INTERNATIONALE DE
IE DE CATASTROPHE

D INTERNACIONAL DE
A DE CATÁSTROFE

INTERNATIONAL SOCIETY
OF DISASTER MEDICINE

الجمعية الدولية لطب الكوارث

Secrétariat: Dr Marcel R. Dubouloz - P.O. Box 3 - CH-1254 JUSSY/GENÈVE, Suisse
Tél. (22) 759 13 12

Nr 48 January 1992

NEWSLETTTER

ASSESMENT OF THE MEDICAL SERVICES'COMMITMENT CAPACITY, OF A DISASTER MEDICAL GRAVITY INDEX AND OF DISASTER PREPAREDNESS

by Dr D. SCHWANDER, Service of anaesthesiology-resuscitation, Cantonal Hospital 1700 Fribourg, Switzerland, ISDM member
and by Dr J. DE BOER, Direction of Civil Protection and wartime disasters. Ministrie van Welzijn, Volksgezondheid en Cultuur, Postbus 5406, 2280 HR Rijswijk, Holland, ISDM Vice-President

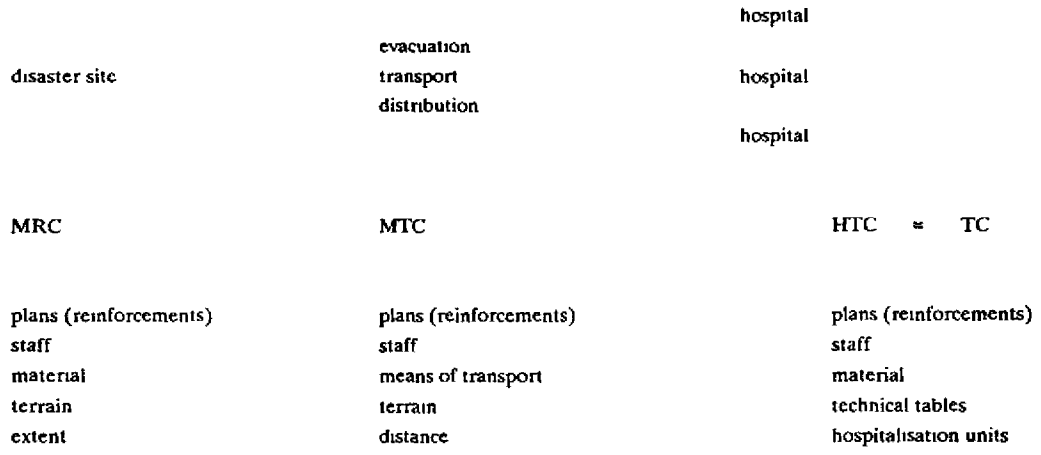
Medical organization in the event of a disaster is usually divided up into three relatively close, organized systems (Fig. 1) :

- on-site medical organization;
- evacuation of the injured, that is, their transfer to and distribution among various hospitals;
- admission to the hospitals in accordance with their disaster plans.

The medical care of the injured, then, is progressive. It begins on the site of the disaster itself (rescitation, conditioning), continues during their transfer and ends in a hospital. The usual term for this is the rescue chain. The synchronization of the different links of this chain and of their respective capacities is decisive if this progressive treatment is to be adequate.

The assessment of disaster preparedness in certain regions is highly subjective. In a modern society, however, objectivity is essential and the following approach endeavours to be objective.

Figure 1 : Chain of progressive medical care



THE DIFFERENT CAPACITIES OF THE MEDICAL SERVICES

Each of the three systems mentioned has its capacity :

- medical rescue capacity on the disaster site (or MRC);
- medical transport capacity (or MTC);
- hospital treatment capacity (or HTC).

The medical rescue capacity (MRC) is defined as the number of victims receiving treatment, either basic or sophisticated, per hour on the disaster site.

This capacity depends on the number of medical teams and the back-up material available. It is generally accepted that a team composed of a surgeon, an anaesthetist and two members of the nursing staff can dispense treatment (resuscitation and preparation for evacuation) to 10 seriously injured persons (categories or priorities 1 and 2) per hour, on condition that they have the requisite equipment and first aid workers at their disposal. A team of this kind could probably function for 10 hours. This assumption has not been sufficiently proved, for after 8 hours of hard, continuous work, fatigue and the lack of material are going to reduce the MRC considerably. This is why, in general, the hourly capacities are multiplied by 8 to obtain total capacity for a real period of 10 hours. After a few hours of rest and replacement of material, capacities could once again become normal.

The medical teams should have at their disposal a large number of first-aid workers to carry out subordinate tasks such as watching over the injured, escorting them during transport, maintaining the material, the equipment and communications and ensuring that they are available, helping to prevent panic situations.

This is the only way for the professional members of the medical teams to be free to undertake their purely medical activities effectively.

It has often been stressed that the "inexperience" of the first-aid workers in disaster situations can be a real menace for effective and adequate relief action. This

inexperience is part of the counter-disaster syndrome which is characterized by non-coordinated activity, in particular among those who are not accustomed to misfortune and poverty. This is normally not the case with medical professionals whose daily work brings them into contact with this type of problems and situations. A second argument for subordinating the first-aid workers and excluding improvised rescuers even when they are full of good will, is their lack of clinical sense and their incapacity to correctly sort the injured.

The medical transport capacity (MTC) is defined as the number of injured who can be evacuated, transported and distributed to the neighbouring hospitals per hour.

It is generally accepted that each ambulance can contain two category 1 and 2 injured. This capacity must also take account of the number of ambulances (or "medicopters"...) and their drivers, etc., ready to intervene, etc. and of the average distance within the region in which they operate.

So this capacity depends not only on the number of ambulances available and the size of the ambulance staff, but also on the ease of evacuation (distance, terrain), on the (pre-established if possible) plans for the distribution of the injured among the hospitals (for example, one hospital takes the neurosurgery cases, another the vascular surgery cases).

It is generally agreed that in a country with a high hospital density such as ours, each ambulance ready for duty, is capable of evacuating, transporting and distributing two injured persons per hour and that it is not advisable to create clearing stations.

Of course, if the evacuation is hindered by difficult terrain, the distance or bad weather or war, this figure will be lower than 2 per hour.

It is clear that the MTC has to be synchronized with the MRC. If the local MTC is insufficient, other means of medical transport must be immediately available.

The lightly injured (category or priority 3) should go to their doctor's or to a first-aid post (if possible not to the hospital) using alternatives to medical transport, in particular private cars.

The prognosis of the injured improves if the amount of time between the occurrence of the wound or wounds and emergency medical treatment is reduced. The speed with which the treatment can be undertaken is of the greatest importance not only for category 1 cases but also for the category or priority 2 injured. However, rapid transport to the hospital is not necessarily the best way to resuscitate patients of categories or priorities 1 and 2. The transport of the seriously injured, particularly by road or in arms adds a traumatic factor to a precarious situation and can even contribute to the death of an injured person. This is why it is rational to condition before evacuation just as it is rational to take certain of the facilities of hospital medicine to the injured on the site.

The hospital treatment capacity is defined as the number of injured who can be treated, in accordance with normal medical norms or standards, that is, adequately, per hour in a hospital. During disasters requiring primarily surgery/anaesthesiology, such as mass accidents or earthquakes, the HTC depends to a great extent on the number of surgeons and anaesthetists, the strength of the nursing staff, the number of doctors undergoing training, of operation theatres, the reception capacity of the triage and resuscitation area of the emergency centre, the reception capacity of intensive care and finally on the number of anesthetic ventilators available. It also depends on the number of nursing staff on the floors, on central sterilisation

capacity and of the central stores, on the technical resources and the number of hospital wards. Since usually, these parameters are associated with the number of hospital beds, it is generally taken as a rule that an HTC equal to 3 % of the emergency hospital beds is a HTC of 3 injured for 100 beds per hour. Peter (1988) estimated that 40 % of the injured admitted to hospital have to be resuscitated or operated on immediately and proposed the following formula to calculate the total number of injured that a hospital can cope with and admit :

$$\frac{\text{anesthetic ventilators}}{3} + \frac{\text{elective op theatres}}{2} \quad \text{operation theatres reserved for emergencies} \times 2.5 = \text{number of injured admitted}$$

As an example, let us point out that the CHUV (some 1000 beds) CACHUV plan calculates that, with a 1st degree alert, this hospital can cope with an intake of from 10 to 20 seriously injured patients (Gertsch, 1985). The Canton of Fribourg's Mediplan estimates that the Cantonal Hospital (some 500 beds) could admit an intake of 8 seriously injured persons.

If the disaster happens at night or during a week-end, the HTC will be lower than if it had happened on a week-day morning. This will also be true if the hospital is destroyed by an earthquake or bombardment ! If the lightly injured (category 3) are spontaneously transported in private vehicles to the hospital, it will be congested and will not be able to admit the seriously injured (categories or priorities 1 and 2). This is why it would be wise not to evacuate 1 and 2 injured to the hospital nearest to the disaster. To a certain extent this hospital should be excluded from the disaster plan or constitute an evacuation and triage hospital.

To avoid stagnation at one link of the chain of progressive medical treatment, for example at admission to the hospital, the synchronisation of MRC, MTC and HTC is essential. These different capacities should be equal to each other. The smallest capacity or the weakest link decides the capacity of the entire rescue chain.

The "definitive" treatment should be begun as soon as the injured person arrives at the hospital. If treatment during this third phase is bogged down because of the arrival of too many injured, the hospital's disaster plan should be activated. The quality of the first treatment/surgical operation at the hospital is always limited since the patients are sorted again on their admission.

As time passes, increasingly fewer patients can be absorbed by each hospital. Hence the evacuation of the injured to hospitals should be adapted to the variations of the HTC of each hospital.

All the "normal" capacities mentioned apply to a normal situation as far as means of transport, weather, working hours are concerned. If the weather is bad, the terrain difficult, if the disaster happens during the night, the holidays or perhaps the week-end, then these capacities will be lower.

If, however, the roads are perfect, the weather clear, the disaster happens during a working day, outside the holiday season and during the morning, capacities will be greater.

The number of medical teams, means of medical transport (ambulances and "medicopters" in particular) and the HTC of the hospitals in the region should be

well-known figures and periodically up-dated. Otherwise, any synchronisation between MRC, MTC and HTC and any disaster plan will be illusory.

For example, in Holland, the national disaster plan includes 20 hospitals each of which has at its disposal an emergency medical team comprising a surgeon, an anaesthetist and two nurses. If necessary these 20 teams are sent to the site and then can deal with 200 injured per hour. The national plan has 400 (and even 700) ambulances at its disposal so that more than 4000 injured can be evacuated in 10 hours. The HTC is 1000 injured per hour.

In Israel, along the Afosyrian rift, seismologists are expecting a large scale earthquake. A national disaster plan (Eldar, 1984), in view of the damage expected to the local infrastructure, provides for help from outside the disaster area. This aid can deal with a large number of victims occurring in a short period of time using mobile medical teams and aeromedical back-up for transport.

In Switzerland, the means which can be committed to the coordinated health service (SSC) out of the total available are the following :

	Cantons	Civil defence	Army	Means engaged for the SSC
Staff				
doctors	6,500	2,500	6,000	75 %
nurses	15,000	4,000	6,500	25 %
auxiliaries	23,000	40,000	14,500	?
Beds	40,000	70,000	20,000	70 %
Transport (places for patients)	?	6,000	10,000	100 %

In the United States, a start was made in 1980 on the implementation of a national disaster plan, the National Disaster Medical System or NDMS (Mahoney, 1984, 1987; Orient, 1985; Moritsugu, 1986). The plan's aim is twofold :

- to provide additional aid during disasters which exhaust local medical resources;
- to give medical support to the army health service in case of armed conflict.

This national disaster plan was not designed to respond to the aftermath of a nuclear war.

The plan comprises three key elements :

- rapid medical response - medical assistance;
- evacuation of patients;
- definitive treatment of the seriously injured hospitalized patients.

The medical response includes two aspects :

- medical aid teams;
- medical material and equipment.

The medical aid teams set up casualty clearing units of 240 beds and 103 professionals. Patients are received there, are sorted, stabilized and evacuated but surgical capacity is low.

The Americans are gradually creating 150 units of this kind so as to be able to respond to an earthquake with 100,000 seriously injured.

Moreover, the plan includes 15 mobile surgical units permitting the stabilizing of the critically injured needing a surgical operation before being evacuated to the hospital for definitive treatment. Such a unit is capable of carrying out 36 surgical operations per 24 hours. To do so, it has 60 intensive-care beds and 215 professionals at its disposal.

A unit of this kind backs-up 10 mobile evacuation units.

Evacuation to the definitive treatment hospital has recourse first of all to the aeromedical support of the army :

- C-9 Nightingale transporting 40 laid-out injured over 2,500 miles and including a crew of two nurses and 3 medical technicians;
- C-141 converted into a transcontinental medical aircraft, transporting 32 laid-out injured and 70 seated injured;
- C-130 needing only a make-shift landing strip and converted into a medical aircraft for short and medium distances and transporting some 40 injured.

The national plan also envisages recourse to civilian transport such as trains, passenger jets (Boeing 767 with 111 laid-out injured, McDonnel Douglas of the MD-80 series with 45 laid-out injured), bus, etc.

For the definitive treatment, the national plan has chosen metropolitan hospital centres with 2,500 or more beds; these contract to reserve a total of 100,000 of their 726,000 beds (around 15 %) for injured evacuated during a disaster.

In order to assess the commitment required from an emergency aid medical service so as to plan and to manage the continuous response to a disaster, we still have to calculate an index of the medical gravity of the disater (I) and compare it to the total available capacity (TC) of the medical services, that is, MRC + MTC + HTC.

By definition, a disaster's medical gravity index is proportional to the number of injured (N) and the gravity of the disaster (S).

NUMBER OF INJURED (N)

In minor disasters or mass accidents such as transport accidents (head-on collision of trains or buses, derailing), the first estimate of the number of victims made by the layman present who is reporting the accident is usually too high. Even if the figure given for the number of injured (N) is often subsequently modified, it does serve for a first calculation. Successive estimates at intervals of 1, 2, 3, ... hours will be indicated by N1, N2, N3, ...

During major disasters, such as an earthquake, the first reports only describe a part of a much larger situation and generally are under-estimates. So it is necessary to send an airborne medical unit to evaluate overall the region affected and estimate in particular the scope and the extent of the disaster, the nature of the damage, the number of victims and injured and their localisation, the damage to structures such as roads, water supplies, communications and energy, buildings.

GRAVITY OF THE DISASTER (S)

The gravity of the accident can be represented by the symbol S. Generally, in disaster medicine, the injured are categorized in 4 priorities or categories :

1. (red). Cases whose life is in danger and who need immediate attention, in particular respiratory and/or circulatory resuscitation. 30 % of these cases usually die within the first hours;

2. (yellow). Cases whose lives are not threatened but who need hospitalization to be operated on/anaesthetized, observed or receive medical treatment. If these patients are not treated within the following hours (2 to 12 h.) or days, they often need to be reclassed in category 1;

3. (green). Having no general physiopathological troubles just minor lesions, these cases do not obligatorily need hospital treatment but rather less. They need or even only ask for treatment such as a simple surgical treatment (wounds, small fractures) which can be carried out by general practitioners helped by well-trained and experienced nursing staff;

4. the dead and the dying (DOA or desperate cases).

The seriously injured in categories 1 and 2 are those who need the medical attention of professional specialists. They are the persons who have to be evacuated and transported to the hospitals for treatment. They form the crucial group of victims. Crucial because any delay in treating them on the site, during their evacuation and their "definitive" hospital treatment will result in an increase in deaths, dying patients and category 1 patients.

Moreover, during a disaster, the victims may be divided up according to the type of lesions : surgical/anesthesiological, medical, combination of 1 and 2.

Most disasters result in surgical/anaesthesiological patients. This is why surgeons and anaesthetists are usually in great demand during disasters.

The categories 1, 2 and 3 represent roughly 10 %, 30 % and 60 % of living injured. The seriously injured (categories 1 and 2) and the dead or dying represent generally over 50 % of the total number of injured in most earthquakes, train accidents, fires, industrial explosions, terrorist attacks and aircraft accidents. Floods and volcanic eruptions kill more people than they injure.

Disasters linked to mass gatherings and socio-economic disasters usually cause many slight and not very serious lesions.

Generally speaking, the gravity depends on the type of disaster but also on other factors such as the time of the disaster, the place of the disaster, the risk population.

If many seriously injured persons (1 and 2) are expected, the gravity of the incident (S) will be valued at 1.5. However, if only a few slightly injured persons (category 3) are expected, the gravity will be assessed at 0.5. For example, mass traffic accidents cause a number of injured included between these extremes and are assessed with a S of 1.

Once the number of injured (N), the gravity of the incident (S) and the total capacity (TC) of the medical service (TC = MRC + MTC + HTC) is quantified, the medical gravity index can be calculated by the formula :

$$\text{medical gravity index} = \frac{N \times S}{TC}$$

If N x S exceeds the total local capacity of medical services (index > 1), the situation is problematical and the accident can be defined as a disaster (see following table).

Examples of disasters

	N	S	TC	$\frac{N \times S}{TC}$
1976				
Guatemala earthquake	10'000	1.5	1'000	$\frac{100\,000 \times 1.5}{1'000} = 150$
1977				
Aircraft accident Teneriffe	500	1.5	100	$\frac{500 \times 1.5}{1'000} = 7.4$

Legend

N	= number of injured;
S	= gravity of the incident;
TC	= total capacity of medical services (that is MRC + MTC + HTC);
$\frac{N \times S}{TC}$	= index of medical gravity of the incident.

Moreover, the disaster plans should be evaluated for each region. They can be graded from 1 to 5 : no plan available (1), plan being prepared (2), plan available (3), plan available and tested (4), plan available, regularly tested and tried (5).

By adding successively these grades (P) for each region and dividing the total by the number of plans (n) for a country, for example, we obtain an average number of 1 to 5, a figure which represents the quality of the country's preparedness for disasters.

All accidents cannot be classified as disasters, however, since N x S does not always exceed the total capacity of medical services of the region concerned by an accident even if it is disastrous or devastating.

This can be illustrated by the following example. A large explosion in a chemicals factory took place during the night in a remote region during bad weather with a presumed number (N) of 230 injured in categories 1 and 2. Explosions usually seriously injure many people, so S (gravity of the incident) will have a value of 1.5. If there are three hospitals in this region with, respectively, 90, 140 and 180 beds, the total HTC will be 12 (3 % x (90 + 140 + 180). As the MTC and the MRC have to be equal to the HTC, at least 6 ambulances (MTC = 6 x 2) and 2 medical teams (MRC = 2 x 10) have to be available. For a period of 8 hours, the total TC will be 96 (8 x 12).

Because of an abnormal situation on the roads, the weather and the night, less than 96, let us say 85, injured can be dealt with. So,

$$I = \frac{N \times S}{TC} = \frac{230 \times 1.5}{85} = 4$$

which is higher than 1. So the region cannot cope with the accident and the assistance of the neighbouring regions is necessary. Hence, this accident is called a disaster.

Was the earthquake in Mexico in September 1985 a disaster from the medical point of view ?

The tremor on 19 September lasted 3 minutes. Its magnitude on the Richter scale was from 7.8 to 8.5. The magnitude of the secondary tremor on 20 September was from 6.8 to 7.3.

2,831 buildings were damaged 31 % of which were reduced to ruins. 5,829 hospital beds were destroyed or rendered unusable. There were 7,000 deaths, 10,000 serious injured (1,700 of whom very seriously) and 30,000 slightly injured.

More often than not the buildings collapsed like flaky pastry. The victims were buried or more rarely, walled up between horizontal slabs most frequently less than 1 metre, if not several centimetres apart. Most of the survivors were localised in the lower floors, that is, in the floors to which access was most difficult after the collapse. When the building collapsed completely, the victims on the upper floors were usually killed by the violence of the shock.

The resources available in the federal district of Mexico were : 50,000 persons took part in the rescue operations in situ and in the evacuations, 600 ambulances, 20,403 doctors, 32,805 nurses, 15,162 hospital beds, 105 hospitals, 729 other less important treatment centres.

The total capacity of the medical service was enough to cope with all the injured. Even the reception capacity in intensive care beds was more than sufficient.

This was why, during the first 5 days, the local emergency medical aid could deal with lesions of the following type : fractures 25 %, contusions 18 %, psychical traumas 13 %, wounds 11 %, a few rare cases of burns 13 %, non-specified 31 %, of which : TCC 9.7 %, trauma complications 4.9 %, crush syndrome 0.7 %, dislocations 2.8 %.

This methodology, even if it is only approximate, gives the doctor in charge a rapid instrument to estimate whether an accident should or should not be called a disaster, in other words, whether the total capacity, local in particular, is going to be sufficient or not to deal with the number of injured and the severity of the accident. The methodology described is important, not only during the response to a disaster, but also during the preparation of a disaster plan. It can be used in particular

to assess the resources required to obtain the desirable capacity from each link of the rescue chain and the synchronisation of the three links from the disaster site to the hospital.

CONCLUSIONS

During a disaster, adequate progressive medical treatment depends above all on the synchronization of MRC, MTC and HTC. So it is essential that the fire services, the police, the public services, the hospitals, the surgeons, the anaesthetists... should cooperate in the preparation of plans by the national, regional and local authorities. With the methodology described, the medical disaster preparedness of the communes, cantons and countries can be established. This is worth while since during earthquakes, it is estimated that when preparation and first aid are improved, 73 % of deaths can be avoided (Orient, 1985). Moreover, the standardisation of the methodology allows a comparison of disaster preparedness between different regions, for example of the ORCAV and ORCAF plans.

SUMMARY

During a disaster, the synchronization of the different links in the rescue chain and their respective capacities is decisive if the progressive medical treatment is to be adequate. The calculation of a disaster's medical gravity index and the comparison of this with the total available capacity of medical services make it possible to assess the commitment required on the part of the emergency medical aid both in planning and managing the response to a disaster.

The Secretariat would like to thank the authors for having agreed to the puplication of this very interesting article which appeared in the "Revue Médicale de Suisse Romande".

CONGRESS ANNOUNCEMENTS

SECOND ASIAN PACIFIC CONFERENCE
ON DISASTER MEDICINE

September 10 - 13, 1992, Chiba - JAPON.

Correspondence : Second Asian Pacific Conference on Disaster Medicine
c/o Japan Convention Services, Inc.
4F, Nippon Press Center Bldg.
2-2-1 Uchisaiwai-cho
Chiyoda-ku, Tokyo 100
JAPAN

****

8th NATIONAL SAMU CONGRESS,
FIRST EUROPEAN CONGRESS OF EMERGENCY MEDICAL SERVICE

November 18 - 20, 1992, Paris.

Correspondence: 45, rue Boussingault
75013 Paris / FRANCE

****

INTERNATIONAL CONFERENCE
ON EMERGENCY CIVILIAN MEDICAL SERVICES IN A NON-CONVENTIONAL WAR

Tel Aviv, March 8 - 12, 1992.

Correspondence : International Conference
P.O. Box 50006
Tel Aviv 61500 / ISRAEL

****

CONFERENCE ANNUELLE DES MEDECINS DU CORPS DE POMPIERS

Bregenz, Autriche, May 28 - 30, 1992.

Correspondence : Aes Kulaps Medien
A-1030 Wien, Barichgasse 21, AUTRICHE

****

WORLD CONFERENCE ON HEALTH EMERGENCIES
IN TECHNOLOGICAL DISASTERS

Rome, May 5 - 7, 1992.

Correspondence : Servizio Emergenza Sanitaria
Protezione Civile
Via Ulpiano, 11
00193 Rome / ITALIE

****

INTERNATIONAL MANAGEMENT EXPOSITION AND CONFERENCE

San Francisco, March 17 - 19, 1992.

Correspondence : Interface Group
Autwoordnummer 10561
1000 RA Amsterdam / NETHERLANDS

****

INTERNATIONAL TRAUMA ANESTHESIA
AND CRITICAL CARE SOCIETY

Varese, Italie : Aprile 11, 1992

Correspondence : Servizio Anestesia / Ospedale Multizonale
V.le Borri, 57, 21100 Varese / ITALIE

****

10th WORLD CONGRESS OF ANESTHESIOLOGISTS
5th ANNUAL TRAUMA ANESTHESIA AND CRITICAL CARE SYMPOSIUM

Amsterdam, Hollande : June 11 - 12, 1992

Correspondence : Office of International Development
410 W. Lombard Street, Suite 416
Baltimore, MD 21201, USA

****

ISDM LIFE

The ISDM has the great pleasure of admitting new members. We extend a warm welcome to :

Dr Felix MAJIJI - Tanzanie

Dr Lilian BURLANDO - Chili

Dr K.A. NORBERG - Suède

Dr Ahmed EL MICHOU - Maroc

Dr Mohamed ADJOU - Maroc

M. Goal MORAL - Algérie.