedures, like the administration of drugs, antibiotics, analgesics and anticoagulants in the chain of medical care avoids errors, simplifies the transfer of medical information in this chain and is more economic.

Sweeping triage
The first triage at the disaster site in order to locate the most seriously wounded T1 victims.

Victim
Casualty with sustained lesions of mechanical, chemical or nuclear nature or combinations.

Victim distribution
Victims should be transported to and distributed among neighbouring hospitals according to their hospital treatment capacity, while the nearest hospital should be avoided, since walking T3 victims will overcrowd this one. For this a preplanned victim distribution plan is required.

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