THE MANAGEMENT OF MASS BURN CASUALTIES AND FIRE DISASTERS

Proceedings of the First International Conference on Burns and Fire Disasters

THE MANAGEMENT OF MASS BURN CASUALTIES AND FIRE DISASTERS

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Foreword

Thermal harm is one of the most traumatizing assaults on man and his environment. Whether suffered by living beings as burn injury, or sustained by societal structures as fire damage, the resulting physical pain and material loss can be extremely distressing both to the person and to society.

The health professions and in particular burn specialists have been continually developing effective means of combating burn disease and promoting rehabilitation of the victims, especially in mass casualty situations. In parallel, various levels of the community have been mobilizing fire prevention and fire-fighting mechanisms that protect society and the environment from the ever-increasing hazards of fire disasters.

It is therefore surprising that, while aiming at the same objective, the two sectors have rarely come together; doctor has rarely worked with fire chief. Yet both disciplines have so much to learn from and contribute to each other's efforts.

The Mediterranean Burns Club is a professional organization that brings together persons concerned with burn therapy and fire safety in all forms, especially in the countries of the Mediterranean basin. It is honoured to have been identified by the United Nations as a premier scientific body in its field within the programme of the International Decade for Natural Disaster Reduction. It is therefore natural that it should have initiated an international gathering of specialists engaged in burns as a surgical, clinical problem, and of counterparts dealing with fires as a societal, disaster management problem. This novel approach and symbiosis have proved timely and successful.

The First International Conference on Burns and Fire Disasters, and the resulting papers that will be found in this book, reflect the commitment of the Mediterranean Burns Club and of its collaborators to the reduction of fire hazards and the improvement of burn therapy.

M. Masellis, MD
S. W. A. Gunn, MD

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Overview
The First International Conference on Burns and Fire Disasters*

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The first International Conference on Burns and Fire Disasters was held September 25–28, 1990, in Palermo, Italy. The meeting was organized and conducted by the Mediterranean Burns Club and the Division of Plastic Surgery and burn therapy of the Palermo City Hospital, under the aegis of the Parliament.

Over 100 papers were presented, in addition to four round-table discussions and concluding reports by four commissions dealing with fire disasters, preparedness for primary burn emergencies, fire disaster management, and information and communication in national and international organizations.

Collaborating institutions numbered more than 30, including the International Red Cross, the G. Whitaker Foundation, and various components of the World Health Organization (WHO). The collaboration of the International Federation of Surgical Colleges brought with it the combined representation of more than 30 surgical colleges and national societies throughout the world. There were seven collaborating publications, including the *Disaster Management Journal*, the *International Civil Defence Journal*, and the *Annals of the Mediterranean Burns Club*.

Sixteen regional and local bodies cooperated under the coordination of Professor Michele Masellis MD, secretary general of the MBC, and S.W.A. Gunn, MD, FRCSC, president of the MBC and vice-president and scientific director of the European Centre for Disaster Medicine. Dr Gunn is well known as the former head of the Emergency Relief Operations of the WHO, and as the author of a multilingual (English, French, Spanish, Arabic) *Dictionary of Disaster Medicine and International Relief*. The dictionary discusses disasters of every sort and understanding such codes is a vital part of international cooperative efforts in major disasters — such as earthquakes — when local and

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even national resources of the affected country may be inadequate to the vast burdens imposed on institutions and personnel.

A striking example of international cooperation was reported by the team from the US Army Institute of Surgical Research, Fort Sam Houston, Houston, TX. This group provided vital assistance in the immense problems posed by a gas explosion in Russia that killed approximately 300 individuals on a nearby train, and left more than 800 survivors severely burned. The surgical team's report covered geopolitical aspects of a delayed acceptance of proffered help, the importance of a disaster care protocol tailored to anticipated workload and the local environment, the need for translators, communication equipment, and support mechanisms that are independent of local resources. All of these aspects, as well as an efficient, safe transport of personnel, laboratory facilities, and tons of supplies are peculiarly suited to the resources and planning inherent in effective military operations.

At the same time, there are political problems related to allowing the research personnel of a foreign power's military establishment to install a base of operations without the usual visa and related protocols. The success of this US Army mission testifies to the excellence of the advance planning and to the expertise and effectiveness of the personnel involved.

One might reasonably inquire as to how we have come to 1990 before scheduling the first international conference on burns and fire disasters. Obviously, burns and related disasters have occurred from time immemorial, and a fairly sophisticated approach to individual burn and to man-made natural catastrophes has been under development for most of the present century.

The American College of Surgeons established a committee on the treatment of fractures in 1922, which gradually evolved into the Committee on Trauma in 1949. These committees built on the work of groups established before the foundation of the College, both on this continent and abroad. But the College's Committee on Trauma grew in size and scope as a hierarchical organization with subcommittees on education, publications, emergency services in hospitals and at the site of injury, as well as disaster planning and other facets of the overall problem, such as highway safety and alcohol-related injury.

In 1987, the United States incurred over 145,000 trauma deaths and nearly nine million disabling injuries, at an estimated cost to society of $133 billion. These statistics reflect a national disaster, including both individual trauma and multiple simultaneous injuries caused by natural or man-made disasters.

It is disaster management in all of its complex aspects that has gradually come to be recognized as susceptible to analysis, study, and a coordinated and international approach. As Dr Gunn pointed out in his 1986 Abraham Colles Lecture at the Royal College of Surgeons in Ireland, there is an interdependence of all societal sectors in dealing with the vast ecological breakdown brought on by major disasters. Societal resources drawn from public works, politics, agriculture, national finances, and the health care system must all participate in addressing these catastrophes.

At least for someone who does not regularly deal with trauma and disaster, the variety of topics presented at the conference was striking. In addition to lessons learned from individual fire disasters, there were papers that addressed personal protection from forest fires, liquefied petroleum gas (LPG) explosions,

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underground events such as the King's Cross subway fire in London, England, and the legislative reaction to governmental inquiries into such catastrophes. In the city of Nara — the ancient capital of Japan for 100 years in the eighth century — protection of the temples and cultural properties has been effectively managed for many years, despite some 60 fires annually in the wooden buildings of that city, where three million visitors come to a single temple.

There were grimly reassuring discussions on the probability of 'fire storms,' referring to the result of planned incendiary bombings where the column of heated air in the centre causes high velocity wind currents from the outside, which may prevent fire fighting or lifesaving operations and may kill people in shelters because of anoxia. Most modern cities have configurations that are unfavorable to fire storms, but the problems of nuclear attack pose far greater problems. Also addressed was the general lack of advance planning for search and rescue operations in major disasters, which poses problems significantly different from those limited operations handled by fire services in response to everyday fires.

These presentations and many others convey an impression that disaster medicine after the last two decades has begun to develop a 'more organized response, with a studied, technical, managerial approach.' The field has now been included in the curricula of a few medical centres, but much greater attention needs to be paid to this field, given the precariously unstable state of our global village. A number of principles has emerged from meetings such as the one reviewed here, including the concept that preparedness is possible, that disasters have recognizable epidemiological profiles, and that sectorial and international planning are essential for effective action.

It seems probable and highly desirable that the lessons learned from the First International Conference on Burns and Fire Disasters will be dispersed and further refined in subsequent meetings of this type* as part of the worldwide effort to promote trauma care.

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American College of Surgeons Bulletin, 1991, **76**: 66–67

*The *Proceedings of the Second International Conference on Burns and Fire Disasters: Perspectives 2000* will be published in 1993 by Kluwer Academic Publishers.

Section I
Disaster

1
Thermal agent disaster and fire disaster: definition, damage, assessment and relief operations

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The attention of experts today is more directed at analysis of disaster management than at disaster prevention. It is in fact widely believed that the results of studies of disasters, although they have helped to reduce their number, will not be able to eliminate the percentage risk of their occurrence, in view of the imponderability of human and technical errors.

S. W. A. Gunn's *Multilingual Disaster Dictionary* defines disaster management as follows: 'Disaster Management is concerned with all phases of planning, preparedness, training, response, relief, rehabilitation and reconstruction of a major emergency or disaster situation.' Two considerations are suggested by a careful examination of this definition:

1. Disaster management cannot leave out of consideration an overall assessment of the consequences of the disaster: this assessment must be as accurate as possible, whether it refers to a presumed or actual event.
2. The planning of measures aimed at mitigating the effects on persons, in terms of suffering, disability and risk to life, must be related to a more specific evaluation of the damage, i.e. to the types of pathology that have been caused.

FIRE DISASTER AND LIVING BEINGS

A fire disaster has very special characteristics, if one considers the particularities of the causative agent and the type of damage it produces in living beings. When fire comes into contact with objects and materials it burns or destroys them in a relatively short time. The action of fire on living organisms is lethal within a few seconds. In man, if fire is not immediately lethal, it determines a pathological condition, the burn, that is considered to be the most complex trauma that can strike the human organism. A fire of vast proportions can cause damage to the surrounding environment by the massive production of heat and the emanation of burned gases and fumes.

For the above reasons, fire disaster management must be mainly directed at the planning of measures necessary to mitigate the damage caused to man and to prevent its aggravation. It is therefore necessary to bear in mind some specific aspects that manifest themselves during a fire disaster. These can be briefly summarized as follows.

- The number of involved persons is always high.
- The burns are mainly very extensive, and the general condition of the victims is precarious.
- The burn is often associated with other serious pathologies, such as vast wounds, fractures, electrocution or blast lesions.
- Hypovolaemic shock, a characteristic feature in the first phase of the burn illness, as soon as three hours after the trauma, induces a state of tissue hypoxia, with irreversible damage to the various organs and systems.
- The time interval between the accident and initiation of resuscitatory therapy must be less than two hours.
- The inhalation of combustion gases, fumes and hot air causes damage to the airways and this alone can jeopardize survival.
- The place where the disaster occurs is not always easily accessible, and care and assistance may be inadequate.
- The triage *in loco* of the victims must be effected only by specialists, as only specialists are able to evaluate the immediate gravity of the burn.
- The overall assessment of the damage to persons must be made not only on the basis of the number of dead but also on the number of persons in a condition of potential mortality and with severe risk of disability.

THERMAL AGENT DISASTER. BURN DISASTER

In the light of the above considerations, and in order to have at our disposal precise points of reference as regards the management of rescue operations, it may be useful to define precisely the two concepts of 'thermal agent disaster' and 'burn disaster'. Although these two concepts are linked by the common denominator of fire, they refer to events which, in view of a different evaluation of the damage caused, require operational rescue phases with varying commitments. We make the following definitions.

Thermal agent disaster: a disaster causing severe losses of human lives and material goods as a result of massive heat production. This definition expresses the relationship between a generic cause of the event (massive heat production) and the consequences for human beings and material goods. It is an exclusively mathematical expression of the damage caused, i.e. of the number of the dead and injured, and the extent of damage to material goods.

Burn disaster can be defined as the overall effect on living persons caused by massive action from a known thermal agent. It is characterized by a high number of fatalities and of seriously burned patients with a high rate of potential mortality and of disability. Its extent may be aggravated if appropriate rescue operations are delayed. Some decisive factors involved here are the type of pathology caused; the overall characteristics of the harmful action of the thermal agent; the terms of the evaluation of its gravity in relation also to precise modalities of managing rescue operations.

In the burn disaster, the concept of the cause of the event is therefore to be referred to a well-defined pathological condition, i.e. 'extensive burns', already existing in a high number of persons. Its extent depends on the potentially high number of fatalities, which is related to the considerable number of persons involved, the seriousness of their conditions and above all the early initiation of emergency therapy.

The formulation of two different definitions of 'burn disaster' and 'thermal agent disaster' proves useful on both the didactic and the operational level. The formulation in fact allows a more precise collaboration of the two events in the vast chapter of disasters; it offers more specific indications for the drafting of plans for preparedness and alerting and management of the problems connected with their occurrence; and lastly it suggests a more effective programme for the mitigation of human suffering.

OPERATIVE PROPOSALS

The drafting of an operational rescue plan, in the event of a burn disaster, cannot fail to take into account two points: (1) the victim's pathological picture, i.e. the presence of extensive burns together with inhalation lesions and polytrauma; (2) the 'typology' of required intervention. This must develop along three lines: immediate care; medical rescue within three hours; use of specific equipment and means for the rescue of the burned patient.

Such an approach will make it possible to achieve maximum efficiency also in relation to the numerous factors that normally condition the evolution of a disaster:

- The unpredictability of when the disaster occurs
- The moment of the disaster (day, night, festivity, etc.)
- The characteristics of the disaster (with explosion, collapse of buildings, production of toxic gases and fumes, if a forest fire, etc.)
- The area where the disaster occurs (city, non-urban area, accessibility, presence of material suitable for relief operations, etc.)
- The type of building involved (civil dwelling, hotel, office, hospital, etc.)
- The number of persons injured and the type of trauma
- The population's degree of preparedness to manage the disaster situation.

IMMEDIATE CARE, FIRST AID, ORGANIZED RELIEF

We can define three distinct phases in the rescue operation: immediate care, first aid and organized relief.

Immediate care

This is provided by persons present at the scene of the disaster: relatives, friends, passers-by — all those persons who witnessed the disaster or who arrived immediately on the scene. Generally speaking, their help is an automatic reaction derived from affection, friendship and a spirit of human solidarity. This is confirmed by data we have observed in earthquakes. For example, on the occasion of the earthquake in Italy in 1985, 95% of the victims had been extracted from the ruins by citizens using their bare hands before the arrival of organizing relief.

In the event of burn disasters, however, it is important that the first people to provide assistance should be fully aware of what they have to do. They must, for example, know how to approach a fire, how to enter burning buildings that may be full of smoke or toxic fumes, how to rescue a person whose clothes are on fire, how to treat burn wounds and associated lesions immediately, and how to provide medical relief.

First aid

This refers to the action of persons present in the immediate vicinity who have already received training in rescue operations and who organize and go into action within a very short period of time, not more than 2–3 hours. These persons are physicians, nurses and members of voluntary organizations. They are supported by public and private organizations in the area — hospitals, casualty departments, clinics, fire brigade, police, etc. — coordinated by the local authorities.

The authorities act on the basis of guidelines that provide for the stockpiling of specific mobilization materials in the most convenient locations, the management of ambulance services, traffic control, the use of local and regional mass media and general means of transport.

The kind of assistance provided by these first rescuers is of primary importance for the prognosis of the casualties. They must carry out the first triage of urgent cases, taking into consideration the high number of polytraumatized patients. Given the particular evolution of the burn pathology (worsening hypovolaemic shock), they must also initiate all medical and surgical procedures necessary for preliminary resuscitatory therapy and the initial local treatment of burns. These groups could be supported by other teams of physicians, nurses and specialized technicians with appropriate equipment for the specific care of burn patients. These teams, sent in by air, would represent an outpost for organized relief when it arrived.

It must be stressed that it is of fundamental importance that the particular procedures, regarding both medical assistance and general behaviour, that the rescue workers have to carry out must be the object of specially prepared protocols that are publicized through information campaigns, education campaigns, refresher courses and training sessions aimed at citizens of every social extraction, starting at school age.

Organized relief

This refers to the mobilization of all the military and civil defence forces that are ready to intervene in the event of a disaster. These forces arrive *in loco* as rapidly as possible, but certainly not within the first three hours, equipped with the necessary means and structures to enable them to perform their rescue action within the first 48/72 hours after the disaster, until all the wounded have been evacuated.

However, it must be pointed out that these forces are generally trained to manage general disasters rather than burn disasters; hence the necessity that they should incorporate special units for the management of fire disasters composed of personnel trained in the emergency care of severely burned patients and equipped with specific means and materials. These units will be in charge of the preliminary triage, i.e. assessing the general condition of the victims, initiating and monitoring resuscitatory therapy and, pending the arrival of burns specialists, preparing a preliminary evacuation plan, contacting despatching stations, selecting means of transport, organizing first-aid posts and clearing the area of the dead.

CONCLUSIONS

The planning of the management of a fire disaster, in terms of medical and surgical assistance to the victims, has particular characteristics not to be found in other kinds of disasters. The definition of 'burn disaster', which stresses the particular nature of the pathology produced in man and the relationship between the high risk of mortality and delay in initiating therapy beyond strictly defined time limits, indicates the guidelines for the drafting of suitable and appropriate plans for the management of relief.

In the event of a burns disaster, besides the classic concept of first relief, meaning the combined organization of personnel, materials and transport standing by to intervene in the event of a disaster, we must also consider the concept of immediate care, which refers to rescue operations carried out in a competent and well-defined manner by persons who happen to be present *in loco*, and first relief, which is provided by operative forces in the area which have received specific training.

The high number of burn victims, the gravity of the trauma, the need for specific and early therapeutic intervention and the necessity of the involvement of operative forces in the area impose the requirement of specific training programmes for persons of all social levels and for physicians and paramedicals, together with the preparation of mobilization plans for specific means and structures.

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2

The scientific basis of disaster medicine

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While sharing the most elemental cause — the thermal factor — burns and fire disasters have long been considered separately, on the one hand as a purely clinical medical problem, and on the other as a societal, environmental problem. It is becoming increasingly evident that there is close interrelationship between the two at all levels — prevention, response, care, management and rehabilitation — and such *rapprochement* cannot but strengthen the efficiency and efficacy of all concerned. This paper proposes a scientific basis for disaster medicine, in which more burn surgeons are becoming involved.

DISASTER MEDICINE: A NEW DISCIPLINE

Emergency aid is as old as humanity. As long as man has had a heart and a physiological reflex for protection, he has had compassion and an urge to help those who suffer. Nothing new there. But what is new is the accelerating process of change that has seen the emergence of disaster medicine as a gradually, and now rapidly, developing science. It has not, however, always been so; indeed it has taken society enormously long — up to the last two decades or so of our century — to mould this humane, ad hoc, unorganized, not to say disorganized, assistance into something organized and conceptualized, a technically underpinned action that is evolving into the discipline of disaster medicine.

In fact one of the pleasures of disaster management, and to me in particular of disaster medicine, is that one witnesses the unfolding of a new science in front of one's eyes. I find this very challenging and exciting.

A cursory look at the past is instructive. Perhaps the earliest organized aid was that of hunters and warriors, helping dress each other's wounds. The caves of primitive Lascaux and the exquisite pottery of classical Greece are eloquent witnesses. Military medicine grew out of that, and in modern times Florence

Nightingale put the stamp of feminine sensitivity on mass casualty care.

From frontline care we gradually proceed to transnational action with the founding of the International Red Cross and the formulation of international humanitarian law. National Red Cross — and later Red Crescent — Societies sprang up from this, with subsequent federation into the League following World War I.

In all this international reorganization, the medical profession as such had little involvement, a pattern that has only recently begun to change. What has not changed is the predominantly humanitarian core of disaster assistance, whether in natural catastrophes or man-made disasters.

World War II, like all wars, brought its horrors and some beneficial consequences. Towards the end of the conflict UNRRA — the United Nations Relief and Rehabilitation Administration — became the first disaster-management enterprise on a global scale and still holds the record of having dispensed the most massive aid: $20 billion in today's currency during a period of $3\frac{1}{2}$ years of its operation over a vast area extending from the Mediterranean to the Pacific. The birth of the United Nations and of the World Health Organization were the other momentous events in the aftermath of war, and their constitutions have a capital bearing on disaster management.

First of all, WHO redefined health as a 'state of complete physical, mental and social well-being and not merely the absence of disease or infirmity'. The victims of disasters are thus lacking in well-being and deserve care. More specifically, Article 2 of the WHO constitution states that the Organization 'shall furnish appropriate technical assistance and, in emergencies, necessary aid'. The UN charter has similar instruments concerning man's right to protection.

I am honoured to have been associated with the UN system and in particular with WHO for many years, and it is my belief that it is through the moral and intellectual impetus of these global organizations that disaster management is gaining institutional expertise. Disaster medicine, as distinct from trauma management and clinical emergency medicine, is now enjoying an increasingly important place in overall health and development planning. The scene is now set for the new science.

Let us define the new science. Here is my definition of disaster medicine:*

> The study and collaborative application of various health disciplines, e.g. paediatrics, epidemiology, communicable diseases, nutrition, public health, emergency surgery, social medicine, community care, and international health, to the prevention, immediate response and rehabilitation of the health problems arising from disaster, in cooperation with other disciplines involved in comprehensive disaster management.

It is necessary to have standardized approaches and harmonized definitions of concepts and specialized terms in established disciplines, and at its 1991

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*Reproduced from S. W. A. Gunn: *Multilingual Dictionary of Disaster Medicine and International Relief*, © by kind permission of Kluwer Academic Publishers, Dordrecht, London and Boston. (See review in the *Annals of the MBC*, January 1989.)

meeting the WHO Expert Committee on Emergency Relief Operations endorsed this definition and included it in its official report. The definition is also espoused by the Commission of European Communities, which is currently compiling the lexicon of all the terms likely to be encountered in civil protection and management of major emergencies.

Disaster medicine, then (some are already talking of disaster health), is more than the age-old bandaging of wounds and providing emergency relief. To be an effective and efficient managerial system, it has to be an extended method comprising all the phases and facets of the disaster cycle, including preparedness, prevention, immediate response, relief, reconstruction, rehabilitation and development. For disaster is an anthropocentric, sociocentric phenomenon. If a cyclone or an earthquake does not touch man or his social structures, it remains a merely meteorological or geophysical phenomenon.

Disaster*, as I see it, is:

> The result of a vast ecological breakdown in the relations between man and his environment, a serious and sudden event (or slow, as in drought) on such a scale that the stricken community needs extraordinary efforts to cope with it, often with outside help or international aid.

The definition implies an emergency of such magnitude that would require outside help or international relief. I shall discuss later the improvements in international relief as part of the technical advances in disaster management.

Disasters are always sad and destabilizing situations, and disaster response has not always been successful. To be more successful the knowledge and mechanisms have to be based on more solid, scientific precepts. There are positive developments in this regard, and I should like to highlight three areas where scientific underpinning has been effective and where the scientific basis of disaster management is being strengthened. I shall discuss (a) the scientific approach, (b) epidemiological advances and (c) training for disaster management.

The scientific base

An undeniable process now in progress is the increasing technicization of disaster management. However humanitarian disaster medicine may be, and it *is* predominantly humanitarian, it must strengthen its scientific base and develop a strong technical structure. This applies as much to disaster management in the wider sense as to disaster medicine in the specific sense. Research and field surveys over the past few years have shed new light on the effects of disasters and have indicated better ways of providing the appropriate response. From these studies and personal experiences I would enunciate ten principles for the scientific basis of disaster management.

1. Preparedness is possible and essential. The greater the preparedness

*See previous footnote.

for foreseeable or probable events, the more effective relief operations will be.
2. Prevention of many natural disasters is possible, while prevention of all man-made disasters should be possible.
3. No two disasters are alike, but the problems that certain categories of disaster are likely to create are quite foreseeable. Disasters have profiles.
4. Based on such profiles, the disease pattern of each kind of disaster can be formulated epidemiologically.
5. Planning and preparation on a sectorial, national and international basis are possible and essential for effective multidisciplinary response.
6. Mobilization of multisectorial manpower resources (in the case of medical action: nurses, doctors, nutritionists, social health workers, paramedics) must be organized so as to be able to respond immediately to probable, less probable and particular needs when disaster strikes.
7. Risk assessment, evaluation of the risks, estimation of the effects of one's intervention, and a study of the post-disaster situation are essential.
8. The post-emergency phase offers a rare opportunity for taking steps to mitigate the effects of a subsequent disaster. Each disaster is a lesson.
9. The reconstruction phase starts at once and it is part of development.
10. Disaster management takes into full account the community and the local/national institutions involved.

The more one provides a scientific base, the more one becomes convinced that for truly effective disaster management the key is preparedness and prevention, rather than post-hoc, fire-fighting type emergency response: my postulate no. 1.

For this kind of scientific approach and technical underpinning, special studies, surveys, bench and applied research, social and natural science investigations and managerial applications are necessary. One particular endeavour that has proved most promising in disaster medicine is epidemiology.

Disaster epidemiology

Epidemiology is 'the medical discipline that studies the influence of such factors as the lifestyle, biological constitution and other personal or social determinants on the incidence and distribution of disease'*. By extension, disaster epidemiology can be viewed in a broader perspective that links data collection and analysis to an urgent decision-making process. It is not management, but a tool for it.

The effects of disasters can be studied by epidemiological methods. Such studies have included the public health effects of specific disasters; analysis of risk factors for adverse social and health effects; clinical investigations of the impact of diagnostic and therapeutic methods; the effectiveness of various types of assistance; and the long-term influence of relief operations on the restoration of pre-disaster conditions.

*See earlier footnote.

Based on such studies, disease profiles for each type of disaster have been formulated and have already borne results in their application. We know from these studies, for example, that although both earthquakes and flash floods result in great numbers of deaths, the disease patterns they cause are entirely different: multiple trauma for the first, and communicable diseases for the second. And as a corollary, you need more surgeons and fracture splints after an earthquake, and more internists and antibiotics after a major flood. Also, hospital admissions jump impressively immediately after an earthquake, but return to normal pre-seismic conditions within 4–6 days of the impact. Hence the virtual uselessness of mobile hospitals flown from overseas after an earthquake, as they almost invariably arrive late and are of little use.

Descriptive and analytical epidemiological studies have already resulted in improved disaster response and better preparedness levels. Anti-seismic housing design and anti-flood structures owe much to such studies besides, of course, to appropriate construction and planning advances. However, while natural disasters have been extensively investigated, man-made disasters have been more difficult to conceptualize, as they include such diverse events as conflicts, mass exodus, nuclear explosions, technological accidents and environmental disasters that threaten the ecological balance of a community. More studies are needed here.

Training

To carry out more studies, and to put into operation what is learnt, it is necessary to have trained people. In the past, the traditional response to disasters has depended more on goodwill than on knowledge. While such outpouring of personal and international solidarity has brought great comfort to stricken populations, the effective results have been hampered by a lack of trained personnel at all levels.

This is now changing, as change it must, if disaster action is to benefit from technical knowledge and managerial know-how, besides humanitarian compassion. Several universities have introduced training programmes, and research projects are being carried out in many countries. Courses are conducted in disaster health at the European Centre for Disaster Medicine; in management at the Asian Disaster Preparedness Centre in Bangkok, at the Pan African Centre for Emergency Preparedness in Addis Ababa, at the Pan American Health Organization in Washington, and elsewhere. Specialized training is provided by such centres as the Mediterranean Burns Club in Palermo, Italy, while the United Nations programme of the International Decade for Natural Disaster Reduction provides facilities for trainees from developing countries.

Scientific investigation generates its own language and literature. Works on a harmonized terminology have already been mentioned. Serious periodicals are published, such as the quarterly *Prehospital and Disaster Medicine* by the World Association for Emergency and Disaster Medicine, the *Natural Hazards Observer* by the University of Colorado and the *Annals of the Mediterranean Burns Club*, while books have been written on general or particular aspects of major emergencies. Examples include: *Major Chemical Hazards, Refugee*

Community Care, Epidemiological Surveillance after Natural Disaster, Mitigating Natural Disasters — A Manual for Policy Makers and Planners. A rich programme of international conferences is constantly adding to the training facilities and expert communications in disaster management.

All these are healthy signs of a new and vigorous science, a science that is becoming increasingly needed.

CONCLUSIONS

A new discipline needs a sound scientific base, technical underpinning, proper conceptual framework and organized management. In disaster medicine all the health and multidisciplinary aspects of emergency management are essential if disaster preparedness and response are to be more efficient and more effective. There is currently evidence that such scientific strengthening is being applied to the evolving discipline of disaster medicine.

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3
Overcoming the mythology of disaster

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One of the most important professional challenges facing those of us who wish to put our skills and knowledge to the great humanitarian field of disaster relief is to identify and eliminate that part of disaster mythology which is opposed to the best and most effective response we can make to mitigating human suffering arising from catastrophic situations.

It is a *sine qua non* that an emergency plan is no better than the assumptions made about individual or organizational behaviour during disasters, and any assumptions that cannot be substantiated by reality must be discarded.

There is no doubt, and research has consistently demonstrated, that many popular views about reaction to disaster and behaviour in disaster are, to say the least, inaccurate. Any disaster-preparedness activity that is based on incorrect assumptions about anticipated behaviour, whether individual or institutional, is not good planning.

Some officials concerned with emergencies and disaster planning, and others, believe that there is no qualitative difference between a disaster and a minor emergency; for example, police officers who tend to think that a disaster is merely a large-scale traffic accident; and senior officials in the chemical industry who consider that preparedness planning for acute toxic releases, chemical explosions and other mishaps is no more than an extension of everyday corporate health and safety measures. A study of emergency medical services (EMS) has revealed that some EMS personnel believed that special preparedness planning was unnecessary because the provision of EMS in disaster was but an extension of EMS in daily operations — the only difference being one of degree.

These and similar views quite strongly held are simply wrong. In a disaster there is a difference of kind, not just of degree, compared with what goes on in a minor emergency or accident. A disaster involves not just more, but something which is qualitatively different. This has to be considered when planning for disasters, training for disasters, operating under disaster conditions, and evaluating group or organizational activities during such occasions. An accident cannot be seen as a little disaster — neither can a disaster be viewed as a big accident.

This is why Lord Justice Taylor, in the United Kingdom, in his most outspoken report on the Sheffield, Hillsborough stadium disaster, painted a most disturbing picture, a picture of unbelievable complacency, and of lessons of past disasters not being taken sufficiently to heart because of insufficient concern and vigilance and the 'it can't happen to us' syndrome.

Another misconception is that disaster planning can be based on or borrow much from military settings and situations. It is often believed that the best model for disaster organizational preparedness and management is what has been called a 'command and control' model. This is a notion taken from the military area, that a top-down, rigidly controlled and highly structured organizational model ought to be developed for disaster purposes. Leaving aside the fact that the command and control model is more fiction than fact even in the military area, it is not the way armies, navies or airforces actually operate especially in conflict situations, irrespective of stereotypes and mythology to the contrary.

The reality is that command and control models are seldom organizationally viable, and more importantly that they would be poor models for disaster planning even if they could be implemented in the real world. The major exception would be if the military were the only viable and nationwide social institution in the society.

In general, the command and control model assumes that disasters create a tremendous discontinuity with everyday life, which lowers the effectiveness of individual behaviour and reduces the capacities of the social organizations involved. Given this, planning then becomes centred on the development of mechanisms to control supposedly widespread, maladaptive individual behaviour and on the creation of ad-hoc structures to replace the supposedly disrupted and non-functioning social organizations in the disaster area. Planning efforts are thus directed at the creation of a strong authority to overcome the supposed effects of social disintegration created by the disaster situation. Planning in this mistaken model is oriented towards creating new norms for individuals undertaking emergency behaviours. Therefore we get new myths arising.

The first and foremost of these is panic: the belief that spontaneous behaviour on the part of individuals is inappropriate or manifests irrational actions on the part of 'panicking individuals', and that natural and spontaneous behaviour is incapable of being effective in the stress conditions caused by a disaster event. I think much of this attitude stems from the desire of the mass media to sensationalize an event. In reality there is less discontinuity with everyday life than is frequently supposed. Rather than exhibiting irrational and abnormal behaviour, disaster victims maintain as much as possible their traditional activities and their usual occupational and family responsibilities. Most organizations in disasters tend to operate as well as they do on an everyday basis — it is extremely rarely for them to become non-functional, even in the worst of disasters. In this context, that is why, in the United Kingdom, it is recognized that disaster planning should be firmly based on the local government structure.

People, in general, do not panic. Actual cases of hysterical breakdown and wild flights are extremely rare, and are usually of no practical operational importance, if they do occur. In fact, instead of flight away from the danger area, there is more likely to be convergence into the disaster area; instead of collapse into uncontrolled breakdown, people actively move to do what they think should be done in the crisis.

Of course, disaster victims are usually quite frightened, that is only natural; but that does not mean that they will act selfishly or ungenerously. They do not become unreasoning animals, instead they tend to show more rationality under stress than they do normally.

Next to the myth of 'panic' is the supposed myth of 'looting'. To journalists, and sometimes to inexperienced officials, disasters are often seen as offering opportunities for the surfacing of criminal and antisocial behaviour. It is surmised that deviant behaviour will emerge and that the dazed victims or the shattered property in the disaster area become easy targets for looting and other forms of criminal activity. Mr Hyde will take over from Dr Jekyll, crime rates will rise, and exploitation will be widespread. The fact is that many stories of looting will spread, but actual instances will be rare and generally will be done by outsiders rather than by the stricken population itself.

Far more material is given away than can possibly be looted. In fact, the dominant characteristic in the emergency time of disaster is magnanimity rather than barbarity. Exploitation is only likely to be seen in the relatively rare instances of profiteering after the immediate emergency is over. If disasters bring out anything at all in people, it is the philanthropic rather than the misanthropic — 'deliciae humani generis'.

A grave misconception among emergency planners, among relief agencies and many others, is a tendency to assume that disasters leave large numbers of people dazed, shocked and unable to cope with the new realities of the community crisis. It is assumed that they need outsiders to do the most elementary tasks for them, such as clothing, feeding and housing: then that they need outside help in search and rescue, and first-aid teams and emergency medical services.

If the expectation of antisocial behaviour is redolent of Dr Jekyll and Mr Hyde, then the expectation of dependency conjures up the image of 'Big Brother'. If 'Big Brother' does not step in, nothing, it is assumed, will happen. This prospect of reliance, too, is quite false. Those who experience disasters are not immobilized by even the most catastrophic of events. They are neither devoid of initiative nor passively expectant that others will take care of them and their needs. Usually, before the shock is over, search and rescue efforts are initiated by friends, neighbours and families. The injured are tended and brought for medical care to medical services that are still operable, although generally operating in expedient conditions. Shelter is actively sought and given by families, neighbours and friends. In fact the evidence is overwhelming that in disaster self- and family help and mutual, informal initiative and assistance will predominate.

It is a very natural and very human assumption that if people have been struck by some terrible disaster and are in dire need, the standard response must be to pour in traditional aid inputs — food, clothing, blankets and medical supplies. If this response can be moving from the donor nations to the stricken nation within hours of the disaster, so much the better, and so within hours we have the classic radio, television and press appeals. Governments and relief agencies are lobbied, donors respond generously with airlifts, convoys racing across continents, and even flotillas of ships. If television does not show impressive pictures of bulldozers, crates of materials and laden rescue men loading on to jumbo jets, then governments are accused of doing nothing to aid their fellow men.

Sometimes, looking back on some of the disasters that have occurred, it seems that the speed with which this all takes place is only matched by the speed with which the crisis is forgotten, as the media find some other more titillating event to fill the screens and tabloids. A range of impressive inputs, including skilled experts and material backup supplies to keep those experts active for many a long day is set in motion, and in the host country, already beset by a multitude of problems, physical and material resources have to be set aside from the urgent tasks of lifesaving to service all these outside experts, who themselves need effective servicing with interpreters, transport, shelter and feeding. Very rarely does the reality justify exactly that kind of response.

Generally, the reality is that the nation or the community can provide much of that kind of disaster response itself. Outside aid should take on a totally different kind of response in that instance. All countries within subcontinents or regions can produce the skills and human resources necessary. For instance, the Indian subcontinent, with its long history of floods, tidal waves and natural disasters of one kind or another does not need doctors, nurses, hydrologists, agriculturalists, or sanitation engineers. When disaster strikes in that region they can be recruited locally and put to work from within each of the countries in the subcontinent. Central and South America can provide the same human and physical resources for its own regions. Increasingly, the Middle East and certain African countries can offer similar facilities. It is the logistics of mobilizing these skills which provides the challenge.

Clothing, blankets, foodstuffs and sometimes medical supplies, if not available, or in short supply, in the stricken country can usually be purchased from within the region, with the double effect of reducing the astronomically high cost of transport to the donor and of ensuring that the appropriate materials relevant to the ethnic requirements of the country are supplied. European frozen chicken or American corned beef delivered to vegetarian communities in Asia will not be welcomed, and although clothing may be vital to survival, stiletto shoes or discarded chic fashions are not really appropriate to disaster victims. People living in hot climates wearing warm winter clothing, sent by distant well-wishers in, say, the northern hemisphere as a token of human solidarity, will end up with serious skin problems. This is one area where some charitable organizations still have much to learn.

Regrettably, just as there are mythologies about human behaviour in disasters, so there are misconceptions about organizational behaviour. For example, there are widespread beliefs that communication problems stem mostly from technological failures, that there is a considerable breakdown in authority, or that coordination can be brought about by centralizing control. These too are mistaken notions, but unfortunately we do not have the time to consider these or other misconceptions about organizational behaviour in disasters.

As we enter the International Decade for Natural Disaster Reduction, surely our common humanity demands that we develop a more rigorous analysis of the growing problems that face us in the disaster field. We should be proactive and not reactive to the events that challenge us. Far too much of the world's resources have been poured into and down the bottomless drain of disaster relief, mainly because when it comes to the expected effects of disaster, myth still overwhelms reality.

Partly for this reason and partly because of mismanagement born of a lack of prior planning, international relief efforts are plagued with wasteful, useless and often counterproductive activities. That is not to say that disaster relief is wrong — far from it — but that it is the priorities that are wrong. The greatest reality is that we have consistently neglected one of the most important, cost-effective forms of disaster relief — education and training of people and officials and politicians. It is here that disaster relief really starts.

If some of the millions of dollars that have been given to disaster aid, almost as a knee-jerk reaction after the event, were given *before* the event to the vital area of developing social awareness through education and training, then there would be more resources to give to the other, really important areas in disaster relief such as recovery, rehabilitation and reconstruction. Those are the realities that need international attention, and to which the natural humanitarian desires of people should be directed.

The suffering and hardship endured by millions of people around the world caught up in tragedy, pain and hardship demand the best response we can make, for surely, as was wonderfully stated by the late President John F. Kennedy, 'The supreme reality of our time is our indivisibility as children of God and the common vulnerability of this planet.'

4
Analysis of severe fire disasters

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The Executive Board of the WHO has defined disasters as situations where there are unforeseen, serious, and immediate threats to public health. Every year about 150 disasters of different kinds occur in peacetime all over the world, each with more than 20 deaths at the scene and an immediate cost of more than US$ 8 million. Thirty per cent of these disasters are caused by earthquakes, environmental pollution, floods, etc.; 70% are classified as severe fires and explosions due to train crashes, air accidents, underground disasters, etc.

The most severe of the fires are the so-called LPG disasters (LPG = liquefied petroleum gas). LPG is transported and stored in condensed form. If it is exposed to heat, the liquid vaporizes. In a mixture with air, an explosion will eventually occur, a so-called BLEVE (boiling liquid expanding vapour explosion). The numbers of injured in BLEVE disasters have increased from 100 to 2200 and the number of deaths from 60 to 900 when comparing the two last 15-year periods.

The aim of the present investigation was to analyse the fate of the mass burn casualties from 14 severe fire disasters that have occurred within the past 20 years. An effort has been made to study the disasters with respect to *prevention, alarm systems* and *organization,* including resuscitation, triage, early treatment and transportation, as well as *training,* especially with regard to communication links.

MATERIALS AND METHODS

Fourteen disasters since 1973 that resulted in mass burn casualties were analysed (Tables 1 and 2). The study was based on personal observations on the spot in five of the disasters (numbers 5, 7, 9, 11 and 13). Data on the remaining disasters were revealed in a search of the medical literature and from discussions with disaster observers on the occasion of congresses.

Data from the disasters suggested that the outcome might be related to the presence of smoke. The material was therefore divided into two groups: (a)

Table 1. Description of 14 disasters causing mass burn casualties, 1973–1990

Incident	*Country*	*Date*	*Description*	*Main reference*
Indoor disasters				
1. Summerland (SUM)	Isle of Man (UK)	1973.08.02	Fire in leisure complex	Hart *et al.* (1975)
2. Dublin (DUB)	Ireland	1981.02.14	Fire in discotheque	Duignan (1984)
3. Cardowan (CAR)	UK	1984.01.27	Coal mine explosion	Allister and Hamilton (1983)
4. Manchester (MAN)	UK	1985.08.22	Fire in aircraft on runway	O'Hickey *et al.* (1987)
5. King's Cross (KIN)	UK	1988.06.24	Fire in underground station	Morgon (1990)
6. Piper Alpha (PIP)	UK	1988.07.06	Fire on oil platform	Rayner (1990)
7. Scandinavian Star (SCA)	Skagerak	1990.04.07	Fire in ferry	Brandsjo (1990)
Outdoor disasters				
8. Nakivubo (NAK)	Kampala, Uganda	1973.01.13	Petrol tanker crash in market place	Carswell and Rambo (1976)
9. Los Alfaques (LOS)	Spain	1978.07.11	LPG tanker crash at campsite	Arturson (1981)
10. Bangalore (BAN)	India	1981.02.07	Circus fire	Das (1983)
11. San Juanico (SAN)	Mexico	1984.11.19	Explosion in LPG plant	Arturson (1987)
12. Bradford (BRA)	UK	1985.05.11	Fire in football stadium	Sharpe *et al.* (1985)
13. Ramstein (RAM)	Germany	1988.08.28	Plane crash at airshow	Kossman and Trentz (1990)
14. Bashkir (BAS)	Soviet Union	1989.06.04	Natural gas explosion causing a train crash	Davies (1990)

Table 2. Fate of burn casualties following the 14 disasters summarized in Table 1

Incident	*Injured*	*Admitted to hospitals*	*Immediate death*	*Hospital death*	*Survivors*
Indoor disasters					
1. SUM	72	24	48	2	22
2. DUB	92	44	48	2	42
3. CAR	36	36	0	0	36
4. MAN	67	15	52	1	14
5. KIN	59	29	30	1	28
6. PIP	178	11	167	1	10
7. SCA	183	25[a]	158	0	25
Total	687	184	503	7	177
Outdoor disasters					
8. NAK	82	71	11	26	45
9. LOS	242	140	102	108	32
10. BAN	169	77	92	17	60
11. SAN	2300	2000[a]	300[a]	250	1750
12. BRA	136	83	53	5	78
13. RAM	378	344	34	37	307
14. BAS	1206	806[a]	400[a]	130[a]	676
Total	4513	3521	992	573	2948

[a]Figures uncertain

disasters which occurred indoors ($n = 7$); and (b) disasters which occurred outdoors ($n = 7$) (Tables 1 and 2).

RESULTS

The fates of burn casualties following the 14 disasters are summarized in Tables 1 and 2. The results of the comparison between indoor and outdoor incidents are shown in Table 2.

The number of people injured in the disasters was defined as the sum of the number admitted to hospitals with burns and the number killed outright. The total number of injured patients was more than six times higher after outdoor disasters. The total number of casualties admitted to hospitals was nearly 20 times higher following outdoor disasters than indoor disasters (Table 2). Fewer than 50 patients were admitted to hospitals from each of the indoor disasters, while the corresponding figures for outdoor disasters were from 70 up to 2000 (Figure 1).

The immediate death rate was very high in indoor compared to outdoor disasters (Figure 2). The hospital death rate showed the opposite pattern, namely very low figures following the indoor disasters (Figure 2).

The fate of all the burn casualties as a percentage of the number injured is illustrated in Figures 3 and 4. Only 25% survivors after indoor disasters should be compared with 65% survivors after outdoor disasters. Nearly all the mortality rate after indoor disasters (75%) was attributed to immediate death at the site. After outdoor disasters the cumulative mortality rate was around 35%, the

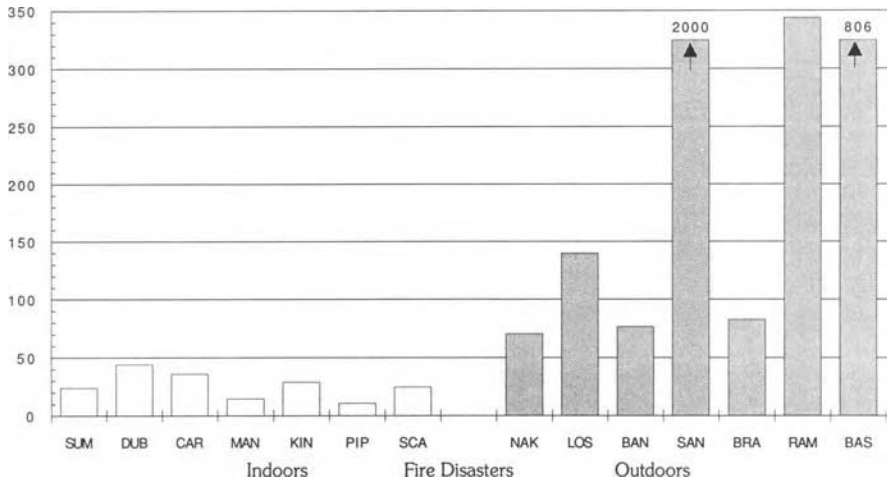

Figure 1. Numbers of casualties admitted to hospitals after seven indoor and seven outdoor disasters. Abbreviations are given in Table 1.

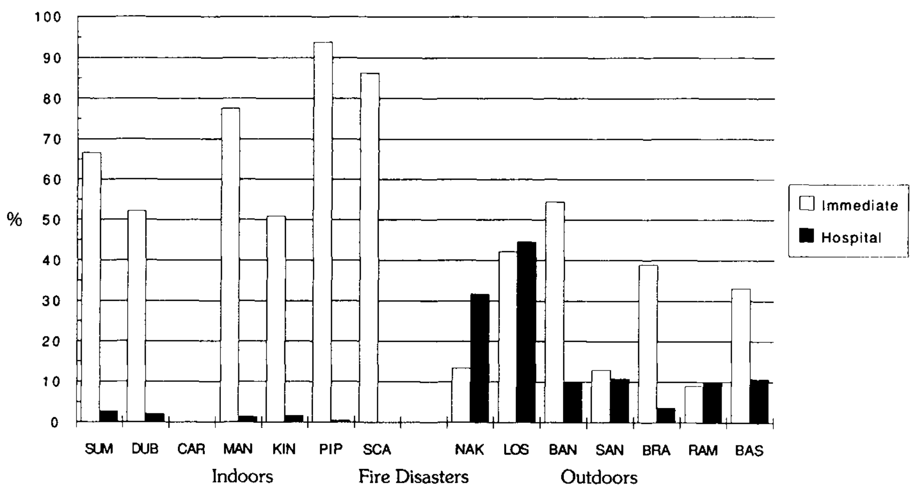

Figure 2. Immediate and hospital death rate in per cent of the number injured after seven indoor and seven outdoor disasters

immediate to late death ratio being about 2:1 (Figure 3). Similar results were obtained if the three disasters with zero and very high mortality rate, respectively, were excluded (numbers 3, 11 and 14) and the calculations were made with the remaining 11 disasters (Figure 4).

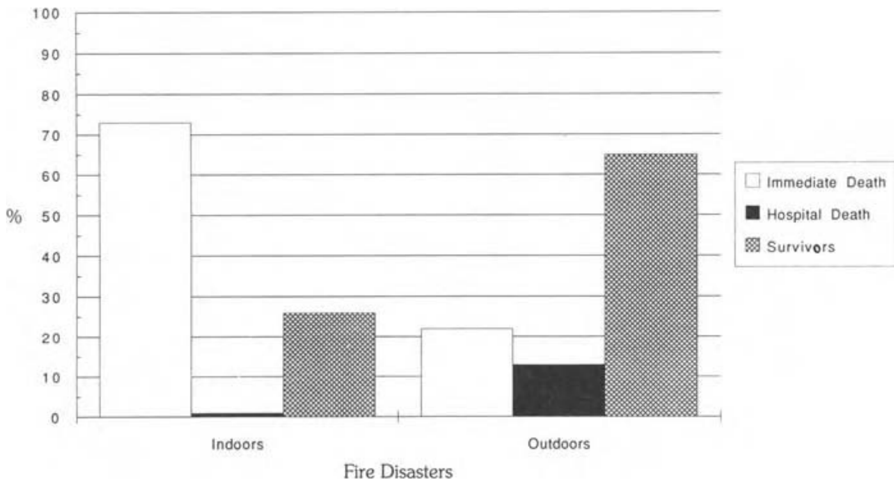

Figure 3. The fate of burn casualties in per cent of number injured. The mean values of seven indoor and seven outdoor disasters are compared to immediate and hospital death rates and survivors, respectively

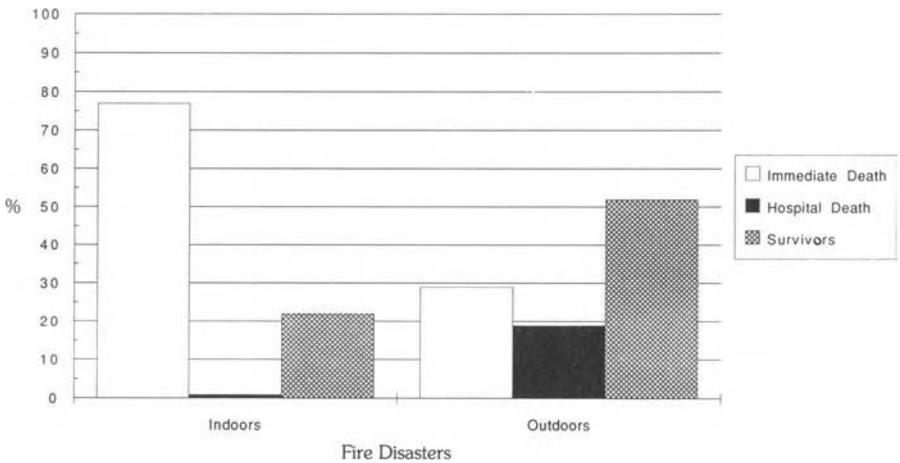

Figure 4. The fate of burn casualties calculated in the same way as in Figure 3 but with the data from disasters 3, 11 and 14 excluded

The majority of victims (60% of all admitted) sustained burns covering less than 30% of the body surface area (BSA). Following indoor disasters, very few patients were admitted with extensive burns (Figure 5). Following outdoor

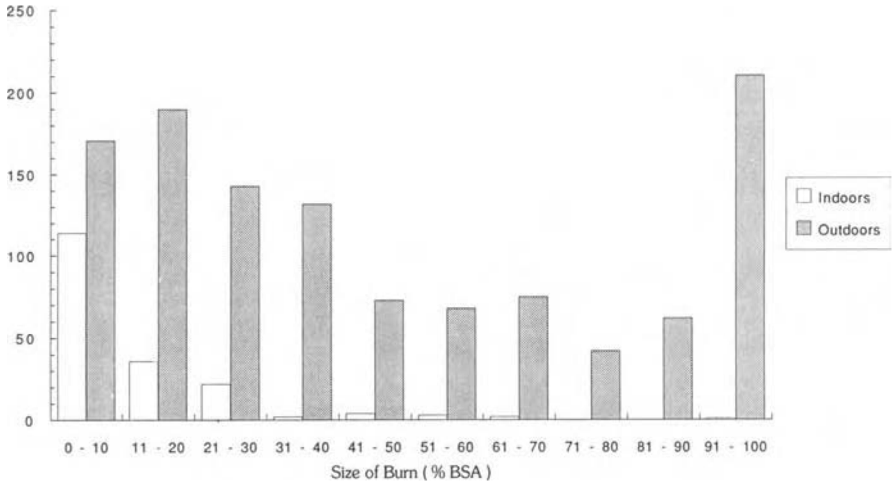

Figure 5. The frequency distribution of burn severity in patients admitted to hospitals following indoor and outdoor disasters

fires, however, a significant number of patients with very extensive burns (covering more than 70% BSA) were sent to hospitals. Following both kinds of disasters, few casualties (about 15% of those admitted) had burn wounds covering 30–70% BSA.

DISCUSSION

Very few descriptions in detail concerning severe fire disasters causing mass burn casualties are available in the medical literature. Similar main results as in the present study were reported by Mackie and Koning in 1990 in a smaller series. If the three disasters with zero and very high mortality rate, respectively, are excluded and the calculations made using the remaining disasters, the most important results are unaltered. This indicates that the data reviewed and the conclusions drawn from the present series might be representative of fire disasters as a whole.

Comparisons between indoor and outdoor disasters clearly show that, in terms of the numbers injured, the worst disasters occurred outdoors. Following outdoor incidents, considerable numbers of lethally injured victims reached hospital alive. The very poor prognosis of these patients is reflected in the high death rate. Following indoor incidents, smaller numbers of patients were admitted and most of them had sustained relatively small burns (less than 30% BSA).

A great number of victims are trapped in indoor fires and fail to escape. The very high immediate mortality rate at the site indicates that these victims presumably died from a combination of hypoxia and inhalation of poisonous

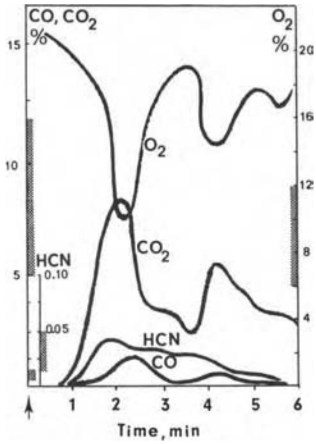

Figure 6. Concentrations of oxygen, carbon monoxide, carbon dioxide and hydrogen cyanide measured about 15 m from the seat of the fire at the structure exit. Observe that within a few minutes the gases have reached toxic levels (indicated on the vertical axes).

compounds. This is confirmed by studies made following the indoor fires in Dublin (no. 2) (Wolley *et al.*, 1984) and Scandinavian Star (no. 7) (Brandsjo, 1990). An investigation carried out by the United Kingdom Fire Research Station into why the Stardust night club fire disaster in Dublin killed 48 people showed the following: the observed high concentrations of CO, CO_2, HCN and HCl in the smoke emanating from the fired reconstruction of a section of the Stardust night club gave a plausible reason for the location of the observed fatalities, death being so rapid that they were unable to find an exit from the building (Figure 6). Following the Scandinavian Star disaster, autopsies of the 158 bodies showed that about 80% of the victims had more than 50% carboxyhaemoglobin in their blood. Some cases also had high blood levels of HCN. A synergistic effect of HCN and CO has been postulated.

The aim of the present investigation was to analyse the different items of importance in disaster medicine. In only one of the 14 disasters was there any disaster plan, namely in the San Juanico tragedy. Preventive measures were usually lacking in all disasters investigated and mistakes were frequently observed. Training of personnel was rare, especially concerning communication links. Long delays in transportation of patients were obvious in most disasters. Short summaries of some of the disasters illustrate these statements.

In the Los Alfaques disaster (no. 9) a road tanker carrying liquefied flammable gas ran into the Los Alfaques camping ground on the east coast of Spain and exploded. One hundred and two people died at the site of the explosion. Fifty-eight severely burned patients received adequate medical care initially and during the transportation to Barcelona. Eight-two patients with extensive burns were taken to Valencia and in most cases no medical steps of any importance were taken during the journey. During the four days immediately following the disaster, the survival rate declined to 45% for the patients taken to Valencia and to 93% for those taken to Barcelona. There were no statistical differences between the two groups with regard to the patients' ages or to the extent and depth of their burns. The medical treatment was similar in the two burn units. The only certain difference was that the patients taken to Barcelona received adequate resuscitation, unlike most of the patients brought to Valencia.

From the prevention point of view, the following observations were made: (1) the tanker driver used a wrong, forbidden route; (2) the tank was overloaded (45 m^3 instead of 40 m^3 of LPG); (3) the tank had erosions and was not pressure tested; (4) the driver was alone in the tanker, and it was hot and siesta time.

The San Juanico tragedy (no. 11) — the worst industrial accident in the history of Mexico City — was an LPG disaster of enormous dimensions. The total number of injured was about 7000 and 300 died immediately at the spot. Two thousand of the injured were hospitalized; 625 of them had severe burns; 250 died in hospitals, the total number of deaths thus being 550. About 60 000 people were evacuated. All together about 7000 people were involved in the rescue work during the first 48 hours. Among them were 200 fire fighters, 1000 physicians, 1300 paramedics, 1800 nurses, 2000 military personnel and 750 ambulance drivers and helicopter pilots.

Preventive measures were lacking (1) Dwellings were built too close to the plant; (2) there was no alarm system indicating pressure drop in the pipe lines; (3) there was no sprinkler system; (4) there had been no training of personnel; (5) it was early Monday morning.

The King's Cross Underground disaster in London resulted in 31 fatal cases mainly due to the fact that: (1) almost no action was taken by the station staff during the first 60 minutes after the detection of smoke; (2) the station had no smoke detectors; (3) there was no sprinkler system and (4) there were few escape ways.

In the Ramstein disaster, in which three aeroplanes came into collision above the Ramstein military air base, 378 people were injured and another 71 died. Triage on the scene was not possible. Most of the victims were transported by 'load and go' system to nearby hospitals. The response of the emergency services at the air base was criticized. Following the two last-mentioned disasters, rapid transports to supporting hospitals were instituted but further transport to designated hospitals was not carried out properly. The result was that some hospitals were overloaded with patients while other nearby hospitals did not get any patients at all.

If a long period of time elapsed before the rescue teams could start triage and resuscitation, most of the severely injured were dead and many of the initially moderately injured had developed serious complications. In all of the indoor disasters investigated, the high immediate death rate was mainly due to inhalation injuries and intoxication. No rescue people reached the severely injured in time.

Another example of a long delay in resuscitation is the Bashkir disaster in the former Soviet Union. A natural gas explosion caused a train crash and fire in a remote area about 20 km from a paved road. Ground ambulances arrived about 3 hours after the fire started. During the next 12 hours most of the severely injured patients were moved to the nearest hospitals (Ufa, 120 km, and Chelyabinsk, 250 km). Soviet medical and paramedical staff slowly realized the large numbers of patients involved, the extent of their injuries and the logistics of their care. The result was acceptance of medical help offered by

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burn-care teams from the USA, the UK, France, Israel and Cuba. This also illustrates the importance of having access to international medical support following disasters of such magnitude that local medical resources are exhausted.

SUMMARY

A survey of 14 severe fire disasters (seven indoor and seven outdoor disasters) which occurred in different parts of the world between 1973 and 1990 showed some results with implications for disaster planning. Incidents occurring outdoors resulted in larger numbers of hospital admissions with more severe injuries and a higher hospital mortality rate than incidents occurring indoors. The majority of burn casualties admitted to hospitals had either burns covering less than 30% BSA from both indoor and outdoor disasters, or very extensive burns covering more than 70% BSA from outdoor incidents. In disaster planning, special emphasis should thus be given to minor and very extensive burns. Moderate to severe burns which have to be taken care of in specialized burn centres seem to be fewer in numbers following severe fire disasters. Expert triage may therefore minimize the requirement for specialized burn beds. Furthermore, education concerning simple management of minor and moderate burns should be given on a broad basis to doctors and nurses outside burn-care facilities.

The outcome is related to the presence of smoke and poisonous compounds. In indoor fires, those who failed to escape presumably died rapidly from a combination of hypoxia and inhalation of toxic chemicals. All kinds of preventive measures must be taken to avoid these kinds of disasters.

Delays in rescue work must be avoided by prior planning, also taking into account international medical support. Advanced planning includes availability of well-trained leadership for disaster situations. It is also vital to plan for supporting hospitals in the first, inner circle and further designated hospitals in an outer circle. Expert triage is important. It is often necessary to work effectively in primitive conditions together with emergency helpers. Methods of treatment must be modified, and medication standardized and reduced to basics.

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Section II

Fire Disasters

5
Fire disasters in Osaka

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Fire disasters in urban areas are theoretically preventable and avoidable, most of them being man-made. Unfortunately, accidents of the same sort occur repeatedly, without any advantage being taken of the lessons learned before. Even though no two disasters are exactly alike, they often show common features and give much useful information for future preparedness and prevention of similar disasters.

In fires in buildings, many new synthetic polymers used for furniture, upholstery, carpets, bedding and curtains yield combustion products such as carbon monoxide, cyanide, phosgene, hydrogen chloride and nitrogen oxides. These noxious gases may be additively toxic and very quickly make the victims incapable of escaping from the site.

In this paper, four major fire disasters which took place in Osaka and its outskirts in the past twenty years are reviewed (Table 1) and their common and specific features are analysed. Here, the term 'major disaster' refers to a disaster involving ten or more deaths.

Important aspects of the prevention of fire disasters, and problems of rescue and treatment of the victims are also discussed.

Table 1. Major fire disasters in Osaka

Type of disaster	*Time of outbreak*	*Deaths*	*Injured*
Gas explosion at subway construction site	08/04/1970, 17:27	79	428
Sennichi Building fire	13/05/1972, 22:27	118	68
Passenger boat fire	18/05/1988, 01:20	11	35
Supermarket fire	18/03/1990, 12:30	15	6

Figure 1. Blown out concrete blocks and burning houses at the construction site gas explosion accident

THE FOUR DISASTERS

(1) A gas explosion occurred at a construction site on a subway in the middle of Osaka City at 17:27 on 8 April 1970. A construction worker with his power shovel broke a large gas pipe, and the leaking but stagnant gas in the underground cave was ignited by a spark from a car engine and exploded. The explosion was so big that many heavy concrete blocks covering the excavation in the construction site were blown into the air, hitting a number of pedestrians. People and cars were blasted and the neighbouring houses caught fire (Figure 1). This accident killed 79 people and injured 428. Major causes of death were head trauma, chest and abdominal trauma, burns, multiple trauma and suffocation.

As the disaster occurred in the middle of the city, all the victims were evacuated from the site within 30 minutes, some by themselves, some with the help of bystanders or policemen and some by professional workers.

Six hundred and fifty-seven personnel and many fire engines with 22 ambulances were mobilized by the Osaka City Fire Department. However, owing to the lack of communication between fire department, police department and hospitals, triage was not smoothly performed and the neighbouring hospitals were chaotic with crowds of patients. What was learned from this disaster was the importance of good communication among the authorities concerned and the necessity for the rescue personnel, policemen and physicians to have knowledge of triage.

Table 2. Method of evacuation and results in the Sennichi Building fire

Method	*Died*	*Survived*
Evacuated by themselves	0	3
Jumped	22	2
Extrication bag	0	8
Aerial ladder	0	50
Left unsaved	96	0
Total	118	63

(2) A major fire broke out on the third floor of the Sennichi Department Store Building in the late evening (22:27) of 13 May 1972. This building was a complex one and the department store itself was closed at the time, but several electricians were still working in the clothing shop on the third floor, and 181 people were drinking, dancing and singing at a cabaret on the seventh floor.

The fire extended so rapidly that the initial efforts to extinguish it made by the electricians and a security guard were not successful. Though all of the third floor and a part of the fourth floor burned down, the seventh floor was not burned at all. Of 181 people who were on the seventh floor at the time, 96 were killed; 22 others jumped from the windows to the ground and died. Only 2 out of 24 who jumped from the seventh floor survived. Even though escape sliding bags were provided in the cabaret, this safety equipment was not properly used and saved only eight persons. Three employees of the cabaret who were familiar with the complicated layout of the building succeeded in escaping from the smoke-filled cabaret hall through the stairway, which was not usually used. A fire engine aerial ladder reached two windows and 50 people were safely evacuated (Table 2, Figure 2).

All the dead bodies on the seventh floor were sooted, but thermal burns were not noted on any of the bodies. A middle-aged man was found dead sitting on a sofa, still holding a glass of whisky. On the stage, a singer was still grasping a microphone as if she had been singing until the moment she fell. While blood cyanide was not measured, autopsy findings coincided with those of carbon monoxide poisoning.

Triage of the victims was again not well performed. Several dead bodies of people who had jumped were taken by the ambulances to the nearest hospitals. Although an on-site emergency treatment post was established within 30 minutes of the accident, only a few of the slightly injured were taken there (Osaka City Fire Department).

(3) A fire disaster occurred in the cabin of a Soviet passenger boat which was anchored at the Central Pier of Osaka Port in the night (01:20) of 18 May 1988, when most of the 424 people on board (295 passengers and 129 crew), most of whom were Russians or Armenians, were asleep. The first alarm to the Osaka Fire Department was notified at 01:52, about 30 minutes after the

Figure 2. Fire-fighting activities at Sennichi Building fire

outbreak of fire, when the ship was already blazing furiously. A Japanese guard who was on night duty at a warehouse near the pier found a foreigner knocking violently on the window of his office and making a gesture to make a phone call. Wondering about his attitude, the guard opened the door but could not understand what the man was shouting. Going out of the office he found the ship burning and he immediately rang the first alarm.

As this fire took place on a foreign ship with no Japanese aboard, no precise report on initial fire-fighting efforts and evacuation was available. Immediately after the initial alarm, Osaka Fire Department mobilized 366 personnel, 13 ambulances, 36 fire engines, 2 fire boats and a helicopter. They saved 21 people who were seeking to escape. Eleven people were found dead and 35 were injured.

The causes of death were thought to be thermal burn and inhalation injury. Many of the wounded had mild to moderate burns, carbon monoxide poisoning and fractures of the feet and legs. It was reported that the firemen found it difficult to enter the cabins to search for survivors because of the complexity of the structure of the ship and the narrow maze-like corridors. In addition, they were not familiar with the structure of the ship and were not able to communicate with the crew because of the language barrier.

Emergency treatment and a triage post were organized about 30 minutes after the initiation of rescue and fire-fighting activities, but only six people were examined there. Ambulances transferred 29 injured to 13 different hospitals according to their severity and this time no dead body was transferred to the hospitals.

Figure 3. Body of a victim of the Nagasakiya supermarket fire, sooted but not thermally burned

(4) The last fire disaster occurred at midday (12:30) on 18 March 1990 in the fourth floor of the Nagasakiya supermarket in Amagasaki City. This building was of five storeys and only the fourth floor was burned. The cause of the fire was thought to be an outburst of flames in the bedding shop on this floor. The smoke spread so rapidly that 21 people on the fifth floor were left behind and 15 of them were killed. The building was not very far from the fire department and the alarm was given soon after the outbreak of the fire, and the fire brigade reached the site only a few minutes later. A rescue party found the trapped people on the fifth floor and saved four by way of the roof of the next building. When the rescue members approached them, some did not seem upset and were calling for help quite calmly. However, just before the rescue members reached these people, they collapsed and could not be saved.

The dead bodies were inspected and autopsy was performed on several bodies at the department of Forensic Medicine of Hyogo Medical College. Intracardiac blood specimens were taken for carbon monoxide and cyanide measurements. The body surface of the victims was dirty with soot but was not burned at all (Amagasaki City Fire Department, 1990) (Figure 3).

Autopsy of trachea and lung showed the pinky red colour of the tissue and soot in the trachea (Figure 4). Out of 14 blood specimens, 8 showed very high carboxyhaemoglobin level (over 50%); in two cases it was only 28.4 and 33.8%. In ten the cyanide level was higher than 3.0 μg/ml, which is believed to be the lethal concentration (Table 3).

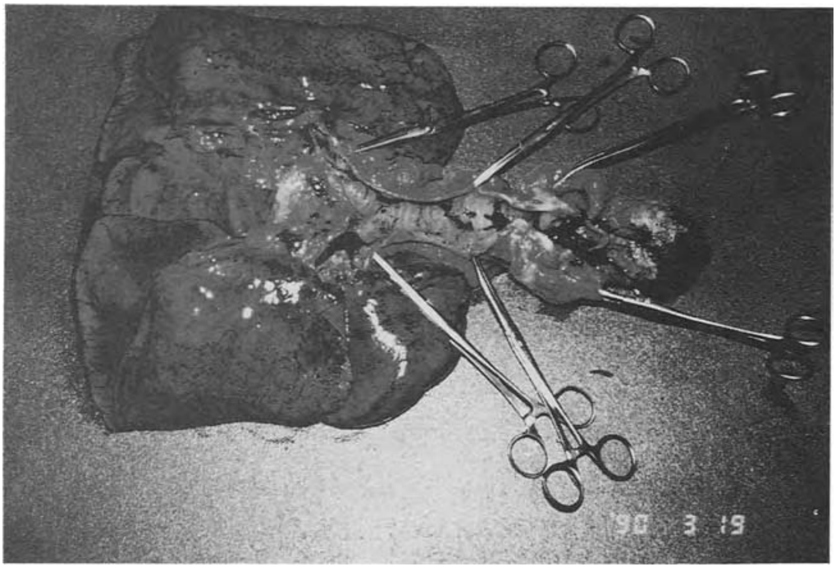

Figure 4. Autopsy specimen of a victim of the Nagasakiya supermarket fire. Pinky red colour of the tissue and soot in the trachea and the bronchus was remarkable

Table 3. Blood COHb and CN of victims in the Nagasakiya supermarket fire

Victim (age, sex)	*COHb (%)*	*CN (μg/ml)*
M.W. 55, M	42.6	2.8
C.Y. 19, F	69.2	3.2
C.I. 20, F	65.5	5.9
E.F. 19, F	67.3	4.9
S.K. 14, M	55.6	3.7
S.S. 52, F	56.6	3.0
Y.T. 7, M	28.4	1.9
F.H. 65, F	54.7	2.1
K.K. 10, M	64.5	3.7
K.Y. 16, F	60.0	3.2
Y.F. 39, F	48.3	3.1
M.K. 30, F	44.7	3.5
H.N. 54, F	33.8	2.7
K.K. 53, M	47.8	5.0

DISCUSSION

There were several common features and problems in these four major fire disasters. In the first and second disasters, triage at the site was not performed, which caused problems in the neighbouring medical facilities. This was improved in the third case. The second and the third disasters reinforced the importance of the fire brigade having accurate information of the construction

Table 4. Comparison of the building fire disasters

	Sennichi Building	*Nagasakiya supermarket*
Outbreak	3rd floor	4th floor
Victims found	7th floor	5th floor
Floor burnt	Clothing shop	Bedclothes shop
Cause of death	CO poisoning Multiple trauma	CO poisoning CN poisoning
Fire shutter	Manual, left open	Automatic, obstacles
Safety equipment	Not properly used	Not used
Sprinkler	Not fitted	Not fitted

of buildings and also of ships entering port. Today, Osaka City Fire Department has an excellent computer system which almost instantaneously provides the layout of every building in Osaka. Evacuation of the casualties from these three disasters was unexpectedly rapid and the on-site emergency treatment posts set up within 30 minutes were almost unnecessary. They may be more useful in the event of much larger disasters or in rural areas where medical facilities are not easy to obtain, but in disasters in urban areas the importance of emergency treatment posts is still controversial.

The fire defence law in Japan must be one of the strictest in the world. Large buildings where numbers of people assemble are obliged to be provided with safety equipment and facilities such as a fire alarm system, a sprinkler system, fire shutters, hydrants, fire extinguishers, escape sliding bags, ladders, etc. Nevertheless, these facilities and equipment could not prevent the tragedies. At the Sennichi Department Building, the switches of the fire shutters installed at the escalators were off and the smoke extended through this duct and attacked the people on the seventh floor. After this accident, the fire defence law was amended and the standards for safety facilities were made stricter. However, the Nagasakiya supermarket fire could not be avoided. The floor area of the shop was designed to be a little smaller than the very limit of the legal obligation for a company to equip a sprinkler system. In addition, in front of the fire shutters there was a large pile of merchandise that prevented the safety system from working properly.

When the two building fires are compared, several common features are noted. The original fire broke out on the lower floor in clothing and bedding shops which had a lot of synthetic fabrics and polymers, killing many people on the upper floor in a very short time. Fire defence equipment did not work well because of careless human errors, which must be recognized. The building design was used as a means to slip through the meshes of the law, and the safety escape equipment was not properly used (Table 4). That some of the victims died almost instantaneously was conspicuous. It is apparent that carbon monoxide poisoning was the major cause of death. However, cyanide may also be considered one of the important causes of death of these victims, though it was not measured in the victims of the Sennichi Building fire. The high blood concentrations of cyanide in the victims of the Nagasakiya fire is self-explanatory. The use of amyl nitrite pearls in unconscious inhalation injury casualties should be considered seriously in the prehospital setting (Jones *et al.*, 1987; Lundquist *et al.*, 1989).

CONCLUSION

Four major fire disasters in the past 20 years in Osaka have been reviewed. Several common features were found that were and will be useful to prevent repetition of the tragedy. The role of cyanide as the cause of morbidity and mortality in building fire disasters should be considered more seriously.

ACKNOWLEDGEMENTS

The authors deeply appreciate the generosity of Mr R. Tsubaki and Mr M. Nishiyama of Osaka City Fire Department and Mr Y. Dohmoto of Amagasaki City Fire Department in showing us important documents on the above disasters.

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6
Lessons from the Dublin 1981 fire catastrophe

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In February 1981 a fire occurred in a Dublin ballroom known as the 'Stardust'. It caused the death of 48 young people, with serious injury to 128 and minor injury to 86 others. The total attendance was more than 800. The area of the dance hall was 1853 m^2.

An immediate public outcry was instrumental in pressuring both Houses of the Oireachtas (government) to set up a judicial tribunal of inquiry which sifted through verbal evidence from survivors, the management of the Stardust, and officials of the Corporation of Dublin in both the Planning and Fire Brigade Departments, as well as experts from various institutions concerned with fire prevention and rescue procedures. This paper summarizes the report which, after a study of how the fire started and why it spread so rapidly, was submitted in June 1982 to the Minister of the Environment apportioning blame and making recommendations for the future.

The building was constructed in 1948 as a factory (Figure 1); it was changed to a public amenity centre in 1978, and further changes were made in 1980 to allow for dances. Planning permission was obtained at all stages but was subject to requirements for fire prevention to be specified by the Chief Fire Officer (CFO).

While many of the requirements of the CFO were carried out, some were not and at no stage from the time that the Stardust opened to the time of the fire was there any inspection to ensure that the necessary adjustments were carried out. This particularly related to the height of a ceiling in the west alcove where the seats were tiered and the fire started, and to the various exit doors and the failure to have water-hose reels on the premises as well as the unauthorized use of floor tiles on the walls. The west alcove was separated from the main dance hall by blinds, the presence of which had no effect on the fire other than keeping it from being observed in the early stages. The seats were made of PVC-covered polyurethane with a tubular steel and chipboard framework. The main entrance/exit (Figure 2) did not meet specifications and

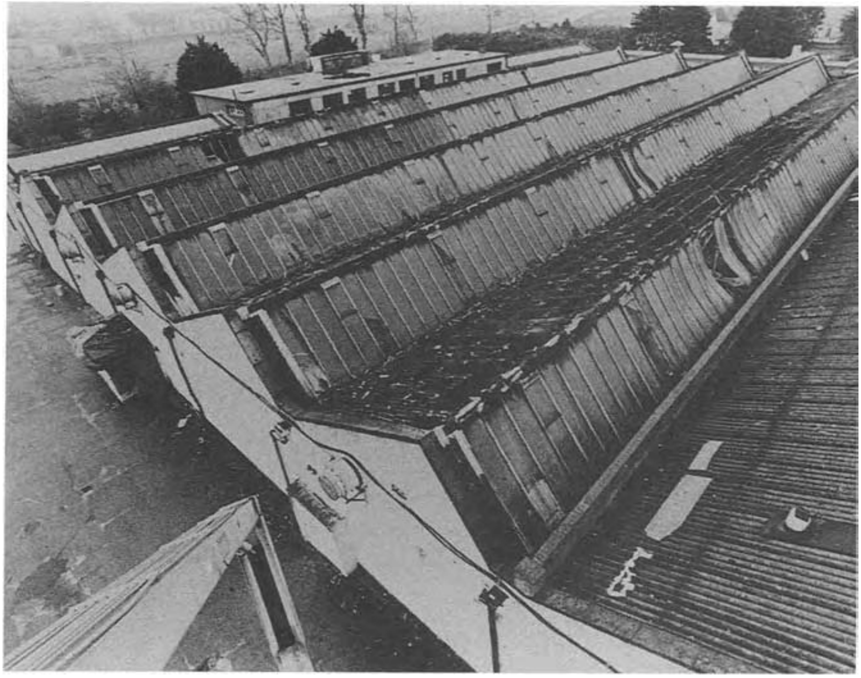

Figure 1. Photograph of the original factory built in 1948

there was no way that the two outer metal shutters could be kept in the open position.

The fire was started deliberately (though the culprit has not been caught) in a seat in the back row of the alcove already referred to. Figure 3 shows a 'mock-up' of the west alcove showing where the fire started from a naked flame. It spread rapidly up the walls because of the poor fire resistance of the wall linings and after a period of about three minutes was so out of control that portable fire extinguishers were useless. The blinds were lifted to show the full extent of the fire which within 7–8 minutes had spread and engulfed the whole dance hall, venting through the roof.

It was during this stage that patrons made their escape through the exits, some of the doors of which were chained and padlocked and took some time to be opened. Others were obstructed, and in particular the main entrance/exit was obstructed by the steel shutters at the sides and by a table in the middle used by security personnel (Figure 4). Off the main dance hall were some toilets and small rooms, the windows of which were welded closed. Some patrons were caught in these and were not extricated until 20 minutes after the fire brigade arrived.

The main cause of death was toxic fumes (Table 1).

- Carbon monoxide is the main toxic fume in fires of this nature. It was found in lethal quantities in the blood of most of those who died.

Table 1. Levels of carbon monoxide, cyanide and alcohol in 45 victims of the Stardust disaster

Fire victim no.	*Carbon monoxide (% saturation of blood)*	*Cyanide (μg u/u)*	*Alcohol (mg/100 ml)*	
			Blood	*Urine*
1	36	27.7	6.3	
2	25	11.2	25.8	
3	50	36.4	125.1	
4	31	13.5	2.1	
5	26	17.0	Nil	
6	14	blood unsuitable	90.5	
7	39	13.2	36.3	
8	25	53.9	Nil	
9	40	7.6	145.1	
10	30	17.4	Nil	
11	26	16.3	Nil	6.5
12	20	19.1	207.8	287.4
13	42	123.3	211.0	
14	39	58.6	14.0	
15	27	7.1	212.5	249.9
16	45	19.5	79.2	103.6
17	36	14.6	92.7	134.2
18	34	72.1	11.7	14.7
19	10	4.5	126.4	
20	27	39.7	72.9	109.1
21	33	10.5	Nil	Nil
22	36	66.7	115.0	133.5
23	59	30	155.5	140.9
24	20	8.4	152.0	244.3
25	20	12.4	148.9	175.6
26	41	12.7	129.7	
27	56	11.4	90.8	126.5
28	30	33.1	1.9	4.9
29	39	11.7	4.4	
30	42	26.4	102.5	143.6
31	15	12.1	103.8	
32	55	100.5	175.6	
33	48	28.8	124.7	
34	29	49.2	63.7	
35	50	122.7	158.8	
37	18	9.3	92.8	111.0
38	50	153.0	23.9	
39	3	6.5	101	187.2
40	30	40.7	Nil	13.3
41	24	59.2	123.4	164.8
42	56	37.4	195.3	294.2
43	61	61.8	178.7	233.3
44	42	22.7	Nil	
45	46	5.0	74.4	
47	0	3.9		

- Hydrogen chloride, a known toxic product from the burning of PVC, was not a significant cause in the deaths.
- Hydrogen cyanide, a product of the burning of polyurethane polymer foam, was an appreciable contributor to the deaths of some, though

Figure 2. The entrance/main exit showing shutters closed on each side, which opened upwards and without any mechanism to hold them open

potentially lethal levels were found in only four of the dead. Alcohol had been consumed but was not deemed to have been the direct cause of the death of any of the victims.

The tribunal laid the responsibility for the fire, and its consequences on the following.

1. *The owners and their advisers.* They failed to keep the requirements for fire precautions in the design, execution and supervision of the conversion. They were also negligent in failing to ensure that staff were knowledgeable in fire drill. In spite of this, no criminal proceedings were taken against them.
2. *Local government.* The Planning Department failed to make adequate

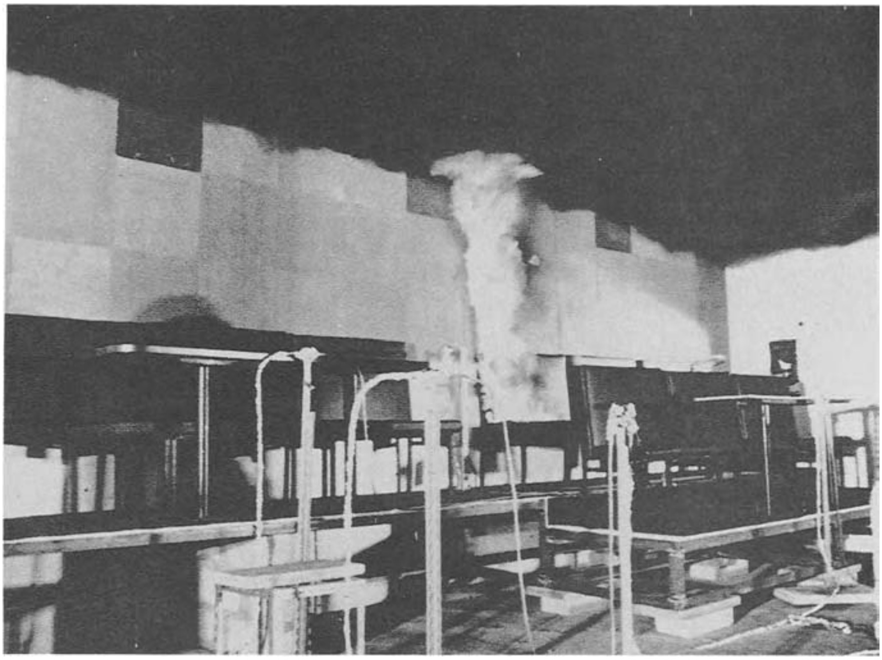

Figure 3. A 'mock-up' of the west alcove showing where the fire was started, by a naked flame

assessment of the drawings and specifications of the conversion and granted planning approval subject to the applicant ascertaining and complying with the requirements of the CFO. The Fire Department did not ensure that their requirements were met and no inspection of the completed conversion was made by any member of the fire brigade or fire prevention department from the day it opened until the fire. Much of the blame attributed to the fire services was highlighted as being due to inadequate manning, and over the past ten years great effort has gone into improving the staffing of the fire department dealing with fire precautions and into the equipment and communications available to fire officers.

3. *The Department of the Environment.* (a) The department failed to make statutory building regulations, which they were empowered to do by existing laws. A law making such regulations was eventually passed in 1990. (b) It failed to ensure that the fire services in local authorities were adequately staffed, properly equipped and trained. (Increased financing to the department, with training courses and improved equipment, has been ongoing since 1981.)

Compensation to the victims and their relatives was paid out of a Criminal Compensation Fund.

A personal view is that some lessons have been learnt but it is still possible

Figure 4. The main exits from the inside after the fire

for a Dail Deputy to state in 1990 that a 'Stardust' type of fire could again occur in Dublin with loss of life. On the information that I have obtained I think that there would still appear to be a lack of liaison between planning departments and the fire services.

No doubt the chief responsibility inevitably lies with owners and management, and if corners are cut in the interest of avarice and monetary return, then fires will inevitably occur and there will be unnecessary loss of life.

7
Forest fires and the danger to fire-fighters

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In the last decade the problem of forest fires in Italy has been characterized by alternation of a great interest in the subject followed by a year of reduced interest. In 1988 there were 13 500 fires affecting an area of 186 000 hectares, 60 000 of which were woodland. The average area of each fire was 14 ha, i.e. an extent requiring considerable efforts in order to extinguish the fire.

In 1988 the extent of the damage was estimated to be 68 billion lire. Some fires were particularly serious. Between the end of December 1980 and mid-January 1981 a fire covered 900 ha in the communes of Givoletto, Valdellatorre and Varisella (Piedmont), and in the same period there was another serious fire that affected 1700 hectares in the Orco Valley (Piedmont). In August 1981 a serious fire broke out on Mt Argentario (Tuscany) affecting an area of 1700 ha of which 600 ha consisted of woodland of particular landscape and environmental value. In August 1988, on Mt Gargano (Puglia), flames destroyed 350 ha of pine-forest and 400 holiday-makers had to be evacuated.

Not all these events, however, had the same effect on public opinion. For example, much more was said about the Argentario fire than the Piedmont fires, even if these affected a much greater area of woodland. This shows that public opinion is not always struck by the real gravity of such fires. This depends on environmental damage and on the danger the fires constitute for personal safety.

In the first months of 1990 in Piedmont conditions were particularly favourable for forest fires, which affected an overall area of 40 000 ha, with as many as 120 fires on the same day. In August 1990 there were some very serious fires in Tuscany, especially in the vicinity of Leghorn. These fires led to highly polemical arguments. The fire-fighting operations were criticized, as were also the laws assigning responsibility; the hunt was started up as usual to identify the fire-raisers and rewards were offered for their capture. The possibility was discussed of transforming all areas destroyed by fires into parks. Other countries besides Italy have to face the same problem.

In 1985 Spain had 12 284 fires affecting 486 000 ha. In France in 1986, 50 000 hectares were burned, with 12 victims and 200 houses destroyed. In 1988 in Greece 80 000 ha were swept by fire. These figures are high, but there are in fact even worse situations. In Australia in 1983, 600 000 ha were swept by fire, with 71 dead and 2000 injured. In 1988 in Yellowstone Park (USA) 400 000 ha were burned, although even these seem little compared to the single fire which in 1987 in China swept through 1 300 000 ha, leaving 50 000 people homeless.

Fires have widely differing patterns from year to year. In 1981 Italy had fires in an area of nearly 230 000 ha, and in 1985 only just over 75 000 ha. Algeria in 1985 had only 4600 ha burned by fire, and 221 000 ha in 1983. Greece, in the same years, had figures of 105 000 and 19 600 ha, respectively. This variability depends on meteorological conditions. These are the main predisposing cause, which other almost entirely human-related factors then trigger off. This does not, however, mean that fires are always or often criminally caused. Criminal intent does exist but should not be regarded as the main cause, as is often suggested by the mass media and sometimes even by specialists in the field.

THE PLANNING OF FOREST FIRE PREVENTION

The erroneous belief that forest fires are mainly of criminal origin is inevitably reflected in fire-prevention planning, which is therefore based on a false premise: if it is thought that most forest fires are of criminal origin, insufficient attention will be paid to culpable accidents which are in fact the commonest cause of forest fires. As a result, the general population is not given adequate information as to how to avoid dangerous behaviour. The belief that criminal intent is the prevalent cause leads to the conviction that any fire is necessarily unpredictable and that for this reason the only way to get it under control is to use powerful fire-fighting means, which are considered to be the only effective method. It is universally considered correct to use heavy tank trucks, which are of undoubted value in all places that can be reached by ordinary roads but which are quite inadequate for use in most forest areas where road access is limited.

This belief explains why roads are constructed for heavy vehicles while the ordinary forest road network is neglected. As it is inconceivable that sufficient roads should be built to provide access to all parts of a forest affected by fire, there is no other alternative but the aeroplane, which is the only means of transport able to operate in any location. This, however, leads to the necessity of the availability of a very large number of aircraft in order to be able to cope with events that are often both numerous and simultaneous. These comments should not be construed as a denial of the utility of heavy vehicles, whether trucks or aeroplanes.

We believe that the only way to protect our forests effectively from fire consists in thorough planning which provides also for the correct but not exclusive use of these means of transport. This planning must strike a balance between preventive procedures, extinguishing of the fire, and the reconstitution of the damaged area. On this basis a definition can be made of the decisive function of the preventive measures, and the consequent operational possibilities of the fire-fighting squads. These will have to work on the basis of a predicted fire typology, making use of equipment and facilities present on the spot and planned in every detail. This approach makes it possible to intervene with means that are appropriate for the individual incidents that occur, i.e. to distinguish between the various degrees of difficulty and to make use of the most suitable means.

The vast range of possibilities affords a variety of extinguishing techniques, but whichever is chosen the fire-fighter remains an essential figure. Particular attention must be paid to his protection and to the prevention of accidents. A correct fire-prevention plan expresses a priority of operations on the basis of the value of the property to be defended, but it must place personal safety at the top of the scale of priorities. In practice, however, this consideration is often neglected simply because of the erroneous belief that it is possible to intervene only with heavy vehicles which are thought to reduce the fire-fighters' risk of exposure to the flames. When a region presents a high fire risk, there are dozens of cases of small outbreaks, some of which may develop into full-scale forest fires. In such a situation all persons involved in fire-fighting operations are exposed to severe risk. There are numerous cases of more or less serious burns, many occurring among the general population in the areas swept by fire. Summer fires frequently involve tourist resort areas, while winter fires more often concern agricultural and sylvicultural areas. In either case it frequently happens that persons without the most basic protective equipment are the first to intervene or to be involved in some way in the fire. When small fires turn into full-scale forest fires, the official organization moves into action. This is made up of command stations of the State Forestry Corps, which by law is responsible for fire extinguishing, and of the Coordinative Body of Volunteer Fire-fighting Squads, which on the basis of the same law have been formed throughout Italy. This is the organizational structure which takes the first and often decisive action. When the fire is of such dimensions that other squads have to be called in, the State Forestry Corps will require the aid of other fire-fighting resources. These are heavy land vehicles, light aircraft made available by the regional authorities, heavy aircraft laid on by the Civil Defence Unified Aircraft Operational Centre, and if necessary, the armed forces. If a fire spreads from the forest and becomes a threat to civil or industrial property, it falls under the competence of the National Fire Corps.

This clarification of individual competences is important if we are to avoid mistakes of general approach and erroneous conceptions on the basis of which the wrong decisions may be taken.

It is also to be borne in mind that the techniques and the equipment to be used in forest fires are quite different from those suitable in civil fires. In the latter case heavy vehicles can usually reach the scene of the fire and have access to unlimited water supplies. In the forest it is very difficult for heavy vehicles to reach the fire, and more often than not the fire-front has to be reached on foot and fought using shoulder-carried equipment.

Another aspect distinguishing forest fires from civil fires is the speed with which the fire-front advances. This feature, which to a large extent determines the difficulty of extinguishing the fire, obliges fire-fighting operations to concentrate on the actual fire-front with a frontal attack, since the alternative of waiting for it to arrive at pre-established points would inevitably mean the sacrifice of part of the forest. However, it is also true that in some cases the high intensity of the fire makes it necessary, even if equipment is available, to wait for the fire to reach points where the fire can be more safely and more efficiently extinguished. In some lucky cases these points can be reached by roads allowing access for heavy vehicles, and in such cases these vehicles can be used with greatest success. Usually, however, the place most suitable for taking up a position is well inside the forest area, where the road density is not likely to exceed 30 metres/ha.

All this means that fires can be properly fought only if it is possible to penetrate into the heart of the forest. The use of heavy vehicles at the edge of the forest should be seen as a support for the work being done in the forest and as a precautionary measure in case this work is insufficient and the fire spreads outwards. It also follows that aircraft should be seen as an indispensable support when fire-fighting operations in the forest are particularly difficult. As aeroplanes are called in only in the case of very extensive fires, their use must be coordinated by experts on the spot, in the neighbourhood of the fire, as the damage varies considerably according to the behaviour of the fire-front and also in particular to the nature of the forest. The species of the trees, their state of care and general condition, the age of the undergrowth, and the general structure and other characteristics of the forest are the elements on the basis of which it may be decided whether to concentrate efforts in a particular area or alternatively to refrain from action in order to have more resources for the protection of another, more valuable or more exposed, zone.

BEHAVIOUR OF THE FIRE AND THE OPERATING ENVIRONMENT

Forest fires are of different typology depending on weather conditions, the quantity and density of the burnable biomass, and its horizontal and vertical distribution. The quantity of combustible material available and the vegetable species particularly influence heat emanation, while the density and the horizontal and vertical distribution of the combustible material more specifically affect the spreading of the fire-front.

It is extremely difficult to keep all these considerations in mind, but in the planning phase it is necessary to hypothesize the characteristics of possible fires. The prediction is based above all on a floristic analysis of the species that are most liable to spread the fire.

In order to determine the probable behaviour of a forest fire, special attention must also be paid to the horizontal continuity of the combustible material, i.e. the distance between the foliage of the individual trees that create the forest coverage. It is also necessary to know the vertical continuity of the combustible material, which is determined by the distance between the lowest levels of the tree foliage and the shrub level of the ground cover. It will thus be possible to estimate whether the fire is likely to spread at ground level, only burning the ground cover, or will succeed in reaching the foliage of the trees.

The typology of forest fires is extremely variable in relation to the characteristics of the territory, and through planning it is possible in part to predict and in part to manage the extent and the consequent danger of fires.

In fire-fighting, the direct attack is the most immediate and decisive technique, although this is possible only when heat emanation is limited. If firebreaks have been created to allow direct attacks on the fire-front, it is possible to predict a fire's behaviour: firebreaks enable the fire-fighting squads to know what kind of difficulties they are going to have to face. These difficulties are related particularly to the quantity of heat emanated and the temperature reached where the fire-fighters are at work. The temperature increases only in the vicinity of the fire-front and maximum temperatures are always found in the highest part of the vegetation. Measurements (Trabaud, 1979) performed using thermocouples in brushwood fires indicated that the temperature reached varies from 800°C to over 1200°C depending on whether the fire occurs in spring or in autumn. In other vegetational conditions (Countryman, 1969) temperatures were recorded in the 1040–1370°C range.

The thermal field can vary considerably but extremely high levels usually occur only where the combustible vegetable mass has a high surface area/volume ratio. When surface area is high compared to volume, there is an increased possibility of gas exchange with the atmosphere. Where such conditions exist, fires develop in which extinguishing operations become difficult not only because of the heat emanated but also because of the speed which fire spreads. In grassy prairie environments the fire-front can advance as fast as 3 m/s. Elevated heat production may also occur in Mediterranean and Alpine environments, usually in areas where the density of the vegetation makes fire-fighting operations extremely difficult.

Temperature also varies in relation to the distance from the ground. Temperatures were measured (Pitot and Masson, 1951) of 90–140°C at ground level, 285–560°C at a height of 5 cm, and 140–375°C at 140 cm. Fire-fighters can face only the lowest of these levels of heat. Flame-fronts producing temperatures above 500°C at the highest part of the vegetation prevent any direct attack, i.e. fighting the fire in the vicinity of the flames. Thus, whenever such high temperatures occur, indirect extinguishing techniques must be used until the fire reaches an area that is more suitable for a direct attack. Protective clothing must therefore guarantee safety only with regards to heat conditions that the individual can reasonably tolerate.

In fact, any clothing capable of offering the fire-fighter adequate protection and enabling him to work in comfort even in conditions of maximum thermal generation would have to be able to resist extremely high temperatures. The size and the weight of such clothing would inevitably make it unusable. Furthermore, even if such clothing could be manufactured, it would not be rational to use it in conditions where the presence of fire-fighters would in any case be risky and of dubious utility. When the heat emanation of the fire-front is extremely high — and in this case the fire-front inevitably advances at great speed — the work of the fire-fighters can have few positive advantages because of the risk and the fatigue to which they are exposed. In such cases the fire must be extinguished indirectly.

In a direct attack it must be borne in mind that temperatures up to 500°C have to be faced. In these cases the highest heat levels develop above the vegetation and are of very short duration. It is known that the heat flow disperses vertically and that only a small part of it contributes to the spreading of the flame-front. This part of the heat is directed laterally by radiation. The fire-fighter is always in the zone where he may receive this fraction of radiant heat. On the other hand, if the flame, which is simply a mass of burning gas, is blown by the wind towards the fire-fighter, there is a much higher transfer of thermal energy than that normally transferred by radiant heat, although it is very short-lasting. The short duration of the phenomenon prevents any rise of the temperature above that which might be caused by normal radiation, which though transferring less heat is of much longer duration and is tolerated by fire-fighters engaged in normal operations.

FIRE-FIGHTING AND PERSONAL SAFETY

It is the intensity of the fire that usually determines the choice of the method of extinguishing it. The different operating techniques can be carried out at ground level or from the air, and very often simultaneously. If the orography is irregular and the fire is advancing rapidly, the indirect approach is recommended. When possible, however, an attack is mounted directly on the fire at close quarters.

The methods of action are numerous and they vary according to circumstances. For the same reason, various types of equipment are commonly used. Even the direct attack on the fire varies in place and in time. For example, in a ground fire that develops along the floor of a broad-leaf forest in autumn, before the leaves have been compacted by atmospheric precipitation, it is advisable to avoid the use of equipment intended to suffocate combustion. This kind of equipment, which is not meant to be used on light-weight combustible material, would only stir up burning foliage and vegetable matter. In such cases the most suitable apparatus is a motor-fan, usually shoulder-held. This sends out a violent blast of air which easily removes the vegetable matter along a strip, which will either slow the fire down or stop it completely if it is very weak. If the fire is of low intensity, a violent jet of water can be used to extinguish the flames.

When the fire is spreading through compact materials or ground cover, the most appropriate piece of equipment is the fire-beater, an instrument consisting of strips of material attached to a long handle.

When the vegetation is bushy the fire-rake can be used. This is a stout form of rake which is robust enough to smash down the bushes, enabling other operators to complete clearance work with other equipment. Shoulder-held manual or motor pumps may also be used to direct powerful jets of water on to more violent fires in order to reduce the level of the flames and to enable operators with other equipment to work more easily.

All the equipment so far described is extremely simple but quite indispensable. This manual and easily transported apparatus is predominantly used in areas where there are few forest paths and the fire has to be reached on foot. If access is also possible for motor vehicles, various types of equipment can be used to spray liquids that are usually highly effective but difficult to transport across rough terrain.

All fire-fighting operations involve a risk factor and fire-fighers must therefore be as well protected as possible. The most serious risk is burns. To prevent these, specially made equipment must be used: fire-suits, helmets, goggles, anti-smoke mask, gloves, boots. This equipment is indispensable not only to ensure operational functionality but also to limit the risk of accidents.

In 1988 in Italy there were 6 fatal accidents and 80 persons injured and in 1989 there were 32 fatalities and over 80 injured. However, the general picture offered by the statistics is always incomplete because they do not include a large number of accidents which may cause severe burns even though the fire is of very limited extent. This happens, for example, in the case of fires lit for sylvicultural or agricultural purposes by persons — often elderly — who are then unable to control the spreading of the fire, which immediately becomes extremely dangerous, without, however, taking on the characteristics of a full-scale forest fire and therefore not being included in official statistics.

In Italy, a special law (No. 47) was passed in 1975 that sanctioned the creation of volunteer forest fire squads, which drew attention to the importance of the necessity of personal protection, an aspect that previously had been entirely neglected. Initially there was a lack of precise regulations regarding the technical specifications of protective clothing and above all a lack of experience in the field of forest fires and their prevention. At first green and even camouflaged fire-suits were worn. However, these were soon discarded because it was found that they hampered location of the operators, especially as helicopters began to be used more frequently and pilots found it difficult to locate the fire-fighting squads. Accordingly, colours were adopted that can be seen in vegetation even from considerable distances.

Before experience taught better, protective clothing was made of easily flammable material. It was therefore necessary to improve its efficiency and its resistance to fire. This was necessary because cases occurred of persons being burned not only by the fire itself but also by combustion of the protective clothing they were wearing. Wide use was made of fireproof materials, which were not, however, sufficient in themselves to guarantee personal safety because they did not prevent heat transmission even if the material itself did not burn.

In recent years protective clothing has been developed that slows down the transmission of heat for sufficiently long periods. This was made possible without any great difficulty by the use of large amounts of insulating material: this did not, however, guarantee lightness and air permeability.

Failure to ensure these characteristics makes such protective clothing unsuitable for use in fire-fighting, as the physical exertion required causes abundant sweating. If the clothing worn, especially near the fire-front where the temperature is very high, prevents the evaporation of large quantities of sweat, there will be a rise in body temperature that will reduce physical efficiency, with a consequent increase in the risk of accidents. Also, sweating may induce the operator to neglect the norms governing the use of protective clothing so that he wears it unbuttoned or incomplete. Another important feature to be respected is that the operator must be able to perceive any slow and gradual increase in heat.

In this way the fire-fighter realizes when the protective function of his clothing is about to cease after a long period of exposure to high temperature. It is thus possible to avoid the extremely dangerous situation in which the fire-fighter feels the heat only when his protective clothing begins to transfer it almost entirely because the insulating capacity is no longer functional. If such a situation does occur, and even if the fire-fighter moves to a cooler environment, the clothing will continue to yield internally the heat it has stored (some will also be lost externally), so that as a result the danger of skin burns continues for some time. If instead the clothing is manufactured in such a way that the fire-fighter can become aware of the approach of this situation, he can avoid serious danger simply by moving away from the high-temperature area. In this way more time is allowed for heat loss and the internal clothing temperature will not reach dangerous levels.

Truly efficient protective clothing must also be comfortable to wear so that fire-fighters are unencumbered during operations. This applies when they are advancing on foot, or using shoulder-carried equipment and tools for cutting, compressing combustible material or digging in the ground. The clothing must therefore allow ease of movement and its dimensions must not be excessive.

This general rule is particularly important in multistructured protective suits. These are designed to provide special defence for parts of the body that are either more vulnerable because they are covered by thinner skin, or functionally important, or difficult to heal if affected by heat trauma. In the light of these criteria, the protective clothing is of varying thickness and shape depending on the part of the body covered.

The wearability of this clothing must ensure that every part of the body is effectively covered by its appropriate protection during all the movements that may be made during fire-fighting operations. Protective clothing must clearly combine all the above-mentioned features: the characteristics of heat protection, the possibility of the perception of gradual temperature rise, high permeability to air, good wearability and a multistructured material. One of these features is not on its own sufficient to make clothing truly protective. For example, poor air permeability prevents the evaporation of sweat; this increases the humidity of the clothing material, with a consequent reduction in its insulating capacity. In fact, this property, which in conditions of low humidity can be very high, drops considerably as humidity rises. Laboratory tests carried out in conditions of low humidity may indicate theoretically excellent heat-insulating capacity in a particular material, while in practice this may not be so if the clothing has poor air permeability and sweat is prevented from evaporating and is absorbed by the material.

CONCLUSIONS

The extinguishing of a forest fire is a dangerous activity both because of the nature of the forest environment, where movement is difficult, and because of the speed and intensity of the fire-front.

The behaviour of the fire is extremely variable and requires the use of appropriate equipment. This may have widely different results depending on the preventive measures already existing in the territory. The technical methods adopted in fighting forest fires also vary considerably from one case to another.

However, all preventive measures, as also the choice of equipment and fire-fighting techniques, must be coordinated in a single fire-prevention plan.

Whatever the situation there must always be the maximum protection for all those who have to face the risks any fire inevitably involves, the first of which is burns. The use of appropriate clothing capable of providing adequate protection against high temperatures is the first rule in correct fire-fighting operations.

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Forest fires in Sicily

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This paper presents the experience of the Sicilian Region Forestry Department, which from its creation has been actively engaged in extinguishing forest fires. It has also suffered tragic experiences that have not gone unnoticed by the press. The emphasis will be on past and present legislation and on the regional administration's constant commitment to the prevention and control of forest fires.

In order to reduce the number and extent of forest fires, the Sicilian Region, preceding the national legislation, approved Law no. 36, of 16 August 1974, which tackled the complex problem of fire prevention. Article 5 of this law states: 'Without prejudice to the primary competence of the Corps of the Fire Brigade, the Sicilian Forestry Department shall adopt measures of prevention, vigilance, sighting and reporting of forest fires, and organize extinguishing operations exclusively in woodland areas.' Thus for the first time funds were allocated to forest fire prevention.

The following year, in the wake of State Law no. 47 of 1 March 1975, the Sicilian Region — in Law no. 88 of 29 December 1975 — took cognizance of the regulations for the prevention of forest fires as laid down by the aforementioned state law which were 'to be applied inasmuch as they were compatible with the relevant regional legislation', and set up the Forest Fire Prevention Service, charged with the coordination of all activity concerning the prevention and control of forest fires, to be achieved by special operative centres of the Regional Forestry Divisions.

In accordance with Article 1 of Law no. 47/1975, the 'Regional Plan for Protection from Forest Fires and for the Reconstitution of Forests' was prepared. This plan identified homogeneous territories in Sicily, on the basis of which fire prevention districts and operative bases were set up on a provincial basis. The same plan defined programmes for the reconstitution of woods and forests damaged by fire.

However, the Regional Forestry Department, even before Regional Law no. 36/1974, had already — in the conviction that forest fires were to be counteracted by preventive measures, early sighting and immediate intervention — instituted an early-sighting device by means of a number of radio-connected watch-towers in the territory under its control.

With the extension of this service throughout the entire regional territory, it has become possible to keep all forest areas under constant surveillance and to sight any fire as soon as it breaks out. A link-up system of radio transmitter–receivers then makes it possible for the full-scale fire-fighting teams to move in rapidly.

These teams are made up of specialized workers normally engaged in routine maintenance work who are on stand-by call to interrupt their everyday work and rush wherever they are summoned by the uniformed personnel stationed in the Forest Posts and by the directors of the forestry service.

The extent of the fire and the danger it presents involve the responsible services to a greater or lesser degree up to the level, if necessary, of the Regional Operative Centre, which has the authority to instruct the Civil Defence Unified Air Operative Centre to send in aeroplanes of the national service and from Catania airport. These aircraft can reach the area of the fire rapidly and bomb it repeatedly with water cascades.

Sicily is now in the process of improving its fire-sighting service with the creation of a monitoring network which, by means of special infrared sensors sensitive to variations in heat and light conditions, can detect fires 24 hours a day much sooner than a lookout on a watch-tower, and report them immediately to muster centres where the go-ahead can be given for fire-fighting operations to begin.

Other improvements have been made: the first fire-fighters on the scene can now make use of a better network of service roads, allowing access for tank trucks and all-terrain vehicles for the transport of water, men and material to the fire zone; large tanks have been installed containing water mixed with chemical retarding agents which extinguish the flames without interfering with the fertility of the soil; wide firebreaks have been created which criss-cross the forests so that fires can be stopped in predetermined areas; and protective measures for the trees themselves have been carried out with the pruning and elimination of unwanted shrubs in the undergrowth. For these reasons we can say that the problem of forest fires in Sicily, if not absolutely under control since chance elements are always involved, has certainly been limited in its most destructive manifestations.

There are not many forests in Sicily — woodland accounts for just 10% of the island's surface area — and their protection and surveillance is of primary importance if future generations are to be saved the danger of desertification and catastrophic disturbances of the hydrogeological equilibrium.

Forest fires, like any other calamity, cannot occur without some triggering cause and, in order to spread, they require certain concomitant factors without which the damage they cause would be insignificant. The various factors favouring the spread of forest fires in Sicily include:

- The long dry season with low atmospheric humidity, high temperature and strong wind.
- The high flammability of Mediterranean conifers and the natural herbaceous vegetation.
- The wide distribution of woodland in the regional territory.

- The abandoning of country areas by the peasant population.
- The ever-increasing number of tourists and occasional visitors.

The triggering causes, on the other hand, are difficult to identify since, if we exclude self-combustion (and it has been ascertained that it can indeed be excluded) and if we consider that the current legislation prohibits all construction and grazing in territories that have been destroyed by fire, which rules out building and farm speculation, not much else is left to consider.

Some indicate hunting as a principal cause, but it is well known that hunters — simply because they are hunters — are particularly interested in the conservation of the natural environment. Others suggest as a cause the possibility of creating opportunities for labour, which might induce potential fire-raisers to destroy forests so that they have to be replanted. However, although this cause may merit some attention with reference to Sicily and the south of Italy in general, it cannot explain the occurrence of forest fires in the central northern regions, where the problem of casual labour in agriculture and forestry does not exist but where, more than elsewhere in the last few years, the sad phenomenon of forest fires has been steadily on the increase. Acts of petty revenge for true or imaginary wrongs and the absent-minded behaviour of Sunday picnickers cannot account for the occurrence of devastating fires, which have clearly been carefully and skilfully started.

Some believe in the existence of an endeavour by certain interested power groups to destabilize the state by showing that it is incapable of protecting public parks and forests and thus the health of the general public; to others, however, this may appear to be merely political fiction.

It remains true, however, that the phenomenon of forest fires, whether due to all or any of these causes, in different countries of Europe and the world is due to the universal presence of the two elements (combustible material and oxygen) necessary for a fire, plus that other indispensable element, a source of heat, which is almost invariably the responsibility of people with little social or civic conscience.

It is precisely the certainty that forest fires are bound to occur from year to year that has induced the Forestry Department to equip itself with all the most modern technological means available: snowcats, tank-trucks, portable motor-pumps, pick-up and equipment trucks, wheeled bulldozer-tractors, generators with photocells, personnel transport trucks, long-wheelbase all-terrain vehicles, tank trailers, chainsaws and bush-cutters, and all the traditional equipment such as rakes, bill-hooks, shovels, pickaxes, fire-beaters, hatchets, portable searchlights, binoculars, maps, etc., all of which are extremely useful for both individuals and teams.

But if on the one hand the greater degree of modernization of fire-fighting techniques has reduced the danger of accidents, it is still an ever-present risk and all necessary prudence must be observed in order to protect the fire-fighters, who must therefore be equipped with proper boots, fire-proof suits, helmets with protective visors, gloves, safety tool-belts, protective masks, asbestos blankets and anti-heat umbrellas.

The danger of burns is ever-present and justifies the adoption of all appropriate safety measures. Sudden changes in wind direction and advances of the fire due to the topology of the terrain may lead to unpredictable movements of the burning material and sparks stirred up by the use of manual equipment, and also burns may be due to contact with naked flame. In the first case a little care and the use of protective clothing can prevent accidents, but in the second case — especially if the exposure to fire is not of short duration, there is the risk of severe injury.

The most dangerous type of fire is one that is sweeping up steep slopes or along narrow gorges, or that is driven by a scirocco wind. This is because the heat, smoke and flames allow no space for adequate protection. It was such a fire, in the Monte Inici gorge at Castellammare del Golfo in the Province of Trapani, that caused the death of four fire-fighters in 1979.

An encircling fire, though apparently impassable, can be broken through provided that the fire-fighters keep their heads and make proper use of their protective clothing, above all their fire-proof suits and anti-smoke masks. It should, however, be pointed out that fire-fighters involved in manual extinguishing operations in organized teams are generally considerably reluctant to use the appropriate protective clothing and that it is also no easy task for administrators to provide for the equipment of all the volunteers who step forward, either altruistically or because they have been invited to do so. This state of affairs increases the potential risk.

For some years now the Sicilian Region Public Forestry Department, convinced that effective protection can be achieved only through the education of present-day and potential future users, has been creating properly equipped barbecue areas where fires can be lit without danger of their spreading. These areas are now to be found in public forest-land near towns and villages and indeed anywhere picnickers are likely to be found in great numbers. Through its Forest Fire Prevention Working Group, it has promoted a concentrated information campaign in the mass media (daily press, radio, TV). Another important contribution has been the free distribution in the last three years to all first-year secondary schoolchildren of a book entitled 'Our Friend the Tree', which in over 200 pages gives information aimed at stimulating the protection of plant life. This book has been handed out to 300 000 youngsters and we hope they will turn out to be strenuous defenders of our forests, so that our society will be a better place to live in. It is now being reprinted for the third time and as soon as it is ready it will be sent to anyone requesting a copy.

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Safety regulations in high-risk industries. The situation in petrochemical plants in Sicily

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The matter of public safety and health was first considered at the European Community level in Directive 501/82 of 24 June 1982, which also covered for the first time the question of the protection of the environment with regard to the high risks presented by certain industrial activities.

The following definition of 'serious accident' is given in the European Community Official Gazette NL 230 of 5 August 1982 (The risks of serious accidents arising from certain industrial activities): 'the occurrence of a large-scale leak, fire or explosion due to the uncontrolled development of some form of industrial activity that gives rise to serious immediate or eventual risk for persons in or near the plant and/or for the environment, and which involves the use of one or more dangerous substances'.

The problems presented by the risks of fire or explosion and their consequences, such as the emission of toxic fumes, directly concern the National Body of Fire Brigades, which has the institutional role of carrying out action of prevention and control in this delicate sector throughout the national territory of Italy.

With more timeliness than is usual in the realm of public administration, and long before the EEC directive was adopted by the Italian state (comparatively recently, in DPR (presidential decree) 175), the subject was dealt with — and, in the light of subsequent events, we may say with great foresight — in DPR 577 of 29 July 1982, the object of which is 'the approval of regulations concerning the provision of fire prevention and vigilance services'. DPR 577/82 created conditions which made it possible for the fire-fighting organization to fulfil its new and heavy commitments, with the creation of the Fire Prevention Regional Technical Committees.

A regional technical committee is a collective organ consisting of the Regional Inspector of the Area Fire Services, who chairs the committee, and other high-ranking fire service officers, together with external members from the regional government, the Order of Engineers and the Department of Labour.

DPR 577 also required manufacturers to produce complete documentation containing analytic safety and reliability studies of their processing plants and protection systems. The industries were thus for the first time obliged to take direct responsibility for their actions, as they were now required to provide the control and inspection bodies not only with all the information necessary for these authorities to enable them to express a judgement but also with their own assessments of the reliability of the plants and their protection systems.

Article 19 of the DPR echoes the EEC directive: 'The Regional Inspectors of the National Body of Fire Brigades, having examined from the point of view of fire prevention all projects for the construction, enlargement or modification of important installations or plants or any others which because of the technology involved present high levels of risk, shall make all the necessary recommendations, after having consulted the Regional Technical Committee and in accordance with the EEC Directive; all such projects shall be accompanied by analytical safety and reliability studies of the processing plants and protection systems.' The criterion previously adopted in high-risk plants, i.e. the observance of strict fire regulations, was thus abandoned — and this seems to be the revolutionary aspect — in favour of complex studies of safety and reliability.

The last paragraph of Article 19 provided for the issue of an MD (ministerial decree) to regulate matters of practical application. This MD was duly proclaimed on 16 November 1983 with the following object: 'A list of the high-risk activities subject to surveillance by the Regional or Interregional Inspectors of the National Body of Fire Brigades, in accordance with Art. 19 of DPR 577 of 19 July 1982.'

A subsequent decree of 2 August 1984 laid down 'Norms and specifications for the formulation of the safety report for the prevention of fires in activities with a high risk of accidents, in accordance with the Ministerial Decree of 16 November 1983'. Appendix A of this decree contains the specifications for the preparation of the safety report both in the phase of 'authorization of construction' and in that of the 'detailed project'.

The specifications consist of a probability estimate of risk according to the following sequence: (1) identification of possible accidents; (2) assessment of the probability and/or frequency of the occurrence of accidents; (3) calculation of the consequences of accidents.

The safety report must also demonstrate the adequacy of the measures adopted for fire prevention in the narrowest sense, active and passive prevention, protection from criminal acts by external persons, and overall security. The safety report must in particular also consider:

- A subdivision of accidents according to whether they are caused by factors external or internal to the plant, or by particular features related to certain activities.
- Preventive measures and plant management criteria intended to reduce the frequency of accidents.

- In relation to the assessment of the consequences of accidents, the measures of active and passive prevention adopted in order to limit the extent of the possible damage to persons and property.
- All other aspects that may be useful in the preparation of plans for emergencies inside and outside the plant.

The 'detailed project' must include all clarifications, integrations and variations of the 'safety report for authorization of construction' that may have been found to be necessary, if the 'safety report of the detailed project' is substantially different from the conditions originally presented. In other words, the 'safety report for authorization of construction' corresponds to what is normally considered to be a general overall plan, while the 'detailed project' represents the detailed statement of the final executive plan.

Following these initiatives the Ministry of Health also took an early interest in the problem, and in line with EEC directives issued an ordinance (on 21 February 1985) relating to 'A national census of industries engaged in high-risk activities'. It was not, however, until 1988 that Italy adopted the EEC directive (commonly referred to as the 'Seveso' directive) in its entirety. This was done in DPR 175 of 17 May 1988. This law requires manufacturers not only to abide by its dispositions but also to respect 'the current regulations governing industrial safety and hygiene and the safeguard of the population and the natural environment'.

The responsibilities of the National Body of Fire Brigades are clearly indicated in the 'General Safety Regulations' stipulated in Article 1 of the DPCM of 31 March 1989, which requires manufacturers to obtain from the local Fire Brigade Authority 'the authorizations concerning fire prevention as prescribed by the law and to respect them'. All the prerogatives of the Regional Inspectors and of the Regional Prevention Committees still remain therefore in force, also as regards the examination of authorization of construction and detiled project safety reports.

The procedure for the issue of the fire prevention certificate by the provincial fire services commander is in two phases (authorization of construction and detailed project), occurring at different times but in substantially the same manner:

1. The manufacturer presents the authorization of construction safety report to the provincial fire services headquarters.
2. This report is sent on with a qualified opinion to the regional inspectorate.
3. The regional inspectorate carries out an investigation.
4. The regional fire prevention committee considers the case.
5. The regional inspector expresses his opinion.

The procedure is similar for the Detailed Project Safety Report. The final stage is an inspection by a commission of three experts appointed by the Regional Technical Committee in accordance with Article 14 of DPR 577.

If the commission is satisfied, the regional inspector informs the provincial fire services commander who then issues the fire prevention certificate. This certificate is the only deed of authorization prescribed by the current law. These procedures are, however, extremely complex for the following reasons:

- The very long and cumbersome investigation prescribed by DPR 175 is concluded by the Environment Ministry together with the Health Ministry, which after consultation with the competent authorities (Health Commission and the Committee at the Civil Defence Department) and the four technical organs may express an opinion that is entirely or partially different from that pronounced by the regional inspector and the regional fire prevention committee and sanctioned in the fire prevention certificate issued by the provincial fire services headquarters.
- The National Body of Fire Brigades, which is one of the four technical organs, must be consulted by the investigating officer, and the Chief Inspector General who represents the body may express an opinion that conflicts with the opinions and official acts of the body's peripheral structures.
- DPR 175 stipulates that if the public administration fails to express its opinion on the safety report within 60 days of its presentation, accompanied by the required sworn survey, the manufacturer may begin his activity; the state in other words admits its incapacity to fulfil its obligations in this delicate field of high risks within a reasonable time limit and, not wishing to delay industrial initiatives which necessarily have to be initiated as rapidly as possible if they are to be productively competitive, virtually abdicates its responsibilities.
- In the case of industrial activity involving the use of mineral oils, some old laws still apply which require authorizations from various ministries (Transport, Interior, Merchant Marine, Industry). These ministries, after considering the opinion of the consultative commission for explosive and flammable substances, may then require that certain fire-prevention measures should be adopted on the basis of principles that are different from and sometimes contradictory to those followed in the approved project.

As can be seen, DPR 175 may very easily give rise to conflicts not only between different public organs but also, although fortunately only theoretically, within one and the same administration.

There have already been various occasions when different and even contradictory assessments have been made, which were not simply due to sterile opposition between persons or public bodies but were caused by fundamentally different positions on extremely important matters. For example, it would appear to be extremely important in risk assessment to define what kind of fire reference should be made to: to the severest possible fire imaginable, which is, however, extremely unlikely to occur, or to the severest fire that has some likelihood of occurring?

We tend to the opinion that with all due caution the fires to be taken into consideration are those that have some likelihood of occurring. The severest possible fires imaginable can be considered in the preparation of external emergency plans. Not all experts agree on this, and the need for clear definitions is therefore all the more urgent.

In the light of the above considerations and of past and possible future events, and in order to prevent high-risk industries from being affected by the same kind of emotional psychosis that put a stop to 'nuclear' power, we believe it imperative that current regulations and procedures should be reviewed and harmonized without delay.

DPR 175 is currently being revised. We are certain that the new version of the law will consider the general interest and need that industry should be able to expand and improve its standards, with all guarantees of safety, on the basis of clear and more rapid administrative procedures.

The most important petrochemical centre in Italy, and possibly all Europe, is in operation in Sicily. In the Sicilian provinces of Caltanissetta, Messina and Syracuse there are industrial plants where considerable quantities of substances are stored, transformed and produced, which present a high risk of fire, explosion and toxic leaks. The risk represented by these plants is increased by their proximity to built-up areas, and in some cases to towns with a high density of population.

We now list the individual plants and the hazardous substances involved. These plants belong variously to public bodies, agencies with state participation and private financial holdings. We should point out that the names of some of the companies may change in the immediate future as a result of the financial operations related to the creation of Enimont.

Province of Caltanissetta
Ultragas Italiana spa
Agip Petroli spa
Raffineria Siciliana
Enimont Anic
Enimont Agricoltura
ISAF spa

Province of Messina
Raffineria Mediterranea spa

Province of Syracuse
ISAB spa
Praoil srl
Montedipe srl
Esso Italiana spa
Enimont Anic srl
Enimont Augusta srl

Altogether these industrial plants cover an area of about 22.5 million square metres, distributed as follows:

Province of Caltanissetta	5 100 000 m^2
Province of Messina	1 400 000 m^2
Province of Syracuse	16 000 000 m^2

We have preferred to consider the overall area covered in each province rather than the area of the individual industries because these are generally so close to each other that, as far as risk is concerned, they constitute a single entity, even if they are in fact separate companies. In risk assessment the possible influence of neighbouring plants has to be taken into account, and the overall risk is not simply the sum of the risks presented by each plant.

The above data indicate the necessity of appropriate measures in the region in order to prevent accidents or at least to limit the damage they cause.

The laws passed in the last few years, despite the shortcomings we have pointed out, and the sense of responsibility shown by the industries operating in the region permit us to state that the measures adopted guarantee an acceptable level of safety both in the plants themselves and in the surrounding territory. This is based on the knowledge that the plants were originally designed and have been subsequently restructured according to modern technological processes and with the problem of safety as a prime consideration. This safety depends, moreover, not only on the original project and its subsequent modifications but also on continuous maintenance, an efficient inspection service, and the positive cooperation of the organizations responsible for the observation of safety norms.

10
Domestic fire problems in Third World countries

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Third World countries are full oı problems, one of which is the outbreak of fires, coupled with the inability of fire services to control them effectively. Most of these countries are installing new industries to improve their agricultural and industrial capabilities. This has changed not only the type but also the magnitude of fire risk. Data regarding outbreaks of fires and the losses caused by them are not available, and in these countries it is not even easy to collect statistics. Immediate remedial steps are therefore necessary to save valuable human lives and property.

FACTORS IN THE OUTBREAK OF DOMESTIC FIRES

Most of the developing countries have their own stereotyped living styles and, perhaps owing to insufficient resources and greater pressures from other sectors, fire safety is often down-graded. The following factors affect the state of outbreak of domestic fires, their prevention and fighting techniques adopted.

Fuel used

A variety of fuels is used. On an average, 75% of the population resides in villages and depends on primitive methods. Those few who live in towns enjoy somewhat modern facilities, such as relatively safer cooking and heating systems, but even they have their peculiar hazards.

Most of the fuels used are prone to accidental outbreaks of fires.

Firewood. Being readily available, firewood is used by more than 90% of the population. It is used in small pieces in open fireplaces and it causes domestic fires due to smouldering and shooting off of fragments.

Kerosene. Kerosene is the second major type of fuel used in villages, towns and cities and is burnt in locally made inexpensive stoves. The consumer faces two hazards: first, careless handling due to ignorance of the characteristics of kerosene oil, viz. flash, ignition and flammable limits; and second, unsafe design, improper materials and substandard fabrication of stoves. The biggest danger from such stoves is that of explosion. The percentage of domestic fires caused by bursting stoves is much higher than from other causes of domestic fires.

Coal. Apart from cooking and heating, coal is also used in domestic appliances, e.g. coal-irons. Some varieties of coal have their own characteristic effects on burning, such as disintegration and shooting off from fireplaces. These often settle on ordinary combustibles and set them on fire. Although the number of fires caused by coal is less than that of kerosene, it is significant. In addition to fire risks, coal stoves cause carbon monoxide poisoning in unventilated rooms.

Petroleum products. Petroleum products such as natural gas and liquid petroleum gases (LPG) are also used for heating and cooking. The use of these gases poses a variety of peculiar fire hazards, e.g. fire in gas pipes and mains, and explosion in rooms due to accumulation of leaked gases.

Living conditions

Developing countries are poor and living conditions are not good. They lack basic facilities such as residential space, amenities and services. Entire families are housed in small homes comprising one or two rooms, where kitchens are generally inside the living area. Most of the rooms lack ventilation and this helps accumulation of combustible and poisonous gases.

Cooking

Food is cooked on open fires (Figure 1) and sparks gushing off cracking fuel pieces can initiate fires. Other kitchen fires are often caused by water thrown on to hot oil.

Unattended fires

Natural gas or LPG stoves are often put out by boiling water or milk, but the gas continues filling the kitchen area and surrounding space with combustible gas that needs only a spark for ignition.

Dress

Women wear loose dress such as saris. The dopatta or scarf is an essential item of dress. During work in the kitchen or near a fire, clothes often catch fire. With

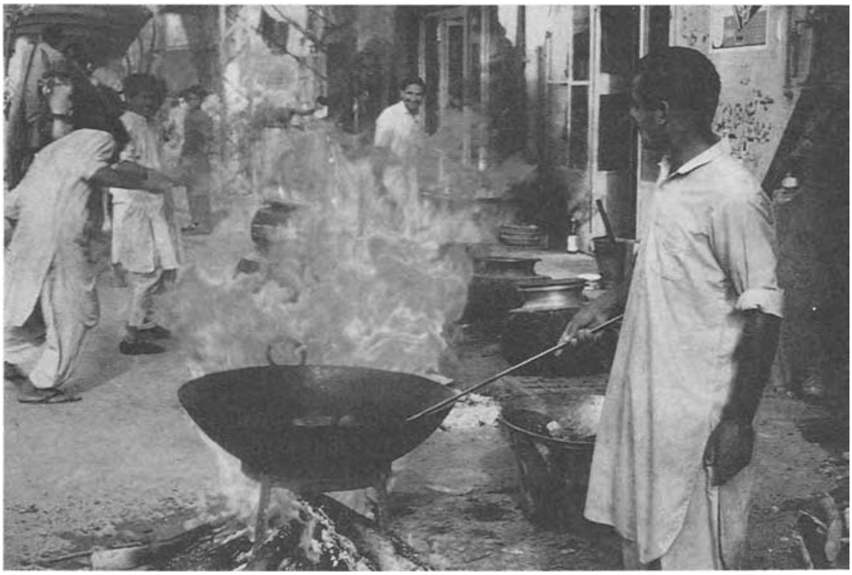

Figure 1.

the introduction of artificial silk, rayon and nylon fabrics in daily life, the fire risk has further increased. These are used extensively by women and children and saris and scarves with hanging pieces are normally the starting point of fatal injuries.

Lack of safety arrangements

People of the Third World are generally not safety conscious. Very few maintain first-aid appliances; not even a bucket full of water. Homes therefore become high fire-risk areas.

Fire service facilities and response to fire incidents

The equipment held at the fire stations is normally very old. It cannot be used effectively for fire-fighting and consequently the efficiency of the fire services is low. In addition, the fire-fighters are poorly trained; they receive only the basic training and little practice at the fire stations and have no technical know-how or experience.

Informing the fire services of an emergency can take a long time, as telephones are not always available. Additionally, fire services in rural areas are often located at distances of more than 50 km. Generally fire services use

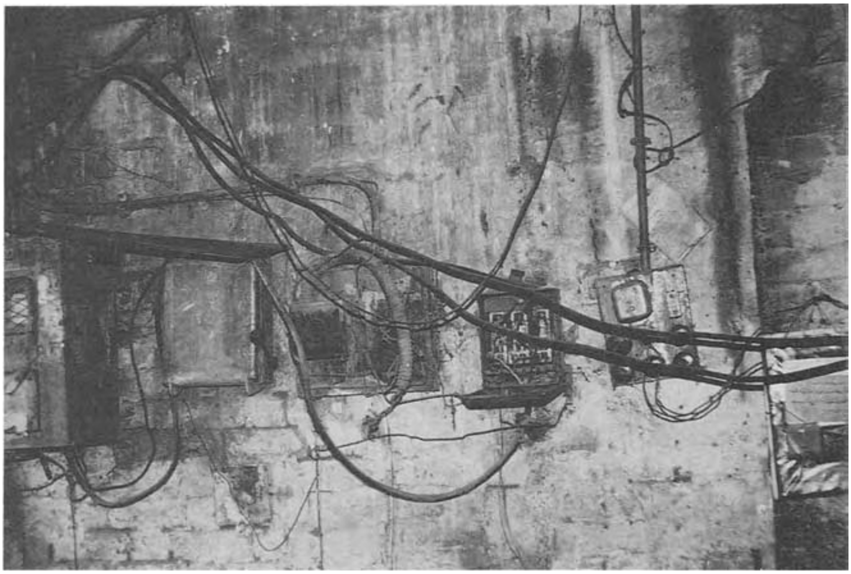

Figure 2.

long vehicles, which cannot be deployed for fire-fighting operations in densely populated areas and on narrow, unpaved roads.

Education

The literacy rate in nearly all Third World countries is very low: lack of education is the major cause of domestic fires. Women in particular have no concept of initiation of fires, their spread, prevention, and safety against them. They thus become frequent victims.

Careless use of electrical appliances (Figure 2)

Houses in small towns and villages become fire hazards because of irregularities such as use of old and substandard wiring; overloading circuits; short-circuits; use of multiple extension wires and multiplugs; incorrect use of electrical appliances; use of faulty switches; and use of unsuitably thick and strong fuses.

Personal habits

People often smoke in their beds, using an instrument known as 'huqqa' (hubble-bubble).

In villages, smoke is generally used against mosquitoes, flies, etc. The smoke is produced by an incomplete combustion in dry leaves and old cotton clothes and the system constitutes a hazard.

Naked lamps are commonly used in various environments and are potential fire hazards.

WHAT SHOULD BE DONE?

1. Mass campaigns for safety in homes should be initiated in the form of safety courses, programmes on radio/television, and features in magazines and newspapers covering such topics as:

- Use and methods of handling the reactive chemicals
- Safety education at school
- Safety courses for mothers directed against fires and other emergencies, and dealing with small kitchen fires, etc.
- Safety courses for men directed against fire at work.

2. Standardization of domestic appliances through government regulations and enforcement of manufacturing standards in design and use.

3. Social organizations should help housewives in organizing their kitchens and the rest of the household. Civil defence and social welfare departments should organize safety courses to deal with daily domestic emergencies and occupational hazards.

4. Availability of small and inexpensive fire extinguishers. Standard fire extinguishers are too heavy for easy handling and too expensive for poor people to afford. International organizations could design a small, lightweight and inexpensive fire extinguisher and make it available in poor countries.

5. Inexpensive — if possible free — first-aid kits should be made available to every family, and basic training in 'first aid to the injured' should be organized for all.

6. Training the public through mobile training teams. We in Pakistan have started such a programme. For this purpose we have established Women's Mobile Civil Protection Training Teams in nearly all big towns. The main function of the teams is to train and educate women in first aid, home nursing and domestic fire-fighting, as well as at the workplace.

I should at this point briefly mention a problem that arises when we are dealing with disaster prevention. A disaster usually represents an exceptional and extremely negative effect. It is something that nobody willingly discusses and which is instinctively thought of as something remote from reality. It is therefore very important to make people acquire, as far as this is possible, automatic responses to certain stimuli. This can be achieved by the use of simulation techniques, role-playing and other teaching methods which make the learner as active as possible.

CHANNELS FOR EDUCATIONAL COMMUNICATION

There are three main categories of communication channels: those providing mass communication, those implying the educator's direct intervention, and those involving interaction between educator and learner.

The mass communication channels include posters, notices, the press, cinema, TV and radio. These channels reach a large section of the population even in remote areas. However, it is difficult to have direct information about the effect that the message has produced and attempts at verification do not provide accurate data. These channels should be used at the beginning of an education campaign, when it is still a question of heightening general awareness of a particular public health problem.

Among the channels implying the educator's direct intervention are graphics displays, charts, photographs, films, slides, flannelboards and plastigraphs. These channels become so many instruments in the hands of educators, whose active presence is required as they have to present, describe, illustrate and explain whatever is being proposed. These instruments/channels are mainly used when educators are addressing a known and limited number of persons; they are used in lectures, round tables, debates, meetings and open discussions on a particular topic on which the mass media have already increased general awareness.

The channels requiring the interaction of educators and learners are essentially dramatization and the use of puppet-figures. Dramatization makes use of normal theatrical techniques, or of instruments of psychological dynamics such as role-playing; puppets are used almost exclusively in the case of child learners.

These are very delicate instruments which must be used by professionals who are experts in psychology and education. They should be used when the learning process has gone beyond the assessment phase, and they serve to stimulate a particular emotional involvement which may be useful in order to trigger the process of change. This channel is used only with small groups (8–10).

When these various channels are used, certain fundamental points must always be borne in mind:

- Whatever the channel, the message should never be intimidatory, frightening or catastrophic, as this might arouse a process of repression of the message.
- The colours, pictures and situations should never misrepresent the content of the message.
- The message should convey the key idea for the solution of the problem in a reassuring fashion; it should enable the learners to understand clearly what their personal role is in the solution.
- The message should not engender useless fatalistic reactions.

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11
Domestic burns in children caused by butane gas explosion

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Between January 1989 and June 1990 a total of 729 burned children were admitted to our hospital. Of these 55 (13.4%) were victims of butane gas explosion accidents. In the majority of cases the explosion occurred in the kitchen and very frequently the mother was also injured. In our series 22 of the butane gas-burned children came from just seven families involved in accidents. The explosions were sometimes very serious and in half the cases the home was completely destroyed. This gives rise to difficult socioeconomic problems, also as regards the hospitalization of the burned adults. The age distribution of the 55 children was as follows: 0–5 years, 23; 6–10 years, 21; 11–15 years, 11. In the case of nursing infants we admitted the mother even if she was not burned, and *a fortiori* if she was also burned.

We considered that it might be interesting to note the geographical origin of this type of victim. Twenty-eight of the children came from the city of Algiers and its immediate environs. Twenty-seven were sent from other parts of the country.

The time delay between the occurrence of the accident and admittance to the hospital in Algiers was as follows: 1–6 hours, 32 patients; 7–12 hours, 10 patients; 12–48 hours, 6 patients.

The above group of children lived in the city of Algiers or in the immediate neighbourhood. The other seven children were admitted later (two between 3 and 12 days after the explosion, five more than 21 days after the accident). The children in this group obviously were residents at some distance from Algiers and they were admitted only for the purpose of a skin graft or for the treatment of sequelae.

The approximate extent of the burns was: 15–25%, 11 patients; 26–40%, 21 patients; 41–60%, 12 patients; over 60%, 11 patients. The relative frequency of extensive burns reflects the fact that in this type of accident all parts of the body are invested by the burning gas, especially the face and hands.

The depth of the burns was: intermediate, superficial and deep, 35 times;

deep, 17 times; superficial, 5 times. The burns thus form a mosaic pattern from the point of view of depth. We endeavoured above all — but unfortunately only by clinical means — to determine the extent of airways damage. Damage to the airways was found in 21 cases, manifesting itself in acute dyspnoea, cough and bronchitis. In all cases the face was deeply burned with considerable palpebral and labial oedema.

The short-term evolution in our series was as follows: recovery without skin graft, 14 cases; recovery after one skin graft, 11 cases; recovery after two or more skin grafts, 9 cases.

There were 21 fatalities in this series of burned patients, of which 15 occurred in the first 24 or 48 hours after admission as a result of blast shock (not verified by autopsy). Of the other six deaths, four were attributed to septicaemia occurring 5–10 days after admission and two were caused by cachexia 2 or 3 months after the accident in children admitted from the interior of the country.

The long-term evolution could be evaluated in only 10 cases:

Inguinal bridle	1	on 07/06/89
Hand contracture	1	on 09/07/89
No sequelae	2	on 26/06/90
Digital palmatures	1	on 26/06/90
Finger flexion	2	on 08/07/90
Foot bridle	1	on 08/07/90
Face/hands cheloid	2	on 31/07/90

CONCLUSION

No judicial inquiry was ordered into any of the domestic butane gas accidents to children that we report. In Algeria such accidents, caused by explosion of the gas, are attributed to misuse of the gas cylinders and not to filling or manufacturing defects. For this reason a prevention campaign has been launched in the national press, but this is inadequate and during the months of July and August 1990 two families with children aged from 2 to 11 years were devastated by burning butane gas.

12
Accidents due to electricity and burns. A statistical analysis of events occurring at the National Electricity Energy Board during the period 1988–1989

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One of ENEL's (National Electricity Energy Board) most important activities is electrical installations and special attention is paid in working procedures to prevention of accidents due to electricity. The results are presented of an analysis of electricity related accidents causing burns that occurred to ENEL workers during the period 1988–1989. These events, though accounting for only 3–4% of all annual accidents, are carefully tracked because of the severity of the injuries they cause. The main features of these accidents are, above all, human-related, and therefore play an important role in their occurrence. A new approach is presented for analysing accidents in order to evaluate whether they could be prevented and their causes eliminated. The results show that, at least in theory, the causes can be eliminated in 90% of cases.

INTRODUCTION

In the general picture of ENEL accidents, those due to electricity, though numerically few compared to the overall total (see Table 1), are carefully tracked at all operative and functional levels both because of their specific correlation with ENEL's institutional activity and because of the serious consequences of this type of accident in terms of damage to persons and property. As Table 1 also shows, the serious nature of electrical accidents results in the highest number of work days lost due to injury.

This study takes into account all industrial accidents occurring in ENEL during

Table 1. Classification of accidents by type

Type of accident	*Percentage*[a]	*Average duration*[b] *(days)*
Impact, pressure, or friction against stationary objects	10.4	16.4
Impact, crushing or cutting from moving objects	30.9	19.0
Falling or slipping of the person	23.1	30.8
Strains or forced movements	13.2	23.2
Action of electric current	3.5	43.9
Thermal action (excluding electricity)	1.4	15.9
Action of harmful chemical agents	0.8	11.3
Road accident	6.5	7.3
Total	100.0	22.8

[a]Percentage mean value in 2-year period 1988/89
[b]Average duration = days off work for each accident

Table 2. Classification of accidents by voltage

Voltage	*Number of accidents*	*Percentage*
Plant		
Low voltage (< 400 V)		
Planned work on live plant	187	63.6
Planned work in disconnected plant	72	24.5
Medium and high voltage (> 1000 V)	27	9.2
Apparatus using low voltage	8	2.7
Total	294	100.0

the period 1988/89. Particular attention was paid to electrical phenomena which caused burn lesions. The link between electrical accidents and burns is obviously very close: this is confirmed by the finding that out of 356 such events in the period considered, 294 (about 83%) caused burns. The remaining cases consisted of 13 electrocutions, 33 ophthalmias or conjunctivitides and 16 various lesions.

The total number of cases (burns) considered was therefore 294 (144 in 1988 and 150 in 1989). The analysis throws light on the particular nature of the circumstances of the accidents and on their specific consequences. In particular, the following sections illustrate the classifications most commonly used in the study of accidents (place of work, type of activity, material agent, site of lesion and professional seniority). A further section deals more specifically with the causes of each individual accident. These causes are related to objective risk factors (technical defects/adverse environmental conditions) and/or subjective risk factors (errors/omissions).

CLASSIFICATION OF ACCIDENTS BY VOLTAGE

Table 2 classifies the accidents on the basis of voltage and the type of work being performed. The data show that the majority of electrical accidents occur in low-voltage plants during programmed procedures, which are in fact those most commonly undertaken by ENEL workers.

Regarding voltage, a brief explanatory note may be useful with reference to current Italian legislation. DPR (presidential decree) no. 547/1955, Art. 344, prohibits all work on live elements and in their immediate vicinity when the voltage is greater than 25 V towards earth if alternating, or greater than 50 V if direct. This regulation may be ignored, in the case of voltages not greater than 1000 V, provided that the order to effect the work on live parts is given by the works director, and all necessary precautions are taken to protect the workers.

In addition to the national legislation, ENEL has its own internal set of regulations concerning the following phases of the application of preventive measures:

- Identification of risks and preparation of the work
- Safety measures at sectionalization points
- Safety measures on the work site.

For the implementation of these regulations there are specific organizational procedures which provide for the identification of typical operators and the utilization of documents for the exchange of information.

It should also be mentioned that the DM (ministerial decree) of 9 June 1980 permitted ENEL to allow work on live plant with voltages over 30 kV provided that precise operational regulations and training and qualifying procedures are observed.

CLASSIFICATION OF ACCIDENTS BY PLACE OF WORK

Table 3 illustrates the classification of accidents by place of work. This table underlines the number of accidents due to failure to use proper means of protection. As we shall see, the likelihood that burns may result from an electrical accident (in the sense of the initial event of a process that can cause physical harm) is very closely connected, much more so than any other type of accident, to failure to use standard means of personal protection. The considerable number of cases of accidents in two specific work places, i.e. secondary distribution substation and distribution line/plant, is a reflection of the high frequency of this kind of work and of the variety of situations that electricians have to face.

CLASSIFICATION OF ACCIDENTS BY TYPE OF ACTIVITY

Table 4 gives the classification of accidents by type of work or the specific activity of the squad carrying out the work. The notes indicate the main 'subjective error causes' related to the types of activity with the highest accident rate (see below for further explanations of the classification).

The data confirm the findings of the classification by place of work that the number of accidents increases in particular kinds of work related to distribution.

Table 3. Classification of accidents by place of work

Place of work	*Overall number of accidents*	*Number of accidents caused by non-use of protection*
Hydroelectric plant	6	1
Thermoelectric plant	13	4
Electric power station	8	4
MV/LV substation	56	52[a]
Distribution line/plant	204	180[b]
Pole transformer	(16)	
LV air cable	(35)	
LV underground cable	(19)	
Power point	(58)	
Measuring equipment	(61)	
Other work places (offices, premises, etc.)	7	
Total	294	241

[a]Of which: 16 due to non-use of insulating gloves; 9 due to non-use of other means of personal protection; 20 due to non-use of several means together; 7 due to non-use of protective devices
[b]Of which: 80 due to non-use of insulating gloves; 18 due to non-use of other means of personal protection; 71 due to non-use of several means together; 11 due to non-use of protective devices

Table 4. Classification of accidents by type of activity

Type of activity	*Number of accidents*	*Percentage*
Work on conductors	45[a]	15.3
Work on power points/measuring groups	118[b]	40.1
Installation	(20)	
Removal/replacement	(33)	
Disconnections	(22)	
Other	(43)	
Work on other electrical parts	57	19.4
Manoeuvres	54[c]	18.4
Other	20	6.8
Total	294	100.0

[a]Of which: 9 due to unauthorized operating; 3 due to non-use of protective devices; 18 due to use of wrong procedures; 3 due to wrong handling of materials or tools; 7 due to other errors; 5 not caused by subjective error
[b]Of which: 14 due to unauthorized operating; 17 due to non-use of protective devices; 42 due to use of wrong procedures; 14 due to wrong handling of materials or tools; 20 due to other errors; 11 not caused by subjective error
[c]Of which: 3 due to non-use of protective devices; 9 due to use of wrong procedures; 13 due to wrong use of equipment; 10 due to carelessness; 8 due to other errors; 11 not caused by subjective error

CLASSIFICATION OF ACCIDENTS BY MATERIAL AGENT

Table 5 illustrates classification of accidents by material agent. This classification takes into account the particular elements (machines, plant, tools, equipment, etc.) which in the dynamics of the accident prove to be most important as far as prevention is concerned. The material agent may therefore not actually be

Table 5. Classification of accidents by material agent

Material agent	*Number of accidents*	*Days off work*	*Average duration[a] (days)*
Conductors	33	1 369	41.5
Manoeuvring elements			
Switches/sectionalizers	42[b]	2 029	48.3
Other	14	458	32.7
Measuring elements			
Meters	28	1 272	45.4
Other	20	1 073	53.6
Protective elements			
Switches/limit-switches	13	790	60.8
Other	9	180	20.0
Distribution/sectionalization boxes	65[c]	2 221	34.2
Handtools	15	617	41.1
Other	55	2 445	44.5
Total	294	12 453	42.4

[a]Average duration in days off work per accident
[b]Of which 38 low-voltage switches
[c]Of which: 33 power point/switch pillar; 24 low-voltage line/sectionalization boxes

the direct cause of the lesion: for example, in the case of a workman working on a ladder in an electrical plant who receives a shock and falls off the ladder, breaking his foot, the material agent is the element of the electrical plant that caused the shock which in turn caused the fall, and not the ladder.

Table 5 indicates in particular that the number of accidents with meters is fairly limited (28 cases in the 2-year period) even if these parts are the ones most frequently involved in ENEL plant work. This is due to the very high safety procedures of meters installed on the consumers' premises.

CLASSIFICATION OF ACCIDENTS BY SITE OF LESION

The site of the lesions can be seen in Table 6. The hands are the part of the body most frequently involved in burns following electrical accidents (about 32% of cases). This finding was more or less to be expected, but it serves to stress once again that in electrical accidents proper personnel protection can eliminate or at least considerably reduce the consequences of the accident.

CLASSIFICATION OF ACCIDENTS BY PROFESSIONAL SENIORITY

Table 7 indicates the years of professional seniority of the 294 accident victims. Contrary to what might be expected, it can be seen that electrical accidents are more frequent among personnel with a certain degree of professional seniority. This would suggest that in general more experience leads to greater professional confidence and the conviction that one's personal ability is sufficient to avoid

Table 6. Classification of accidents by site of lesion

Site of lesion	*Number of accidents*	*Percentage*	*Average duration (days)*[a]
Head	33	11	26.1
Right arm	73	25	32.9
(Right hand)	(55)	(19)	
Left arm	57	19	33.5
(Left hand)	(38)	(13)	
Various sites	126	43	56.9
Other	5	2	23.2
Total	294	100	42.4

[a]Average duration in days off work per accident

Table 7. Classification of accidents by professional seniority

Years of professional seniority	*Number of accidents*	*Percentage*
0–5	19	6.5
5–10	26	8.8
11–16	80	27.2
(Of which 15)	(36)	
16–20	61	20.7
(Of which 16)	(22)	
(Of which 17)	(26)	
21–25	67	22.8
(Of which 22)	(22)	
(Of which 23)	(26)	
26–30	32	10.9
> 30	9	3.1
Total	294	100.0

electrical danger. We must combat this way of thinking and behaving, in the awareness that even if electrical contact very often does not cause an accident, serious, sometimes fatal, consequences do occur, owing to particular objective environmental situations or to the subjective psychological state of the operator.

It is difficult to convince operators of this risk and to persuade them to observe the appropriate precautions. ENEL has, however, taken this task upon itself and is promoting a safety campaign for the prevention of industrial accidents. Particular stress is laid on the necessity of proper planning and preparation of all work, including the identification of the risks involved and the relevant safety measures to be adopted.

CLASSIFICATION BY CAUSE OF ACCIDENT

Tables 8 to 10 analyse the classifications according to objective cause, subjective error cause and subjective omission cause. Although these classifications may not appear to be of immediate value, they take on fundamental importance in

Table 8. Classification of accidents by cause: objective cause

Objective cause	*Number of accidents*	*Percentage*
Equipment, apparatus, part of plant[a]	114	38.8
Area or place of work[b]	12	4.1
Work levels or supports[c]	1	0.3
Natural and atmospheric conditions	1	0.3
Unpredictable objective cause	23	7.8
Other objective causes	34	11.6
No objective cause[d]	109	37.1

[a]Not protected, not indicated, inappropriate, defective, etc.
[b]Crowded, narrow, limited, steep, etc.
[c]Not protected, inappropriate, defective, not resistant, etc.
[d]The presence of a known objective cause which it was decided not to eliminate but to tackle by means of appropriate procedures (e.g. low-voltage operations) means that the resulting accident is classified as not having an objective cause

the examination of accidents for preventive purposes, since they enable us to emphasize the responsible factors that to varying degrees determine the lesion and provide an indication for corrective action. Let us examine in detail the three classifications.

1. *Classification by objective cause.* By objective cause we mean:

- A technical failure (in the project phase, in construction or in maintenance) that can be identified and therefore prevented, or that cannot be detected either by visual examination or with the tools normally available on a work-site.
- Adverse environmental conditions that are identifiable, but not avoidable (bad weather, difficult or irregular terrain, presence of obstacles, limited space, etc.).
- An unpredictable risk factor due to abnormal behaviour by persons not part of the work squad.

Table 8 gives the data for this classification. It can be seen that in the dynamics of the accidents an objective element is present (though not exclusively) in two-thirds of the cases.

2. *Classification by subjective error.* By subjective error we mean:

- Incorrect behaviour by operators (whether the accident victim or other members of the work squad) consisting in technical errors (failure to follow prescribed working methods, procedures, safety norms, work organization, etc.).
- Incorrect behaviour by operators, consisting in careless performance of habitual or routine actions (lack of concentration, oversight, forgetfulness, lack of coordination, etc.).

Table 9. Classification of accidents by cause: subjective error

Subjective error cause	*Number of accidents*	*Percentage*
Unauthorized operations	30	10.2
Non-use or annulment of safety devices	29	9.9
Non-observation of prescribed procedures	86	29.3
Wrong manoeuvring or handling	41	14.0
Decision to work in dangerous position	25	8.5
Lack of concentration/carelessness	26	8.8
Other subjective causes	1	0.3
Not classified	16	5.4
No error but negligence	23	7.8
No error or negligence	17	5.8
Total	294	100.0

Table 10. Classification of accidents by cause: subjective omission

Subjective omission cause	*Number of accidents*	*Percentage*
Non-use of isolating gloves	105[a]	35.7
Non-use of goggles/mask	17	5.8
Non-use of another protective means	5	3.8
Non-use of various protective means	92	31.3
Personal protection means used	53	18.0
Non-use of safety devices	16[b]	5.4
Total	294	100.0

[a]Of which: electrical work on conductors, 12; electrical work on power points/measuring groups, 54; other electrical work, 19; manoeuvres, trials, checks, 20
[b]Of which: earthed and short-circuited devices, 5; voltage detectors, 3; other devices, 3; various devices together, 5

This classification is illustrated in Table 9. A comparison between the data in Table 9 and those regarding all ENEL accidents reveals some specific characteristics of electrical accidents. One thing in particular is clear: in the dynamics of this kind of accident, human behaviour plays a more important part than in other types of accident. Compared to a national rate of about 70% of accidents attributable to incorrect behaviour, the rate for electrical accidents reaches 94.2%.

3. *Classification by subjective omission cause.* By subjective omission cause we mean non-use or incorrect use of prescribed means of personal protection (gloves, helmet, safety belt, etc.) and of collective protection (earthing and short-circuiting devices, delimitations, etc.). Table 10 indicates the main forms of omissions connected with the electrical accidents considered. The comparison between electrical accidents and other types of accident is also interesting as regards omissions: it can be seen that it is the cause of about 82% of electrical accidents compared to an overall average in accidents of about 12%.

ACSI CLASSIFICATION

To conclude, we mention briefly a particularly interesting theme to which those of us involved in safety enforcement have been directing our attention. This consists of a new approach to the problem of accident prevention that has been studied at ENEL. Named the ACSI (accident cases and statistics analysis) classification, it is based on the identification of two fundamental types of accident, those that are avoidable and those that are unavoidable.

(I) *Potentially avoidable accidents.* In these cases the hypothetical possibility exists that they could be recognized beforehand and consequently avoided. In this category we have accidents due to

- Non-use or incorrect use of the prescribed means of personal or collective protection.
- Technical error, meaning inefficiency on the part of the operator (non-application of prescribed working methods, procedures, safety norms, etc.).
- Technical danger of unknown nature but considered 'potentially avoidable', which can lead to malfunction, breakage, electric discharge, fire or other similar causes of accidents.

(II) *Accidents that are in practice unavoidable.* In these accidents one can realistically rule out the possibility of their being foreseen and therefore prevented. In this category we include

- Environmental danger, including adverse environmental conditions that can be recognized but not eliminated.
- Accidental danger, meaning a risk factor that cannot be recognized and therefore cannot be eliminated (acts of God, fortuitous circumstances, uncontrollable actions, etc.)
- Banal errors committed in relation to habitual or generic actions (lack of concentration, absent-mindedness, lack of coordination, etc.)

A preliminary application by ENEL of this accident classification has revealed the following situation as regards *overall accidents*:

Potentially avoidable accidents	*40%*
Potentially avoidable objective danger	11%
Non-use of protective means	21%
Potentially avoidable subjective error/inefficiency	68%
Unpredictable and/or unavoidable accidents	*60%*
Practically unavoidable objective danger	15%
Completely unpredictable	30%
Subjective error/inefficiency	55%

The trend is towards a reduction of the first and an increase of the second.

Table 11. Analysis of electrical accidents vs all accidents

	All accidents (%)	*Electrical accidents (%)*
Practically unavoidable objective danger	9	1
Completely unpredictable accident	18	5
Practically unavoidable subjective error	33	4
Total unavoidable accidents	60	10
Potentially avoidable objective danger	4	6
Non-use of protective means	9	60
Potentially avoidable subjective error	27	24
Total potentially avoidable accidents	40	90

The same analysis applied to *electrical accidents* gives the following picture:

Potentially avoidable accidents	*90%*
Potentially avoidable objective danger	6%
Non-use of protective means	67%
Potentially avoidable subjective error/inefficiency	27%
Unpredictable and/or unavoidable accidents	*10%*
Practically unavoidable objective danger	3%
Completely unpredictable	54%
Practically unavoidable subjective error/inefficiency	43%

The above results are also summarized in Table 11.

CONCLUSIONS

On the basis of our findings and classifications, in the dynamics of electrical accidents the human component related to incorrect behaviour (errors and/or omissions) is preponderant. This is only confirmation that in this field a great deal of work remains to be done, not so much from the point of view of regulations but rather from the conviction that work done well means above all work done safely.

This is the philosophy of ENEL's wide-scale programme of stimulating awareness of the problem (i.e. the safety campaign already mentioned), which involved 18 000 technicians in the first phase and 55 000 workmen in the second phase, and which is not yet finished.

The technicians were reminded of the necessity that in the programming of work it is important to take into account all safety aspects, identifying *a priori* risks connected with the activity to be performed; executive personnel have been given all necessary information for safe completion of the work.

The campaign aimed at the workmen is intended to make them reflect on the various phases of the work to be done, by convincing them of the necessity of taking all preventive measures necessary to ensure that the work is carried out in conditions of safety.

13
Fire in port

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Commander, Port Authorities, Italy

Any port area is a high fire-risk area, both because of the cargoes passing through (whether liquid or solid) and because of the intrinsic features of the wharves and the ships that dock there. In some cases this potential danger is increased by the fact that the port is an integral part of a city. Some ports are so much part of a town that incoming or outgoing port traffic may obstruct everyday city traffic or even bring it to a standstill. An inevitable consequence of this is delay in the arrival of rescue vehicles in the event of an emergency.

Even greater problems are presented by ports (the so-called industrial ports) which have wharves close to coastal depots or any kind of industrial plant. In such cases, a fire may not develop directly in the port area or on board ship but may break out in the surrounding areas and spread inside the port with potentially even more serious consequences.

Ports are not infrequently situated in positions considered at high risk from the point of view of environmental safety, so that it is necessary to have complete information about all the possible sources of danger in the zone, as well as about the vehicles, personnel, material and other means that can be immediately called into use in the event of emergencies due to external fires.

It is equally clear that the dangerous nature of the area surrounding the port may discourage the harbour master from authorizing the docking at particularly exposed wharves of ships carrying highly flammable goods or the loading and unloading of goods in particular dangerous packages (explosive or flammable goods, etc.).

These considerations underline the fact that the surrounding environment considerably affects not only port activities but also the general management policy of the particular port, and consequently all traffic options.

In Italy Law No. 690 of 13 May 1940 decrees that fire-fighting in ports is the responsibility of the commander of the port authority and is carried out by the provincial fire brigade. The harbour master directs all services for the prevention and extinction of fires in the port area, both on land and on board ships and barges, in full respect of the specific competences of the captains of military or merchant ships and the chiefs of fire brigades in relation to current regulations.

Every port possesses an adequate organization for the prevention, limitation and extinction of fires in the port area. This organization must be kept updated and in a state of continuous efficiency by the harbour master.

As regards the organization of fire-fighting, Italian ports can be divided into three categories. First- and second-category ports have special Port Detachments of the provincial fire authorities which possess not only normal land equipment but also nautical fire-fighting means and specially trained personnel for the prevention and extinguishing of fires aboard ship. Third-category ports do not possess these Port Detachments and the fire-fighting service is provided by the normal services of the provincial fire brigade, assisted when necessary by other services.

In Italy, regulations regarding fire prevention in port and aboard ship are laid down in the Italian Navigation Code, in the regulations as to its observation, in the safety regulations for merchant ships and human life at sea, in instructions issued at various times by the competent sections of the Ministry of the Merchant Navy, and in special norms relative to particular ports, as established by the harbour master in relation to local needs.

The prevention of port fires is one of the most demanding services performed by the military personnel of the port authorities for the safeguarding of public safety. This is an 'institutional' responsibility articulated in various police regulations that port authority personnel must ensure are enforced both on board ships in port (especially if carrying dangerous cargoes) and on land in the port area.

The action of the port authority military personnel can be integrated, if necessary, by that of other agents in the public forces (Art. 85 Ex. Reg. of the Navigation Code), without any prejudice to the authority of the harbour master.

It is clearly impossible to dictate absolute rules for the action necessary to extinguish fires because of the variety of conditions, means and situations and of the different natures of individual fires. There are, however, some fundamental criteria that fire brigades follow in their fire-prevention activity, in fire-fighting when fires have broken out, and for the protection of persons and the security of port installations and ships.

Fire prevention activity concerns every sector where fire is a potential danger, and in particular: on board ships anchored in port or offshore carrying flammable, explosive or otherwise dangerous cargoes; on board ships where there is welding work using oxyacetylene flames or electric arcs; in port depots or warehouses containing flammable goods; on board or near craft engaged in the loading of liquid or solid fuels; and during public events involving firework displays.

1. The port water plant must have a sufficient number of fire hydrants. The merchant navy administration has the power to oblige licensees of areas, buildings or any other property in the port area to organize their own fire prevention and fire-fighting services; it is also empowered to oblige the licensees of the water installations to organize their services in relation to fire-fighting necessities.

2. Harbour masters have the authority to enforce the observation of special rules and fire safeguards in the performance of any work for the construction, fitting, repair and maintenance of ships.
3. Tug-boats operating in port waters must be provided with fire-fighting equipment which will be defined in relation to the specifications of individual vessels by the Ministry of the Merchant Navy, after consultation with the Ministry of the Interior. Harbour masters have the authority to oblige licensees of tug-boat services to keep one or more tug-boats on standby duty, even on a permanent basis.
4. Harbour masters, for the purposes of fire prevention, have the power to direct that: (a) Captains of Italian and foreign merchant vessels, during their stay in port, must present details of their cargo to the Maritime Office and provide all information requested of them regarding the organization of fire-fighting services on board their vessels. (b) The said ships, during their stay in port, must maintain their plant and services for the detection and extinguishing of fires in a state of efficiency and readiness. (c) There must be a permanent fire-watch service on the ships by the ship's crew or by local personnel with express authority. (d) The ships must carry out fire drills with the presence on board of the local fire brigade and auxiliary squads. Harbour masters may for the above purposes order on-board inspections to be carried out by firemen and other competent authorities.

In normal circumstances, as most port activities are the object of specific police authorizations from the maritime authority (Art. 81 of the Navigation Code), preventive norms are included in the individual measures. Maritime police local regulations provide for the various safeguards necessary for public safety. Military personnel on fire patrol must therefore enforce the general and special norms, ascertaining and dealing with any violations that may be observed.

In larger ports the fire patrol and the so-called 'fire guard service' do not normally have other police duties as their task is mainly a static service of vigilance, in which the personnel has to remain physically in danger areas and undertake preventive action. In the event of an emergency they have to alert the appropriate body in accordance with the general fire plan.

In the event of a fire, the harbour master takes charge of fire-fighting operations. He is empowered to proceed without any formalities to requisition any craft or vehicle present in the port area. The harbour master is responsible for coordinating the action of the fire brigade with that of other land or sea forces and of all those persons required to respond to the requests of the maritime authority. The commanding officers of the armed or police forces called to the scene of the fire to maintain public order and to assist in rescue work are obliged to comply with the instructions given by the harbour master. The chief of the fire brigade is in charge of the management and the technical deployment of the means and men under his command and of auxiliary forces. The captains of merchant ships and duty officers and officers in charge of fire squads on board must in the event of fire on board their ship in port comply with the instructions given by the harbour master in all matters regarding the safety of the port and of ships in port waters.

If a ship's fire-fighting equipment proves inadequate, the harbour master has the authority to send on board men and equipment of the fire-fighting service and also to take over the management of fire-fighting operations on board. If the ship is not Italian, the harbour master must inform the consul of the country under whose flag the ship is registered.

In the event of fire on a warship, the management of fire-fighting operations is exclusively the responsibility of the captain of the ship, who must keep the harbour master informed of the extent of the fire and the progress of fire-fighting operations. The harbour master is responsible for directing rescue operations regarding the safety of the port and other ships and, as requested, assists the captains of warships with the port's fire-fighting equipment and organization.

The action of the port authority personnel must therefore be directed mainly at guaranteeing proper use of immediate fire-fighting means until the fire brigade arrives. In general this action consists of moving ships and barges away from areas threatened by fire, and removing goods or dangerous material that might feed the fire. The fire brigade is responsible for deciding all technical measures that may prove necessary. For effective action the Port Authority personnel are mobilized on the basis of an 'emergency plan'* which involves: firemen from the local fire brigade and from other nearby towns, port police authority, local prefettura and questura, carabinieri, customs and excise officers, and the local police force.

Fire-fighting operations will be all the more effective if the harbour master already has thoroughly organized in advance all preparations for the rapid mobilization of means, equipment and personnel. For this reason, unannounced fire drills are extremely useful (at least once every 6 months) in order to test the efficiency of the organization and to discover any shortcomings or imperfections.

Italian ports rarely possess their own permanent medical posts. The law of 13 May 1940 which deals with port fire-fighting services in fact makes no provisions in this regard. It would, however, be extremely useful to create, at least in the larger ports, one or more permanent first-aid posts with ambulances and medical and paramedical personnel on standby ready to act throughout the day or at least at those times when ships are being loaded or unloaded. These medical posts would have to be provided with all necessary medical equipment for first aid to burn victims pending their transfer to local hospitals by means of the ambulance standing by.

The creation of one or more permanent port medical posts would naturally also make it possible to provide more immediate assistance in the event of any other accidents occurring on board ship or on the wharves, some of which, as has been seen recently, may have fatal consequences. This medical service could be organized on a voluntary basis with the contribution of all users of the port.

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*Every port normally has its own 'fire-fighting protocol' compiled and updated by the harbour master, which gives all information regarding the organization for the prevention and extinguishing of fires in the port area. The main information in this protocol concerns: (a) general guidelines and particular instructions for the prevention and extinguishing of fire in port and in the vicinity; (b) location of port fire hydrants (for supplying water to merchant ships and to fire-fighting units); (c) sea and land means and equipment (fixed and mobile).

14
Fire on board ship

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Fire on board ship is one of the most serious risks for property and persons, as well as for the surrounding environment. A ship is evidently subject to the same risks with regard to fire as a civil or industrial land structure. On board ship there are tons of liquid fuel, electrical equipment, air-conditioning plants, engines, boilers, stores of flammable material and crew accommodation areas (kitchens, mess rooms, lounges, cabins, WCs). To all this we must add the load, which in cargo vessels consists of a high percentage of solid and liquid goods that are flammable or at least combustible, and often of a dangerous nature. In passenger ships the load consists of accommodation and entertainment facilities for the passengers and, in ferries, of a large garage for motor vehicles. Offshore rigs and tanker storage ships are essentially oil plants.

A ship, however, by its very nature, is bound to spend the greatest part of its working life at sea where, in the event of a fire, difficulties related to the meteorological and maritime environment coexist with the need to cope with the emergency, in conditions of limited space and without the possibility of immediate assistance in terms of personnel or facilities to combat the fire and to assist casualties, who may be burned, poisoned or traumatized.

Thus a fire on board ship during navigation represents an extremely high-risk situation which may cause (see Note 1) physical harm or death to passengers, and loss of the ship or considerable damage to its structures and equipment. Furthermore, when the ship is carrying mineral oils, chemical or gas products, gases will certainly escape into the atmosphere and very probably liquids and solids harmful to the environment will be spilt into the sea. When the ship is unable to manoeuvre because of the damage it has sustained, especially in narrow waters, it may run aground so that mineral oils from the ship's fuel or the cargo are spilt into the sea. When the wrong rescue methods are employed, for example the indiscriminate use of large quantities of water, the ship may be lost as a result of instability, and not because of the fire (see Note 2).

PREVENTION, FIRE-FIGHTING AND FIRE SECURITY: THE FUNCTION OF THE INTERNATIONAL CONVENTIONS AND OF NATIONAL REGULATIONS

The main problem in fire prevention, fire-fighting and safety on board ship is that of knowing the 'enemy', i.e. fire (see Note 3), and the environment where it flourishes. This requires on the one hand technological means of reducing to an absolute minimum the possibility of fire breaking out and limiting its capacity to spread, so that there can be automatic intervention, and on the other proper training of fire-fighting and fire-prevention squads. Numerous papers have already been published on this subject and all have one aspect that is worth underlining: all the regulations, as they have been updated over time, have aimed to improve the standards in two respects.

1. *Passive defence*, in terms of the fireproof compartmentalization of the ship, the use of fire-resistant material, improved electrical installations, fireproof air conditioning/refrigeration/ventilation plants, proper stowage of combustible materials in relation to their flash point
2. *Active protection*, in terms of fire detection and localization devices, automatic extinguishers of various types (sprinklers, sprays, and equipment using inert gas, CO_2, foam, halogenated liquids), mobile equipment for the use of the ship's fire-fighting squads (portable extinguishers, fire hydrants, foam extinguishers), and fire emergency training (see Note 4).

All these precautions are agreed upon and established by the International Maritime Organization (IMO) through international conventions, which are obligatory for all ships flying the flags of countries belonging to the convention, and through resolutions or recommendations providing guidelines, which, however, are not binding for the national legislation of other countries.

At present the 'Safety of Life at Sea — London, 1974' Convention (SOLAS) is in force (see Note 5), of which chapter 2 establishes merchant ship passive and active defence criteria.

It should be borne in mind that the SOLAS regulations are scarcely ever retroactive, i.e. they are applied — especially when introducing new shipbuilding criteria — only to 'new' ships. This explains, though does not justify, why it is mainly 'old' ships (see Note 1) that are liable to fires.

SOLAS 74 provides for obligatory programmed maintenance of all fire-fighting equipment for active defence and for maintenance in a state of working efficiency of all material for active or passive defence. All ships are subject to initial and periodic checks to ensure proper observation of the national and international navigation safety standards, including fire precautions. These checks are carried out by the maritime authority of the ship's flag state, which is responsible for issuing the relevant certification (see Note 6). In Italy the checks are carried out by officers of the Port Authority Body (see Note 7), in collaboration with inspectors from the Italian register of shipping.

In order to prevent ship-owners from using 'flags of convenience' to operate substandard ships in possession of certification 'of convenience', 14 European countries (see Note 8) have set up a control system, known as the Paris Memorandum or MOU (Memorandum of Understanding), for the correct application of the international conventions (including SOLAS 74), consisting of periodic six-monthly inspections on board foreign ships docking in their ports. In Italian ports these inspections are carried out by officers of the Port Authority Body. The US Coast Guard operates a similar scheme in the United States.

PROBLEMS PRESENTED BY PARTICULAR KINDS OF SHIPS: CARRYING DANGEROUS GOODS; CONVEYING PASSENGERS, ESPECIALLY RO-RO

Independently of the observation of current standards (see Note 5), all ships carrying substances harmful to the marine environment (see Note 9) present, in the event of fire, problems relating to the chemico-physical modification which the cargo undergoes due to the increase in temperature, and relating to contamination risks for fire-fighters and the possibility of air and sea pollution. Every ship carrying such a cargo must have on board the 'Safety data sheet' regarding the goods in question, with instructions, among other things, as to measures to be taken in case of emergency.

Even if passenger ships also meet the severest requirements of SOLAS 74 as regards fire security, they present their own set of practical problems due to the need to evacuate large numbers of persons, whose physical capacity may not be perfect (elderly people, children etc.); the presence of smoke; the possibility of bad sea and weather conditions; and the passengers' involvement in an emergency in a ship whose layout they do not know. These difficulties are increased in ferries because of the short duration of the voyage (normally less than 24 hours), which gives passengers the impression they are on a bus, rather than on board ship.

For these reasons, starting at the ship's design phase, maximum attention must be paid to organization in emergency conditions. If necessary mathematical models can be used. Similarly, the passengers' attention must be drawn to instructions and information they receive about standards to be observed in the event of an emergency.

SAFETY AWARENESS AND CREW TRAINING IN FIRE PREVENTION AND FIRE-FIGHTING

In view of the poor support given by the various countries, whether industrialized or not, to the development of safety awareness, the International Maritime Organization has set itself the objective, in the IMO Convention known as the Standard of Training, Certification, and Watchkeeping for Seafarers (STCW 78), to guarantee a minimum training basis for all merchant ship crews. This convention, together with the obligation to carry out periodic practice drills, should ensure an acceptable standard of training (see Note 10).

ASSISTANCE FROM COASTAL SERVICES TO A SHIP IN NAVIGATION WITH A FIRE ON BOARD

The criteria to be kept in mind when assistance is being given to a ship at sea with a fire on board are (a) the international conventions regarding assistance and rescue, according to which salvage of the property represented by the ship and its cargo is the concern of private enterprises (see Note 11), and (b) the obligation binding all ships and maritime authorities to aid persons in danger (see Note 12).

We cannot pass over the first point without mentioning that the vessels used by various private assistance and salvage companies are not always adequate for the task when operating on a burning ship, particularly because of the absence on the salvage vessels of fire-fighting squads specially enlisted for this specific purpose. Regarding (b), with the enforcement of the SAR (Search and Rescue) Convention — Hamburg 1979, the IMO has created, independently of the various current national regulations (which must, however, conform to the convention), an effective instrument for the search and rescue of ships in danger (see Note 13).

Systems like ARES (automazione ricerca e soccorso/search and rescue automation), operated by the Italian merchant navy, and the US Coast Guard's AMVER are appropriate solutions to the problem of knowing the positions of ships in an area so as to permit the necessary intervention of vessels and aircraft for the protection of human life in emergency situations (see Note 14). In the same way, the VTS (vessel traffic service) makes it possible to plot all ships present in a determined zone so that assistance can be given rapidly and efficiently to persons in danger at sea (see Note 15).

ARES and VTS are managed by the Port Authorities Body, which is responsible for organization and intervention with its ships and aircraft in the various phases of rescue at sea.

MEDICAL FIRST AID FOR BURNED PEOPLE ON BOARD SHIP DURING NAVIGATION

By virtue of ILO (International Labour Office) Convention 92, every ship is provided with equipment and facilities for medical first aid to deal with all the usual needs. The legislation of individual countries establishes the cases in which it is obligatory to have medical and nursing staff on board (see Note 17).

This combination of regulations does not, however, guarantee the provision of necessary care for the victim of a fire accident apart from basic first aid. This means that, without in any way diminishing the importance of the valuable service provided by IRDC (International Radio Centre) (see Note 18), it is necessary to be able to transfer such casualties to a specialized medical centre (see Note 19).

These considerations clearly point to four primary elements in response to fire on board:

- Prevention, which can be achieved by improving shipbuilding techniques and inducing safety awareness among the crew and passengers.
- Active fire protection, which must be as far as possible automated.
- Rescue operations, which must be made more efficient and rapid by the use of plotting systems wherever ships are sailing.
- Medical assistance on board ship.

Of these, the first is by far the most important.

NOTES

1. Statistical data published in *Lloyd's Register Casualty Return* indicate that in 1988 (latest figures available) fires/explosions were responsible for the loss of 31 ships with a total gross tonnage of 125 229 tons, equal to 14.48% of the total tonnage of all lost ships; 83 human lives were lost. Fourteen of the accidents causing loss of the ship developed from fires/explosions in the engine room. Analysis of the data shows that:

- Fourteen of the lost ships were subject only to national navigation security regulations as owing to their particular features they did not come under SOLAS 74 standards.
- The other 17 ships, covered by SOLAS 74 standards, fell into the following categories:

Age (years)		*Gross tonnage (tons)*	*Type*
6–9:	2	up to 1 600 : 4	Tanker : 5
10–14:	1	up to 3 000 : 5	general cargo : 2
15–19:	5	up to 20 000 : 6	passenger : 1
20+:	9	up to 70 000 : 2	ro/ro : 1
			refrigerator ship : 3
			others : 2

Of the 17 ships hit by fires/explosions, only 11 were in navigation; two of these were loaded tankers (*Athenian Venture*, Cypriot flag, TSL 18251, age 13 years; *Odyssey*, Liberian flag, TSL 65746, age 17 years); one was an unloaded bulk carrier that caught fire following war action in the Strait of Hormuz (*Don Miguel*, Maltese flag, TSL 10526, age 12 years).

With regard to ships flying the Italian flag, the 1989 data show that of the four ships that suffered fires, none was lost, damage being limited to structures/plants; only one ship had a fire in navigation. The age of all four ships was over 19 years. In 1990, at the time of writing, there has been one sinking as a result of fire, that of a 9-year-old gas tanker in navigation. (For the preparation of these notes the writer thanks the General Management of the *Italian Naval Register* and *Lloyd's Register of Shipping*.)

2. Contrary to general belief, it is advisable to limit the use of water on board ship as an extinguishing agent.

- Water is effective only in Class A and Class B fires (i.e. excluding paints, solvents, mineral oils and petrol), while there may be on board ship various flammable and combustible material requiring other extinguishing agents (foam extinguishers, inert gases, CO_2, chemicals, halogenated liquids).
- In normal conditions there are on board live electrical systems which it may be impossible to disconnect or cut off in the event of fire. It is well known that in such cases water must not be used as an extinguishing agent because of its significant electrical conductivity.
- Water causes damage to the load and the equipment on board that is often greater than that due to the actual fire.
- Water favours the spread of polluting substances into the sea.
- In the event of very high temperatures, as may occur in fire at sea, pyrolysis of water may occur, with the liberation of oxygen which goes to feed the fire.
- Water remaining inside the ship's compartments (holds, engine-rooms, cabins, etc.) creates so-called 'free mirrors' which have a negative effect on the metacentric height of the ship, with resultant reduction of its stability. Many cases are known of ships that have run the risk of overturning because of the unconsidered use of water, particularly by land fire-fighting squads (just as there have been many known cases of ships with cargoes in their holds that have continued to burn despite the massive use of water).

All things considered, water can be used as an extinguishing agent only with great caution and in limited cases: to extinguish small fires and fires in the initial stages; to cool incandescent parts (provided that the water used is adequately eliminated overboard); to spray fire-fighting teams, for protective reasons.

3. It may be opportune to remember that 'fire' as a physical phenomenon is combustion characterized by an emission of heat accompanied by smoke and flame or both, and that 'a fire' in the ordinary sense means combustion so rapid as to develop uncontrollable in time or space. 'Combustion' is an exothermic chemical reaction between a fuel (a combustible) and a substance that will support combustion (a comburent). In other words, the co-existence of combustible, heat and comburent, together with free radicals which contribute to autocatalysis (maintaining the chain-reaction) generates a fire. This is the so-called 'fire-cross'.

Combustible

Energy FIRE Comburent

Autocatalysis

Any attempt to control and extinguish the fire must therefore eliminate at least one of its constituent elements. On board ship it is of particular importance to prevent accidental outbreaks of fire, due to negligence or carelessness. Hence the ban in certain parts of the ship on smoking, lighting of naked flames and leaving electric circuits live (unless properly insulated); the importance of preventing leakages of combustible or flammable materials and of not leaving rags or oily wads lying around; and the need to keep the engine-room clean. It is equally important to prevent transmission of heat by radiation, conduction or convection; to a large extent this is taken into account in the criteria of 'passive/active protection' adopted on board ships.

The following publications consider these points:

International Chamber of Shipping:
International Safety Guide for Oil Tankers and Terminals
Tanker Safety Guide (liquefied gas)
Tanker Safety Guide (chemicals)

International Maritime Organization: *Emergency Procedure for Ships Carrying Dangerous Goods*

Society of International Gas Tanker and Terminal Operators: *Cargo Firefighting on Liquefied Gas Carriers*

US Department of Transportation, Maritime Training Advisory Board: *Marine Fire Prevention, Firefighting and Fire Safety*

4. Current international standards require that on board ship there must be a specific fire-prevention organization, consisting of the following

- A muster list, indicating the tasks assigned to each crew member in the event of fire, the persons responsible for the use of fire-fighting equipment and installations, the officers responsible for the maintenance and efficiency of same, and the assistance to be given to passengers in the event of fire.
- Instructions to passengers as to procedures to be followed in the event of fire.
- Planning and indication of escape routes.
- Periodic fire drills and periodic tests of fire-fighting installations.
- Fire patrols.
- Display of ship's 'fire routine' for immediate consultation by the crew.
- Availability of 'fire manuals' illustrating the specifications, operation, location and maintenance of the fire-fighting equipment on board.

The Italian regulations have laid down since 1932 that, in addition to international rules, all Italian ships of 5000 tons or more gross tonnage authorized to carry 400 or more passengers must have a 'fire-fighting post' with particular equipment; a team of 'firemen'; and a fire-fighting squad in each of the 'fire prevention zones' into which the ship is divided for fire-barrier compartmentalization of the ship with the task of assisting the team of 'firemen'. (Regulation for the Safety of Navigation and of Human Lives at Sea, approved by DPR (presidential decree) 1154 of 14 November 1972.)

5. SOLAS 74 (International Convention for the Safety of Life at Sea, 1974) is the last of a series of conventions since 1929. SOLAS 29 was followed by SOLAS 49 and SOLAS 60. The present convention has been almost entirely modified by the amendments of 1981, 1983, 1987 and 1988, which are all in force.

In the case of ships built before the SOLAS 74 amendments came into force the standards are applied — unless otherwise stated — that were in force at the time of their construction.

SOLAS 74 and the later amendments are recognized by 106 countries and 7 territories, whose fleets represent 97% of the gross tonnage of the world's entire merchant fleet (updated to 31 December 1989). The SOLAS 74 standards do *not* apply to: warships and troop-carriers; cargo ships of less than 500 tons gross tonnage; ships not mechanically propelled; wooden ships of primitive construction; pleasure craft not engaged in commercial traffic; fishing boats; ships plying exclusively between ports in their flag state.

The following regulations are closely connected with SOLAS 74:

IBC CODE (International Code for the Construction and Equipment of Ships Carrying Dangerous Goods in Bulk)
IGC CODE (International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk)
IMDG Code (International Maritime Dangerous Goods Code).

6. Ships covered by SOLAS 74 must carry the following papers:

Passenger ships: Passenger ship safety certificate, valid for 12 months.
Cargo ships: Cargo ship safety certificate, valid for 24 months, subject to confirmation between the 9th and 15th month. Cargo ship construction safety certificate, valid for 60 months, subject to annual confirmation. Radiotelegraph (or radiotelephone) safty certificate, valid for 12 months.

Cargo ships authorized to carry dangerous goods are issued with the 'Certificate of fitness for the transport of dangerous goods', normally valid for 60 months and subject to annual inspection for confirmation.

All these papers are issued by the administration of the ship's flag state or by an organization recognized by that state. In Italy these papers, except for the 'Cargo ship construction safety certificate' (issued by the Italian Naval Register in the name of and on behalf of the Italian government), are issued by the port authorities, in their capacity as local organs of the Ministry of the Merchant Navy.

7. The Italian Port Authorities Body, created by RD (royal decree) 2438 on 20 July 1865, is one of the constituent bodies of the Italian merchant navy. It depends on the Ministry of the Merchant Navy for the performance of its tasks as established in the Navigation Code approved by RD 327 on 30 March 1942. The body is responsible for administrative functions regarding navigation and maritime traffic, including safety and the safeguard of human life at sea, prevention of pollution of the marine environment, search and rescue at sea by ship and by aircraft, fishing control, protection of underwater archaeological sites, keeping registers of maritime and port personnel and issue of maritime professional certificates, keeping of ship registration records, issue of licences for pleasure sailing, management and surveillance of maritime landed property, management of maritime ports (excluding those where port agencies operate) and their activities, control of ships arriving and leaving, embarkation/disem-

barkation of ship's crew, maritime military service, management of the Loran C Chain in the Mediterranean, management of the National Operating Centre, and management of VTS. The body consists of officers aided by petty officers and sailors with the rank of quartermaster of the Italian Navy Crews Body. At the top of the Port Authorities Body is an inspectorate general under the authority of an admiral inspector (a rank equivalent to that of rear-admiral with special assignments). The peripheral offices (except for a few of limited importance) of the Ministry of the Merchant Navy are run by officers of the Port Authorities Body assisted by military personnel in the body and by civilian staff.

8. The Memorandum of Understanding on Port State Control was signed in Paris on 26 January 1982 by the maritime authorities of 14 countries (Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom). The memorandum binds adhering countries to activate an efficient system for surveying safety standards, living conditions on board, and the prevention of pollution by ships docking at ports under their jurisdiction. In performing these inspections the surveyors must verify that the ship satisfies at least the international standards recognized by the country in which the inspection takes place (e.g. whether the ship satisfies the fire prevention standards established by SOLAS 74, even if the ship's flag state has not signed this convention; appropriate instructions are given, and a further check is made to see whether they have been carried out, in order to ensure that the ship is in order). Following the inspection the ship is issued with a certificate valid for 6 months. The results of inspections are communicated to the Administrative Centre of Maritime Affairs in Saint-Malo (France), which the maritime authorities of the various countries adhering to the memorandum may contact (by means of the SIRENAC computer system) for information about the instructions given and the inspections carried out on the various ships docking at their ports. On this subject see also G. d'Agostino, Fronte del porto, le regole sicure, *Guardia Costiera*, no. 3, 1990.

9. With regard to sea transport, substances are considered 'dangerous' or 'harmful' if their characteristics are such that they can cause damage to persons, the marine environment or the vessel carrying them; among these characteristics the most important are flammability, toxicity and corrosiveness. Not all substances considered 'dangerous' or 'harmful' for other purposes are necessarily considered so for sea transport, and vice versa; also, not all of these substances are admitted for sea transport, but only those on certain lists approved by the maritime association, depending on the manner of transport.

'Dangerous' or 'harmful' goods may be transported by sea in packages; in mobile tanks (tanker trucks, tank containers, tank trailers, tank wagons); or in bulk, in tanker ships. Goods in packages can be transported as general packed cargo (traditional cargo ships); in packages inside containers (traditional-type ships, container ships and ferries); in packages inside containers on trailers, railway wagons, trolleys or trucks (ferries); or in packages on trailers, wagons, trolleys or trucks (ferries).

As an example, the international classification of dangerous goods transported in packages is as follows:

Class 1	Explosives
Class 2	Gas (compressed, liquefied or dissolved under pressure)
Class 3	Flammable liquids
Class 4.1	Flammable solids
Class 4.2	Flammable solids or substances liable to spontaneous combustion
Class 4.3	Flammable solids or substances which on contact with water emit flammable gases
Class 5.1	Comburents
Class 5.2	Organic peroxides
Class 6.1	Poisons (toxic)
Class 6.2	Infectious
Class 7	Radioactive
Class 8	Corrosive
Class 9	Various dangerous substances.

However, in the event of a fire, all transported substances are potentially dangerous because of the transformation they may undergo with increase of temperature.

10. The STCW 78 (Standard of Training, Certification and Watchkeeping) convention establishes the following. (1) All those intending to obtain the qualification of Captain or Deck Officer must have attended a recognized fire prevention course and passed an examination on 'Fire prevention and fire-fighting procedures', including the ability to organize fire drills, knowledge of the classes and chemistry of fires, and knowledge of fire-fighting plant and equipment. (2) All those intending to obtain the qualification of Chief Engineer or Engine-Room Officer must pass an examination on the 'Methods and means of prevention, localization and extinguishing of fires'. (3) All deck and engine-room officers and hands on oil, chemical or gas tanker ships must have successfully attended a training course including fire prevention and fire-fighting.

With regard to fire-drills on board ship, SOLAS 74 (83) establishes that, depending on the type of ship (passenger or cargo), these should be carried out weekly or monthly.

Ships flying the Italian flag are inspected annually by officers of the Port Authorities Body in order to check, among other things, the efficiency and functionality of the ship's fire prevention organization as well as the crew's level of preparedness for fire emergencies.

The following points might be stressed in this context. The psychological capacity of persons normally engaged in other activities to face a fire on board ship cannot simply be taken for granted, even if these persons have been properly trained. The limited times for which crew members remain on the same ship, because of their labour contracts, do not improve knowledge of the ship and efficiency of reaction to fire. The constant trend of cutting crew sizes (while respecting IMO resultion A.481) raises doubts about the possibility of guaranteeing the safety standards laid down by international conventions.

11. See Brussels Conventions of 23 September 1910 and 29 September 1938 and also the very recent 'International Convention on Assistance to Ships and the Salvage of Persons and Goods', adopted in London on 28 April 1989 at the IMO.

For general concepts of assistance and salvage, see *Manuale di Diritto della Navigazione*, Lefevre d'Ovidio-Pescatore, ed. Giuffrè.

For Italian standards, see Art. 489ff in the Navigation Code.

For the new IMO 1989 Convention see C. Callando, Regime internazionale dell'assistenza e salvataggio e protezione dell'ambiente marino, *Guardia Costiera*, no. 2, 1989, and R. Foti, La nuova convenzione internazionale su assistenza e salvataggio — Punti qualificanti, *Guardia Costiera*, no. 2, 1990.

12. Reg. 10, Chap. V of SOLAS 74 states: 'The captain of a ship in navigation which receives a signal from whatever source indicating that a ship or an aircraft or their safety boats are in danger is obliged to proceed full speed ahead to rescue the persons in danger, informing them, if possible, of what he is doing'.

Art. 69 of the Navigation Code in force in Italy establishes that 'Any maritime authority that learns of a ship in danger or of a shipwreck or other accident must immediately provide for rescue operations...'

13. The SAR (Search and Rescue) Convention binds adhering countries to adopt all procedures necessary to provide persons in danger at sea off their coasts with the required services of search and rescue. In observation of this convention, Italy has created the ARES system (see Note 14) and has reorganized the Port Authorities Body: by the Interministerial Decree of 8 June 1989, the divisions of the Body that perform technical and operational tasks in the sector of assistance, navigation safety, rescue, maritime and state land police control, as well as surveillance — also with a view to the prevention and repression of pollution — of maritime waters subject to the jurisdiction of the state, together constitute 'Coastguard', a section of the body directly dependent organically and operationally on the inspectorate general of the body itself.

The organizational structure of the service is as follows. *Central level:* Inspectorate General of the Port Authorities, responsible for the Coastguard service; National Centre of Maritime Search and Rescue. *Local level:* 6 local operational centres (Genoa, Naples, Bari, Ravenna, Catania, Cagliari), 44 operational sections, 100 bases with naval vessels, 3 fixed-wing air bases (Catania, Guidonia, Pescara), 7 helicopter stations (Genoa, Rome, Naples, Bari, Ravenna, Catania, Cagliari).

According to the regulations in force in Italy, the following specific equipment must be carried on board rescue vessels in addition to standard equipment: two or more mobile pumps (unless there are fixed pumps), by exhaustion, with an overall delivery of 400 tons/hour or more; two aqualungs; two masks with filter; four leak-sealers for leaks of about 1 m by 2 m; one complete flame-cutting set; exhaustion hoses: at least 20 m for each pump; ten fire hoses; at least three fireproof connecting pieces on the fire manifold; metal tubing (at least 20 m) of the right diameter for the hoses; one diver's motor-compressor with equipment; an extra supply of towing cables; one emery wheel, one electric drill, one hand drill and sufficient associated equipment; assorted tools; one anvil, one forge; one daytime signalling light; two underwater lights; one searchlight of 500 W or more and two mobile electric lights; hoists with 50 m of steel cables of adequate diameter and length; at least 200 m of flexible bipolar electric cable with rubber (or equivalent) protective covering with copper section $2 \times 10\,mm^2$ for outboard electrical power; 10 orange smoke signals; 30 manual white-star signals.

14. In accordance with Chap. 6 of the Appendix to the SAR convention, Italy has instituted, in virtue of the MD (ministerial decree) of 22 July 1987, the ARES search and rescue automation system. In the event of accidents or dangerous situations this system provides updated information regarding ships' movements in order to reduce the delay between loss of contact with a ship and the start of search and rescue operations, when no danger signal has been received; to permit rapid localization of ships to be called on to provide assistance; to make it possible to establish a limited search area when the position of a ship in danger is unknown or uncertain; and to facilitate the supply of medical assistance and medical information to ships without a doctor on board.

15. VTS (vessel traffic service) enables land stations (vessel traffic centres) to monitor maritime traffic in a given area (as for air traffic) in order to eliminate risks to the safety of ships and the environment. The IMO has issued guidelines for the functioning of VTS, in Resolution A.578 (XIV) 'Guidelines for Vessel Traffic Service'. In December 1982 the EEC financed the COST 301 project for the creation of an integrated VTS network along European coasts. Italy participates in this VTS network with a national VTS which was created by SELENIA; the national VTS will interact with SIDIMAR (sea defence system) at the Ministry of the Merchant Navy in Rome. On this subject see the proceedings of the International Conference on VTS in the Mediterranean, held in Genoa on 20–22 February 1990, organized by the International Communications Institute, the French Institute of Navigation, and the Italian Institute of Navigation.

16. Convention no. 92 of the International Labour Office, now in force, establishes that every merchant ship must be provided with a special room for use as a sick bay (the number of beds is fixed by the administration of each flag state), with adjacent WC and provided with medicines and medical equipment of such quality and quantity as may be determined by the flag state. Both the IBC code and the IGC code establish that every ship must be provided with first-aid medical equipment, as established by the administration of the flag state; the ships must also be equipped with their own decontamination apparatus (showers, eyewashes).

17. Italian legislation establishes that:

- All Italian ships of over 200 tons gross tonnage must be provided, in relation to the voyage in question and the number of crew, with a surgery room, a sick bay with at least two beds, with adjoining WC

Table 1

Type of ship	*Doctor*	*Nurse*	*First-aid person*
Large passenger ship for Mediterranean cruise	1	1	–
Ferryboat for transport of 500 or more passengers in public service in the Mediterranean, with 6 or more hours of voyage between ports of call	1	–	–
Ship sailing outside the Mediterranean	–	–	1
Ship used for passenger traffic outside the Mediterranean, if the total number of passengers and crew does not exceed 150 persons[a]	1	2	–
Ship used for passenger traffic outside the Mediterranean, if there are more than 1000 passengers[a]	2	4	–

[a]This applies also to foreign ships embarking passengers in Italian ports.

and isolation room (Law 1045 of 16 June 1939).

- All Italian passenger ships (and foreign ships if they embark passengers in Italy) engaged in long-distance international voyages and carrying more than 50 passengers must be equipped with a ship's hospital and a surgery room (this incorporates the above-mentioned law) (RD 178 of 20 May 1897);
- All Italian ships must be provided with medicines, medication equipment and sanitary material, in relation to the type of navigation they are qualified for and to the type of ship; this equipment must be inspected every 6 months by the Maritime Sanitary Authority (MD 279 of 25 May 1988);
- Italian ships must have among their crew the crew members listed in Table 1 (MD 13 May 1986; RD 20 May 1897; DPR 620 of 31 July 1980).

18. The IRDC (International Radio Doctor Centre) was created in 1935 in order to provide medical assistance and advice by radio to sailors of all nationalities on ships without a doctor on board, in navigation on all the seas of the world. The service is entirely free and is available 24 hours a day. Besides the duty doctor permanently in service at the IRDC, a team of physicians, which includes the leading names in Italian medicine, is ready to give its disinterested advice. The IRDC has its headquarters in Rome and operates its own radio station which ensures continuous listening on the Maritime Mobile Service band. Requests for assistance can be sent entirely free not only to the IRDC but also to Rome Radio Postal and Telegraph Services, to all coastal stations of the US Coastguard, to Manila Radio and to Pacheco Radio (Argentina).

19. This kind of transport cannot always be carried out with the necessary urgency. While it is not difficult to intervene rapidly with helicopters in offshore areas or in narrow seas (e.g. the Mediterranean, the South China Sea, the North Sea), considerable problems are presented by the transport of

15
Marine fire casualties in merchant ships: the Greek statistics

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Fire casualties on ships lead almost certainly to disastrous results because of the limited and isolated areas of the vessels and the lack of immediate and easy access for the rescue team. Preventive measures are therefore much more effective in the effort to avoid such casualties than rescue and fire-extinguishing procedures or devices. For this reason we carried out a statistical evaluation of the casualties on Greek merchant ships, over the last 5 years, in order to clarify aspects of the fire accidents and understand the nature of this serious problem.

There is no doubt that Mediterranean countries have the largest merchant fleet in the world and Greece has by far the largest gross registered tons (GRT) (Table 1). Fluctuations in GRT in the last 5 years are shown in Table 2; the absolute number of ships is gradually decreasing for national and international economic reasons.

An average of 69 ships are victims of a marine casualty every year, 3.15% of the Greek fleet over 100 GRT (Table 3). These accidents cause on average 471 injuries per year, two-thirds of which occur in the open sea; on average

Table 1. Gross registered tonnage (GRT) of the Mediterranean countries (1988)

	GRT		*GRT*
Cyprus	18 394 594	Malta	2 995 373
Egypt	1 210 215	Portugal	919 731
France	4 468 313	Syria	70 211
Gibraltar	2 070 991	Turkey	3 099 493
Greece	21 436 070	Yugoslavia	3 463 015
Italy	7 424 769	Morocco	432 817
Lebanon	410 251		

Table 2. Number of Greek merchant ships > 100 GRT

	Number of ships	*Total GRT*
1985	2 456	28 646 160
1986	2 138	24 792 516
1987	2 061	22 706 257
1988	1 854	21 496 070
1989	1 820	20 315 018

Table 3. Numbers of ships suffering marine casualties

	Name	*GRT*	*Percentage*
1985	75	871 816	4
1986	65	1 271 328	3
1987	71	1 139 379	3.40
1988	68	939 835	3.10
1989	64	450 344	3.20

Table 4. Injuries during marine casualties, by location

	1985	*1986*	*1987*	*1988*	*1989*
Open sea	334	518	379	190	286
Ports, shipyards, coast	78	123	172	134	140
Total	412	641	551	324	426

114 injuries occur in ports, ship yards and coasts, which have easier approach and faster medical aid (Table 4).

Fire casualties represent 12% of all marine casualties (340). Nevertheless, fire is the fourth commonest cause of marine casualties, after stranding, foundering and engine damage (Table 5). Fire accidents injured 70 crew members and led to 14 total losses of ships in the period (Table 6). These 70 burn injuries represent 3% of marine casualties in general. Only the more serious accidents were reported in the ships' logs and all cases were hospitalized.

Only 7% of the injuries occurred in ports and ship yards, whereas the majority occurred in the open sea. It is interesting that 56% (40 persons) of the burn injuries were officers (Table 7). Captains, chief engineers and in general all officers are the most injured (45 out 70) and represent 63% of all fire victims. Unskilled personnel and technicians are less often injured (34%) (Table 8).

For the area where the fire started, we present Lloyds international statistics which are roughly proportional to the Greek statistics. The engine room is by far the most common area where fire started (35%), followed by the accommodation compartments (10%) (Table 9).

The majority of marine casualties took place on cargo ships (57%). Tankers follow with 21%. A matter for relief is that passenger ships come last on this list (Table 10). Most (67%) of these ships were between 11 and 20 years old (Table 11).

Table 5. Distribution of Greek ship casualties according to cause[a]

	1985	*1986*	*1987*	*1988*	*1989*
Foundering	14 (18)	8 (12.5)	3 (4.5)	3 (5)	6 (9.5)
Stranding	30 (40)	21 (32)	33 (47)	21 (35)	26 (41)
Fire	9 (12)	15 (23.5)	8 (11.5)	6 (10)	4 (6)
Contact	3 (4)	1 (1.5)	4 (5.5)	9 (15)	7 (11)
Engine damage	14 (18)	14 (21.5)	10 (14.5)	6 (10)	5 (8)
Collision	2 (2)	2 (3)	5 (7)	6 (10)	9 (14)
Other causes	3 (4)	3 (4.5)	7 (10)	9 (15)	7 (11)
Total	75	64	70	60	64

[a]Numbers in parentheses indicate percentages of total accidents in year. Percentages are rounded to 0.5%, so that percentages need not sum to 100

Table 6. 1985–1989

42	Fire marine casualties in Greek ships
70	Burn injuries
14	Total losses of ships

Table 7. Burn injuries, by location

	1985	*1986*	*1987*	*1988*	*1989*
Open sea	19	21	9	9	8
Ports, shipyards, coast	0	0	3	2	0
Total	19	21	12	11	8

Table 8. Rank of crew members involved in burn injuries

	1985	*1986*	*1987*	*1988*	*1989*
Captains, chief engineers	1	0	2	1	1
Officers	10	11	6	8	5
Unskilled personnel	6	9	1	0	1
Technicians	0	0	3	2	1
Trainees	0	1	0	0	0
Passengers	2	0	0	0	0
Total	19	21	12	11	8

In summary, fire marine casualties cause at least 70 severe burn injuries, the majority of which occur in the engine room and accommodation facilities. Most of the accidents take place while ships are in the open sea where immediate hospitalization of severely burned patients is not possible. These facts indicate the necessity of taking more preventive measures to avoid fire casualties and burn injuries on board ship.

To accomplish this goal, apart from the fire-extinguishing devices that every ship must have, more accurate knowledge needs to be given to naval officers during their training. Details about the causes of fire casualties, their conse-

Table 9. Area of ship where the fire started (world figures)

	1985	*1986*	*1987*	*1988*	*1989*
Unknown (explosion)	16	28	13	30	37
Accommodation	8	2	3	6	6
Engine room	19	16	9	19	23
Loading	4	1	1	0	2
Repair	1	0	1	4	1
Total	48	47	27	59	69

Table 10. Category of ship suffering fire casualties

	1985	*1986*	*1987*	*1988*	*1989*
Cargo ships	6	6	5	4	3
Tankers	1	4	2	1	1
Passenger	0	2	1	0	0
Others	2	3	0	0	1
Total	9	15	8	5	5

Table 11. Distribution by age (years) of Greek merchant ships declared fire casualties

	< 10y	*11–20*	*21–30*	*> 30*	*Total*
1985	0	8	0	1	9
1986	2	10	1	2	15
1987	0	3	3	2	8
1988	1	3	1	0	5
1989	0	4	1	0	5
Total	3	28	6	5	42

quence to the burn victims, statistical evaluation and facts on the economic consequences of fire accidents, should be taught to navy cadets.

The pharmacy of every ship should have the necessary wound and burn dressing materials, fluids and medications for systemic therapy during the shock period. Information on what must be given to a burn victim can be received over the radio at any time, since it is relatively easy to describe the extent of the accident if appropriate figures with the percentage of body surface are provided to every ship.

It is more than obvious that Greece and the other Mediterranean countries pay dearly every year in human lives and hospitalization of burn victims because of marine fire casualties. With the presentation of these data we would like to make a start towards a Mediterranean campaign for the prevention of and better rescue of marine fire casualties.

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16
Fire services at a motor racing track

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The Pergusa motor racing track is 9 km from Enna. Italy's highest provincial capital (948 m above sea level). It runs round Lake Pergusa, which now, sad to say, is drying up. Races of international importance are held here for all categories of racing cars and motorcycles.

The Pergusa motordrome is open all the year round and can be used even in the winter months because of the mild weather. For this reason it is the most important permanent motor racing track in the south of Italy. Its high standard is confirmed every year by the fact that it is regularly chosen for important races in every championship category and by the attention that an increasing number of industries pay to it for trials and tests of every sort.

The safety of its structures has been steadily improved and everything is being done to improve its services as well. We deal here with the fire prevention service.

The Pergusa track is 4950 m long and there are 15 fire-fighting stations. As the circuit is circular, three artificial chicanes have been created which cause cars to slow down. Extinguishers and trailers are kept ready in the pits.

When cars line up at the start of a race the fire squads stand by with portable extinguishers. There are portable and trailer-carried extinguishers at the entrance and exit of every chicane.

Around the track there are five fire trucks with spherical and portable Halon 2402 extinguishers, equipped with jacks, metal-shears and nippers. The fire trucks are located at the chicanes and at the first bend, together with pick-up trucks and ambulances with physicians and nurses. After the start a fast car follows as far as the first bend.

The medical service is provided by physicians from the Italian Federation of Sports Medicine. The chief physician at the Race Direction Medical Centre has TV and radio links with two fully equipped anaesthetists/resuscitators. Along the track there are six ambulances, of which two are specially equipped for resuscitation. At every ambulance station there is a doctor with reanimation equipment.

At important races there is an ACI Elisoccorso helicopter on stand-by

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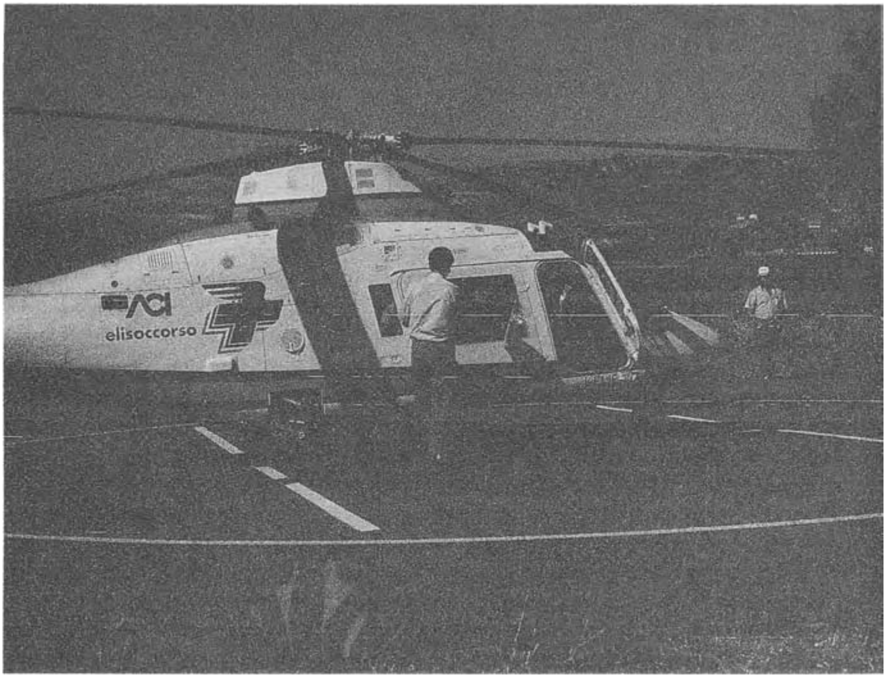

Figure 1.

(permanent as from September 1990) (Figure 1). This rescue helicopter is equipped to provide resuscitation during the rapid flight to Enna Hospital or the Palermo Burns Centre.

Every race attracts large numbers of fans who watch from the stands or the hillsides surrounding the track and the lake. Speeds of 310 km per hour are reached, especially on the long bend, and the fastest lap speeds are around 210 km per hour. Accidents are most likely where cars are decelerating, i.e. when going into the chicanes, or when accelerating as they come out of them. The rescue teams therefore stand by at these points. Sometimes the medical stations are 'lucky' in the sense that an accident followed by fire happens right in front of them.

The speed and efficiency of the rescue services are tested during every race. To illustrate what may happen, we describe a dramatic accident that happened three years ago during a Grand Tourism race. Just after the start a car skidded a few metres before the first bend, hit the guardrail, turned over and, having itself been hit by another car, burst into flames (Figure 2 shows a frame from a TV recording made by the closed-circuit service). The driver was able to get out, with his clothing on fire, just as the fire truck and the fire-fighting squad arrived. In ten seconds (it seemed a lifetime!) they put out the flames on the driver and also on the car, which was a total wreck. The driver was taken to the Palermo Burns Centre, under Professor Masellis, who treated him successfully for burns over the whole body.

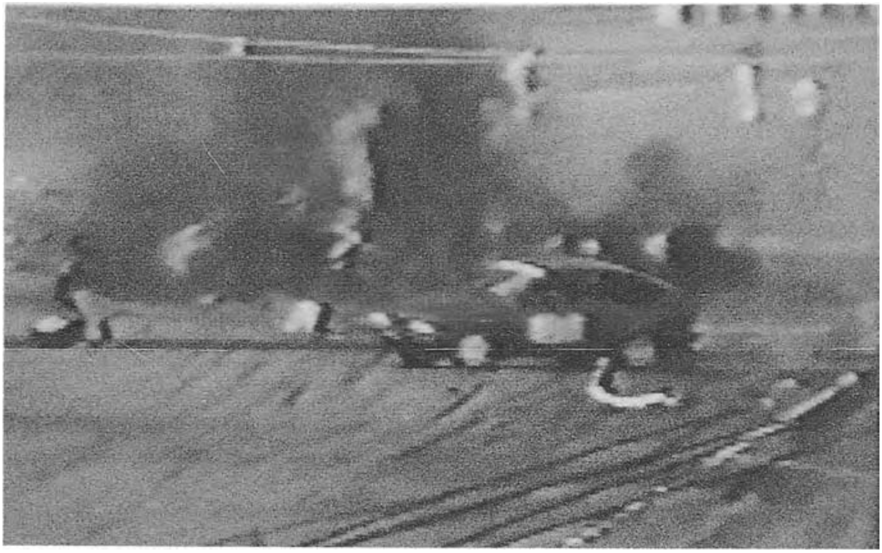

Figure 2.

This description of the means available at the Pergusa track should not give the impression that everything is perfect. Much still has to be done before we can say that we are fully prepared to fight a fire, let alone that we are able to conquer it.

17
Fire emergency in a hospital

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Hospitals, whether general, geriatric or psychiatric, and other similar institutions, are generally regarded as havens of safety where the patients, more or less dependent, are poorly inclined to react to an aggressor like fire originating from within the actual structure. The medical and administrative directors of such institutions, in their desire to avoid the mere suggestion of this potential aggressor, generally fail to give any appropriate instructions.

However, accidents of varying gravity do in fact occur in hospitals. These accidents, far from being minor, are frequently disastrous. Some regrettably fragmentary epidemiological analyses have shown that the consequences are magnified by structural features and such elements as the time of occurrence of the fires (more than half in periods when the number of staff is reduced). When the causes of the fire are analysed, one notices a large proportion of negligence (e.g. smoking) or carelessness; the study presented here is based on research conducted in France.

For research purposes, hospital fires are normally divided into two main categories, depending whether they break out in areas with patients (wards, medication and operating rooms) or in 'technical areas' that are part of the logistical infrastructure. This is not a purely theoretical distinction, as the consequences can be considerably different. Fire can cause thermal, toxic and mechanical lesions. The presence of medical fluids is an added consideration and their specific management presents numerous problems. Systems generally thought to be vital for the institution are destroyed or put out of action; consider, for example, the lack of sufficient light for rescue work because of the release of dense, oily smoke that incapacitates the patients and even well-equipped firemen.

In the event of a fire, whatever its initial extent, two interconnected groups of questions have to be asked: Will the behaviour patterns be appropriate, considering that it is known that 5–10% of individuals are subject to panic? What decision should be taken regarding activity actually in progress?

During the fire emergency it will be necessary to reconsider the possibilities offered to the decision-makers, who must have perfect knowledge of the layout of the buildings, the staff, routes and facilities for movement, the state of the patients, the presence or absence of out-patients or visitors. The central problem is the mobilization of the patients, which means transfer to a place of safety or protected area, or a more or less general evacuation. This mobilization itself involves certain risks which have to be assessed as accurately as possible for each category of patients. It is essential to consider certain dynamic parameters of this procedure: flow (and risk of flow-back), duration, priorities, and destinations (in or outside the hospital). It is therefore advisable to make continuous assessment of the human and technical means available for these tasks, with deliberate underestimations. The importance of permanent preparedness is self-evident.

One element of the management of fire emergencies that is relatively easy to know concerning evacuation is the architecture of the hospital or accommodation structures. The possibilites are: (1) pavilion-style: the fire spreads less, and horizontal access and evacuation are facilitated; these are often old buildings; (2) high-rise: greater concentration of patients, horizontal transfer to protected areas has to be found; (3) old and complex buildings: precise layout plans are indispensable in order to direct rescue operations; (4) wide-scattered buildings: horizontal movements are facilitated and the compartmentalization must be respected and if possible amplified.

A second element of emergency treatment is knowledge in real time about the patients' state of autonomy. The nursing team, using information systems, should be able to provide useful assistance in this respect. The patients can be divided into three groups on the basis of the medical equipment they require, their need for accompaniment and their dependence. The first group of patients can be evacuated by unskilled external personnel. The second group consists partly of patients not requiring any special medical equipment but needing stretcher transport. This can be makeshift (e.g. a mattress dragged along the floor) or complex (a chair in a lift). Other patients requiring some medical equipment will take only the absolute minimum; they will need two persons to accompany them and they require transfer to specific destinations. The third group, which could be subdivided *ad infinitum*, consists of patients who need special measures, as far as that is possible. This group pays the highest cost for evacuation or mobilization, a cost that may quickly become very heavy. It consists mainly of patients in intensive-care units, operating theatres, etc. Fires may be rare in these units but that does not make them any the less dramatic: a patient on the operating table can benefit from transport only by mobilizing the team responsible for his survival.

A miscellaneous group of other equally vulnerable and numerically important patients consists of children, who easily panic; psychiatric patients, who nearly all have polymedication but who know the nursing staff; and old people, who are very often emotionally attached to objects, and physically unable to move rapidly (some may be deaf, which makes alarm-bells ineffective).

In the event of a foreseeable emergency it is therefore indispensable to define an institutional response which will allow a certain degree of adaptation of plans that have already been carefully tested. The institutional response concerns all those involved in emergency action, whether internal to the hospital or external, for example organized groups of rescue workers. The response is first of all structural and involves measures of strictly observed sectoralization, efficient lighting for the rescue work, smoke clearance and the like. Assuming that the layout and maintenance conditions of the buildings are known, it is important to prepare a response based on the combination of realistic plans and the ongoing training of hospital staff and external rescue workers (this training can be done jointly).

The observation of existing rules and the compulsory familiarization with precise but elastic instructions must be the task of the security service, which will have adequate means at its disposal; all personnel must be obliged to attend training sessions, insisting particularly on those physicians who are refractory to this form of constraint. Fire drills, even if only partial, are useful to test the plans, to educate people to be accustomed to danger, to train different personnel to cooperate and, above all, to demonstrate that certain transfers of patients are possible.

Patients must be informed intelligently so that they are reassured rather than frightened. The effects of panic and improvisation are more to be feared than an arousal of the patients' awareness. They must be made to realize that the hospital staff are competent not only in handing out pills but also in facing collective danger.

In conclusion, a good state of preparedness, the performance of theoretical exercises by the decision-makers (for example through teaching experts) and the continuous classification of patients on the basis of their degree of dependence are standard measures that make it possible to offer a coherent response to the incongruous phenomenon of a hospital being transformed from an institution of protection into one of destruction.

18
Fire prevention countermeasures for cultural properties in Nara City

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Nara City was the ancient capital of Japan for 100 years in the 8th century, and it was prosperous, not only as the western terminal of the Silk Road, but also as the centre of Buddhist culture in Japan. There are, as a result, a large number of important cultural properties in Nara City, totalling 769 designated properties. They include 118 national treasures and 526 important cultural properties. Buildings constitute 29 of the 118 national treasures in Nara City and also 68 of the 526 important cultural properties. Other articles designated as cultural properties are paintings, sculptures, items of industrial art, old manuscripts, archaeological assets and historical data (Table 1). The national proportion of buildings of national treasures and important cultural properties in Nara City is 29 out of 207 and 68 of 1842, respectively. These are considered valuable and Nara contains very large numbers compared to the other 47 prefectures and 3245 municipalities in Japan. Flood or earthquake disasters are rare in Nara City. Because most of the buildings are made of wood, most

Table 1. Designated cultural properties in Nara City (total 769 properties)

Classification	*Total*	*National treasures*	*Important cultural properties*	*Prefecture-designated cultural properties*	*City-designated cultural properties*
Buildings	139	29	68	31	12
Paintings	76	7	52	6	11
Sculptures	294	44	202	30	18
Industrial art	136	27	102	4	3
Old manuscripts, etc.	105	7	89	5	4
Archaeological assets	14	4	10		
Historical data	5		3		2
Total	769	118	526	76	50

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disasters are caused by fire. Disaster countermeasures in Nara City have had to contend with approximately 60 fires per annum in recent years. Among these fires, about 30 were in buildings, but no cultural properties were damaged.

In this paper, countermeasures for protection of cultural properties are described, with particular reference to the facilities of Todaiji Temple, which is a world-famous tourist attraction with the great statue of Buddha.

Todaiji is the largest temple in Japan, with 3 million visitors a year; its site is approximately 100 acres and there are many buildings, including smaller temples, boarding houses for the priests, pagodas, etc. The fire prevention countermeasures at Todaiji temple are as follows.

1. Regarding the electrical facilities in the buildings, Todaiji has automatic alarms in each building, electricity contact-breakers, and TV cameras to prevent incendiarism.
2. Loudspeakers are installed at many places and these will give warning of the fire.
3. Lightning conductors are located on the roof of each building which exceeds the highest level of the trees in the area.
4. Many ponds around the temple provide water for fire extinguishing.
5. A 1500-ton capacity water-tank is installed at 2.5 times the height of the roof-top of the temple of the great statue of Buddha; water for the tank is piped from the mountainside.
6. All roads in the temples are cleared to allow fire brigade vehicles to circulate easily without hindrance.
7. A drench system is used to check the spread of fires.
8. Government authorities carry out fire drills twice a year relating to cultural properties in Nara City.
9. Many Nara City citizens are members of the Volunteer Fire Brigade that protects Todaiji Temple.

We wish to protect our own important historic properties by these measures. We expect them to be useful also in the protection of cultural properties in other countries.

Section III

Preparedness for Primary Burn Emergencies

19
Immediate assistance and first aid on the spot in fire disasters — education of the public and self-sufficiency training

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Fire is a dramatic disaster not only because of its devastating effects on property and individuals but also, and above all, because of the panic it engenders in all those who suddenly find themselves face to face with the spread of flames. In the presence of fire, a certain degree of panic is the most natural, almost physiological reaction, occurring in every living creature from insect to man. An initial moment of psychological paralysis is common in all persons, followed by total inability to think rationally, which in turn leads to acts of instinctive behaviour with a single aim: to escape to safety.

This sequence of actions not infrequently serves only to worsen the amount of damage caused and to create an even more dramatic and tragic situation. This may indeed be the only reaction possible in animals, which are purely instinctive, but in man there is another option which at first sight may seem almost paradoxical: to keep calm and take rational decisions. This can be achieved in one way only: through information about the risks involved, through understanding of the dangers, and through instruction about how to behave in case of fire.

BURN DISASTER

Whether a fire disaster strikes a building, a hospital, an airport, a ship, a factory, a sports stadium or a campsite, it is inevitably a highly devastating event because of the social and public context of these structures. The extent of the disaster is determined by the distribution of material objects and, above all, by the number of persons involved. Those who escape death may suffer extensive burns that may be immediately life-endangering.

The problems of the involvement of human beings in a fire disaster are expressed precisely in the concept of 'burn disaster', which may be defined as 'the overall effects on living persons caused by the massive action from a known thermal agent. It is characterized by a high number of deaths and of seriously burned patients with a high rate of potential mortality and disability. It may be aggravated if appropriate rescue operations are delayed.'

Some specific aspects of burn pathology, such as may occur in fire disasters, will help in the understanding of this definition. The inhalation of combustion gases, fumes and hot air can cause life-endangering damage to the airways, even if the actual burns are limited in extent. Burns covering more than 20% BSA (body surface area) in the adult and 15% BSA in the child cause a state of deteriorating hypovolaemic shock requiring resuscitation within the first three hours. The burn is often associated with other trauma (fractures, wounds, electrocution, etc.) which may complicate the prognosis *quoad vitam*, if not treated in good time.

IMMEDIATE CARE AND FIRST AID

The characteristics of relief action in a burn disaster are closely linked to the particular nature of the damage that fire causes in living persons and material objects, the manner of its occurrence, the dangers to which the rescue workers are exposed, and the specific type of care that has to be given to the victims.

The timeliness and the effective impact of relief work depend on both general and local factors. In the specific case of the 'burn disaster', as defined above, the particular circumstances — such as the *moment* when the disaster occurs (night, daytime, public holiday, in unfavourable weather conditions), the *place* of the disaster (residential area, skyscraper, isolated locality), the degree of *accessibility*, the *distance* from operational rescue forces — all acquire importance because any delay will prevent relief work from being immediately available.

A decisive role is therefore played by local intervention factors that chiefly depend on the behaviour of the people present at the scene of the disaster, and on the action of the operative teams that arrive rapidly on the scene.

The peculiar nature of the burn disaster therefore dictates well-defined chronological and qualitative operative phases. A person with burns of the airways and associated trauma needs immediate care of a different type from that given to the victim of an earthquake, flood or cyclone. It is also of fundamental importance, for prognostic reasons, that pending the arrival of organized relief some medical and/or surgical first aid must be given within a very short time according to the type of pathology present.

The prognosis of burn disaster victims is thus conditioned by the degree of preparedness of the population facing the fire emergency and by the operational capacity of volunteers, physicians and nurses present in the area or in the immediate vicinity who have received previous training in this specific type of relief work.

If people are to be able to give immediate care, either to themselves or to others, they must know precisely what they have to do, they must have information not only about behaviour guidelines that will enable them to save themselves (self-rescue) but also about elementary principles necessary for immediate help to others. Understanding the danger represented by fire also means how to tackle it and how to defend oneself from it.

The more specific aim of first aid is to contain the injury and to reduce the risk of mortality. This is the responsibility of the trained groups already mentioned, who are organized within two or three hours of the disaster. These groups, consisting of physicians, nurses and volunteers, with well-defined tasks, perform the first emergency triage and, bearing in mind the particular evolution of the initial phase of the burn pathology, set into motion all the procedures necessary for initial resuscitatory therapy and local treatment of burns.

TEN GUIDELINES FOR IMMEDIATE CARE OF BURN VICTIMS:

1. *Self-control*

The first rule to follow in the event of a fire is: 'Don't panic'. Rescuers must behave rationally and avoid any needless action. The first thing is to examine the situation, assess the gravity of the fire and opt for the appropriate behaviour. To help others one must first be able to protect oneself.

2. *Self-protection*

Rescue workers must know how to protect themselves from flames, fumes, toxic gases, falling masonry and other hazards to their personal safety.

- Do not walk over ground covered with easily flammable material (paper, sawdust, brushwood, etc.).
- Keep away from anything containing flammable liquid that might explode. Open containers holding liquids that burn at low temperature (e.g. petrol or kerosene) radiate heat that may be sufficient to ignite them.
- Do not cross floors or lofts, or use stairs, or walk under ceilings exposed to flames.
- Do not stand downwind from the flames, and anticipate a sudden change in the direction of the fire. Even in the absence of wind, crossing zones exposed to air currents (tunnel exits, airshafts, narrow passageways) becomes risky.
- Consider the possible direction in which the fire may spread in order to protect yourself from the flames.
- If possible, use protective clothing and devices; for example helmets to protect the head and prevent the hair from catching fire; dark glasses, even ordinary sunglasses, to protect the eyes from glare, sudden blazes and flying flaming particles; gloves, a welder's apron, etc.; a safety-belt, if available, which can be worn and tied to a rope held by another rescue worker, when carrying an injured person; and dust-masks, which prevent the inhalation of solid particles liberated by the fire and thus prevent irritation of the upper airways.

3. *Reducing the activity of the fire*

Pending the arrival of the fire brigade:

- Evacuate all people at risk, beginning with those in places most immediately threatened.
- Remove from the area of the fire all flammable material, gas cylinders, etc.
- Switch off ventilation and airconditioning systems to keep out fresh air which feeds the fire and to prevent the flammable and toxic gases and vapours from spreading.
- Switch on any fixed extinguishing equipment such as waterjets and sprinklers.
- Use correctly the available portable fire-extinguishers.
- Avoid using water to extinguish flames on or near electric plants (the material that such structures are made of can react by considerably increasing in temperature or by releasing flammable and noxious gases).

4. *Extraction and transfer of victims to the open air*

Before or upon entering a burning room:

- Put a wet cloth over the mouth, or wear a gas-mask.
- Enter the room on all fours and crawl forward in this position, as smoke tends to rise.
- If there are flames in the room, wrap yourself in a blanket and advance on all fours.
- Crawl backwards down any stairs in order to avoid tripping.
- Before a closed door, it is advisable to feel the handle or the door itself before opening it; you could be caught in a blast of flames and smoke as soon as it is opened.
- Watch out for glass surfaces (doors, windows) because the heat and pressure generated by fire can cause them to explode.
- Approach cautiously air-shafts or small rooms without any ventilation. A rope guide is useful.
- Avoid passenger or goods lifts as a power breakdown can transform them into traps and they also become flame shafts.
- If trapped in a room, the best thing to do is to shout for help from a window.
- Do not stay any longer than necessary in a room. Do not be too sure: in other words, do not do anything rash.

5. *When clothing is on fire*

It is extremely distressing to feel oneself wrapped in flames or to see another person transformed into a flaming torch. In these circumstances it is more than ever essential to remain calm and to know precisely what to do.

- To extinguish flames in one's own clothing, one must clasp one's arms around the chest, and roll about on the floor.
- To extinguish other people's clothing, it is best to throw the person to the ground (tripping them up if necessary), to get them into a horizontal position, and to wrap them in a blanket or carpet or any other heavy material that can be rolled up (if they remain standing or sitting the flames will rise to their face and inevitably they will inhale hot air, smoke, etc.).
- Burning clothing should not be extinguished with violent jets of water aimed directly at the person: this can increase pain and the state of shock. Jets of water containing large amounts of oxygen can increase the combustion of petroleum and of synthetic clothing materials.

6. *Removal of burning clothing*

- Cut away belts, sleeves and tight clothing with great care.
- Remove rings, bracelets and other constricting items: as the burn oedema develops these can cause ischaemia.
- Do not violently tear off clothing, especially socks and shoes, adhering to burned surfaces, as this would also tear away skin that would be useful in the healing process.
- Remove at once, having first cooled them if possible with cold water, clothes impregnated with boiling liquids.

7. *Emergency treatment of burned areas*

To prevent burn lesions from deteriorating, the following are essential.

- Do not burst any blisters or remove the epidermis. Exposure of the dermis only increases the loss of body fluids and heat, besides increasing pain and the risk of infection.
- Cool the burned parts with water or wet cloth. This stops the action of the thermal agent and considerably reduces pain. Very extensive burns must be treated either by immersing the part in water at room temperature or by covering the part with damp cloth. The cooling operation should generally not exceed 20 minutes. It should be guided by the patient's general condition and the degree of pain relief achieved. Cooling a patient must be stopped if he begins to shiver, as this can lead to hypothermia. Children and elderly persons and those in a state of shock must be treated with even greater care, with less energetic and shorter cooling. Non-extensive burns can be soothed with ice-packs or by placing the part under a running tap.
- Use clean plastic bags, if available, to wrap burned hands and feet, or to spread out like adhesive flaps over burns on the thorax, limbs, etc.
- Wrap burned parts or the entire body in a freshly laundered dry sheet, towel or cotton or linen cloth, and do not apply dressings, as these would cause constriction as the burn oedema increases.

- Do not medicate burned parts with ointments or other drugs as these would only mask the picture.

8. Pending more complete relief

- Check for other associated trauma, such as bleeding, fractures, head injury and respiratory distress.
- Use a belt, cord, etc., as a tourniquet to stop haemorrhage.
- Plug the wound with a tampon, if available.
- Lay the patient flat and apply splints to fractures.
- Clear the airways by extending the head of the victim and begin mouth-to-mouth resuscitation.
- Give just coffee or tea or even a little water (but not more than 100–150 ml). Stop giving liquids if the patient vomits. Give no alcohol.
- Keep the patient warm by covering with a blanket.
- Reassure the patient.

9. Chemical burns

The following three rules are helpful.

1. First, wash the part that has been exposed to the chemical with copious amounts of water (eyes and face with greater care). Remove impregnated clothing and wash any parts previously covered.
2. Without delay establish the chemical's pH by one of the following simple tests: *Tip-of-the-tongue test*: Touch the burned skin and place the finger on the tip of the tongue; if the chemical is acid, there will be a bitter taste; if it is alkaline there will be no particular taste but a pungent and dry sensation. This test is safe and reliable. *Saliva test*: Spread a little saliva with a finger over the burned skin. If the chemical is alkaline a soapy emulsion will form between the fingers. An acid will cause no reaction. *Bicarbonate test*: Sprinkle some bicarbonate over the burned skin. An acid, but not an alkali, will produce effervescence.
3. If possible, apply mildly neutralizing substances to the washed parts: kitchen vinegar (acetic acid) diluted with 50% water in case of alkali burns; household sodium bicarbonate (two teaspoonsfuls in a litre of water) for acid burns. The eyes must be washed using water only.

It is important to obtain all information on the nature of the chemical and to relay it to the hospital where the victim is taken, so that the appropriate antidote can be applied.

10. Electrical burns

When faced with a burn due to electrical power:

- Switch off the current if the victim is still in contact with a conductor. If this is not possible, and if the current is less than 500 V, separate the part of the body in contact using a pole, broom handle, wooden plank or any other insulating material, or with insulating gloves, rubber shoes, etc.
- Lay the victim flat on the ground.
- If fainted but breathing, lay the victim on one side.
- If unconscious and not breathing, place one hand under the back of the neck and stretch the head back. This will allow air to pass through the upper airways that have been obstructed by the root of the tongue or by the dropping of the jaw.
- If still not breathing, start mouth-to-mouth respiration immediately.
- If unconscious, not breathing, no carotid pulse and dilated pupils, start artificial respiration and external cardiac massage and continue until medical relief arrives. There is absolute priority for hospital transfer.

TEN GUIDELINES FOR FIRST AID TO BURN VICTIMS BY TRAINED TEAMS

1. Immediate triage of seriously ill victims

The victim of a fire disaster may also have suffered cranial, thoracic, spinal or abdominal trauma which can be masked by the overall picture of extensive burns. It is necessary to establish the priority of treatment and whether the patient's life is in danger. The first thing to look for is haemorrhage and breathing difficulties.

2. Inspection of the upper airways

- Involvement of the upper airways should be suspected in face and neck burns. It is necessary to check to see whether the nose hair is burned, whether the oral mucosa shows burns, whether there are carbon particles in the sputum, whether there is wheezing, hacking cough, dyspnoea, difficulty in expelling secretions, or hoarseness.
- The more serious the thermal damage to the upper airways, the more rapidly and the more seriously oedema of the glottis will set in with subsequent obstruction of the airways. In serious cases it is necessary to perform endotracheal intubation. This must be done by an expert because the oedema often conceals the vocal chords and the manoeuvre may stimulate reflex acute spasm of the glottis. In acute obstruction of the airways the only manoeuvre possible is tracheostomy.
- Inhalation of hot gases can cause burns in the lower terminal bronchi. Inhalation of boiling steam produces alveolar damage. Inhalation of smoke causes corrosive pulmonary damage by the action of combustion products such as hydrochloric acid and phosgene.

The thick black smoke released by burning polyurethane foam contains cyanide compounds that can cause rapid unconsciousness and death. In such cases the patient should be made to breathe; if a manual ventilator is available (Ambu type), ventilate the patient until medical relief arrives. If an oxygen cylinder is available oxygen using a high-pressure mask (100%) should be given.

3. *Qualitative assessment of the burns*

This can necessarily be only approximate. It is necessary to distinguish between:

- *Superficial burns* (first- and second-degree) with red areas alternating with areas of healthy skin, or de-epithelialized areas with the underlying healthy dermis red and wet. These are very painful when exposed to the air. They secrete a considerable amount of fluid, which facilitates the onset of shock.
- *Deep burns* (third-degree) with areas of dead, whitish tissue beneath a thin carbonized stratum that is easily removed, or dark, dry, very adhesive areas. Deep burns are not painful.

4. *Quantitative assessment of the patient's burns*

This must be done after removing the patient's clothing.

The Rule of 9. For adults, 9% for each upper limb and for the head, 18% for each lower limb and for the front and back of the thorax. For the other parts, with less extensive burns, the surface of the palm is equal to 1%. Erythema is not calculated. In children the head is equal to 20% of the entire BSA.

- Moderately serious burns: 20–40% BSA second-degree burns and 20% third-degree burns;
- Serious burns: second- and third-degree burns involving over 40% BSA;
- Very serious burns: involving over 60% BSA.

5. *Intravenous resuscitatory therapy*

- Infusion therapy is necessary if the burned surface exceeds 15–20% in the adult, or 10–15% in the child. If it is impossible to administer infusion therapy, the patient should sip water containing a little salt (1 litre + 5 g (one teaspoonful) salt) and one spoonful of bicarbonate of soda. If the burned surface is more than 25–30%, infusion resuscitatory therapy is essential and urgent.
- The veins of choice for needle puncture are those of the upper limb (forearm or fold of the elbow), if the area is free of burns.
- If the veins are not visible a cut-down will be necessary, even through the burned area.
- The venous catheters should be of good calibre and not too long.
- Analgesia is not necessary in cutting through burned surfaces and accurate closure of the surgical wound is not essential.
- Before connecting the i.v. infusion set, blood samples are taken for lab tests. If it is not possible to obtain blood from the catheter, do not insist.

- I.v. fluids containing 130/150 mmol/L NaCl should be given: failing this, normal physiological solution.
- It is also possible to use protein colloidal solutions, plasma, Ringer's lactate or acetate, as available.
- If more than 1 hour has passed since the accident, it is possible to use colloidal solutions of low molecular weight (Hemagel, Macrodex). These enhance renal osmotic excretion of haemolytic pigments in the glomerular filtrate.
- The fluid requirements in the first 4 hours can be calculated as between 0.5 and 0.65 ml/kg for each percent of the burned body area.
- If 2000 ml of fluid has to be infused in the first 4 hours, the infusion rate should be calculated as 500 ml per hour (7 drops per minute).
- If the infusive therapy begins after 30 minutes, the infusion rate must be increased in order to make up for the delay.

6. *Analgesia therapy*

Good analgesic therapy must reduce clinical shock; maintain and even increase blood pressure; ensure that breathing is not impaired by the drugs; produce amnesia in the distressed patient; make use of the simplest method for pain relief; avoid using drugs that lead to addiction; use only drugs with a wide margin of safety.

Third-degree burns are not painful and more superficial burns do not always require analgesic therapy. The following drugs are preferred.

- Tilidine hydrochloride (Valoron) in drops, administered sublingually. Dosage: 1 drop per year of age in children. Generally it is possible to give 5 drops at the beginning, repeated after 5 hours. Adults: 20 drops. This drug does not cause amnesia. It may prove difficult to administer to a crying child.
- Ketamine hydrochloride (Ketalar), preferably administered intramuscularly because in the circumstances it may be difficult to find a vein. The action is prolonged if administered intramuscularly. This drug appears to possess all the requirements of analgesia but as it is a general anaesthetic it is not without danger. It must be administered by physicians in subanaesthetic doses of 0.3 mg per kg body weight.

If these drugs are not available and if pain has not diminished on application of cold packs, small doses of diluted morphine sulphate (10 mg of morphine sulphate in 10 ml) may be given intravenously in doses of 0.1–0.2 mg per kg body weight. The injection must not be intramuscular or subcutaneous because the accumulated drug may be reabsorbed when the circulation improves, causing sudden and unexpected respiratory distress.

7. *Bladder catheterization*

- Insert an in-dwelling urinary catheter.
- Connect it to a drainage bag.
- Measure total and hourly urine volume.

8. Pressure-relieving incisions

If more than 2 hours have elapsed since the accident, it is necessary to incise the burned areas down to the healthy fascia level in order to eliminate compression on the underlying tissues. Because of the non-elasticity of the skin and the worsening oedema, deep circumferential burns that involve the neck, thorax, limbs and hands can prevent thorax expansion and constrict arteries and veins, thus obstructing the circulation.

9. Re-examination of the patient

Soon after immediate care is given, it is good practice to:

- Recheck respiratory capacity.
- Recheck the percentage of burned body areas.
- Reassess fluid therapy on the basis of the amount predicted and the amount actually administered.

10. Hospital transfer

- It is important to assess whether it is possible to transfer the patient by ambulance, helicopter or aeroplane.
- If transfer is immediately possible and transport time is 15–20 minutes, the burn victim can be sent immediately (even without initiating therapy).
- It is necessary to find out in advance where the patient is to be sent and to calculate the journey time, bearing in mind traffic hold-ups and other possible delays. The ambulance or other transport team must be informed about the procedures they must observe to ensure continuation of the infusion therapy that has already been initiated.
- Fractured, immobilized limbs must be supported in the non-pressure position.
- It is essential to accompany the patient if there are respiratory problems.

HEALTH EDUCATION AND TRAINING OF THE PUBLIC FOR ASSISTANCE IN BURN DISASTERS

The above-mentioned considerations indicate that the procedures initiated to assist the victims of a burns disaster, either by the first rescuers present on the spot or by the better-organized relief forces arriving soon afterwards on the scene, are of particular importance.

All assistance to persons who have been exposed to fire and have extensive burns must be specific, precise, considered and timely.

At the same time rescue workers must defend themselves from the risks of fire and be fully aware of the difficulties they face when saving fire victims.

Health education and training programmes thus assume particular importance. These have to tackle three aspects of the disaster:

- The technical aspect, aimed at the analysis of the extent of the damage caused by the fire and of the immediate behaviour of the people directly involved.
- The clinical aspect, assessing the extent of the damage to persons, the evolution of the various phases of the burn, and the specific type of therapy to be given.
- The operational aspect, concerned with plans for coordinated and effective relief, ranging from self-relief to immediate assistance and specific first-aid measures.

The implementation of these plans must follow well-defined programmes of teaching at school, starting from primary school level, through educational civil defence courses; periodic refresher courses for physicians, nurses, volunteers, Red Cross, fire brigade, police, etc.; and periodic exercises with simulated fire disasters, with the involvement of the general population and the local rescue forces.

Particular attention must be paid to the teaching methods. These must be effective and suitable for separate age groups. In addition to illustrated brochures, stickers, colouring albums, posters, notices, etc., various audiovisual means, in particular videotapes, have been successful. These re-create and simulate situations, and propose actions for the assistance of the victims.

A simple user-friendly interactive instrument using the most advanced techniques has been developed with regard to prevention of fire disasters. This system comprises a personal computer, a videodisk reader and a touch-screen — a monitor sensitive to finger pressure. It combines the purely informative content of an ordinary documentary film with a number of educational elements put at the disposal of the user. When users view the videodisk containing a film on prevention of industrial accidents, and go through the question-and-answer programme, they have access, in any sequence, to the various guidelines on prevention, behaviour and first aid described in the film.

The programme provides users with self-teaching and self-testing elements, which otherwise would be merely passive teaching. The self-teaching phase enables users to follow their own chosen training programme according to their individual learning capacities, and to review repeatedly the various guidelines and suggestions as they see fit. The self-testing phase enables users to assess the degree of learning by simply touching the screen which answers the question indicating the right or wrong choice.

The clear advantages over traditional training methods (conventional audiovisual courses, and those based on the use of printed texts or photographic material) derive from the dynamic interaction between the user and the learning instrument and from the multimedia presentation of the learning material. Recent research on learning capacity has in fact shown the importance of the interaction of the training instrument. Most people are able to learn 50% of what they hear and see at the same time, while they can learn 90% if they can themselves, at will, re-see and re-hear the material.

Multimedia presentation (audio, video, written text, graphics) of a subject provides various ways of gaining the user's attention and achieving greater effectiveness than the usual monomedium message. Clearly such systems, which are essential not only for prevention but also for teaching may become fundamental in refresher courses.

CONCLUSIONS

The need to bring relief to burn victims within a very limited time and the importance of specific first-aid techniques make it necessary to consider, even during the planning stage, three distinct phases of relief operations: immediate assistance, first aid, and organized relief.

Immediate spontaneous assistance and first aid, provided by the people present on the spot and by teams of trained volunteers, physicians and nurses within 2–3 hours, are fundamental for the prognosis of fire disaster victims.

A timely, rational, safe and effective intervention is the main guarantee *quoad vitam* for the victims of a fire disaster. The first rescue workers must be aware of the tasks to perform, must be able to act autonomously and must make sure that the work corresponds to the plans and needs.

They must know how to stay mutually coordinated as they constitute the spearhead of the more complex body of organized relief which will not be able to reach the scene for at least 6–7 hours.

As in any other disaster, plans for relief operations in a burn disaster will remain just so much paper if they are not tested by training programmes, if they are not made intelligible to the public, if they are not supported by the necessary management resources and if they are not implemented properly.

The acquisition of emergency professionality by ordinary people is a sign of civil and cultural progress.

Thus the man in the street — the potential first rescue worker — must not only be able to receive specific training for emergency situations but, more importantly, be aware that he is in a state of preparedness to offer his aid methodically and effectively.

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20
Health education in disaster medicine

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The instruments that current scientific research for the prevention of disasters and their negative effects places at our disposal are the assessment of the environmental impact of industrial, civil, military, research and political works for development purposes; analysis of the vulnerability of the territory; and information, education and participation of the population.

This last instrument should be regarded as most important if we bear in mind that human behaviour is the factor which, at all levels, from government decisional levels to everyday operational levels, most affects the population's state of health. This is particularly true when behaviour refers to the management of structures and environmental facilities for work, everyday life, leisure, and certain natural conditions (seismic zones, territory subject to flooding, tornadoes, etc.). In emergencies human behaviour is a decisive factor in the creation of dangerous or harmful situations, and it plays a basic role in the more or less negative evolution of the effects of a disaster.

The expected behaviour of a population, and therefore its degree of education and information, and its ability to take part in the management of a crisis, are fundamental elements in the analysis of the vulnerability of a territory.

For all these reasons the measure of the level of prevention achieved depends on the number and the effectiveness of public education and information programmes that have been carried out.

DEFINITIONS AND CONCEPTS OF SAFETY EDUCATION

With regard to training for disaster prevention it might be more appropriate to speak of 'safety education'. Safety is a basic need, and as such it is an aspect of human health if considered holistically, i.e. as the result of an equilibrium between the physical, psychological and social components. It is therefore appropriate in my opinion to speak of health education for the prevention of disasters and the attenuation of their negative effects.

Green *et al.* write that 'health education is an ensemble of combinations of planned learning experiences intended to facilitate the voluntary adaptation of behaviour conducive to the maintenance and promotion of health.' The US Presidential Committee for Health Education has given the following definition: 'Health education is a process that fills a gap between sanitary information and the habits of the population. It motivates the individual to use information in order to keep healthy, to avoid actions that are harmful to health, and to adopt habits that promote health.' A. Seppilli defines health education as 'a social operation aiming to modify human behaviour consciously and lastingly in the field of health problems. It presupposes knowledge of the group's cultural background and the focalization of its subjective interests, and requires the overcoming of any resistance by the group to the operation.' WHO in 1954 declared that 'the goal of health education is to help populations to achieve health through their own behaviour and their own efforts. Health education is therefore based first of all on the interest that individuals show for the improvement of their living conditions; it aims to make them realize, as individuals, as members of a family, a collectivity, or of a state, that health progress depends on their own personal responsibility.'

These definitions indicate that health education is characterized by three basic concepts. (1) Educational intervention is a social intervention, i.e. it is the result of the commitment of various professional skills and of sectors of society which in varying ways are involved in the specific health problem for which the educational intervention is required. (2) Educational intervention must help the individual and the collectivity to acquire the ability to operate conscious choices in everything concerning health and safety. (3) Educational intervention must motivate the population to adopt correct practices by means of adaptation of knowledge and cultural schemes that are the heritage of the collectivity to the needs of health protection and of disaster prevention.

THE THEORETICAL BASES OF HEALTH EDUCATION

In the programming and realization of health education intervention, due consideration must be given to the need to refer to multiple cultural environments, as the basic knowledge on which health education is based is provided not only by the health sciences but also by behavioural, communication and pedagogical sciences, apart from knowledge provided by specific technical fields, which, depending on the type of disaster or risk, may be engineering, chemistry, physics, veterinary sciences, and so on.

Educators must above all be familiar with the health sciences, including the constitution and functioning of the human organism, the relationships between the human and the natural and social environment in which people live and work, the origin of health problems, and the treatment of disease and techniques for recovery.

Educators must make use of child and adult education techniques; they must be able to communicate with large populations, smaller groups and individuals; and they must be familiar with the behavioural sciences, since the main objective of their work is the changing of human behaviour.

ROLE OF HEALTH EDUCATION

Among the risk factors that can be assessed, those that concern health education are risks depending on human behaviour, although the same behaviour patterns can be classified as risk factors when they play an important role in causing a disaster.

The role of health education is to facilitate the learning of behaviour patterns that will reduce risk factors and increase protection factors by means of the identification of motivational elements related to behaviour. Risk factors connected with inappropriate behaviour patterns may be personal (age, sex, psychophysical condition, cultural level, etc.) and environmental (working environment, living conditions, physical characteristics of the territory, social, political and economic conditions, etc.).

METHODOLOGY OF HEALTH EDUCATION

An education programme must be based on a precise method which starts from an analysis of the problems of health and safety and therefore of education needs, and identifies the educational goals; this is followed by the phase of realization and finally by the phase of assessment, which concludes the education programme but at the same time opens up new educational horizons in a continual spiral of social progress.

As often happens in the traditional relationship between physician and patient, diagnostic logic is adopted also in the case of health education. Three types of diagnoses are formulated, each corresponding to one of the phases of the programme.

1. Epidemiological diagnosis is used to identify indicators obtained statistically; these help us to understand whether a health and safety problem exists, what it is and how great it is.
2. Behavioural diagnosis is the systematic identification of habits which appear to have a causative link with the problem in question. This is the most important point in the whole process because it is here that we can understand what behaviour constitutes a risk for health and safety and what interpretative value is attributed by individuals and by the collectivity to the event causing the behavioural response. This is the moment when it is possible to trace the personal and collective motivations that drive persons to particular behaviour.
3. Education diagnosis identifies the behaviour patterns that must replace erroneous patterns, by the selection of the information the public must receive and the actions they must perform in order to manifest behaviour patterns that can be considered appropriate. It is necessary also in educational diagnosis to define the motivations that will support the actions and to identify the protection factors capable of improving the efficiency of the new behaviour.

In the phase of educational diagnosis it is advisable to create what might be termed a 'scenario bank', i.e. a collection of all the possible scenarios in relation to the emergency situations that have previously been identified. This is very useful for the correct preparation of the operative phase of the education programme. The scenarios can be created with the assistance of experts but also with the assistance of the persons for whom the programme is intended.

The final stage is the process of assessment. No assessment can be performed unless clear, precise and measurable general and specific goals have been established. The goals must be structured in such a way that they can be assessed. Let us take an example: if the problem revealed by the epidemiological diagnosis is the high risk of forest fires, the general goal will be a reduction in the number of forest fires due to careless behaviour; a specific objective will be the teaching of information and practical skills relevant to the prevention of the risk of forest fires to all secondary school children or to a percentage of them. As can be seen, these objectives, when formulated in this way, can be expressed numerically, i.e. they are quantifiable. For an education programme to be assessable the indispensable premise is the quantification and the timing of the goals.

THE STUDY OF BEHAVIOUR

Behaviour is defined as the observable response of the entire organism to a given stimulus. It is the result of cultural attitudes, customs, traditions and habits that lead to a particular approach to a given health problem. The adoption of a particular behavioural pattern is therefore the result of a process that is triggered by a variety of motivations; it may be determined by the emulation of a model, or be derived from family custom, or religious or moral beliefs; it may be the psychomotor response to the mark left by negative or positive experiences regarding a particular event.

Personal motivation, in all cases, plays a decisive role. It represents the sum total of conscious or unconscious psychocultural dynamics that drives a person towards a particular behaviour. To change behaviour patterns, it is indispensable to investigate motivations.

THE THEORY OF CHANGE

According to Kelman, every change in personal behaviour corresponds to stimuli due to environmental factors. In the interaction between the individual and the environment, an important role is played by certain sociopsychological processes which can be divided into three categories: (1) a process of compliance, which means the adoption of a behavioural pattern because of an external control (e.g. observance of the highway code because of the fear of a fine); (2) a process of identification, which means the adoption of a behavioural pattern because of the powerful stimulation exercised by a particularly influential model (e.g. observance of the highway code because the greatest racing-driver in the world declares that he always observes it); (3) a process of internalization, which means the adoption of a behavioural pattern because of a decision taken on the basis of values which the individual freely and consciously considers to be of primary importance (i.e. observance of the highway code because one does not want to cause harm to oneself or to others).

We can make good use of the last two processes. Internalization is the main instrument, while identification is an instrument of consolidation to be used only when there are clear signs that the new behaviour has been internalized.

COMMUNICATION

Communicating means 'making common knowledge'. In the case of health education, the common knowledge is a body of information and experience that leads to the adoption of new and more correct behavioural patterns.

The action of communicating involves a process that develops according to Lasswell's scheme: who says what to whom and with what effect? Communication in fact takes place between a sender and a receiver; it presupposes the structuring of a message by the sender (and also vice versa) and the choice of a channel and a code which serve respectively to convey the message and to give the message expressive 'identity' and therefore intelligibility. The channel is the means by which the communication takes place (interpersonal relations, radio, TV, the press, etc.) and the code is the language with which the message is formulated.

The closer the expressive identity of the language to that of the receiver, the more easily and the more accurately the message will be decoded. For this reason, in every process of communication it is of primary importance that the language used should be clear, simple and basic, without technical terms and as near as possible to the form of expression used by the receivers.

THE LEARNING PROCESS

The learning process of a behaviour pattern is articulated in six phases: learning, interest, assessment, trial, adaptation and adoption. The cognitive, emotional and psychomotor aspects are inseparable in all these phases, but the psychomotor aspects intervene especially in the second part of the process, after the assessment phase.

In the first two phases people learn that there is a new and different way of behaving in relation to a given safety problem, and they feel general interest for all the information they receive; in the next two phases they assess whether the proposal corresponds to their real interests and try to put it into practice, at the same time seeking personal motivation for the change. In the last two phases they try to adapt the new behaviour to their own particular conditions, and if this attempt at adaptation succeeds, they adopt the behaviour.

This process is slow because it involves a cognitive-emotional restructuring of internal attitudes which is then translated into a different way of reacting to given stimuli. In the adult this presupposes the presence of a sufficiently high 'potential for change'. The process is easier in the child because it is only necessary to introduce safety education into a global educational process that is already in progress.

I should at this point briefly mention a problem that arises when we are dealing with disaster prevention. A disaster usually represents an exceptional and extremely negative effect. It is something that nobody willingly discusses and which is instinctively thought of as something remote from reality. It is therefore very important to make people acquire, as far as this is possible, automatic responses to certain stimuli. This can be achieved by the use of simulation techniques, role-playing and other teaching methods, which make the learner as active as possible.

CHANNELS FOR EDUCATIONAL COMMUNICATION

There are three main categories of communication channels: those providing mass communication, those implying the educator's direct intervention, and those involving interaction between educator and learner.

The mass communication channels include posters, notices, the press, cinema, TV and radio. These channels reach a large section of the population even in remote areas. However, it is difficult to have direct information about the effect that the message has produced and attempts at verification do not provide accurate data. These channels should be used at the beginning of an education campaign, when it is still a question of heightening general awareness of a particular public health problem.

Among the channels implying the educator's direct intervention are graphics displays, charts, photographs, films, slides, flannelboards and plastigraphs. These channels become so many instruments in the hands of educators, whose active presence is required as they have to present, describe, illustrate and explain whatever is being proposed. These instruments/channels are mainly used when educators are addressing a known and limited number of persons; they are used in lectures, round tables, debates, meetings and open discussions on a particular topic on which the mass media have already increased general awareness.

The channels requiring the interaction of educators and learners are essentially dramatization and the use of puppet-figures. Dramatization makes use of normal theatrical techniques, or of instruments of psychological dynamics such as role-playing; puppets are used almost exclusively in the case of child learners.

These are very delicate instruments which must be used by professionals who are experts in psychology and educators. They should be used when the learning process has gone beyond the assessment phase, and they serve to stimulate a particular emotional involvement which may be useful in order to trigger the process of change. This channel is used only with small groups (8–10 persons).

When these various channels are used, certain fundamental points must always be borne in mind:

- Whatever the channel, the message should never be intimidatory, frightening or catastrophic, as this might arouse a process of repression of the message.
- The colours, pictures and situations should never misrepresent the content of the message.

- The message should convey the key idea for the solution of the problem in a reassuring fashion; it should enable the learners to understand clearly what their personal role is in the solution.
- The message should not engender useless fatalistic reactions.

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21
System of postgraduate training in burn emergencies in Prague

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The science of disaster planning has shown that the severity of a burn disaster is magnified by the total number of burn injuries. In 1982 Sorensen pointed out that the overall sum is in any case large, whether it is a question of few severe injuries or many smaller ones, and specified that they require a large burns centre or unit.

The Prague Burns Centre has been serving in both respects since its foundation in 1953, but the significance of centralization of burn care was thoroughly appreciated only when the intensive care unit (ICU) for severe burns was established in 1969. As a centre for extensive burns it has been receiving annually an average 150 severe burns from the 7 million inhabitants of the Bohemia region of Czechoslovakia, which means that it has been treating, in 14 beds in the ICU, almost all casualties requiring anti-shock therapy. As a large burns centre it has been accepting all burn casualties from the Prague District (except infants).

An average of 500 patients per year have been admitted, including those in the convalescent period for reconstructive surgery (21 beds for adults and 18 beds for children).

Apart from securing complex and continual burn care, the burns centre was designated a teaching institution for medical students and for postgraduate training. Training for burn medicine includes theoretical courses of lectures and practical courses of work at the bedside and in operating theatres (Figure 1). Lecture courses have been organized since 1979 by the Postgraduate Teaching Institute for Physicians and Pharmacists in Prague. It is in charge of further education in all medical specialities. Various Chairs in this Institute are responsible for branches of Medicine and Pharmacy: one of the Chairs supervises preparedness of medical staff for disasters and catastrophic events, and is directed by the Department of Civil Defence of the Ministry of Health and by the Ministry of National Defence.

There have been two series of theoretical training. One is general and obligatory for all medical specialties. It presents basic considerations on burn

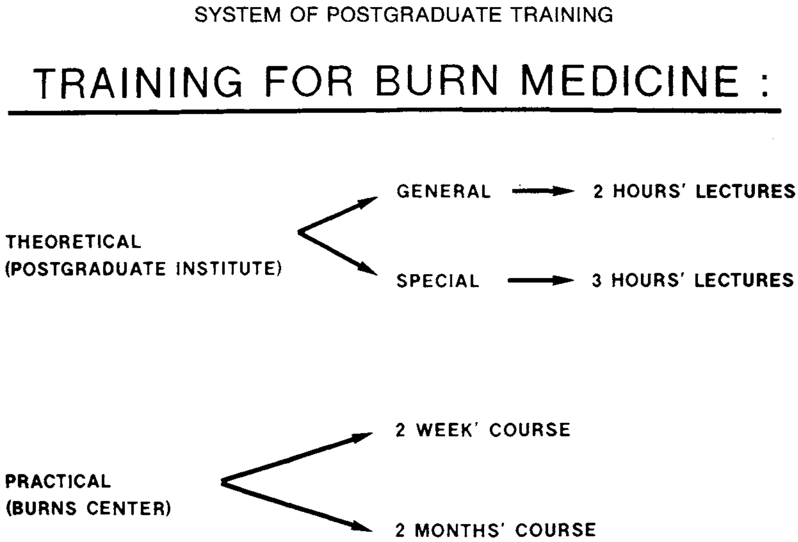

Figure 1. General scheme of training for burn medicine

care regarding first aid, field triage, primary transport with anti-shock treatment, and ethical problems at the accident site. In addition, two 2-week courses were organized in 1979 and 1981 dealing with complex and continuous burn care. These courses were designed to update the knowledge of general surgeons. For the same purpose, two 1-week courses were held in 1986 and 1989.

The second series of theoretical training was intended to be a special course obligatory for selected medical staff. It was initiated in 1982 (Figure 2). Its organizer is the Chair supervising preparedness for disasters and catastrophic events. Modern triage is based on a judgement of the actual or possible severity of the victim's injury. It gives the highest priority to victims who will live only if treated; the lowest priority is given to victims who will live without treatment or who will die despite treatment. The process of triage is a continuous one, depending not only on the severity of somatic injury, but also on the degree of stress to which burn victims are exposed. Traumatic stress and also subsequent psychological breakdown must be anticipated, because many victims may perish because of stress.

The triage process is the key to effective management at the emergency receiving area. The hospital's capability of providing care is limited not only by the number of beds available and the size of the emergency department; the most important factor is the number of operating theatres that can be staffed and run continuously. Should the casualty load exceed the available space, the areas into which expansion can take place must be known and identified in each health facility.

The special training process prepares experienced staff whose principal aim is to determine orders of priority for operating room time, to advise more junior surgeons, and to redeploy members of surgical teams as necessary. Burns require the continuing use of operating theatre time over a period of weeks for dressings and grafting. In addition, the special training is intended to provide

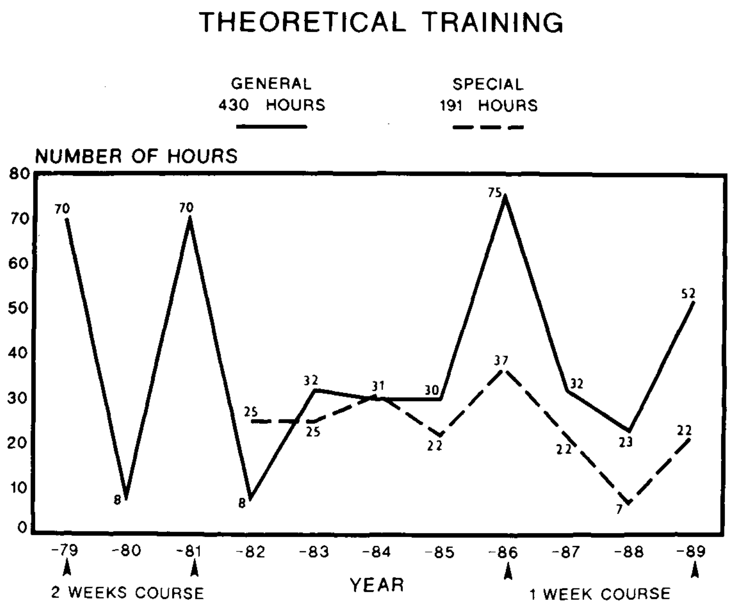

Figure 2. The first series of theoretical training for all medical specialties: a total of 430 hours' general training (solid line) and 191 hours' special training (dashed line)

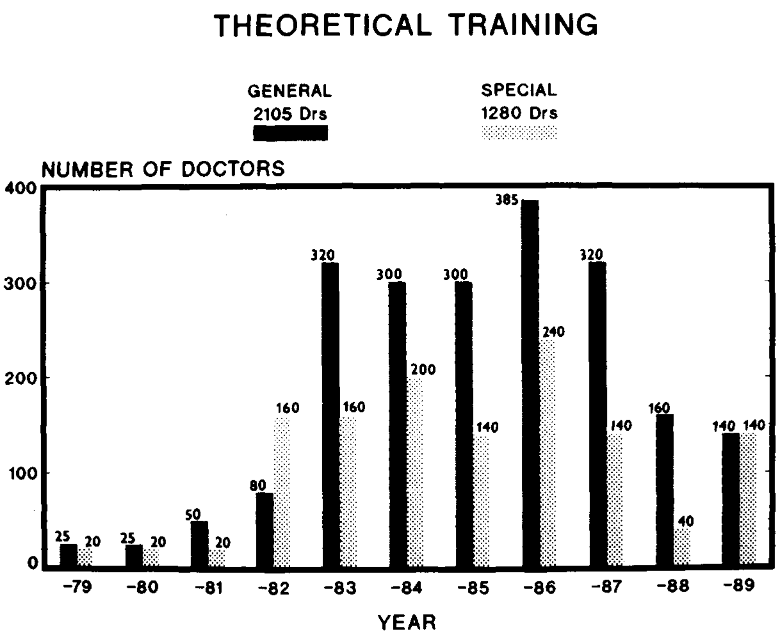

Figure 3. The second series of theoretical training for selected medical staff: a total of 2105 doctors in general training (black bars) and 1280 in special training (stippled bars)

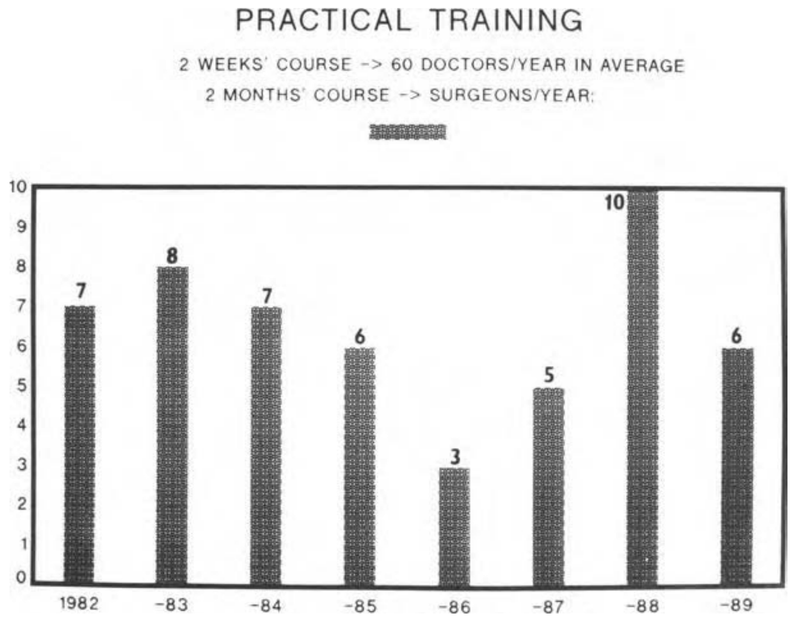

Figure 4. Surgeons trained per year on the 2-month practical course since 1982. On the 2-week course an average of 60 doctors per year were trained in the period

sufficient numbers of surgeons and anaesthetists skilled in the management of burn cases. The special theoretical training took place only occasionally between 1979 and 1981, but since 1982 it has been held regularly. During the last decade, there have been 430 teaching hours in general training and 191 hours in special training (Figure 2) and in total 2105 doctors have been generally trained and 1280 specially trained (Figure 3). The concomitant practical training has also been carried out in two different courses in the Prague Burns Centre: a short 2-week course in operating theatres and in wards has been obligatory for all general surgeons as part of the second degree examination in general surgery. On average 60 surgeons have been trained per year. The practical training lasting two months has been scheduled for those who have been appointed as commanders of civil defence for a district. Fifty-two surgeons have passed through this practical training since 1982 (Figure 4).

In many hopitals such a trained individual may not be immediately available, and it is well known that untrained and inexperienced doctors often cause more problems than they solve. Although all disasters are different and individual hospital circumstances vary so much from place to place, in every institution a senior doctor, nurse and administrator must work together from a control centre where they can coordinate the hospital's response to the casualty load and adjust the hospital plan.

In mass disasters two spheres of ethical problems are encountered. The first concerns burned patients at the accident site who require an individual approach, since without considering complex and long-term burn care it is impossible to accomplish adequate triage for treatment and transport. The second sphere of ethical problems arises in the centre, where it must be decided in whom and when to start or stop so-called titrated therapy. The principle that access to it is the right of every individual who needs it has imposed on the physician complex ethical decisions in disaster situations. Apart from the discontinuation of sophisticated life-supporting techniques, the problem arises of what quality of life we are able to secure. Last but not least, there is the right of a person to die with dignity, which is also one of the ethical problems in burn care.

22
Training of specialists for burn care in Turkey

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In Turkey, six specialized burn units are referral centres and 107 hospitals accept burn victims, although most of these have no specific departmental organization and proper facilities for care of burn patients. Burn facilities in Turkey are mainly directed and run by general surgeons and some by plastic and reconstructive surgeons.

At Hacettepe Hospitals there are an average of 400–600 applications a year of paediatric and adult burn patients to the emergency and outpatient departments, of whom 15% are in need of specialist care. Given these figures, the need for qualified medical personnel proficient in burn care is not small. Unfortunately, there is no legal obligation for training and certification for burn-care specialists in Turkey. There is also no centre exclusively for continuing and postgraduate burn training. At Hacettepe Medical School we give every resident in general surgery basic and advanced knowledge of acute burn care.

The ten-bed acute-care burn unit at Hacettepe University Hospitals in Ankara is organized and run by the department of general surgery. All residents of general surgery rotate through the burn centre, initially during their first and/or second year residency for a period of 3–4 months. Thereafter, in their fourth and fifth years, they work for another 4 months as a responsible chief resident of the unit, performing necessary operations and taking decisions under supervision. The unit is supervised by three staff members. Besides general surgery residents, residents of the department of plastic and reconstructive surgery also rotate through the burn unit for varying periods (Figure 1). It is expected that every surgeon who finishes this residency programme can manage an acute burn patient as long as no special facilities are required.

After finishing the residency programme in general surgery, the residents are given in addition to their general surgery diploma a certificate for their rotations through the burn centre. This document has some benefit in finding an appropriate job, but it is not an attestation of specialty.

The programme was started in 1975 by M. Haberal and his colleagues; 61 general surgery specialists have since finished their residency at Hacettepe.

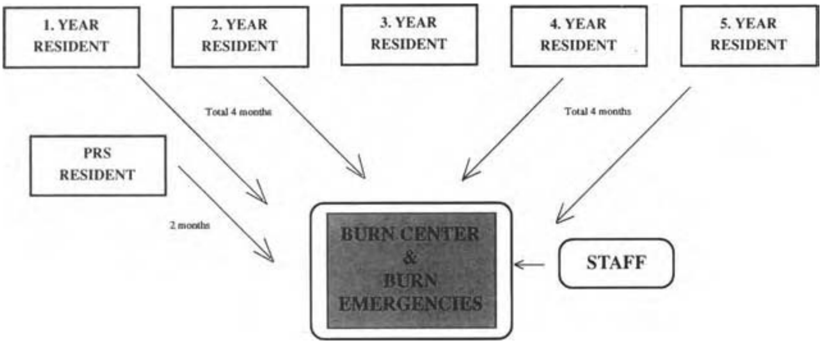

Figure 1. Scheme of rotation of residents through the burn centre

With these surgeons experienced in proper burn patient treatment and distributed throughout the country, we feel that we have made a contribution to the improvement of the quality of contemporary burns treatment in Turkey.

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23
The organization of safety and fire prevention in a multidisciplinary research centre

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The research centres set up in Italy and the rest of Europe in the 1960s following the model of those in the United States present a number of particular characteristics as regards their industrial installations.

1. The many different kinds of activity pursued within the same research centre, consisting of experimental work in various scientific disciplines: physics, chemistry, agriculture, biology, mathematics, etc.
2. The installations are of all sorts — small laboratories and mechanical workshops, experimental plants and data processing centres, libraries and canteens, greenhouses and carparks, and so on.
3. The activities are developed on the basis of programming that is always in a state of evolution and sometimes so rapid that there are frequent modifications and transformations of the buildings housing the experimental structures.
4. The number and professional skill of the staff are continually changing, especially where there are frequent links with university structures and where there are frequent staff exchanges with other similar national and foreign organizations.
5. The activity is pursued in a number of widely dispersed buildings that often require modification and adaptation.

THE ITALIAN NATIONAL AGENCY FOR ALTERNATIVE ENERGY

A typical example of the type described above is the Energy Research Centre (CRE) at Casaccia, which is situated on the extreme outskirts of Rome in an area of about 100 hectares. The activity, as the name suggests, concentrates on energy and allied themes. Originally the centre's main objective was research in the peaceful uses of nuclear energy and ionizing radiation, but more recently, with the change of the institutional task assigned to the agency by the government (its name was altered from CNEN (National Centre for Nuclear Energy) to ENEA (National Agency for Alternative Energy), the activity has concentrated far more on research and development in the field of alternative forms of energy in general: energy saving, solar energy, wind energy, biomass energy, etc. At the same time more importance has been given to research into the impact on the environment of all these various types of energy.

The first 15 years of the centre's existence, when its activities mainly concerned experimental nuclear plants (experimental reactors, production pilot plant, reprocessing, post-radiation tests, as well as physics, chemistry and biology laboratories where isotopes and radioactive sources were widely used), contributed decisively to the creation among the researchers and technicians of an awareness of the importance of safety and protective measures that it would be hard to find in any other field of activity.

THE ORGANIZATION OF PREVENTION AND SAFETY

Activities involving radioactivity have from the start been controlled by a series of laws, regulations and decrees issued from 1960 onwards. This was the year when Law 1860 established in Italy the safety criteria for the peaceful uses of nuclear energy and ionizing radiation.

The cornerstones of these regulations, as also further defined in the subsequent Law 185/64, are as follows:

1. The professionals responsible for plant supervision are all defined by law and approved by specific examining boards: plant chief, plant supervisor, operator.
2. The professionals responsible for the safeguard of the workers and the work environment are: a qualified expert responsible for physical surveillance; an authorized physician responsible for medical surveillance (both these professional figures must have their names on specially prepared national lists and they must be specifically assigned by their employer to operate in defined areas of activity), and a plant or environment sanitary physicist, operating in collaboration with the qualified expert.

In more complex plants it is necessary to prepare preliminary, intermediate and final safety reports.

At the Casaccia ERC it has become customary to prepare safety reports also for the less important plants and for conventional plants where nuclear or radioactive material is not used. This has contributed to the creation of a genuine safety awareness, which is applied in various ways but with the same basic principles in all the various activities.

The safety report and other documents together constitute the documentation necessary for the issue by the control body, after due approval by the examining authorities, of the operating licence, which is composed of a fundamental part — the 'technical operating instructions' — and a subsidiary part — the 'operating manual'.

The lower category licences issued by the prefect are subject to the control of the same bodies that contributed to the definition of the ordinances described above: Department of Labour, fire brigade, and the local and interzonal health units.

The internal safety conditions are safeguarded, even before the surveillance service is called into action, by the effective creation of 'safety delegates councils' which gather together all the persons with the professional skills necessary to ensure the proper functioning of the plant in normal and above all in abnormal conditions.

The composition and the tasks of these councils are laid down by law in the case of nuclear plants; they have also been instituted at the Casaccia ERC in the less important plants and laboratories as well as in high-risk conventional plants such as the liquid-sodium circuits for component trials.

The centre's safety delegates council is a central organ which also examines all problems of interdisciplinary safety or general problems of internal coexistence or external impact on the environment. This promotes harmonious development of the various activities which, as described, are related to a wide range of scientific and technological disciplines.

FIRE PREVENTION

Fire prevention at Casaccia is carried out in three basic phases of planning, realization, and emergency management and preparedness. For reasons of space we will omit the realization phase and concentrate on the planning and management phases.

Planning

Fire prevention is a preliminary consideration before the planning of a building or plant even begins. An analysis has to be carried out of the feasibility of a project, based on the almost axiomatic assumption that the sum of the two risks of fire and radioactivity (or toxic substances) must be considered unacceptable in any working or living environment. As the chances of effective intervention in the event of a fire involving these substances are considerably limited by a number of factors, the absolute criterion here — more than in any other field of human activity — must be prevention. This is the basic assumption on which all preventive measures are based, so that it is practically impossible for the two events to occur together. An overall fire prevention plan is thus developed, the aim of which is to programme a series of integrated operations involving systems, procedures and personnel so that everything that has been previously planned is actually put into operation.

All the above considerations are decisive in the phase of programming the fundamental requisites: the general layout of the plant, with particular reference to the possibility of the mobilization of rescue vehicles; verification of the internal layout of non-risk areas and access and escape routes; definition of 'fire areas'; analysis of fire risks; creation of structures preventing the spread of fire (fire shutters, non-combustible filters, etc.); and electric cables with special fire-resistant features such as slow propagation, low emission of fumes and toxic and corrosive fumes (National Fire Prevention Association figures show that the material used for electric cables is the cause of 31% of fires caused by electricity).

These and other basic concepts can be summarized schematically as automatic controls, planning of ventilation systems, and centralization of all alarms and detection and automatic extinguishing systems, which must be fully visible and fully audible both on the spot and on central control panels so that any accident can be immediately located. Other systems of intervention and containment, such as hydrants, sprinklers and other fixed systems, firebreak doors and fire-resistant compartments must be kept rigorously up to standard. Nuclear fuels, radioactive and toxic substances and radioactive waste must at all times, except when actually being processed, be kept in metal containers which are to be removed and stored as soon as possible. All extinguishing agents that may be contaminated must be monitored and if necessary immediately disposed of.

Another more general consideration is that the 'fire load' of all structures and materials in a building must be reduced to the absolute minimum: in other words, it is essential that all such installations should be made almost exclusively of non-combustible material. The areas in which this measure is impossible to apply are defined 'fire areas' and they are separated from other areas by fire barriers with a 2–3 hour resistance. If personnel have to work in these areas, there must be at least two escape routes on opposite sides located no more than 30 metres from any given point.

All of these and other aspects are described in detail in the plant operating manuals. Collectively they constitute the 'technical instructions' that are attached to the 'operating licence' issued by the competent authority (which in Italy is the Ministry of Industry).

EMERGENCY MANAGEMENT AND PREPAREDNESS

When all the plants and working areas have been planned and built according to the prescribed criteria, they are managed by a safety organization which for each of the important plants provides a specific internal and external emergency plan, in relation to the importance and extent of the accidents that may be hypothesized. The plans are reviewed, and if necessary updated, every 6 months by a provincial committee chaired by the local prefect.

Any potentially serious accident triggers first of all the 'plant plan' and then the centre's emergency plan which provides for the intervention of a whole series of structures and competences (Figure 1). These plans have precise, predetermined objectives and rapidly provide qualitative and quantitative data regarding any damage to persons or property in the centre as well as the possible environmental impact of the accident on the surrounding territory.

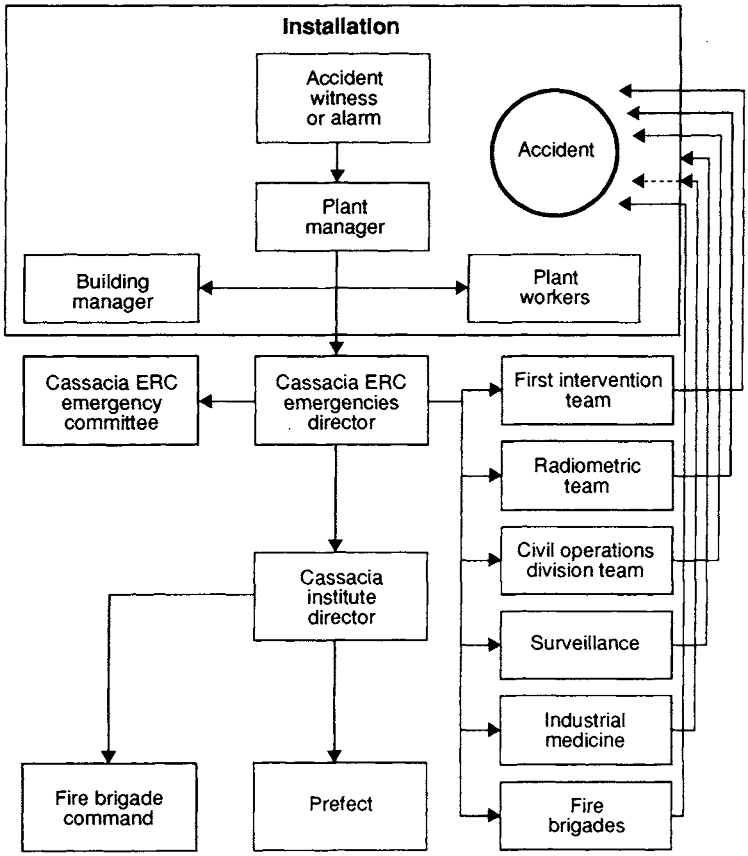

Figure 1. Schematic of the emergency intervention plan

In serious incidents the plan naturally provides for immediate communication systems and the intervention of the public forces — first the prefecture, which coordinates all interventions, and then the fire brigade, which takes over management of the operations, and the local health authorities for interventions concerning the population and the surrounding territory.

The technical instructions generally recommend at least one annual exercise to test and review the efficiency of the emergency system. This system, thanks to a permanent on-call system, is guaranteed 24 hours a day every day of the year and has been used by the public authorities for various types of intervention following incidents in Italy, especially in cases involving radioactive substances or nuclear-powered plants.

This complex of systems, regulations and procedures has helped create in the centre a safety awareness that would be hard to parallel in other research or industrial installations of the same dimensions; the application of this awareness to fire prevention has thus become a natural and automatic development, thanks also to the stimulating contributions and the continuous collaboration of the National Body of Fire Brigades and in particular of the Provincial Command of the Rome Fire Brigade.

The organization of safety and radioprotection — which includes all the professional skills devoted to accident prevention and the safeguard of workers' health, work sites and the environment — also includes a unit specialized in fire prevention and a first-intervention team on permanent 24-hour call which, when necessary and without in any way replacing the fire brigade, is able to use the means at its disposal to tackle all limited-scale accidents and to prevent minor incidents from developing into major ones with unpredictable consequences.

In this organization a particularly important role is played by the industrial medicine service which, in addition to its routine task of medical surveillance, also manages specific first-aid posts for sodium burns occurring in certain experimental plants. Special smokeproof rooms have been constructed in the vicinity of these plants to be used as emergency first-aid stations for the treatment of sodium burns (as sodium burns are purely a medical matter, the ways in which they are treated in Europe and the United States are reviewed in the appendix).

EXPERIMENTAL PLANT FOR THE STUDY AND QUALIFICATION OF VENTILATING AND FILTERING SYSTEMS: IPF-8000 FILTER TRIAL PLANT

One of the most important considerations is the limitation of the escape of toxic elements into the external environment by means of active containment by ventilating and filtering systems. For this purpose an experimental plant has been created at the ENEA Centre at Casaccia to test and qualify ventilating and filtering system components for performance by simulating the effects of various accidents (fires, escape of toxic substances, explosions, etc.).

The main parameters used for simulating the possible operating conditions of filtering substances are as follows:

- Capacity: 1000 to 8000 m^3/h.
- Temperature: room temperature to 500°C.
- Relative humidity: room humidity to 100%.
- Fume and particulate load.

(With reference to the last point, two shock-overpressure and fume-production testing sections have been planned but not yet built.)

The plant consists essentially of the filter testing system and a number of dependent systems. The filter testing system consists of a supply line with filters purifying incoming air; a heating section consisting of a diathermic air-oil exchanger and a cascade electric resistance battery (330 kW); a filter testing line at the standard capacity of 1700 m^3/h; a high-capacity filter testing at the capacity of 3400 m^3/h; and 8000 m^3/h line to test filter groups consisting of four parallel filters and prefilters; and a line for the testing of new methods of measuring filter efficiency using laser spectrometry (project complete but not yet realized).

Among the dedicated systems, some are particularly concerned with methods of filter efficiency testing: an NaCl aerosol input and detection system; a DOP aerosol input and detection system; a filter or adsorbing material testing system; and a calibrated powder input system. The plant also possesses a water demineralizing system, a vapour generator, and a boiler for heating diathermic oil.

All test controls and inspections are carried out from a control room by means of a computer which also makes it possible to acquire and process data from the tests.

Because of its versatility the activities of the IPF-8000 plant can easily be extended towards the testing and qualification of air-operated shutters, valves, ventilators, instruments and so on.

All of these capacities of the IPF-8000 plant make it a point of reference for the various public organs (Ministries of Industry, Environment, Health, etc.) that are interested in the problems raised by the impact on the environment of the escape of air-borne substances, a topic of considerable importance world-wide today as it embraces a number of well-known threats to the environment such as the greenhouse effect and acid rain.

The plant may also be of interest to certain institutions, e.g. fire brigades, that are concerned with plant and building ventilation systems; the importance of efficient ventilation systems in at-risk situations is universally recognized.

APPENDIX

Taken from the manual *Notes on the engineering and safety of sodium plants*, ENEA, vol. 3, April 1982.

FIRST AID IN SODIUM BURNS

General notes

All personnel employed in the plant must know the first-aid norms to be observed in the event of accidents to persons and must be able to use the first-aid material contained in the first-aid boxes.

First-aid posts

It is recommended that in every building with experimental plant there should be a fireproof room equipped as a medical station for the first emergency treatment of sodium burns. This first-aid post must be managed by the plant medical staff.

In our centre there are two first-aid posts, one for each building, with a bed, a bath containing vaseline oil, cabinets for the safe-keeping of medicines and surgical equipment necessary for first-aid treatment, eye baths, PVC bottles containing vaseline oil, and a cylinder of oxygen.

Treatment of sodium burns

The first treatment of sodium burns is still a controversial point on which experts are in disagreement. Some believe in the efficacy of immediate abundant washing with water, while others recommend complete immersion of the burned part or of the entire body in vaseline oil. The existing clinical experience makes it difficult to choose between the two methods, as each has something to be said in its favour. In order to give an overall picture of the treatment of sodium burns we will describe the procedures used in Europe and the USA.

PROTOCOL A

Procedure used by the AEC (Atomic Energy Commission) for first-aid treatment of sodium burns

The burned person must be moved as little as possible. The first-aid operator must wear goggles and gloves.

(1) The first procedures are as follows.

(a) Remove the sodium or NaK from the victim's skin, using a blunt instrument and avoiding any friction. If the sodium is still burning remove it immediately, i.e. do not extinguish flames by covering them. Flames should be extinguished by wrapping the victim in a blanket only when the victim has been exposed to a very large quantity of sodium or NaK or when flames have spread rapidly over a large area of the body; it is also possible to use a powder extinguisher for sodium fires, provided great care is taken to prevent the extinguishing powder from reaching the eyes, nose or mouth. Sodium or NaK in contact with the skin must be removed until only a thin film of white oxide remains.

(b) Remove the victim's clothing, avoiding any sudden movements that might extend the contamination of sodium or NaK over other parts of the victim's body.

(2) When the above operations have been carried out, wash the wound, using for the skin 1% acetic acid solution and for eyes and mucosa 2% boric acid solution. The washing must be carried out using abundant quantities of frequently renewed solution. Compresses can also be dabbed gently on to the wounds, avoiding any rubbing movements. These procedures must be continued until the victim is taken to the medical service. If medical service assistance is still not available after the solution has been applied for more than 30 minutes, wash the burns with copious quantities of neutralized water at low pressure.

(3) The burns must not be covered with sterile bandages until the victim leaves the place of the accident.

PROTOCOL B

Instructions for first aid for sodium burns as observed by Westinghouse at Walta Mill

(1) *Emergency first aid.* To remove sodium or sodium potassium from the victim's skin in an emergency, follow the general instructions.

(2) *Methods.* Removal of alkali metal from the skin of the burn victim requires the use of water. This method is justified by the availability of large quantities of water and by the rapid and complete removal of alkali metal with progressive washing performed with a strong jet of water on the affected part, followed by the application of neutralizing substances.

When the eye is affected, water is used because the eye itself, when irritated by the presence of a foreign body, produces copious amounts of water. The use of low-pressure water in addition to the water produced by the eye does not in any way endanger the eye.

(3) *Procedures.* If the victim has been splashed by liquid sodium: (a) Bathe with water; (b) Remove clothing the liquid metal has adhered to. (c) Transfer the victim to a medical centre after removing the liquid metal. (d) Use a dry towel or a plastic or wooden spatula to remove the remaining metal particles, gently rubbing the affected area. (e) Neutralize the burned area using 3% acid (medical centre). (f) Wash the affected area with soap and water. (g) Protect the affected area with gauze. (h) Take the burned person to a doctor and if necessary to hospital.

If the victim has been splashed by solid sodium or NaK: (a) Scrape the affected area, removing the particles of liquid metal using a towel or a wooden or plastic spatula. (b) Inform the medical centre. (c) Neutralize the affected area with 3% acetic acid. (d) Wash the affected area with soap and water. (e) Protect the affected area with gauze. (f) Take the victim to a doctor and/or to hospital.

If the victim has been splashed in the eye by liquid or solid sodium or NaK; (a) Wash the eye with a strong jet of low-pressure water for 20 minutes. (b) Bathe the eye for 5 minutes with collirium containing boric acid. (c) Cover the eye with gauze. (d) Take the victim to a doctor and/or to hospital.

(4) *First aid.* When sodium comes into contact with the skin, three basic first-aid procedures must be followed: (a) Remove sodium-soiled clothing and remove all particles of sodium from the skin and hair. (b) Using a safety shower, expose the victim to a strong jet of water for 10 minutes. (c) Call a doctor immediately; if sodium has gone into the eye, wash for 10 minutes with jets of water until the doctor arrives.

PROTOCOL C

First aid in the event of sodium burns as prescribed by some of the more important US experimental laboratories

(1) *Effects on human tissue.* Despite all the precautions adopted, accidents may happen in which staff are splashed by sodium or NaK. The organs most likely

to be affected are the skin, the eyes, the mouth and the mucosae. All staff must be aware of the harmful nature of such burns and the possible effects on human tissue so that they can immediately take the particular precautions necessary to prevent lesions. A first-aid service must be available, together with medical assistance, in order to reduce physical suffering and injuries.

(2) *Effects on skin.* Sodium and NaK destroy tissue following exothermic and chemical action due to its humidity. The two actions are simultaneous, thermal action occurring because of the high temperature of the burning sodium and chemical action because of the formation of sodium or potassium hydroxide by reaction with body fluids.

(3) *Prevention and cure of skin damage (first aid).* A safety shower must be available for personnel hit by a jet of sodium or NaK. There are two reasons for thorough washing with a strong jet of water: to remove as much sodium as possible, to extinguish the fire and to cool the skin; and to reduce the chemical reaction of the oxide with body fluids due to the action of sodium still attached to the skin. Sodium burns should not be treated with mineral oil, ointments or acetic acid, because they are difficult to remove in second- and third-degree burns. It has been proved that the chemical substances used to remove mineral oil or acetic acid from wounds can actually aggravate the wounds. The immediate first aid procedure is to apply cold water or sterile ice compresses to the affected part.

(4) *Effects on the eyes and treatment.* Minute particles of sodium and its hydroxide can enter the eyes, even if they are protected. The eyes must therefore be washed in abundant water and treated immediately by an oculist. The use of boric acid and/or mineral oil or other types of medication should be avoided in the treatment of eye lesions caused by sodium, as these substances are difficult to remove and hinder accurate assessment of the extent of the lesions.

(5) *Effects on the mouth, throat and lungs.* The effects on the mouth, throat and lungs are due mainly to the reaction of the oxides which become hydroxides and provoke caustic scalding of the mucosa. Safety showers should be used immediately, as well as eye baths to wash the eyes. It is also advisable to drink plenty of water. If any signs of irritation are noticed in the mouth, throat or lungs, a doctor, if possible an ear, nose and throat specialist, should be consulted immediately.

PROTOCOL D

First aid in the event of sodium burns as practised at the Risley Centre

(1) Clinical characteristics caused by contact with sodium

Damage to the skin. (a) If first aid is initiated immediately, the extent of the burn can be much reduced. The burned area blisters over with superficial erythema. This type of burn can be classified as second-degree. The physician must assess the burned part of the body, taking 20% of body surface as a critical reference limit. (b) If first aid is delayed or if the sodium remains impregnated in clothing, the sodium may ignite, causing burns in the deeper layers of the skin. Delay in treatment causes the affected area to appear with an erythema, at the centre of which a dark brown or white margin is clearly visible. It is important to remember that severe pain is felt at the moment of the burn and then rapidly subsides. (c) A skin rash may occur if the skin is exposed for long periods to oxide or hydroxide fumes with concentrations greater than 2 mg/m^3.

Damage to the eyes. Sodium entering the eye is very painful. Sodium hydroxide is extremely caustic and causes serious and sometimes irreversible damage, depending on the quantity of sodium and the length of time it is in contact with the conjunctiva. It may cause opacity of the cornea, ulceration and vascularization or adhesion of the eyelid and the cornea. Vascularization of the cornea makes it impossible to perform a corneal transplant. The damage suffered by the eye may develop into glaucoma and cataract, which may eventually necessitate removal of the eye.

Damage to the airways. If inhaled, the alkaline fumes generated by the combustion of sodium can damage the airways, sometimes seriously. The first effect of these highly irritant fumes is violent coughing, which is a warning sign to leave the scene of the accident. If a person is trapped or unconscious and therefore unable to leave the accident area, there is the risk of severe damage to the airways, which may lead to pulmonary oedema.

Damage to the digestive tract. The damage to the digestive tract caused by swallowing caustic chemical products concerns the oesophagus and the stomach. There may be nausea and vomiting. It is rare for large quantities of caustic substances to be swallowed because of their unpleasant taste and irritant qualities.

(2) Therapy (general principles)

The aim of immediate first-aid therapy is to remove the sodium with water or similar substances. Water is the ideal fluid, although its use may not be possible because of the presence of large quantities of sodium in the reactors. For this reason it is advisable to use paraffin oil or olive oil.

First aid (general). (a) The burned person should move as little as possible. (b) The rescue worker must wear at least protective goggles.

Skin burns. (a) Pour liquid paraffin on the burned area, covering it completely. (b) Use gauze or cotton with great care to remove fragments of sodium. (c) Any splashes of sodium in the eyes, mouth or nose must be removed. (d) If the victim is wearing protective goggles, make sure they are tightly fitted until the face is thoroughly cleaned; then remove the goggles, making sure the eyes are closed.

Care of the eyes. (a) If the eye has been splashed by sodium, it must be irrigated with water or paraffin oil. Because of the intense pain the eye must be held open by a third person. (b) It should be clearly understood that the damaged eye must be irrigated immediately. There are no exceptions to this rule, no matter how damaged the eye may be. Immediate first aid is more useful than later prolonged irrigation because the damage the eye sustains increases rapidly from minute to minute if it remains in contact with strong alkalis.

Care of the airways. (a) Make sure that breathing is unimpeded. (b) If necessary use respiration apparatus.

Care of the digestive tract. Make the patient drink water or milk in order to dilute any alkaline substances that may have been swallowed.

(3) Medical treatment of the burns

Skin. When the burn victim is admitted to the medical centre, the first treatment consists of the cleaning and drying of the burned area which has previously been protected with oil. Parts of the body that can be rapidly immersed in water and ice are to be treated in this manner. Other body areas may need prolonged abundant washing in water. Depending on the degree of the burn and its extent, the burned area must be protected with sterile dressings. For this purpose it is advisable to use gauze treated with paraffin in order to prevent adhesion. This treatment has given good results in all cases of limited burn surface. When the body surface is more extensively burned, more specialized treatment of the burns must be undertaken.

Eyes. If the eye has been splashed by sodium it must be subjected to further prolonged irrigation. Therapy aimed at preventing or reducing complications in the eye can be administered only by specialized personnel. In the event of less serious lesions, such as splashes of diluted alkaline substances, the eye can be treated with antibiotic drops.

Digestive tract. In all cases copious amounts of fluid (water or water and milk) must be swallowed.

Airways. The inhalation of vapour containing acetic acid exerts a calming effect, especially in the upper part of the airways. If lung damage is suspected and a reduction in oxygen consumption is observed, it may be necessary to administer oxygen.

Variations to the medical treatment. It may be beneficial to immerse the patient totally in a bath of water or oil. This method of burn treatment obviously requires the ready availability of a suitable bath and sufficient water or oil. Any further sodium that has to be removed from the skin can be carefully scraped off. If the sodium is still burning it must be removed as it burns. The person doing so must wear protective garments.

FIRST-AID PROCEDURES FOR SODIUM BURNS IN FRANCE, GERMANY, BRITAIN, ITALY AND THE UNITED STATES

There are two forms of immediate treatment for sodium burns: (1) Washing with copious amounts of water in order to remove the sodium as quickly as possible. (2) Immersion of the affected part in oil and subsequent washing with oil in order to prevent any chemical reaction.

In some cases both methods are used. For example, in the event of (superficial) burns the affected part is carefully washed with a cotton pad impregnated with olive oil. After complete removal of residual sodium; the part is washed with a jet of water. Washing with a jet of water seems to be preferable when the burned part is limited in area. When the burns are more extensive and when the sodium is deposited on clothing, great care is needed as washing with a jet of water is not advisable, particularly when the accident occurs in the vicinity of the reactors. When there is a leakage of sodium causing burns, limited quantities of water should be used. Its use, however, creates a fire hazard in many reactor zones and around plant where the use of water is forbidden. In such cases olive oil is therefore recommended.

Another aspect to be stressed is the importance of protective measures for the eyes. Protective goggles should be used whenever there is the risk of an accident. If the face has been splashed with sodium, the goggles must be kept tightly on until the face has been properly cleaned, and when the goggles are removed the eyes must be kept tight shut.

If sodium has been swallowed, immediate first aid consists in the washing of the nasal and oral mucosa with water or 3% boric acid, followed by the administration of large amounts of milk and water.

Comparison of the various procedures in the member states

The Americans are more in favour of using water. First-aid procedures are more or less the same as those in Germany, France and Italy. There are, however, some differences. In Germany, for example, jets of water are used to remove residual sodium in the case of eye burns of thermal or caustic origin. This method is advisable only in so far as it permits immediate intervention. It requires the presence of an expert on the scene of the accident, which is unlikely. It remains true that in all cases the eye must be irrigated and washed with abundant water as quickly as possible.

The American procedures pay greater attention to skin and eye burns, while Germany and Italy also consider cases of ingestion of sodium, with consequent gastrointestinal damage. In such cases, water and milk should be given in large quantities.

The British procedures contrast the use of water and of oil in first-aid treatment. The removal of sodium with large quantities of water must be done as soon as possible, and this method is adopted when the sodium-affected area is limited. This method is not advisable in the event of extensive burns or when the sodium adheres to clothing. The other method of first aid, using oil, consists in immersing the affected part in oil in order to prevent any chemical reaction; the sodium can be removed later by mechanical means. The use of oil (e.g. olive oil) is recommended whenever the use of water might represent a fire hazard in the event of a sodium leak or when there are reactors or plant in the vicinity where the use of water is forbidden.

German procedures combine the use of oil and of water in external burns. The first intervention is with a cotton pad impregnated with olive oil; after removal of residual sodium the part is washed with jets of water. In eye burns damp cotton is used to remove residual sodium from the conjunctival sacs.

In Britain, in the light of the above considerations and in agreement with general trends, liquid paraffin is the first immediate treatment. The paraffin used is not the ordinary medical substance, which is too viscous, but a slightly different product with a specific gravity of 0.83–0.87 g/ml. When the eye is splashed with sodium, the first-aid procedure is irrigation by means of liquid paraffin. Because of the severe pain the eyelids must be held open by a third person during irrigation. When paraffin is used, the sodium must be first completely removed in order to prevent any reaction between paraffin and sodium.

In Italy, external burns are treated by removing metallic sodium with low-pressure paraffin oil washing. In very extensive burns it is advisable to immerse the entire body in a paraffin oil bath. First-aid procedures also include abundant washing with acetic acid and 3% boric acid in order to eliminate the caustic products of alkali metals and to reduce pH. Local anaesthetics are sometimes also applied in addition to the above treatments. If the eye is affected by caustic burns, it is washed in 3% boric acid.

In France external burns are treated (1) by removing the sodium with a blunt instrument, taking care not to lacerate the skin; (2) by washing the affected part with abundant 2% acetic acid. If the eye is affected it is washed with acetic acid until the arrival of a doctor. If the doctor has not arrived within 30 minutes of the accident washing of the eye continues using low-pressure water.

INGESTION OF SODIUM. EFFECTS OF CHEMICAL TOXICITY ($NaOH$, NaO, KOH)

Alkali metals are more corrosive to human tissue than most acids. Particles of sodium and of sodium oxide and hydroxide (and their potassium equivalents in the case of NaK) provoke irritation and rapid destruction of the tissues with which they come into contact. This is especially true as regards the mouth, throat and lungs.

Any contact between sodium or sodium oxide and internal body tissues may be considered equivalent to exposure to sodium hydroxide (the same applies to potassium) because of the considerable quantity of water in the throat and lungs, which favours rapid transformation of these compounds into hydroxides. These substances are considered to be irritant and not poisonous.

First-aid procedures in the event of the ingestion of sodium. When sodium has been swallowed first-aid procedures in both Germany and Italy consist of copious washing of the oral and nasal mucosa with abundant water and 3% boric acid solution. If the ingestion of sodium has affected the gastrointestinal system, it is advisable to administer large quantities of milk or water. If the airways are affected, the first-aid measures adopted in the United States, Germany and Italy include the inhalation of vapour and oxygen.

Conclusions

The degree and gravity of sodium burns can be considerably reduced by effective and rapid first aid. All personnel should be well acquainted with the procedures for treating sodium burns, especially with regard to eye burns.

EFFECTS OF SODIUM FUMES ON THE ORGANISM

The Italian Association of Chemical Manufacturers states that prolonged exposure to sodium has not been observed to cause chronic physiological reactions. In persons not accustomed to exposure to alkali metals, some coughing, sore throat and nasal irritation may be found. The characteristic irritation of the mucosae causes recurrent sneezing.

The threshold limit for sodium hydroxide set by the American Conference of Government Hygiene Manufacturers (ACGHM) is 2 mg/m^3 of air, established on the basis of the irritant effects of caustic vapours. The present threshold level represents a considerable concentration in the air, which, however, is not excessively irritant.

The physiological reaction is damage to the internal mucosae of the body due to the thermal effect and burns caused by alkalis. Alkali metals are very rarely swallowed. The immediate and violent local reaction would cause serious and probably fatal burns.

Short-term threshold limit exposure in emergency situations. The Italian National Academy of Sciences has stated that 'The corrosive action of alkalis on the eye, skin and mucosae is known to all; the inhalation of sodium hydroxide vapours can produce multiple effects, from simple irritation to serious pneumonia, depending on the concentration of the vapour.'

When exposed to caustic dust not all persons react in the same way. However, it has been observed that in general 6 mg/m^3 causes intolerable respiratory distress.

On the basis of available data the Italian Toxicology Commission advises that in emergency conditions the following threshold limits should not be exceeded: 10 minutes, 4 mg/m^3; 60 minutes, 2 mg/m^3.

The eye may suffer serious damage in contact with sodium hydroxide vapour or dust. For this reason all workers should be urged and compelled to wear appropriate protective goggles whenever there is the risk of exposure to a concentration over 2 mg/m^3.

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Personal protective equipment in operations involving burn risks: theory and practice

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The protection of the individual is an extremely important objective in all activities in the industrial, civil, military and sporting sectors in which it is impossible to eliminate inherent fundamental dangers.

Burns, sometimes associated with other lesions such as contusions, cuts, abrasions and with asphyxia due to the inhalation of combustion products, are frequent occurrences in numerous situations. They may be fatal but more often they cause permanent invalidity because certain parts of the body of high functional and aesthetic value and considerable anatomical complexity present therapeutic difficulties both in the acute phase and in the treatment of sequelae (Figure 1). In these situations burns are a specific risk from which people must defend themselves by means of targeted personal protection, i.e. protection in order to avoid or reduce the harmful consequences of the specific burn lesion.

We have carried out a study of protective devices and found that safety measures are inadequate in the majority of cases in which there is a burns risk, as they are based on empirical suppositions and are produced with inappropriate materials. Also the effectiveness of safety measures is generally assessed by unreliable or inconclusive tests.

Protection requires measures and equipment that guarantee safety in an operation involving risk; if these measures do not exist, we cannot speak of effective safety. Individual protective equipment must fulfil three basic criteria:

1. *Specificity*. Traumatic effects have specific causes, and the protective device must therefore be planned and constructed bearing in mind the specific traumatic agents if they are to protect from injury from that specific cause.
2. *Suitability*. In order to be effective the protective device must be able to counteract the effects of the traumatic agent, with consideration of the manner and the intensity of its action. In addition, it must be impossible

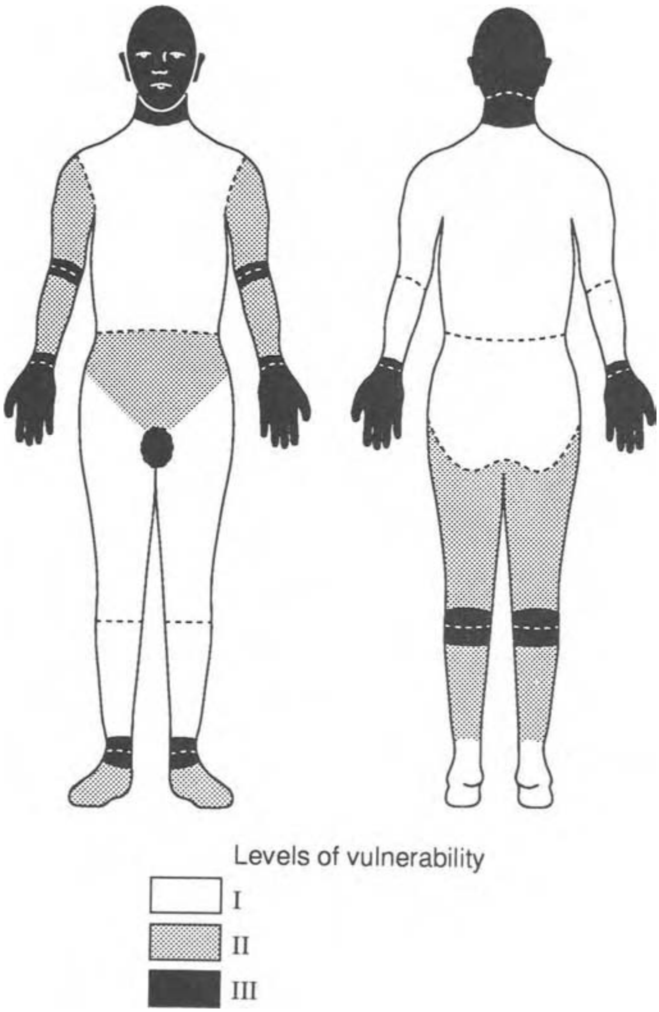

Figure 1. Levels of vulnerability

to use it incorrectly. In other words, even if the device is inherently safe, total or partial misuse must in no way affect its characteristics.

3. *Comfort.* The commonest reasons for non-use or misuse of a protective device are its intrinsic features (excessive weight, poor air circulation, limitation of personal movement) causing it to be uncomfortable to use even for short periods, especially in certain climatic conditions. Lack of comfort and awkwardness of use therefore disqualify a device as a means of protection.

A device's protective capacity is often mistakenly equated with a property of the material used in its manufacture, for example its resistance to flame,

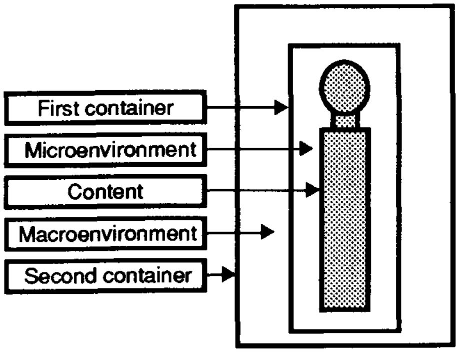

Figure 2. The protective garment and the microenvironment

which is just one element of protection. But for a device to give effective protection against burns, it must possess not one but a series of qualities: resistance to fire, isolating capacity, air circulation, and resistance to mechanical stress.

The equipment must be self-extinguishing as soon as the action of the flame ceases; its ignition temperature must not be lower than that of the surrounding environment; and it must not melt in high temperatures. It must afford protection from burning agents and from elevated external temperatures, with a gradual interruption of the heat flow, while at the same time permitting the physiological dissipation of the heat and humidity generated inside it. It must also be stout enough to stand up to the wear and tear to which the external environment subjects it.

The isolating capacity, which is an essential element of protection from burn risks, is defined by the protection time (PT), given by PT $= T_1 - T_0$, where T_1 is the time necessary for an internal protected part to reach the same temperature as the external source of heat, and T_0 is the time necessary to reach thermal equilibrium in the absence of the protection. The higher the value of PT the greater the isolating power of the device and therefore its protective efficiency, provided it possesses the other necessary characteristics. If PT $= 0$ the equipment itself constitutes a danger because of its inefficiency, as may occur in the case of certain synthetic materials that can burn until they are completely destroyed, sometimes even increasing the initial temperature (Magliacani, 1988).

A protective garment can be considered a microenvironment, containing within it the individual, himself part of a macroenvironment (the external environment). Heat exchange between the person and the exterior is therefore mediated by the barrier delimiting the interior space (Figure 2). We are therefore considering thermoregulation between an object (the wearer) and two containers, one inside the other, in which the thermal balance between the wearer and the first container is dependent on the dispersion in the second space of heat accumulating in the first space (Figure 3).

The heat present inside the protective outfit is the result of both an exogenous and an endogenous load (Khogali *et al.*, 1987). The exogenous thermal load is

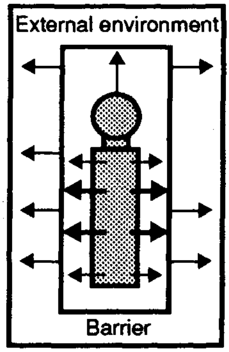

Figure 3 Heat dispersion

Table 1. Heat production involved in various activities

	Energy expended (kcal/h)	*Heat production (kcal/h)*
Walking on level ground (4 km/h)	150	110
Shovelling	360	270
Tree felling	640	480
Forging	390	290
Work on furnaces	610	460
Refuse removal	700	525

determined by air temperature, wind speed, relative humidity, mean radiant temperature, duration of exposure, and clothing worn. A protective outfit affords protection from external heat by two mechanisms: reflection of radiant heat and/or the high degree of resistance to heat transmission due to thick layers of isolating materials. The latter may represent an obstacle to the external dissipation of the heat produced by the wearer as a result of working activity.

The endogenous thermal load is the sum of base metabolism and physical exertion. Whatever the environmental conditions, an individual engaged in physical work produces thermal energy in relation to muscular activity. This heat production derives from the low yield of muscular work, in which 75–80% of energy expended is dispersed in the form of unproductive heat.

For the various kinds of muscular activity that may be performed during the extinguishing of a forest fire (Ceretelli, 1986) or work in a foundry, Table 1 shows values of energy consumption and heat production.

All physical activity thus leads to a considerable physiological increase of internal temperature (and therefore of superficial temperature), regardless of the external temperature. Unfavourable environmental conditions or limited dissipation of body heat due to wearing of an outfit with poor air circulation can considerably increase this temperature still further.

Experimental research (Gobbato, 1986) has shown that the maximum quantity of heat that can be accumulated without causing physical damage is 77 kcal/m^2 of body surface (an increase of 77 kcal corresponds to an increase

Table 2. ACGIH recommendations for environmental temperature in work situations

Work/pause ratio	*Temperature at workload* up to 200 kcal/h	*200–350 kcal/h*	*350–500 kcal/h*
Continuous work	30.0	26.7	25.0
75% work/25% pause	30.5	28.0	26.0
50% work/50% pause	31.5	29.5	28.0
25% work/75% pause	32.5	31.1	30.0

in body temperature of about 1.8–1.9 °C). This means that the physical activities listed in Table 1, in the absence of heat contributions from the external environment, would in the average person have the following maximum tolerability times:

Walking on level ground (4 km/h)	70 min
Shovelling	30 min
Tree felling	20 min
Forging	30 min
Work on furnaces	20 min
Refuse removal	15 min

The accumulated heat is dispersed by peripheral vasodilatation and by sweating. Peripheral vasodilatation is the first level of defence. The increase of blood flow in the skin increases its temperature and favours the loss of body heat by convection and radiation (conduction accounts for only 2–3% of total heat loss and is therefore of negligible practical importance). This gives rise to the dissipation of what is known as 'perceptible heat'. The evaporation of sweat also cools the skin and the blood flowing in the dilated vessels. The evaporation of 1 ml of sweat allows the dissipation of about 0.6 kcal, and as a person can produce 1000–1500 ml of sweat per hour (with a total of 10–12 litres in a day) the dissipation of heat by this mechanism is 600–900 kcal/h. In this way we have the loss of 'imperceptible heat'.

Dissipation by convection and radiation ceases when the temperature of the environment reaches about 35°C, beyond which point there is an inversion of the heat flow. Dissipation by evaporation is conditioned not only by environmental temperature but also by relative humidity and wind speed. As the air temperature rises and convection and radiation become less efficient, the cooling of the body depends more and more on the evaporation of sweat, which increases in direct proportion to wind speed (a wind speed of more than 2 m/s, especially in very hot low-humidity environments is dangerous because of the risk of dehydration).

The American Conference of Governmental Industrial Hygienists proposes the limits shown in Table 2 for environmental temperature for a working person (expressed in wet bulb globe thermometer degrees); if the limits are exceeded, persons will suffer internal temperatures of over 38°C. These figures are not absolute; they are conditioned by their intrinsic limitations and they also vary in relation to the physical characteristics of the individuals concerned.

In exceptional weather conditions, or when the physical characteristics of

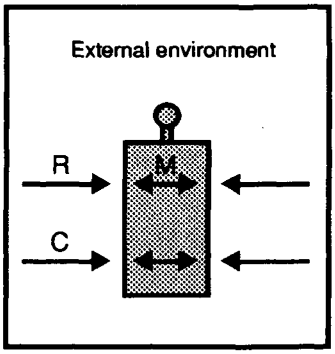

Figure 4 External environment

the individuals concerned are considerably different from the average, or when a protective outfit is worn, these figures are less reliable. The problem of direct evaluation of heat stress in the individual is thus far from solved.

Body heat equilibrium (BHE) depends on the relationship between metabolic heat and the yield/environmental heat absorption, according to the equation

$$\text{BHE} = M \pm C \pm R - E$$

where M = metabolic heat production, C = convective heat loss, R = radiative heat loss and E = evaporative heat loss. Convection and radiant heat may pass from the individual to the environment or vice versa, depending on environmental temperature, while evaporative heat is always subtracted (i.e. it passes from the individual towards the environment). For this reason, in activities in hot environments, when the air temperature and mean radiation are higher than the body temperature, the endogenous production of heat (M) is associated with a heat load by convection (C) and radiation (R) (Figure 4), so that the only mechanism for heat loss is evaporation (E), either through the respiratory mucosa or above all through the skin. The wearing of a protective outfit, especially if particularly thick (as is normally the case for protection from external heat), therefore plays an important role in the dynamics of heat exchange, according to the degree to which it affords protection and whether it allows dispersal of internal heat.

When a protective outfit is worn, heat loss by convection and radiation is negligible; it may occur through conduction, but only to an insignificant extent, and above all through the evaporation of sweat. The air circulation in a protective outfit is therefore of critical importance.

In normal conditions the extent of sweat production varies in different parts of the body in decreasing order: (palm of hand) > (sole of foot) > (forehead = retroauricular skin = back of hand) > (forearm = arm = leg = thorax = abdomen = back). Sweat production sites also differ in relation to type of sweating (Pinnagoda *et al.*, 1990), according to whether it is due to exposure to heat and/or physical exercise. Sweating due to exposure to heat occurs all over the body; sweating due to emotional stimuli involves particularly the palm of the hand, the sole of the foot and the armpits; while sweating due to physical activity is a combination of the two. This distribution must be borne in mind when a protective outfit is being designed, so that evaporation can be facilitated in the areas where sweating is more abundant.

For the reactions of cell nuclei to function properly, the internal body temperature must be a constant 37°C. Slight variations may cause some mild discomfort, but any large increase may have severe clinical consequences, such as heat stroke.

An inadequate heat exchange between the individual and the environment creates conditions of heat imbalance with negative effects on work capacity, owing to reduced muscular performance and reduced care and attention. The literature reports reductions in performance of up to 40%, and a compromised concentration capacity which leads to a fourfold increase in the number of errors committed, with an obvious increase in the risk of accidents (Melino, 1977).

When the specific risk is from burning because of the high temperature of the operative environment, the outfit must not only afford protection from flame and heated or burning objects but must also prevent radiated or convective heat from directly reaching the person, while at the same time allowing the dissipation of internally produced heat towards the external environment. A protective outfit cannot therefore be regarded as a rigid, inert barrier — it must be able to guarantee the required heat exchanges that depend on the environmental and subjective situation.

It is therefore unrealistic to attempt to create an outfit with the necessary characteristics of protection and comfort if there is inadequate information on the levels of temperature, humidity and wind speed in the environment and the heat produced by the individual as a result of physical exertion of specific types. The outfit must serve as a means of overall protection. It must therefore be designed so that each element is compatible with and complementary to the others, which together provide the necessary safety.

Research in this field has enabled us to identify certain errors in the current production of protective outfits and to establish the essential characteristics of an effective system of protection. The numerous defects we have detected reflect an unscientific approach to the basic problem. Fundamentally they can be described as a failure to guarantee that effective protection coexists with comfort. A protective outfit, in addition to these two generic qualities, demands other precise safety elements:

- Coverage of the whole body.
- Differential protection of areas of greater functional and aesthetic value which, if damaged, would complicate prognosis because of the difficulties of treatment and the high rate of incapacitating sequelae.
- Effective isolation providing for gradual transfer of heat that is perceptible to the wearer, in order to allow time to leave the danger zone before any damage is caused.
- Sufficient resistance to the mechanical stresses typical of the working

environment, in order to prevent damage or tearing that would leave parts of the body without protection.

- Good visibility of the wearer, even in conditions of poor light, in order to indicate his position in the event of an emergency.
- The possibility of performing efficiency controls, so that the durability of the outfit can be tested.
- Ease of use, which is the result of appropriate design and manufacture on the basis of the most recent scientific and technological developments, enabling the outfit to be used in all climatic conditions, even in the presence of very high environmental temperatures, without causing overheating of the body or limitations of physical movement, and without annulling the qualities of the materials used.

CONCLUSIONS

In burns resulting from risk activities that we have observed, we have noted two recurrent causes, which are often associated: (1) human error, due to overconfidence (poor professionality and inadequate training), negligence (carelessness in performing assigned tasks) and fatigue; and (2) insufficient protection, due to lack of a protective outfit, use of an inappropriate outfit or inappropriate use of an appropriate outfit.

It is possible to reduce human error if fire-fighters are physically fit, properly trained and informed, and aware of the risks to which they are exposed. Protection will be adequate provided non-specific, inappropriate and uncomfortable outfits are abandoned in favour of equipment expressly designed for the specific risks against which they are intended to afford protection, always remembering that as there is not only one type of risk it is inconceivable that there should be just one type of protection.

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25
Risks and protection of fire-fighters in forests. An outline

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RISKS ENCOUNTERED

Primary risks

- Accidental
  - Common trauma (wounds, sprains, fractures); polytrauma
  - External burns; microburns of the tracheobronchial tree
  - Damage to the eye
  - Hymenoptera stings
  - Particular: electrocution; explosion of buried mines; liberation of toxic substances
- Medical
  - Heat stroke/hyperthermia
  - Carbon monoxide poisoning
  - Epileptic fits
  - Cardiovascular attacks
  - Fatigue
- Aggravating factors
  - Psychological or emotional stress
  - Duration of operations
  - Climatic conditions
  - Hygienic and dietary conditions
  - Terrain
  - Errors in orders; poor assessment of risks, poor understanding of equipment

Secondary risks

- Short-term
  - Infection: ENT, lungs, eyes, digestive system (drinking polluted water), tetanus
  - Cardiovascular attacks, tachycardia, coronary incidents

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- Long-term
  - Pulmonary disease (burned lung)
  - Digestive system (stress ulcer)

TREATMENT

- *Preventive:* safeguard of physical condition and operative capacity; training; control of food and drink; proper sleep; collaboration for the study of individual and collective protection
- *On the ground:* presence of a medical unit in any operation lasting more than 8 hours

ROLE OF THE MEDICAL UNIT

- Industrial medicine on the spot
  - Sanitary control of operative hygiene, and food and drink supply
  - Use of individuals according to functions compatible with their physical or athletic capacities
  - Information to the relief operations director as to the medical conditions of the fire-fighting teams
- Medical care
  - Mobile infirmary for minor conditions
  - Resuscitation and evacuation preparation unit for major trauma or illness
  - Medical and psychological assistance to the population

LOCATION OF MEDICAL UNIT

- Near operational areas but relatively sheltered
- Near a safe main road and/or heliport for evacuation
- Near the relief operations director
  - To check the condition of personnel coming off duty
  - To inform him of the operative capacity of the fire-fighters
  - To assist in the management of food and drink
  - To help regulate operations for the rescue of human lives

EQUIPMENT OF THE MEDICAL UNIT

- Radioambulance, all-terrain if possible, with fire service physician and fire service nurse
- Resuscitation ambulance, all-terrain if possible, with a crew of four men in possession of the National Rescue Certificate and specialized in resuscitation
- An accommodation facility with either a logistic vehicle or a tent.

Section IV

Fire Disaster Management

26
Problems of search and rescue in disasters

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In an examination of the multiplicity of disaster plans throughout the world, it is evident that most are inherently, at best, crisis management mechanisms and, at worst, merely damage limitation documents. They are simply stratagems implemented at a time of crisis to protect the system.

Effective disaster planning can not only lessen property loss and social disruption caused by disaster impacts, but also reduce suffering and the distress of casualties. Furthermore, owing to the increased urbanization of society and the increasing risk of new industrial processes, improved disaster planning involves effective planning over the whole spectrum of response. Therefore, whilst it is recognized that disaster planning is important, it is ironic that much of it is notably weak in many important areas, and in some cases non-existent. This weakness is evident in the field of disaster search and rescue.

Search and rescue activities present a number of problems for both the community and the administration. Search and rescue in disaster is primarily the finding, extricating and/or transporting of victims, including the dead and injured as well as the non-injured. It does not involve providing emergency medical services. Within the community, search and rescue is not well organized for a number of reasons, often because of the sheer magnitude of the events. Everyday equipment and relatively untrained personnel may be adequate for dealing with small periodic emergencies, but the task can become overwhelming if there are a large number of casualties or if the area to be searched is extensive.

In addition not only does the task occur immediately after impact with the inherent stress of the need for timeliness, but seldom does any one specific community group assume responsibility for the activity. Unless there has been significant pre-disaster planning and training for organized search and rescue involving a variety of local groups, even the more formal response will be emergent, *ad hoc* in nature and often relatively inefficient. Search and rescue activity creates problems of communication and control of personnel. Personnel engaged in search and rescue are sometimes widely dispersed and often outside the channel and control of normal communications.

It can be argued that fire services are well placed and structured to undertake the search and rescue role, and it is not disputed that fire organizations are adept at fighting fires in disasters. Their normal day-to-day operations have immediate applicability in such situations. But unlike fire-fighting, search and rescue in a disaster context is not a traditional task for fire organizations. The limited search and rescue that the fire services undertake when responding to everyday fires is of a qualitatively different nature from that encountered in a major disaster. Even in those fire services that have developed plans to coordinate and sector the activity, problems can still emerge given the urgency, uncertainty and inherent inter-organizational nature of such an undertaking.

In major disaster situations, particularly earthquakes, widespread damage to structures will result in large numbers of casualties and trapped persons within the immediate stricken zone. Damage to roads and communications may limit access by rescue forces for many hours, and yet there still persists the myth that it is necessary to pour in massive rescue forces from outside the area, and particularly from donor nations.

Although it is virtually impossible to forecast accurately the nature and scale of a disaster, and very difficult to visualize a rescue operation of the magnitude which might result, some basic concepts can be developed from a study of past experiences.

- It is appropriate to consider the worst case and assume that the number of casualties and trapped persons needing rescue will be very great in relation to the capability of the rescue forces to deal with them.
- It can be anticipated that persons who are trapped will attempt to free themselves and untrapped survivors will go to their aid.
- A concentrated effort to rescue trapped persons during the first few hours after a disaster will yield greater dividends in lives saved than any effort made later.
- Although this action will seem to indicate the desirability of a well-trained force in being, the sheer magnitude of the inherent problem precludes such action. No administration could maintain a standing force capable of handling the potential rescue workload.
- When large numbers of persons require rescue and the resources are heavily taxed, the greatest dividend will be obtained from concentrating available forces on light rescue. (Light rescue, 2 man-hours per rescue; heavy rescue, 20–40 man-hours per rescue.)
- Much of the work associated with light rescue requires only elementary skills and training. By using trained rescuers solely in supervisory and skilled rescue roles it is possible to add large numbers of untrained workers to a trained nucleus and thereby rapidly expand the rescue capability.

From the foregoing it can be deduced that: (1) there must be a rescue capability in every administrative area; (2) organizational and planning emphasis should be placed on the development of a hard core of trained rescuers which can provide a framework to which large numbers of local volunteers can be added in an emergency.

27
Planning of rescue work in mass fire disasters. The Paris Red Plan

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Paris and three adjacent *départements* come under the responsibility of the BSPP (Brigade de Sapeurs Pompiers de Paris, Paris Fire Brigade), with an overall population of over 6 million. To carry out its daily rescue work the BSPP is organized in two sections: a section for immediate on-site aid, represented by first-aid teams, distributed in 78 relief centres; and a medical section, represented by seven intensive-care ambulances, distributed in six different territories. All operations involving medical assistance are coordinated by a physician-in-charge. There is also a permanent director of medical relief (DMR).

For several years various organizations have been involved in disaster relief. This type of relief poses the problem of the coordination both of the BSPP's own means and of means external to the BSPP. In 1978 the BSPP therefore drew up a special plan for mass fire disasters. This plan, known as the Red Plan, is the practical application, on the basis of a pre-established doctrine, of personal and material means in order to combat the consequences of a mass disaster, guaranteeing that the massive increase in sanitary needs is matched by an equivalent commitment of appropriate rescue means.

The Red Plan can be adopted in various circumstances, but fire is the cornerstone of its operation. Its originality lies in preparedness, on the level of both means and functions:

- *Means.* Preparedness involves, on the one hand, personnel trained in disaster medicine, a certain number of physicians having attended training courses organized by the BSPP for its own superior officers; and, on the other, materials, with the installation on site of specific materials for mass disasters (inflatable modular structures, disaster stretchers, oxygen therapy equipment);
- *Functions.* The three functions of recovery of victims, care and triage, and evacuation are organized beforehand.

The specificity of the Red Plan is its mixed and global hierarchy. There are two adjunct directors with predetermined tasks working under the orders of a rescue operation director (ROD) who is a superior fire brigade officer. These are (1) the director of fire relief (DFR), responsible for fire-fighting, reconnaissance work, the search and localization of victims, and the technical operations of clearance of the area; and (2) the director of medical relief (DMR), responsible for the creation and operation of the medical rescue chain, assessment of the extent of the necessary intervention, and evaluation of the number and condition of the victims.

The role of the first physician to arrive on the scene of a disaster is to guarantee the medical management of rescue operations, pending the arrival of the DMR, by making a rapid reconnaissance; estimating roughly the number and condition of the casualties; selecting the location of the triage centre/advanced medical post (TRIC/AMP); and sending updated information to the physician-in-charge.

The DMR has three specific tasks: to analyse the situation; to plan the chain of medical relief; and to give orders for the realization of this plan. The DMS is on permanent link-up with the rescue operations director and the physician-in-charge.

THE MEDICAL RELIEF CHAIN

Collection

This consists of:

- Localization of victims.
- Maintenance of vital functions.
- Extrication of trapped victims.
- Stretcher transport to TRIC/AMP.

Victim collection is the responsibility of the rescue workers, but according to circumstances it may be medicalized (particularly when extrication is lengthy).

Medical care and triage

This is carried out in a TRIC/AMP. The criterion of choice depends on various elements: safety, accessibility, ergonomics, and proximity. This centre is organized into three zones:

- Zone of relative emergency where less urgent cases are grouped together.
- Zone of absolute emergency where severe cases are treated.
- Mortuary.

The chief physician of a TRIC has medical personnel working under him, while the rescue workers are responsible to a triage centre officer. These personnel have a logistical role.

The chief physician of a TRIC/AMP is responsible for ensuring that the following are accomplished, either personally or by others:

- Examination and classification of victims.
- Care and preparation for evacuation.
- Compilation of medical file.
- Regulation of bed availability.
- Maintenance of supplies.

Evacuation

This is carried out under the responsibility of an 'evacuation officer', whose responsibility is to:

- Control the means of transport (regrouping them and maximizing their potential).
- Organize the muster area of the evacuation vehicles, obtain replacement evacuation vehicles and decide itineraries.
- Direct and control the despatch of victims.

In order to allow identification of the various personnel, the following special colour code is recommended:

ROD and DMS	red apron
Victim collection officer	white apron
Collection personnel	white armband
Triage station officer and chief physician	yellow apron
Evacuation officer	green apron
Evacuation personnel	green armband

If the Red Plan is a plan put into operation by the BSPP, other external organizations will also be involved: the geographically nearest SAMU and SMUR (mobile emergency medical services), in particular with a physician-in-chief who will be in charge of the hospitalization of victims; French Red Cross; civil defence, private ambulance services; police; and armed forces.

CONCLUSION

The Red Plan drawn up by the Paris Fire Brigade for the influx of large numbers of victims is characterized by notions of preparedness and unity: unity of action in collection, triage and evacuation of victims; unity of command; and unity of doctrine.

28
Field logistical organization in the Italian Army Medical Corps

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This paper briefly describes military organization and medical support in the field for fighting units in wartime. Primary elements of this situation include concentration in time of events; involvement of wide areas; numbers of victims greater than the capacity of local sanitary resources and structures, which are usually damaged and partially or totally non-functional. The same features are characteristic of mass emergencies after disasters. The principles of military sanitary logistics are therefore the same as those governing the organization of medical relief for civilian populations affected by disasters.

The essential characteristic of a modern military sanitary organization consists of the distribution of human resources and the medical structures at various levels of geographical location and of function. In military terminology these levels are known as 'rings'.

Field sanitary logistics has demonstrated in the course of time multiple functional requirements which have led to the creation of a 4-level logistical arrangement, each level having its own precise responsibility and field of activity. These levels comprise units of various hierarchical rank and together constitute the links of the logistical functional chain. The links differ in one or more of the following features: type of medical facilities available; area of operation; degree of autonomy, depending on equipment and quantity of materials; type and entity of therapeutic treatment.

Medical activities aimed at restoring the physical efficiency of the sick and wounded include: first aid; collection of casualties; preliminary treatment; despatch of casualties; clearance of the area; hospitalization and care.

These activities are performed at the various levels by the executive organs concerned, based on the principle that treatment must begin as soon and as near the disaster front as possible using emergency measures to keep the patient alive; must be provided at different levels of sanitary organization; and must be located according to a criterion of increasing specialized needs from the disaster area outwards. In particular the first ring contains two executive organs: (1) casualty collection nucleus and (2) medication post. These are located in the zone directly to the rear of the fighting units, a zone which in the event of a natural disaster can be considered equivalent to the epicentre.

At this level the following activities are performed:

- First aid, given on the spot where the injured lie, with measures administered by the personnel in charge of casualty collection, integrated in the case of soldiers by self-help and mutual help (all soldiers are issued with a first-aid kit).
- Collection, i.e. rapid transport of the injured to a medical post.
- Preliminary treatment, administered in medication posts: medication and treatment to restore and support the patients' vital functions and to prepare them for subsequent transfer. With the compilation of the diagnostic file a first classification is made of the injured and treatment and transfer priorities are established.

The second ring is made up of formations operating some distance away from the battlefront; in the case of a mass disaster this corresponds to the area where the effects of the catastrophe are less pronounced. At this level the most important unit in field sanitary organization is the sanitary division, which organizes the wounded despatch post; the ambulance station; the field hospital (45–135 beds); and the disinfection, decontamination and land improvement squad. The main sanitary activities at this level are:

- Transport of wounded from medication posts to wounded despatch post.
- Triage.
- Hospitalization and treatment of the untransportable sick and wounded and those requiring urgent surgery (first-level emergency).
- Distribution of medicines.
- Disinfection, decontamination and land improvement.
- Identification, composition and disposal of cadavers.

The territory furthest from the battle-front or, to continue the simile, the natural disaster, outlying areas where infrastructures and routes of communication have not been damaged, contains sanitary structures belonging to the third ring, some already existing in peacetime and others specially created to meet the emergency situation. These are:

- Wounded clearance units providing transport by ambulance or specially equipped buses for wounded from the second or third rings.
- Permanently operating military hospitals and specially mobilized auxiliary hospitals, which will occupy military and civil infrastructures (barracks, schools, hotels). These take second- and third-level emergency cases, as well as first-level cases following treatment in the field hospitals.
- Hospital trains used both for transport of the sick and wounded to hospitals in the national territory and for diagnostic tests and surgery; these trains are equipped with a laboratory for analyses, a radiology unit and an operating room.
- Sanitary depots, for the stockpiling of medical supplies and sanitary equipment.

The fourth ring is composed of the sanitary organs of the army and the combined forces, with functions of command, coordination and control.

The subdivision into rings is valuable from both the practical and the organizational points of view, as the ring is not a rigid immutable entity. Its purposes and functions can be modified on the basis of varying needs. One or more rings can be eliminated or omitted depending on efficiency and appropriateness and the final organizational structure can vary as different situations vary.

This logistical chain, inspired by criteria of simplicity and realism, has already shown its validity in numerous exercises not only in Italy but also abroad, as conducted by the Italian Peace Contingent in Lebanon and by the Allied Command Mobile Force in Europe. It has also been tested in relief operations for civilian operations in all the great natural disasters that have struck Italy in the last few years: the Vajont and Florence floods, and the Belice and Irpinia earthquakes.

Relief work for the civilian population is an activity which the armed forces have always performed, as they constitute the main structure capable of offering a significant and possibly decisive contribution to this specific sector, not only because of their permanence, internal organization and presence throughout the national territory but also because of the vast resources in men and material available and the speed of response.

Another important characteristic that is often neglected by certain civilian organizations is the logistical self-sufficiency characteristic of all our operative units, which enables them to operate in territories where supplies of energy, water and food are either non-existent or inadequate.

In 1988 Italian law recognized this role of multisectorial collaboration, which integrates but does not substitute the action of the institutionally appointed organs, which is an inalienable function.

In order to perform the various tasks it has been assigned in the best possible way, the Army Medical Corps has undertaken numerous initiatives for the renewal and improvement of its field sanitary structures and for the perfection of its response in disaster situations. One particularly noteworthy achievement is the creation of the new helicopter-borne field hospital. This can be rapidly transported and set up wherever needed and offers a wide variety of treatment. It has easy-to-mount pneumatic tents and a sheltered surgical unit with an operating room and an intensive-care room.

29
The commitment of the Italian Army Medical Corps to relief of the civilian population in the event of public disasters

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Civil defence in a modern nation is one of civilization's greatest achievements and it is therefore right and proper that every effort should be made at all levels to optimize its efficiency.

In the last two or three decades Italy has been obliged on frequent occasions to provide relief to the civilian population as a result of public disasters. We may cite the examples of the earthquakes in the Belice Valley (1968), Friuli (1976), Campania-Irpinia (1980) and Lazio and Abruzzo (1982); the floods in Vajont (1963), Florence (1966) and Valtellina (1987); the bradyseism phenomena at Pozzuoli (1983); and the epidemics of cholera in Campania (1983) and respiratory virosis, also in Campania (1979).

These events involved sanitary activity of a widely varying nature — first aid, disinfection, burial of dead animals, land improvement, mass vaccinations, sanitary controls and medical assistance for the stricken populations, testing of drinking water and food, etc. On these occasions the armed forces represented an extremely useful and timely support for the civil defence organization, and the environmental and dynamic context in which most of the disasters occurred underlined the primary role of the Army Medical Corps in these contingencies. Outside Italy's national frontiers, the Italian military sanitary-logistical structure has operated in Lebanon, where for 16 consecutive months, starting in October 1982, it also assisted the civilian population of Beirut.

In the light of these considerations, an Italian State Law in 1978 institutionalized the armed forces' contributory role to civil defence. This law represents an important step forward in the wider context of the movements of international pacification, without, however, diminishing the principle of national defence, the importance of which the significant events of the last few months have amply underlined.

The institutionalization of the armed forces' contributory role to civil defence does not, however, mean that a fully effective degree of collaboration has been reached by the two bodies. The admirable results achieved by civil defence in the satellite information field are known to all, together with the resulting progress in the speed and efficiency of relief operations. However, it is my impression that not all the means and systems available in the event of a disaster are fully appreciated. The importance of this field of human interest encourages expansion and improvement, which accounts for the rapid evolution of certain organizations, for example the Army Medical Corps.

Tragic events in the recent past have taught us that the availability of large numbers of men and means is neither sufficient nor useful unless properly coordinated. It is essential to organize in the best possible way all the resources the country can count on. This would be extremely beneficial not only for greater efficiency in the immediate present but also for the preparation of a plan of coordination among the various organs involved, so that each can play its role more completely.

The objective of the Army Medical Corps is clear and demanding: it must constantly perfect its standards as regards both personnel and equipment so that it can perform its important but delicate task with ever-increasing efficiency.

30
The organization of the Italian Army Medical Corps in relation to contributions to civil defence in the event of disasters

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This paper describes briefly the general contribution that the Italian Army Medical Corps is able to give in the event of public disasters, with particular regard to the technical aspects. I shall stress the particular philosophy of the army's contribution to civil defence.

I refer to the criterion of 'globality' with which the military organization considers the defence of the territory. According to this, together with the larger and better-known task of sanitary relief to stricken populations, the armed forces are also involved in the work of preparedness for and prevention of natural disasters and in the protection of the environment. Examples of this, to mention only the most important but possibly the least well known, are the Army's seismic detection network in the framework of collaboration with the National Geophysical Institute; the Meteomont Service managed by the 4th Alpine Army Corps in collaboration with the State Forestry Corps for the collection of information about snow conditions and the preparation, with the Military Geographic Institute, of avalanche bulletins; and fauna repopulation operations in the Abruzzo National Park and the Leghorn area.

The same criterion of globality inspires Army Medical Corps relief operations, which are characterized by logistic self-sufficiency and the exhaustive nature of its activity. With regard to logistic autonomy, the assistance given to the Medical Corps by other army divisions ensures the survival of rescue workers and also of telecommunications and means of transport. This safeguards two essential objectives: the avoidance of further demands on stricken centres, and the rapid availability in space and time of the operative forces. The self-sufficiency and completeness of the relief operations produced by this cooperation are sufficient to satisfy most of the needs of a stricken population.

Public disasters rarely affect only one aspect of society — the upsetting of the environmental equilibrium causes not only sanitary emergencies but also biological, chemical and physical problems. The Nevado del Ruiz disaster is emblematic of this: on 14 November 1985 the Nevado del Ruiz Volcano erupted and the heat produced melted a glacier. The consequent river of mud transformed the underlying valley into a marshland from which 20 000 bodies were later extracted. There were also many thousands of casualties. Two aspects of this disaster are significant. Firstly, the injured were covered in a thick layer of mud. This necessitated the creation of special wash rooms and it was only after the preliminary washing operation that many of the injured were found in fact to be dead. Secondly it was necessary to provide surgical treatment and resuscitation of septic patients and patients with gas gangrene.

In such conditions field health units might well be insufficient if they were not assisted by personnel operating in other sectors, including those of logistical support. For this reason the technical devices that are available, although thoroughly researched and well-tried, should be regarded as a point of departure rather than of arrival — it is equally important to operate in collaboration with other specialized army divisions, integrating and improving non-sanitary units which also play a very important role in health relief.

31
The use of aircraft in fire disasters: the Italian Air Force Medical Corps in burn emergencies

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Aircraft have been used for over 50 years in the fight against fire and they represent one of the most powerful weapons for this purpose. Both fixed-wing aircraft and helicopters are used in Italy for extinguishing fires. The Italian Air Force uses exclusively conventional fixed-wing G-222 and C-130 aircraft stationed at the 46th A/B base in Pisa. The Italian navy and the army use only helicopters. In addition, the Ministry of Agriculture and Forests in collaboration with the Ministry of Civil Defence uses CL-215 Canadair 'water-bombers'.

The G-222s and the C-130s use the ammonium phosphate retarding liquid PHOS to extinguish forest fires. This is the most effective agent for preventing the combustion of cellulose, the main component of all plants. PHOS is used either as a preventive measure or directly on fires in forests, maquis, bushes, hedges, haystacks, barns, stubble, dry meadows, woodpiles and any masses of vegetable matter that may catch fire. PHOS powder is mixed with water in various proportions depending on what is to be extinguished — a more concentrated mixture is used in the case of high bush and forest fires.

The retarding liquid is prepared in mixing stations distributed strategically in airports throughout Italy: Pisa (main base), Elmas (Province of Cagliari), Cameri (Novara), Istrana (Tivoli), Grazzanisce (Cesena), Amendola (Foggia), Ciampino (Rome), Sigonella (Catania) and Birgi (Trapani). This distribution considerably reduces the time required for an operation, and permits rapid refilling of the containers with the retarding liquid. The containers are of various sizes depending on their use, and range from 4750 to 11 350 litres. A full load is sufficient to cover a strip between 400 and 500 metres long, less if the scattering pressure is increased. The time required for initiating an intervention after receiving a call is between 20 and 25 minutes.

The helicopters and the Canadair aeroplanes use water taken from the sea or lakes. The CL-215 skims across the surface at a speed of 80 knots and takes just 10 seconds to fill its two tanks with a total of 5400 litres of water. The helicopters use special tanks holding between 500 and 5000 litres. The intervention time for the helicopters is immediate, while the CL-215s take about 15 minutes. The national air fire-fighting service is managed and coordinated by the COAU (Centro Operativo Aereo Unificato — Unified Air Operations Centre) which has its headquarters at the Department of Civil Defence in Rome. Over 850 fire-fighting missions totalling 2150 flying hours had been carried out as of July 1990, and over 31 000 tons of water and retarding liquid have been used.

These details are closely connected with the various problems of air rescue and have an important bearing on matters of prevention and response in fire disasters.

One of the institutional tasks of the Medical Corps of the Italian Air Force (IAF) is to provide immediate aid wherever an emergency occurs. The regulations for the emergency transport of sick persons, trauma victims and the severely burned are governed by norms laid down in 1976 in accord with the Ministries of the Interior, Health, Merchant Marine and Finance. A fire health emergency may concern one or more persons and small or large communities. The number of rescue aircraft used in an emergency naturally depends on the specific emergency — there are mini-emergencies and maxi-emergencies. Immediate assistance to burn patients is provided by the Search and Rescue Air Service (SAR) managed by the 15th Wing based at Ciampino, which uses only helicopters, and by the 31st Wing, also based at Ciampino, and the 46th A/B Pisa, which uses jets and conventional aircraft.

Types of aircraft are: helicopters — HH-3F and AB-212; jets — DC-9, Gulf Stream G:3 Falcon 50; propeller — C-130 and G-222. These aeroplanes have been suitably adapted, pending delivery to the IAF of special air ambulances.

Without doubt the most important type of aircraft in fire emergencies is the helicopter, which is able to perform rescue operations that would be impossible for any other kind of vehicle. It rapidly reaches the scene of an emergency and can carry out search operations and rescue work in mountain, forest and wasteland areas, and it can assist ships at sea and provide relief in the remotest places where a fire may break out, which other forms of transport would either be unable to reach or at least only be able to do so after great delay. The helicopter has a particular advantage over other aircraft because its capacity of hovering means that it does not need to touch down either on land or at sea. It can thus lower rescue workers who can provide immediate aid and by means of a system of winches and lines it can transport injured persons on special stretchers.

The HH-3F helicopters are equipped to provide in-flight emergency medical care while en route to specialized hospitals. The equipment carried by these air ambulances includes automatic respirators, defibrillators, oxygen therapy kits, aspirators, portable cardiorespiratory reanimation kits, etc. The IAF uses fixed-wing aircraft for medium- and long-distance transport. The IAF helicopters, depending on their type, can transport between 3 and 14 stretcher patients, and converted G-222s and C-130s between 30 and 60.

The headquarters of the SAR Centre is at the 15th Wing based at Ciampino. Groups of the 15th Wing operate at Trapani, Brindisi and Rimini. Rescue and back-up squadrons operate at the airports of Cagliari, Decimomannu, Amendola, Grosseto, Linate, Cameri, Villafranca Veronese and Istrana. These bases are strategically distributed so that rescue operations can be conducted all over the national territory and specialized hospitals can be reached in the least possible time.

Modern air transport systems do not present any absolute counterindication for severely burned patients. Here may be mentioned the numerous cases of severe burns which occurred in the Ramstein tragedy, during an air show: even the most severely injured persons were transported by air, some to superspecialized hospitals as far away as the United States, without any life being lost in flight.

On average the IAF performs annually about 1000 rescue missions, totalling about 2500 flying hours; those involving severe burn victims represent only a modest fraction (about 4%) of air rescue missions. In the 5-year period 1985–1990, 45 patients were transported to specialized hospitals (34 to the Ospedale Sant'Eugenio in Rome, 2 to Verona, 3 to Padua, 2 to Milan, 2 to Genoa, 1 to Palermo and 1 to Reggio Calabria).

The Medical Corps of the IAF with its medical officers and sanitary assistants, in close cooperation with specialized pilots, has provided rapid relief and assistance to persons in situations of grave danger due to fire and has made a decisive contribution to saving countless human lives.

32

Infobrul — the value of a telematic databank for burns and burns centres in the event of a disaster

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Because of its unexpected nature, a disaster inevitably gives rise to considerable difficulties in the organization of relief. Early treatment on the spot in exceptional conditions has made great progress in recent years and a chain of assistance now becomes operative very rapidly (the ORSEC Plan, the Red Plan in France).

In fire disasters, the specific character of the thermal lesion increases the difficulties, and the massive arrival of burn patients in a specialized hospital structure will very quickly paralyse its capacity to accept and care for patients. (Our burn centre, for example, has only eight intensive-care beds, plus — in case of need — 10 beds in reconstructive surgery, in the adjoining pavilion). This imposes the necessity of careful triage in order to distribute the burn patients according to the seriousness of their condition to the various hospitals, near or distant.

The idea was conceived of using the Minitel system in disaster situations to offer a listing of burn beds available in the national territory in order to facilitate the acceptance and distribution of burn patients. From this starting-point, the numerous opportunities offered by Minitel have made it possible to elaborate a much larger project (Infobrul).

MINITEL

Minitel is a small information terminal which at first was ignored by health services and rejected by the medical world. It is true, as recently said by Martine du Colombier, the head of Minitel Santé France Télécom, that its somewhat frivolous public image (telephone directory, various services, video games, personal messages) tended for some time to keep it apart from communication and information for hospitals. But hospitals are increasingly recognizing its importance and it can now be said that Minitel is the first information system in France. It has become familiar to all and it can also be used with a printer.

The Emergency Commission of the French Burns Society has elaborated a series of advice and guidelines to be followed in the event of a burn. In particular, the immediate cooling of burns is explained in a small diagram and the recommendation to apply cold water in emergency conditions has already made an impact on the public. Guidelines for other emergencies are also suggested.

It is also possible to have specific access to an epidemiological file. This epidemiological file of the French Society is completely compatible with that of the International Burns Association and the European Organization. It makes it possible to record the circumstances of the burn, the precise site, the environment where the burn occurred, family background, professional activity, precise aetiology of the burn and any equipment involved. All these data are very valuable and our Society's National Prevention Committee uses them to prepare its advice aimed at reducing the number, gravity and cost of burns.

These epidemiological data form the basis of prevention campaigns to educate the public and medical and paramedical workers. They can thus improve safety standards and reduce the possibilities of a disaster.

An anonymous coding system is used in order to respect Article 4 of Law 78-17 of 6 June 1978. In this way there will be no problems with the National Commission on Information Sciences and Privacy. The information system will provide global results as well as specific and anonymous results for each centre.

There will also be a sort of messenger service, acting as a 'mail-box' for messages between members of the society, the conduct of investigations, the organization of round tables, multicentre studies, managing board reports, information about different congresses, and so on. This messenger service is confidential and a password is necessary for access.

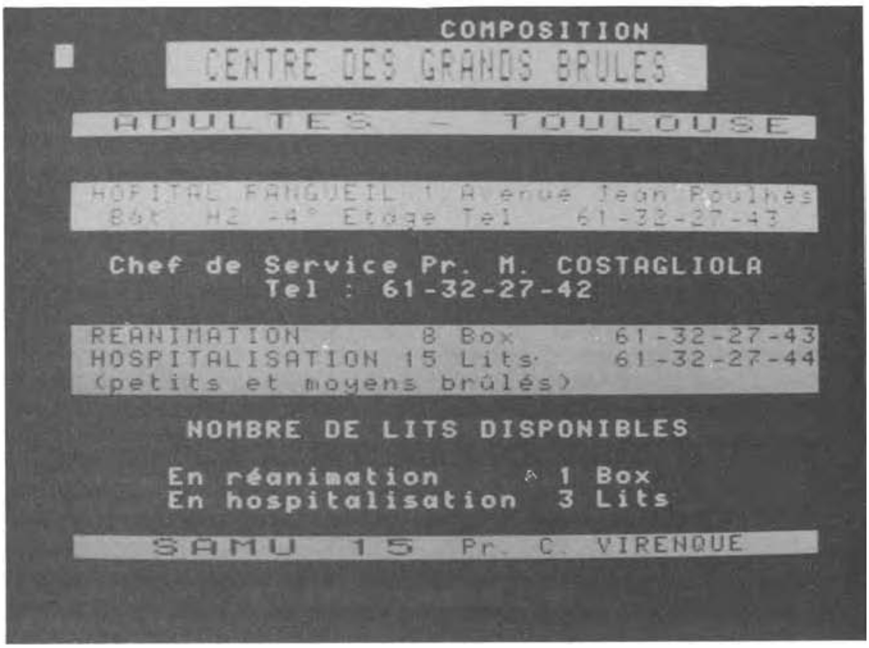
The advantages are undeniable. There is easy access for all burns centres; there is no paperwork; anonymity is guaranteed; and all results are centralized. But one essential point for us is the communication to emergency and hospital structures, information on the capacity of each centre to accept patients and the facilities they can offer in the event of a disaster, in order to optimize hospital services as a function of geographical location and the emergency. The information on bed availability must be continuously updated, and, by using a password, SAMU (mobile emergency medical service), SMUR (emergency medical service) and the prefecture can have access to the information and distribute patients accordingly after a disaster.

The search for available beds gives access to a map of France displaying all the centres and the number of empty beds. A confidential password is required to obtain the display. Valuable information is also provided about hospital capacity, technical procedures, intensive care, fluidized beds, etc.

DEALING WITH LARGE NUMBERS OF BURN PATIENTS

The experience of previous fire disasters (Feyzin in 1958 and Los Alfaques in 1978) confirms that immediate triage is essential in the presence of large numbers of burn patients.

Figure 1. Examples of *Infobrul* screens
a. The *Infobrul* menu
b. List of personnel at the Toulouse Medical Centre



c. Organization of the Toulouse Medical Centre with vital telephone numbers
d. Number of vacant beds at the time of access

It is essential to establish as rapidly as possible all the gravity factors: burn extent, depth, site, age, any associated lesions (respiratory distress, inhalation of toxic gases, traumatic lesions, crush syndrome). Three clinical conditions can thus be defined:

Group I burn patients: very serious, burn extent over 80% BSA (body surface area) with respiratory distress and hypovolaemic shock.
Group II burn patients: burn extent between 25% and 80% BSA.
Less serious burns: less than 25%, usually without associated lesions.

Group II patients are rapidly and efficiently evacuated to specialized centres, and rehydration, oxygenation and procedures for the prevention of infection are initiated. It may occasionally be necessary to perform a tracheotomy at the most advanced medical post, which underlines the importance of information concerning hospital bed availability.

The physician must be in possession of all possible information when making the painful but necessary choice between burn patients to be treated and usefully evacuated and others for whom nothing can be done.

THE VALUE OF A TELEMATIC DATABANK IN THE EVENT OF A DISASTER

In whatever kind of fire disaster, Minitel is not just a gadget, and we are convinced that it should become 'European'. Minitel can play a key role in the chain of relief; it is a link available 24 hours a day; it is never permanently engaged as a telephone may be if there are numerous simultaneous calls; and it is not affected by the same problems as radio communication.

Fire disasters are not very frequent, but they often occur when least expected: we have no excuse for being caught off-guard. It is essential to consider the possibility and to become organized as fully as possible. Fire disasters are often underestimated or neglected — stark proof of this is the fact the issue of *Sciences et Vie* on disasters completely omitted to mention fire disasters.

A link-up between the Minitel network and other information systems will enable everyone to take full advantage of these data banks.

CONCLUSION

Infobrul will not only facilitate communications within the French Burns Society but will also strengthen its dynamic character.

In fire disasters, immediate and accurate knowledge of the availability of hospital beds is a very important aid in the organization of emergency care in exceptional situations when there is a massive influx of burn patients.

33
Organizational criteria for setting up a field hospital after a fire disaster

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In the framework of organizational strategy in the event of a fire disaster, it is impossible, in our opinion, to proceed without a defined operative centre capable of resolving the emergency situation in the disaster area itself. This need, together with experiences reported in the literature (Dioguardi *et al.*, 1988, 1989), prompted us to define the organization and establishment of a field hospital. This structure is necessary for the administration of emergency treatment appropriate to the particular pathology, especially considering all the logistical difficulties following such an event, not the least of which is the problem of relief and transport of casualties.

In a fire disaster the number of persons involved may be so high that it is impossible to consider their immediate transfer to existing specialized structures (i.e. burns centres), both because of the limited number of beds available and because the disaster may occur some distance away.

The structure that we propose is capable of accepting a large number of burn patients and of providing adequate short- and long-term treatment. We considered (1) assessment of structures and materials to be used (Contreas *et al.*, 1989); (2) organization and coordination of the structures (Dioguardi *et al.*, 1989; Fisher, 1977; Gunn, 1981); and (3) prolonged treatment (Enyart *et al.*, 1955).

The choice of structures and materials to be used in setting up a field hospital depends on two basic requirements: on the one hand the necessity of easy transport and rapid assembly of the materials at the scene of the disaster, and on the other the possibility of administering complete and effective treatment to the patients. The best facilities are offered in our opinion by multi-unit pneumatic tents. The reduced weight of these tents, their ease of packing and their limited bulk represent considerable advantages, especially with regard to ease of transport and to rapidity and simplicity of assembly. Their modular composition means that their size can be adapted according to the effective needs of the disaster situation.

In the organization and coordination of a field hospital it is essential that the medical staff carry out a preliminary clinical assessment ('pre-triage') of the burn patients at the site of collection. Subsequent despatch to the operative centre will permit a more complete assessment. Hence the need to coordinate the various components of the hospital according to certain key points. (1) Priority of medical posts — a triage centre must be set up for the precise clinical assessment of the casualties on their arrival from the collection centre; they are then admitted to one of the field hospital tents. (2) Rational arrangement of the tents — the pneumatic tents must respect the exigencies of space required and available. Ward tends must alternate with medication tents, with adjoining filter areas; the optimal ratio between the two types is 2 to 1.

The field hospital also contains tents equipped for use as an analysis laboratory, a services centre, an intensive care area and eventually an operating room.

The air-volume per patient ratio must also be considered, to provide the best possible therapeutic results, also bearing in mind the possibility of protracted hospitalization.

The therapeutic care in a field hospital must necessarily be governed by a predetermined protocol. Pre-triage facilitates the structure's task, but triage is without doubt the key point in the protocol, as it enables the physician to assess patients according to their real clinical needs. Topical treatment of wounds is administered in the medication tents, and if necessary resuscitatory procedures will be performed in specially equipped tents.

The field hospital must be able to offer relatively long periods of hospitalization, with facilities for surgical operations (i.e. an operating tent) for the treatment of burns, thus reducing the necessity of transfer to specialized centres.

CONCLUSIONS

The organization and establishment of a field hospital must be based on a very precise predetermined plan. This plan must define all the logistical and sanitary activities of the field hospital required to manage the disaster in its emergency and long-term aspects.

The possibility of emergency and long-term treatment ensures the efficacy of the field hospital in disaster situations, and for this reason an official proposal for its preparation has been put forward to the Italian authorities concerned.

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Clinical file and protocol for general doctors and for non-specialized hospital doctors to assist burn patients

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An analytical study of over 2500 burn patients admitted to the Palermo Burns Centre in the last 13 years has allowed us to reach a number of conclusions.

For prognostic purposes, in the 'adult' patient with burns covering more than 25% body surface area (BSA) and the child aged between 0 and 12 years with burns on more than 15% BSA, two conditions are fundamental: the time interval between the accident and commencement of infusion therapy; and the quality of the therapy administered.

It is well known that the first clinical phenomenon to manifest itself in extensive burns is hypovolaemic shock as a result of the massive loss of water, salts and proteins from the circulatory system through the damaged capillaries.

Hypovolaemic shock determines tissue hypoxia, with consequent serious damage in progressive order to the organs and systems: kidney, lung, gastrointestinal system and so on.

The rapidity of the onset of hypovolaemic shock is directly proportional to the degree of the burn (II or III degree), the percentage of burned surface area, concomitant general conditions, age, the environmental conditions at the time of the accident and immediately afterwards (closed or open space, heated or cold), the time delay before treatment, and the quality of the infusive intensive care therapy initiated.

For prognostic purposes, the type of immediate aid that the patient receives is of fundamental importance. There can be no doubt that, in the case of an accident occurring in a city or town possessing hospital facilities, treatment is more appropriate than is the case in more remote areas. In this latter event, the general or family doctor, with the equipment at his disposal, represents the only means available to counteract the dramatic burn pathology, in a rapid race against time.

Our investigation has shown that it is precisely at this level that we see the most serious deficiencies in treatment; these may well compromise the prognosis of the illness.

What are the causes of these deficiencies?

Let us summarize them briefly:

- General doctors do not always know or remember some fundamental concepts of the physiopathology of burns. As they are more accustomed to treating medical and routine types of pathology on an outpatient basis, they underestimate the relationship between the extent of burned body surface and the increase of shock.
- They are not always able to make an accurate evaluation of the percentage of the burn areas. The assessment is nearly always either an underestimate or, as in most cases, an overestimate, which leads to serious delays in decision-taking and assessments regarding what treatment to initiate.
- They are not always able to make an accurate identification of the depth of the wounds which have different appearance and gravity according to whether they were caused by fire, boiling liquids, chemical substances or electricity. If the patient has inhaled hot air, smoke or toxic substances, the doctor is not always able to diagnose the involvement of the upper airways, a matter of extreme importance from the prognostic viewpoint.
- The result is that general doctors lack criteria for an accurate assessment and definition of the gravity of the patient's condition and therefore also for deciding upon local and general therapeutic procedures, and the necessity for transferring the patient.

In the light of these considerations, the Mediterranean Burns Club (MBC) thought it might be helpful to general doctors to compile a clinical file which would help them to take the correct local and general emergency therapeutic approach for burn patients.

The file should be available in general doctors' surgeries, especially those in more remote areas at some distance from large towns.

The file, which is shown in Appendix 1, presents, in questionnaire form, all the suggestions necessary to permit a complete therapeutic approach for the patient.

It then becomes the patient's personal file if and when he is transferred to a hospital or specialized centre.

Let us briefly analyse the main parts of the file.

Part 1 is for the patient's personal details and data regarding his weight, the date and time of the burn, the burn agent, the circumstances of the accident, and whether, very importantly, it occurred in a closed or open space.

The Wallace Chart is used to facilitate the accurate assessment of the extent of the burn. This subdivides the overall body area into smaller areas in multiples of 9%.

With relation to the burn surfaces, it is advisable to mark the percentages of superficial, intermediate and deep burns and the overall total.

It is important to carry out an immediate objective examination of the patient in order to evaluate the condition of the cardiocirculatory and respiratory systems. The systems are the first to be affected by the state of hypovolaemia which may establish itself rapidly and with increasing gravity.

The presence of associated trauma may affect prognosis if appropriate measures are not taken.

The presence of pre-existing pathologies, such as cardiopathies, hypertension, diseases of the renal system and hepatopathies must also be carefully investigated as they concern organs and systems that are directly and abruptly affected in the physiopathology of burns.

General practitioners do not always remember the pathological anatomy of fire lesions. For the various types of burn — superficial, intermediate and deep — clinical pictures are given referring to lesions from both fire and boiling liquids.

It is important to discover whether the burns are due to chemical agents, and, if so, to identify them if possible. It is necessary in all cases, presuming that no specific antidote is available, to wash the burned part with copious amounts of water.

With regard to electrical burns, it is important to find out the type of current and the voltage. Identification of entrance and exit lesions makes it possible to find out whether the body or part of it has in fact been traversed by an electric discharge. It is important in all cases to assess and record the condition of the central nervous system, and the presence of praecordial pain or arrhythmia.

It is not always easy in the early stages of treatment of the burn patient, especially if the burns are extensive, to appreciate the severity of his condition and therefore the urgency of therapeutic treatment.

In the file, the severity of the burn is related to age and the percentage of BSA burned. Four degrees are defined — slight, moderate, serious and very serious.

Three age classes have been created since, in our experience, burn for burn, patients over the age of 60 years have less favourable prognoses.

Some general and local therapeutic procedures are suggested for each class of severity pending transfer of the patient, if necessary, to hospital.

In the case of slight burns, for which hospitalization is unnecessary, attention is drawn to the importance of antitetanic prophylaxis and the cleansing and medication of burn surfaces with sterile or clean material.

In moderate burns (10–15% in children, 15–25% in adults and 20% in the elderly), it is also necessary to carry out infusive therapy. A vein must therefore be found and at least saline solution must be infused. If the burns are circumferential and involve the thorax, a hand or a limb, discharge incisions must be considered in order to relieve the subcutaneous pressure caused by oedema. The incisions are made along pre-established lines as illustrated in the diagram. The purpose of this is to prevent damage to the underlying structures and to obtain the desired discharge effect. It must be remembered that incisions should be made only when a long time interval is expected before hospitalization is possible.

In severe and very severe burns, intensive care therapy must be initiated as soon as possible. The administration of saline solutions and/or plasma or its derivatives must be performed using one or more veins situated as far as possible from the burn areas. The airways must be examined to make sure they are clear and, if necessary, mouth-to-mouth respiration and cardiac massage must be practised. The use of drugs, such as cortisone, depends on the patient's overall condition and his degree of shock. With regard to the quantity of fluid to infuse, a simple formula can be used according to which the percentage of burned body surface is multiplied by body weight in kilograms and then by a fixed number 2.5. The result divided by 2 gives the total amount of liquids necessary in the first 24 hours, subdivided into saline solution, Ringer solution and electrolyte solution. In order to counteract acidosis, it is necessary to add, if possible, a 10 mEq phial of carbonate to each 500 cc bottle of solution. The calculated quantity of fluid must be administered evenly throughout the 24-hour period. It is therefore necessary to regulate the dripping from the bottle at a fixed rate. The file shows the quantities of fluids in cc and the respective number of drops per minute.

It is also necessary to proceed to topical treatment of the burn areas. The doctor must therefore:

- remove dirty and singed clothing;
- make the patient lie down and wrap him in a clean sheet;
- if necessary, make discharge incisions.

With regard to the transfer of the patient to hospital or a specialized centre it must be borne in mind that the evacuation of burn patients, especially in large numbers, is a question of great responsibility.

Patients with slight burns do not need to be admitted to hospital and, after medication, they can be treated on an outpatient basis.

Moderate burn patients can be sent to general hospitals.

Only severe and very severe burn patients need to be sent to specialized centres. Their transfer, after they have received all the initial therapy just described, must be prepared with great care, considering the distance to be covered, the vehicles available and the inevitable discomfort which the patients in their delicate state are bound to suffer.

If possible, transfer should be by helicopter, and it must be arranged that therapy continues uninterrupted during the flight.

Before the patient leaves, the summary file must be compiled with all data regarding the patient's personal details, the accident, and medical and surgical treatment given.

CLINICAL FILE FOR THE BURN PATIENT IN A NON-SPECIALIZED HOSPITAL

The burn patient admitted to a peripheric non-specialized hospital needs special treatment suited to the particular state of his disease.

A guideline clinical file may be useful in this case as it can assist the physician in the performance of certain technical therapeutic procedures and in laboratory investigations, both of which are premises for adequate therapy.

Passing over the parts of the file that are similar to the previous file, we can see that important features of moderate burn patients are: use of a urinary catheter to monitor hourly diuresis; the administration of gastroprotective drugs; and the assessment of the patient's general condition by means of haematochemical tests, such as haematocrit, plasma electrolytes, creatinaemia, plasma osmolarity, urine osmolarity and urine electrolytes.

In the case of severe and very severe burns, these tests are integrated with ECG, thorax X-ray and protein electrophoresis.

Regarding the principles of infusion therapy, numerous formulae can be used. The file indicates the best known formulae: Evans' formula, Brooke's formula, Birke's formula and Monafò's formula. The choice of formula depends on the presence or not in the hospital of the various types of solution that each formula uses: saline solution, Ringer's lactate, plasma, albumin and hypertonic electrolyte solutions.

It is pointed out that:

(a) In the absence of specific solutions, it is possible to use saline solution, which is always available;
(b) The formulae, even if administered accurately, are only an indication from the quantitative point of view; and
(c) Regulation of the quantity of fluids to be administered is based on the assessment of certain fundamental parameters, such as arterial pressure, haematocrit, diuresis, and acid/base balance.

Sedation and analgesic therapy are administered when the shock phase is near solution. It must not be forgotten that a state of psychomotor agitation in children is often a symptom of an ongoing state of shock due to hypoxia.

The criteria to be followed to determine possible transfer to a specialized division are identical to those already described.

It must not be forgotten to compile the summary file reporting all medical and/or surgical treatment carried out.

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Appendix 1

Remember that assistance to the burn patient is effective if you proceed gradually and methodically

BASIC RULES

1. Prepare the clinical file and anamnesis.
2. Assess the patient's general state.
3. Perform an accurate local objective examination.
4. Assess the percentage of burned surface area.
5. Assess the patient's state of gravity.
6. Initiate, if necessary, general resuscitatory therapy.
7. Attend to topical treatment of burned areas.
8. Assess criteria for possible hospitalization of the patient, and, if affirmative, select a hospital.
9. Compile a summary of the patient's previous condition and of the various infusive therapies effected before transferring the patient.
10. Organize the patient's transfer.

1. PREPARE THE CLINICAL FILE AND ANAMNESIS

CLINICAL FILE

No. ....

Surname.. Name.................... Maiden name.........................
Address.. Tel. number.........................
Age......... Place of birth .... Date of birth.........................
Weight............ Blood group............ Date of burn .... at........ a.m./p.m.
Date of hospitalization (or 1st visit) .... at........ a.m./p.m.
Burn agent ....
Circumstances of burn...
Closed space ☐ yes ☐ no

ANAMNESIS

Diabetes	☐ yes	☐ no	
Specific disease	☐ yes	☐ no	which ....
Cardiopathies	☐ yes	☐ no	which ....
Hypertension	☐ yes	☐ no	
Gastric ulcer	☐ yes	☐ no	
Duodenal	☐ yes	☐ no	
Renal failure	☐ yes	☐ no	
Hepatopathies	☐ yes	☐ no	which ....

....

2. ASSESS THE PATIENT'S GENERAL STATE

Cardiocirculatory system

Arterial pressure ....
Heart rate ....
Pulse Rhythmic ☐ yes ☐ no
Arrhythmic ☐ yes ☐ no

Respiratory system

Dyspnoea ☐ yes ☐ no
Polypnoea ☐ yes ☐ no
Burns in upper airways ☐ yes ☐ no
Triage ☐ yes ☐ no
Objective examination of lungs
Vocal and tactile fremitus present where ....
absent
Vesicular murmur present where ....
absent

Presence of associated traumas

Cranium ☐ yes ☐ no
Thorax ☐ yes ☐ no
Abdomen ☐ yes ☐ no
Bone ☐ yes ☐ no
(if affirmative, carry out specific clinical test)
Notes ....

3. PERFORM AN ACCURATE LOCAL OBJECTIVE EXAMINATION

Burns from fire ☐ yes ☐ no

1. Superficial (1st degree) (hyperaemia, hyperalgesia) [S]
2. Intermediate (2nd degree) (blisters, whitish dermis, hypoalgesia) [I]
3. Deep (3rd degree) (dark brown or black colour, analgesia) [D]

Burns from boiling liquids ☐ yes ☐ no

1. Superficial (1st degree) (hyperaemia, hyperalgesia) [S]
2. Intermediate (2nd degree) (blisters, whitish dermis, hypoalgesia) [I]
3. Deep (3rd degree) (greyish colour) [D]

Electrical burns ☐ yes ☐ no

Type of current:

1. Direct current ☐ yes ☐ no
2. Alternating current ☐ yes ☐ no
3. Low voltage a.c. ☐ yes ☐ no
4. High voltage a.c. ☐ yes ☐ no

Entrance lesion ....

Exit lesion ....

Burn from heatburst ☐ yes ☐ no

Involvement of CNS ☐ yes ☐ no

1. Clouding of the senses ☐ yes ☐ no
2. Unconsciousness ☐ yes ☐ no
3. Coma ☐ yes ☐ no

Praecordial pain ☐ yes ☐ no

Arrhythmia ☐ yes ☐ no

Burns from chemical agents

Agent	*Clinical picture*	*Topical treatment*
ACID REACTION AGENTS		
Mercurial agents — Mercurous acetate — Mercuric chloride — Mercurochrome	Erythema, phlyctenae	Cleanse with H_2O, remove phlyctenae
Nitric acid	Eschars, deep ulcers	Cleanse with magnesium hydroxide, not H_2O
Phenol	Dark eschars, slightly painful ulcers	Cleanse with H_2O; cover with vaseline gauzes
Acetic acid	Eschars	Cleanse with phys. sol.; cover with vaseline gauzes
Formic acid		Cleanse with phys. sol.: cover with vaseline gauzes
Picric acid	Eschars	Cleanse with phys. sol.; cover with vaseline gauzes
Tannic acid (Digallic acid)	Eschars	Cleanse with H_2O
Hydrofluoric acid	Large eschars, very painful deep ulcers	Cleanse with solution of sodium bicarbonate, infiltrations of calcium gluconate, phial of solution 9 and phial of calcium gluconate (available in pharmacies)
Oxalic acid	Slightly painful superficial ulcers	Cleanse with H_2O and calcium solutions
Hydrochloric acid (Muriatic acid)	Eschars, deep ulcers	Cleanse with H_2O and soap, magnesium hydroxide solution. Phillips Milk of magnesia S. Pellegrino magnesia
Sulphuric acid	Eschars, slightly painful ulcers	Cleanse with H_2O and soap, magnesium hydroxide solution. Phillips Milk of magnesia
BASIC REACTION AGENTS		
Hypochlorites and **bleaches**	Deep ulcers	Cleanse with 1% sodium thiosulphate solution (Phial of 1 g sodium thiosulphate in 10 ml galenic solution; to obtain a 1% solution, dilute a phial in 100 ml distilled H_2O)
Caustic soda	Necrosis	Cleanse with phys. sol. and weak acid solution (Solutions of acetic acid or boric acid)

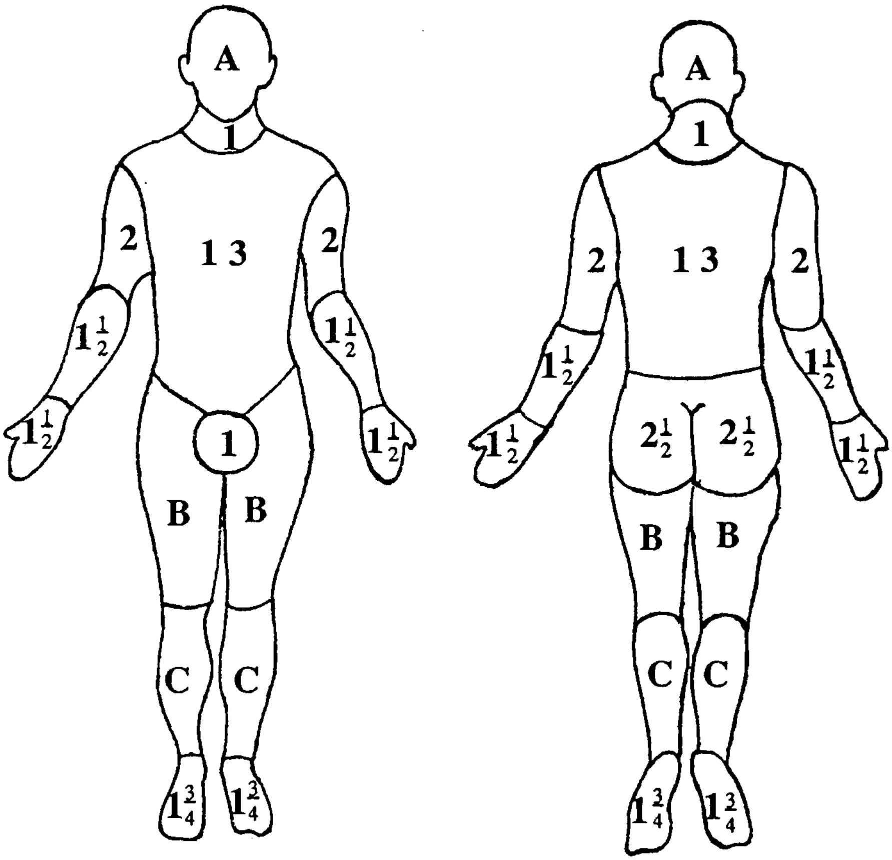
continued

Burns from chemical agents (*continued*)

Agent	*Clinical picture*	*Topical treatment*
BASIC REACTION AGENTS (*continued*)		
Sodium hydroxide	Necrosis	Cleanse with phys. sol. and weak acid solution (Solutions of acetic acid or boric acid)
Potassium hydroxide	Necrosis	Cleanse with phys. sol. and weak acid solution (Solutions of acetic acid or boric acid)
OXIDATING REACTION AGENTS		
Chromium trioxide	Slightly painful dark ulcers	Cleanse with sodium thiosulphate (See above)
Potassium permanganate	Dark eschars	Cleanse with solution; cover with mucilaginous substances (Preparation of Malva Kelemata)
REDUCING REACTION AGENTS		
	Progressive necroses	Cleanse with a solution of 2% copper sulphate with 5% sodium bicarbonate in a suspension of hydroxethylcellulose (Cupric Zn solution containing $ZnSO_4$ 3.5% $CuSO_4$ 1%)
VESICANT AGENTS		
Cantharides	Phlyctenae	Cleanse with H_2O (Olive oil)
Dimethyl sulphoxide	Phlyctenae	Cleanse with H_2O (Almond oil)
Lewisite	Phlyctenae	Cleanse with oily substances (Olive oil)
Yperite	Phlyctenae ulcers	Cleanse with oily substances
Napalm		

4. ASSESS THE PERCENTAGE OF BURNED SURFACE AREA

Quantitative and qualitative assessment of burns at hospitalization



S ☐ 1st degree (%) =

I ☐ 2nd degree (%) =

D ■ 3rd degree (%) =

(Shade in according to degree)

Total (%) ....

Fraction of body surface area (%) in relation to age			
Years	A	B	C
0	9.5	2.75	2.5
1	8.5	3.25	2.5
5	6.5	4.0	2.75
10	5.5	4.25	3.0
15	4.5	4.5	3.25
Adults	3.5	4.75	3.5

Site of burn (for hospital doctors)

Head:	☐ entire face	S	I	D
	☐ scalp	S	I	D
Neck:	☐ circumferential	S	I	D
	☐ front	S	I	D
Chest:	☐ circumferential	S	I	D
	☐ front	S	I	D
	☐ back	S	I	D
Abdomen:	☐ circumferential	S	I	D
	☐ front	S	I	D
	☐ back	S	I	D
Right arm:	☐ circumferential	S	I	D
	☐ axilla fold	S	I	D
Left arm:	☐ circumferential	S	I	D
	☐ axilla fold	S	I	D
Right forearm:	☐ circumferential	S	I	D
	☐ elbow fold	S	I	D
Left forearm:	☐ circumferential	S	I	D
	☐ elbow fold	S	I	D
Right hand:	☐ all over	S	I	D
	☐ back	S	I	D
	☐ palm	S	I	D
	☐ finger 1 circumferential	S	I	D
	☐ finger 2 circumferential	S	I	D
	☐ finger 3 circumferential	S	I	D
	☐ finger 4 circumferential	S	I	D
	☐ finger 5 circumferential	S	I	D
Left hand:	☐ all over	S	I	D
	☐ back	S	I	D
	☐ palm	S	I	D
	☐ finger 1 circumferential	S	I	D
	☐ finger 2 circumferential	S	I	D
	☐ finger 3 circumferential	S	I	D
	☐ finger 4 circumferential	S	I	D
	☐ finger 5 circumferential	S	I	D

Right thigh:	☐ circumferential	S	I	D
	☐ inguinal fold	S	I	D
Left thigh:	☐ circumferential	S	I	D
	☐ inguinal fold	S	I	D
Right leg:	☐ circumferential	S	I	D
	☐ popliteal space	S	I	D
Left leg:	☐ circumferential	S	I	D
	☐ popliteal space	S	I	D
Right foot:	☐ all over	S	I	D
	☐ instep	S	I	D
	☐ sole	S	I	D
	☐ toes	S	I	D
Left foot:	☐ all over	S	I	D
	☐ instep	S	I	D
	☐ sole	S	I	D
	☐ toes	S	I	D
External genitalia:	☐ penis	S	I	D
	☐ prepuce	S	I	D
	☐ vulva	S	I	D
	☐ vagina	S	I	D
Perineum:	☐ anal region	S	I	D
	☐ perianal region	S	I	D
Airways:	☐ burned nasal hair	S	I	D
	☐ burns in and around the mouth	S	I	D
	☐ carbon particles in expectorate	S	I	D
	☐ hoarseness	S	I	D
	☐ irritable cough	S	I	D
	☐ dyspnoea	S	I	D
	☐ difficulty to expectorate	S	I	D
	☐ haemoptysis	S	I	D

S = Superficial burn
I = Intermediate burn
D = Deep burn

5. ASSESS THE PATIENT'S STATE OF GRAVITY

Severity of burn	*% BSA with 2nd- or 3rd-degree burns*		
	Children (0–12 y)	*Adults* (12–60 y)	*Elderly* (>60 y)
Slight	5–10	10–15	10
Intermediate	10–15	15–25	20
Serious	15–20	25–40	30
Very serious	>20	>40	>30

N.B. All burns involving the face are to be considered serious because they involve upper airways.

6. INITIATE, IF NECESSARY, GENERAL RESUSCITATORY THERAPY

General therapy for general doctors

A. Slight burns
1. Infusive treatment unnecessary.
2. Antitetanic prophylaxis ☐ yes ☐ no
3. Cleansing and medication of burn surfaces.
4. Hospitalization unnecessary.

B. Moderate burns
1. Infusive treatment necessary.
2. Find safe intravenous access at some distance (if possible) from the burn surfaces, using vein catheter, butterfly needle etc.
3. Administer salt solution + plasma (or derivatives).
4. Cleanse and medicate wounds.
5. Antitetanic prophylaxis.
6. For deep circumferential burns, consider possibility of pressure-relieving incisions.
7. Administer *per os* not more than 500–1000 ml H_2O according to age.

C. Serious and very serious burns (requiring acute resuscitation)
1. Find one or more safe intravenous accesses at some distance (if possible) from the burn surfaces, using vein catheter, butterfly needle etc.
2. Administer salt solution + plasma (or derivatives).
3. Apply bladder catheter to monitor hourly urine.
4. Check capacity of upper airways.
5. Antitetanic prophylaxis.
6. Topical treatment of burn area.
7. In deep circumferential burns, consider possibility of pressure-relieving incisions.
8. Administer *per os* not more than 1000–1500 ml H_2O according to age.

N.B. The intravenous use of cortisones depends on the patient's overall condition and his degree of shock.

Indispensable initial infusive therapy

The quantity of liquids to be administered in the first 12 hours is calculated by the following formula:

$$\frac{\%\ \text{body surface burned} \times \text{body weight (kg)} \times 2.5}{2} = \_\_\ \text{cc} \begin{cases} 50\%\ \text{PPS} \\ 50\%\ \text{Ringer's} \\ \text{lactate} \end{cases}$$

Plasma protein solution (PPS) and Ringer's solution are administered alternately.

This formula is valid for: Salt solution
Ringer's solution
Electrolytic solution
Protein solution, plasma

If necessary add a 10 mEq bicarbonate phial to each 500 cc bottle of solution.

When the drip apparatus is regulated at 20 drops = 1 cc, the following table can be followed:

500 cc	7 drops per minute
1500 cc	20 drops per minute
2000 cc	27 drops per minute
2500 cc	34 drops per minute
3000 cc	40 drops per minute
3500 cc	47 drops per minute
4000 cc	54 drops per minute
4500 cc	60 drops per minute
5000 cc	67 drops per minute
5500 cc	74 drops per minute
6000 cc	80 drops per minute
6500 cc	87 drops per minute
7000 cc	94 drops per minute

General therapy for hospital doctors

A. Slight burns
1. Infusive treatment unnecessary.
2. Antitetanic prophylaxis ☐ yes ☐ no
3. Cleansing and medication of burn surfaces.
4. Hospitalization unnecessary.

B. Moderate burns
1. Infusive treatment necessary.
2. Find safe intravenous access at some distance (if possible) from the burn surfaces, using vein catheter, butterfly needle etc.
3. Administer salt solution + plasma (or derivatives).
4. Apply bladder catheter to monitor hourly urine.
5. Antitetanic prophylaxis.
6. Administer gastroprotective drugs.
7. Cleanse and medicate wounds. For deep circumferential burns, consider possibility of pressure-relieving incisions (see below).
8. Blood tests: Haemotocrit ....
Plasma electrolytes ....
Acid–base balance ....
Blood cell count ....
Creatinaemia ....
Plasma osmolarity ....
Urine osmolarity ....
Urine electrolytes ....

N.B. The intravenous use of cortisones depends on the patient's overall condition and his degree of shock.

C. Serious and very serious burns (requiring acute resuscitation)
1. Find one or more safe intravenous accesses at some distance (if possible) from the burn surfaces, using vein catheter, butterfly needle etc.
2. Administer salt solution + plasma (or derivatives).
3. Apply bladder catheter to monitor hourly urine.
4. Check capacity of upper airways.
5. Antitetanic prophylaxis.
6. Administer gastroprotective drugs i.v.
7. Topical treatment of burn areas.
8. For deep circumferential burns consider possibility of pressure-relieving incisions (see below).
9. Instrumental tests: ECG
Chest X-ray.
10. Blood tests: Haematocrit ....
Urine electrolytes ....
Acid–base balance ....
Blood cell count (with leukocyte formula) ....
Protein electrophoresis ....
Azotaemia ....
Glycaemia ....
Creatinaemia ....
Plasma osmolarity ....
Urine osmolarity ....

N.B. The intravenous use of cortisones depends on the patient's overall condition and his state of shock.

D. Principles of infusive therapy
Quantities and qualities of liquids should be infused in the first 48 hours according to the most widely used formulae:

Evans' formula

First 24 hours – 1 cc × kg × % BSA = plasma
1 cc × kg × % BSA = salt solution
2000 cc glucose solution 5% in adults
90 cc glucose solution 5% × kg in children

Second 24 hours – 0.5 cc × kg × % BSA = plasma
0.5 cc × kg × % BSA = salt solution
2000 cc glucose solution 5% in adults
90 cc glucose solution 5% × kg in children

Brooke's formula

First 24 hours – 0.5 cc × kg × % BSA = plasma or albumin or dextran
1.5 cc × kg × % BSA = Ringer's lactate
2000 cc glucose solution 5% in adults
90 cc glucose solution 5% × kg in children

Second 24 hours – 0.25 cc × kg × % BSA = plasma or albumin or dextran
0.75 cc × kg × % BSA = Ringer's lactate
2000 cc glucose solution 5% in adults
90 cc glucose solution 5% × kg in children

Birke's formula

First 24 hours – 1.5 cc × kg × % BSA = plasma
1 cc × kg × % BSA = 0.9% NaCl

Second 24 hours – 1 cc × kg × % BSA = plasma
0.5 cc × kg × % BSA = 0.9% NaCl

Palermo formula

First 24 hours – 2.5 cc × kg × % BSA = 50% plasma protein solution (PPS)
50% Ringer's lactate
PPS and Ringer lactate are administered alternately.
Ordinary water, with or without sugar or glucose, can be given *per os* as required.

Second 24 hours – 2.5 cc × kg × % BSA = 50% plasma protein solution (PPS)
50% glucose solution 10% + insulin, electrolytes
Sodium bicarbonate is administered both at the beginning and as required.
Ordinary water, with or without sugar or glucose, can be given *per os* as required.

N.B. 1. In the absence of plasma, dextran and albumin, replace the respective quantities with:
Salt solution
Ringer's solution
Electrolytic solution

2. All these formulae are indicative for the first hours of therapy and are subject to variations in quantity and quality depending on the following parameters:

Clinical parameters:
Blood pressure – pulse rate – cardiac rate
Respiratory rate
Sensorium
Body weight
Gastrointestinal function

Lab. test parameters:

Every hour:	Haematocrit (Ht) Urinary output
Every 4–6 hours:	Acid–base balance (every 2 h if upper airways involved) Plasma osmolarity

Every 12 hours

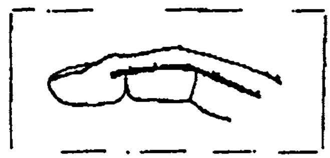
Blood chemistry tests	*Urine tests*
Blood picture	Urinolysis
Ht	Ketone bodies
BUN	Electrolytes
Creatinine	Osmolarity
Glucose	Creatinine clearance
Electrolytes (Na, K, Cl)	Urine urea nitrogen
Calcium	
Proteinaemia	
Acid–base balance	
Plasma osmolarity	

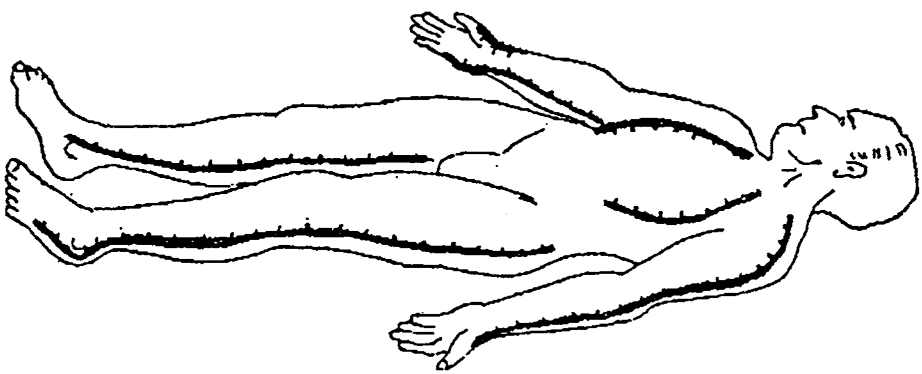
3. Sedation and analgesic therapy, when necessary, must be administered i.v.

7. ATTEND TO TOPICAL TREATMENT OF BURNED AREA

1. Remove clothing.
2. Put patient on sterile or clean sheets.
3. Cleanse burns with salt solution or antiseptic solutions.
4. Apply occlusive dressing with greased gauze and sterile gauzes and wrap the burn surfaces in metalline sheets, sterile sheets or clean sheets.
5. In third-degree circumferential burns of the thorax causing reduction of respiratorial expansion, perform a number of longitudinal pressure-relieving cuts as far as the fascial planes, and attend to haemostasis.
6. Perform pressure-relieving incisions in other circumferential burns (e.g. finger, limbs).

Diagram of pressure-relieving incisions.
In the limbs, neck and thorax, the burn areas are incised as far as the healthy tissue in order to eliminate pressure on the underlying tissue.





8. ASSESS CRITERIA FOR POSSIBLE HOSPITALIZATION OF THE PATIENT (FOR GENERAL DOCTORS)

Criteria for hospital admission

Patients with **slight burns** can be treated as outpatients.

Patients with **moderate burns** must be hospitalized and treated with general or topical therapy.

Patients with **serious** or **very serious burns**: after priority treatment must be hospitalized in nearest Burn Centre.

Burns requiring treatment in a specialized centre include burns involving the:

Hand:	If circumferential
Genitals and perineum:	Especially if involving penis, prepuce and perianal region
Feet:	If circumferential
Chest:	If circumferential
Face:	May affect upper airways

9. COMPILE SUMMARY

Surname.. Name............................ Maiden name..................
Address.. Tel. number..................
Age......... Place of birth .... Date of birth..................................
Weight............ Blood group............ Date of burn ....
Time of burn............ Date of admission...................... Time of admission ....
Burn agent ....
Circumstances of burn ....

Closed space	☐ yes	☐ no
Total of body surface burned	.... %	
Circumferential burn	☐ yes	☐ no
Pressure-relieving incisions	☐ yes	☐ no
Vein catheter	☐ yes	☐ no
Bladder catheter	☐ yes	☐ no
Nasogastric tube	☐ yes	☐ no
Antitetanic prophylaxis	☐ yes	☐ no
Associated traumas	☐ yes	☐ no
1. Cranium	☐ yes	☐ no
2. Chest	☐ yes	☐ no
3. Abdomen	☐ yes	☐ no
4. Bone	☐ yes	☐ no

Instrumental tests: ECG ....
Chest X-ray ....

Blood tests: Haematocrit ....
Plasma electrolytes ....
Acid–base balance ....
Blood cell count ....

Infusions:

1. Intravenous infusion:	Salt solution	ml	....
	Ringer's solution	ml	....
	Electrolyte solution	ml	....
	Protein solution	ml	....
	Plasma	ml	....
	Blood	ml	....
	Other	ml	....
2. Liquids *per os*	Total	ml	....

Drugs administered:

1. Cortisones ☐ yes ☐ no
2. Diuretics ☐ yes ☐ no which ....
3. Sedatives ☐ yes ☐ no which ....
4. Gastroprotectors ☐ yes ☐ no
5. Anticonvulsants ☐ yes ☐ no which ....
6. Other drugs ☐ yes ☐ no

Wounds sutured ....

Surgical intervention ....

Observations ....

10. ORGANIZE PATIENT'S TRANSFER

- Contact the nearest Burn Centre or General Hospital to check the availability for admission of patient.
- Select the means of transport for transfer of the patient: by ambulance or by helicopter if the patient's condition and the distance from the Centre make it necessary.
- Contact the Authorities for use of helicopter.
- If possible, accompany the patient.

CHECK LIST

Have you contacted the nearest hospital?

Have you contacted the nearest Burns Centre?

Are there beds available at the Burns Centre?

Have you called the ambulance?

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Medical care of mass burn victims: the Vishnevsky principles and organization in the Ufa disaster

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Technically advanced installations and dense population in industrial areas increase the danger of technological accidents with mass victims. Any accident even in a city is problematic regarding medical care. The greatest problem in Russia is organization of timely and qualified medical care in the vast regions of our country, which are often far from any populated area. The recent disasters show that it is necessary to further perfect the whole system of emergency medical care, analyse it and support it by scientific elaboration. The plan envisages a two-stage organizational system of medical care.

Special importance is attached to the first stage: emergency care and evacuation. Emergency qualified medical care is provided by the mobile teams and field facilities sent to the disaster area. They can be deployed in the nearest hospitals.

The second stage is medical care of burn victims in hospitals, ambulances and specialized centres until their complete recovery.

In a number of disasters caused by explosions and fires, burn victims make up the most severely injured group. In the last 10 years the burn centre of the Vishnevsky Institute of Surgery has organized and rendered medical care 24 times in disasters. These were caused by gas pipeline explosions, heating accidents in factories, transport accidents, fires and earthquakes: 2924 persons suffered burns, and 182 victims with the most extensive full-thickness burns were evacuated to burn centres. The greatest disaster, 100 km from Ufa, was caused by a huge explosion of accumulated gas leaking from a defective pipeline. Fire enveloped two passing trains which were derailed by the shock wave. The total number of casualties was 1220; 97.4% had burns. In 33% of cases burns were combined with inhalation injury. Every fifth victim had a life-incompatible trauma.

Medical care was rendered in the disaster area, including the nearest hospital

(450 beds). Central vein catheterization was performed when necessary, and controlled infusion therapy and the required anaesthesia were started. After this, with anti-shock therapy continuing, the majority of the patients were evacuated by railway and by air to the burn centres of Chelyabinsk (168 victims) and Ufa. Collaboration between the civil and military medical services and also the help of local volunteers enabled all severely burned patients to be cared for and to continue their intensive care within the first 8–10 hours. Within the first day after the accident, specialists from other cities arrived and later from Britain, the United States, and Israel.

Three hundred and eighteen victims were evacuated to the largest burn centres for further treatment, 166 of them to Moscow. In the burn centres of Moscow and other cities, specialists used the method of intensive care elaborated by the Vishnevsky Institute of Surgery. The method consists in treatment of burned surfaces by idopirone shampoo. Patients with full-thickness circular burns are placed on the 'Clinitron' bed and into abacterial isolators. This allows mummification of the eschar within 3–4 days and achieves a two- to threefold decrease of bacterial contamination; it is possible to perform chemical necrectomy and immediate autodermoplasty. This creates optimum abacterial conditions for the survivability of transplanted autografts. Successful autodermoplasty is achieved in 95% of patients.

A less effective but a simpler means of open treatment is the use of infrared rays in specialized wards, equipped with a forced air cleaning system. The method is based on the ability of infrared rays to penetrate superficially into the body, allowing drying of the eschar, decrease of bacterial contamination, and preparation for the chemical necrectomy with further autodermoplasty.

A considerable proportion of the patients (63%) were treated by the cover method, with ointments such as silver sulphadiazine, idopirone, levocine and flammazine, which also promote quicker transformation of the burn necrosis to dry eschar. This method was used mainly in patients with local burns.

Correction of metabolic disturbances was achieved by the combination of parenteral feeding and durable dose-controlled probe enteral hyperalimentation with the use of enteral alimentation complexes.

Thanks to these organizational and medical measures, 633 of the 806 Ufa accident victims survived. One hundred and seventy-three (21.5%) died within the first 10 days. It should be underlined that the majority of these patients started to receive infusion therapy only 6 hours after the burn trauma, which greatly decreased the effectiveness of the treatment and predetermined the unfavourable outcome. Nevertheless, considering that many severely burned patients were treated simultaneously, the results could be regarded as satisfactory.

The accumulated experience shows that the effectiveness of rescue work depends not only upon the mobility and qualification of the medical services but also upon the organizational preparedness of the municipal and other state services operating in the emergency situation.

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On-site treatment of severely burned patients

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Accidents that cause serious burns often strike fear into the rescue workers. It is necessary to act very rapidly at the site of the accident. 'Savoir pour sauver' (knowledge saves lives) is the subject of many scientific discussions, especially for the anaesthesiologist. Better knowledge enables the physicians involved in first aid to decide on the best management of patients to be transported safely to the nearest hospital.

In burns, tissue damage depends on the exposure time to heat, the temperature reached, and burn depth. 'Burn disease' is defined as damage of 20% of the whole body surface for adults and 12% for children. In these cases the damage alters body organs and biochemical functions, causing shock. Patients who have severe burns need very specialized treatment before being admitted to hospital. Physicians who first arrive on the scene of the accident have various problems to solve in relation to the nature of the disaster, the ability of the rescue workers, and transport efficiency. Triage is important. The following factors have to be considered when selecting patients: (1) fast, precise and complete diagnosis; (2) creation of the best conditions for safe transport; (3) use of the appropriate vehicle.

PHASES OF THE MANAGEMENT OF BURNED PATIENTS

Removal from source of burn. When the patient is removed from the source of the burn (burning clothes, chemical agent, electric current, etc.) the rescue worker has to be careful not to become a victim himself. Clothes and shoes have to be removed and the patient has to be washed with cold water in the case of both burning and chemical agents. In electric burns the current has to be switched off; and in radiation burns specialized personnel will be responsible for removing the source and for decontamination.

Checking of vital signs. After removal from the burn source, the patient has to be treated as a traumatized subject. Particular attention must be paid to the airways and to respiratory and circulatory functions. Respiratory trauma can be caused by smoke or chemical agents or by dehumidification.

Diagnostic criteria. The diagnosis of respiratory damage is made on the basis of voice changes and/or breathing disability. Objective data to be considered are: burns to the face, hair, moustache or beard, acute inflammation of the oropharynx, breathlessness.

TREATMENT OF BURNED PATIENTS

Respiratory damage is treated by prompt administration of oxygen (100%) even if respiratory distress is not present. Orotracheal intubation is necessary when the patient is not conscious or has a respiratory arrest and when severe burns of the oral or pharyngeal cavity are present. Respiratory failure is very common in severely burned patients and the clinical signs are similar to those of the adult respiratory distress syndrome (ARDS).

Circulatory and consequent renal failure can be avoided by intravenous cannulation by a venous catheter, administering an electrolytic solution. For a good therapeutic approach it is also necessary to know that the microvascular outflow of liquids, cellular membrane damage, and colloid-osmotic pressure increase are present in the burned tissues.

Oedema as fluid storage can be present even in undamaged tissues; the blood circulation can therefore be altered, increasing the risk of infection. Oedema of the upper airways increases respiratory failure so that hypovolaemia has to be resolved. Rapid infusion of a colloid solution can reduce tissue oedema, increasing the osmotic gradient between plasma and interstitial colloids.

Cellular membrane alterations increase the shift of extracellular sodium and intracellular water, causing cell swelling. Following these alterations, cardiovascular failure, burned tissue oedema, hypovolaemia and myocardiac depression can occur.

How can all this damage be prevented, especially in the first phase? Immediate treatment has the goal of maintaining tissue perfusion so that organs do not present ischaemia, that the soft tissues remain viable even if burned, and that oedema of the upper airways and burned tissues do not alter respiratory or tissue function.

To accomplish a safe fluidotherapy it is necesary to calculate the extent of the burn. Infusion solutions are many and they cannot be standardized because solutions have to be adapted to the patient. The choice has to be made on the basis of a good knowledge of burn physiopathology and of the features of each solution. The first choice may be the isotonic crystalloid solutions, such as Ringer's lactate to be administered in the first 24 hours. No whole blood should be given in the first 24 hours, in order to avoid sludging; plasma is advised because of its capillary permeability.

Antalgic therapy

It is necessary to reduce catecholamine increase due to pain caused by the burn agents, by administering adequate antalgic therapy. The best route of administration of antalgic and/or anxiolytic agents is intravenous. Application of tampons imbued with cold water can decrease pain. Antalgic therapy depends on the kind of drugs given and on transport time. If pain is slight, acetylsalicylic acid (650 mg/4–6 h by mouth) can be administered. For severe pain, morphine (2–8 mg i.v.) or meperidine (10–15 mg i.v.) can be given. Anxiety should be treated both by reassuring the patient and/or giving diazepam (2–10 mg/4–6 h i.v.)

Treatment of the burn

Essential burn treatment at the site of the accident is relatively easy. No topical agents should be used. Burned tissue can be covered with clean, sterilized wet tampons. The removal of clothing from damaged skin should be avoided as burned tissues must be cleaned in the hospital.

CONCLUSIONS

Emergency situations for severely burned patients are very frequent, and adequate and prompt health care is necessary. The treatment of severely burned patients has to be given at the site of the accident and this is important for the subsequent treatment in hospital. It is necessary for medical staff to arrive promptly on the scene of the accident in order to provide first aid and immediate therapy. This is the appropriate therapeutic approach for burned patients and it will help subsequent treatment in hospital.

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The early cooling of burns

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Although its beneficial effect has been known for 200 years (Davies, 1982) the immediate application of cold water to a burn is a technique rarely performed by first-aid teams, and the few teams that do practise this restorative therapy lack precise indications as to its use.

The purpose of this paper is to provide a brief review of the benefits of the cooling of burns, to suggest some precise indications and to codify its application.

The proportion of persons treated every year for burns is 3 per 1000 inhabitants, i.e. 0.3% of the population (Latarjet, 1989). Among the immediate forms of first aid therapy an important role is played by the cooling of the burned parts by the application of cold water.

THE BENEFITS OF COOLING

Reduction of burn depth

Even if the burning agent is no longer exerting any caloric action, the heat stored in the superficial layers of the skin continues to spread towards the deeper layers. This heat spreads radially both outwards (into the air at the initial moment of the burn) and inwards (to the skin and muscles). Considering that the skin consists mostly of water and that water conducts heat 20 times as fast as air, the dissipation of heat is bound to be in the direction of the deeper layers of the skin, so that its destructive action is extended.

Cooling reduces tissue temperature and therefore the gravity of the lesions; it spares the basal membrane and thus facilitates cicatrization (De Camara *et al.*, 1981).

Reduction of oedema

Simply by diminishing the extent and the depth of the burn, cooling reduces oedema. Also, the resulting vasomotor mechanisms improve the quality of local circulation and reduce the liberation of histamine and kinins responsible for inflammatory phenomena and in particular for oedema, both at the level of the damaged tissues and at a distance.

Reduction of pain

Cooling reduces pain through the effect of the mechanisms already mentioned (improvement of the local circulation, reduction of the liberation of inflammation mediators, limitation of the extent and depth of the burn) (Davies, 1982). The soothing effects of cold, which blocks cutaneous nervous conduction, are also familiar.

INDICATIONS

All recent burns benefit from the application of running cold water. Apart from deep electric burns with a clear cutaneous–mucous manifestation, all burns must be cooled with running cold water, whatever the nature of the burn agent.

MANNER OF APPLICATION

The cooling of a burn must be achieved by a constant flow of water over the burn, extending beyond the region initially burned but avoiding the 'bath-tub effect' i.e. contact of all or part of the body with the water that has been used for cooling.

POSITIONING OF THE VICTIM

Burns in one or two limb segments

The victim should be placed as comfortably as possible and the uninjured parts of the body protected by a waterproof covering. For example, in the case of burns in both legs, water should be applied to the patient in a sitting position. Gravity will ensure the flow of water. In the case of burns in the upper limbs also the victim should be placed in a sitting position, and the lower part of the body covered by a waterproof apron, using, for example, a plastic sheet.

Burns of the back or thorax

The same system can be used provided the seat used has no back (stool, edge of table, edge of stretcher). The waterproof garment is worn like a loose skirt to cover the lower part of the body.

Extensive burns

In this case only the lying position is possible for the application of cold water. The victim must therefore be placed on a hard, flat surface such as a pressure mattress used as a rigid stretcher, covered by a waterproof plastic sheet. Once the victim has been laid on the surface (on the back, abdomen or side, depending on the site of the burns), the hard surface must be adjusted so that the head is raised about 10–15°. This slight inclination will cause the water to flow, preventing it from stagnating between the body and the hard surface, which might cause hypothermia.

If the victim is taken in charge by a medical team, he must be placed as described above on a pressure mattress covered by a waterproof sheet. This protective mattress is then placed on the stretcher which is positioned so that the water can flow as required. In an outdoors environment, the head of the stretcher can be placed on the pavement and the foot in the street.

APPLICATION OF COLD WATER

Water flow

The water must flow abundantly over the lesions but care must be taken to prevent the force of the jet of water from aggravating them by mechanical effect. The water must trickle down by force of gravity. The amount of flow must therefore be sufficient to guarantee a constant trickle over the lesions, without any pain being caused by the contact of the water.

The water temperature must be between 8 and 25°C. Mains drinking water, fire hydrant water, fire-engine water are suitable sources. The temperature of tap water is between 8 and 18°C.

When a fire-engine is present, a small water-sprinkler of any size can be used. This is moved up and down over the area to be cooled at a distance of 10–15 cm. The to-and-fro movement will effectively cool the burned area and the adjacent parts.

In a domestic environment the same procedure can be achieved using a shower attachment connected to a tube to which the water supply is not strong enough to cause diffusion and mechanical effects.

Duration of application

The duration of water cooling in a burn patient is variable and depends to a large extent on the temperature of the water and the time lag before its application. The following rules should be followed.

- Localized burns of limited extent, for which medical assistance and transport will be provided by a first-aid team: cooling must be performed for at least 10–15 min. The cessation of pain is a good indication of the success of the 'treatment'.
- Extensive burns, requiring the assistance of a specialized medical team: the duration of cooling must be decided by the physician, who will take into account the water temperature, climatic conditions and the priority of other measures that have to be taken.

Secondary procedures

During cooling, the outer clothing must be removed but the victim must not be completely stripped. This is unnecessary and would require manipulations that delay cooling. Only superficial garments need be removed (overcoats, jackets, dressing-gowns, pullovers, etc.). Further undressing will be done by the medical team that takes charge of the victim.

The patient is then dried with sterile sheets. Dabbing movements should be used, not rubbing.

When these procedures have been performed the victim is placed on a pressure mattress covered by an isothermic blanket and a sterile dry sheet.

Dangers to be avoided

If the flow of cold water over the burns has clearly reduced their extent and depth, there is no point in applying ice to the burned regions — this might increase the skin damage.

In the case of extensive burns, it is advisable not to prolong the application of cold water excessively as this may cause hypothermia. This type of burn patient needs specialized medical treatment and the physician in charge must be responsible for cooling.

The risk of non-sterile water causing an infection in the burned areas is negligible compared to the advantages, in terms of the saving of skin offered by the cooling of burns.

The delay in hospitalization is not a valid objection because the few minutes spent on cooling the burned region at the scene of the accident represent an invaluable investment, both for the victim (reduction in gravity of the burns) and for society (reduction of hospital stay in a specialized centre).

In conclusion, the key action in the prehospitalization care of burn patients for both first-aid teams and specialized medical teams, is *early cooling* of the lesions, according to the following simple 'ten-to-fifteen' rule: Cool the burns as soon as possible (within 10–15 minutes) by trickling cold water (10–15°C) over the skin from a distance of 10–15 cm for at least 10–15 minutes.

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Therapeutic kit and procedures for fluid resuscitation in disasters

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In disasters, various factors influence morbidity and mortality rates. Key elements are the speed with which the disaster area is reached, the quantity and quality of the professional and material resources available, and the time delay before burned and/or polytraumatized patients can be transferred to specialized hospitals.

Current data indicate that mortality rates reach 50% in extensive burns, that only 30% of patients are transported to specialized hospitals, all others normally being transferred to general hospitals, and that during transfer only 60% of patients receive adequate medical treatment (Marichy *et al.*, 1989).

In order to reduce the risks deriving from inadequate medical treatment at the scene of the disasters, because of lack of specialists or the difficulty of administering complex medical procedures, we have developed an emergency kit which is intended to take its place alongside other existing sanitary instruments that have already been tested in previous disasters, in an attempt to transform the front-line physician into a specialist capable of interrupting the chain of mortality that otherwise becomes inevitable (Figure 1).

The emergency kit enables the physician, after a preliminary clinical screening of the patient and after establishing the most urgent therapeutic measures, to initiate the correct medical, infusional and pharmacological therapy, without necessarily having to transfer the patient immediately to a specialized hospital. This treatment, which can be classified as 'second-level medical assistance' (see Table 1), presents certain advantages over evacuation, which becomes necessary only for the most severe cases, without increase in the risk factors for those remaining in the disaster area.

The main medical objective thus achieved is represented by the rapid practice of the correct medical therapy, reducing the 'latency-risk time' between the zero hour of the disaster and hospitalization in a specialized centre.

The kit (Table 2) enables the physician to rapidly initiate infusional therapy for the maintenance of the patient in a state of haemodynamic equilibrium, to

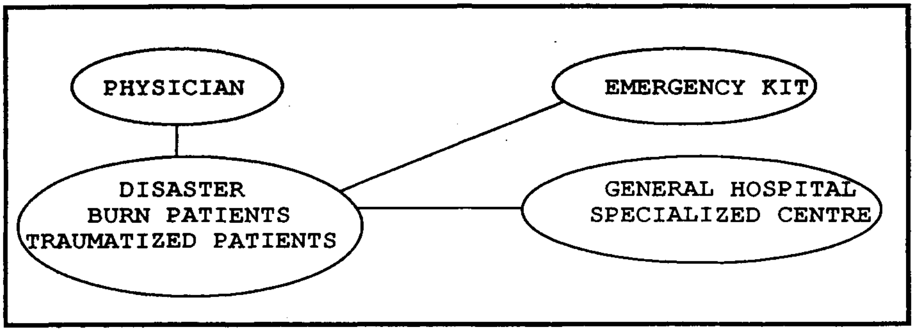

Figure 1.

Table 1. Place of the emergency kit in medical assistance

First-level assistance	Recognition	
Second-level assistance	Evacuation Screening Therapy	*Emergency kit*
Third-level assistance	Psychological assistance Treatment of sequelae	

Table 2. Contents of the emergency kit

12-compartment PVC kitbag
Venous catheterization set
Bladder catheterization set
Nasogastric probe
First choice drugs
Telescopic kitbag support
Clinical and therapeutic file

perform bladder catheterization if necessary, and to administer first-choice drugs, without having to move the patient from wherever he or she happens to be.

The kitbag has 12 ready-to-use compartments, offering the use of various types of solutions which can be infused either consecutively or simultaneously by simply opening the ball-valve (Figs 2–5). The compartments are linked by a ball-valve to a common chamber to which the main outlet tube is connected, complete with an adjustable flow regulator. The overall capacity of the kitbag is 3390 ml, distributed as 6 compartments of 500 ml, 3 compartments of 100 ml, 3 compartments of 30 ml.

Considering the purpose of the kitbag, which must be easy to handle and at the same time complete and complex, the only material that could possibly be used was some form of plastic. However the use of plastic to contain fluids gave rise to other problems. The plastic material can be dissolved by the solutions; there can be interactions between container and contents; there can

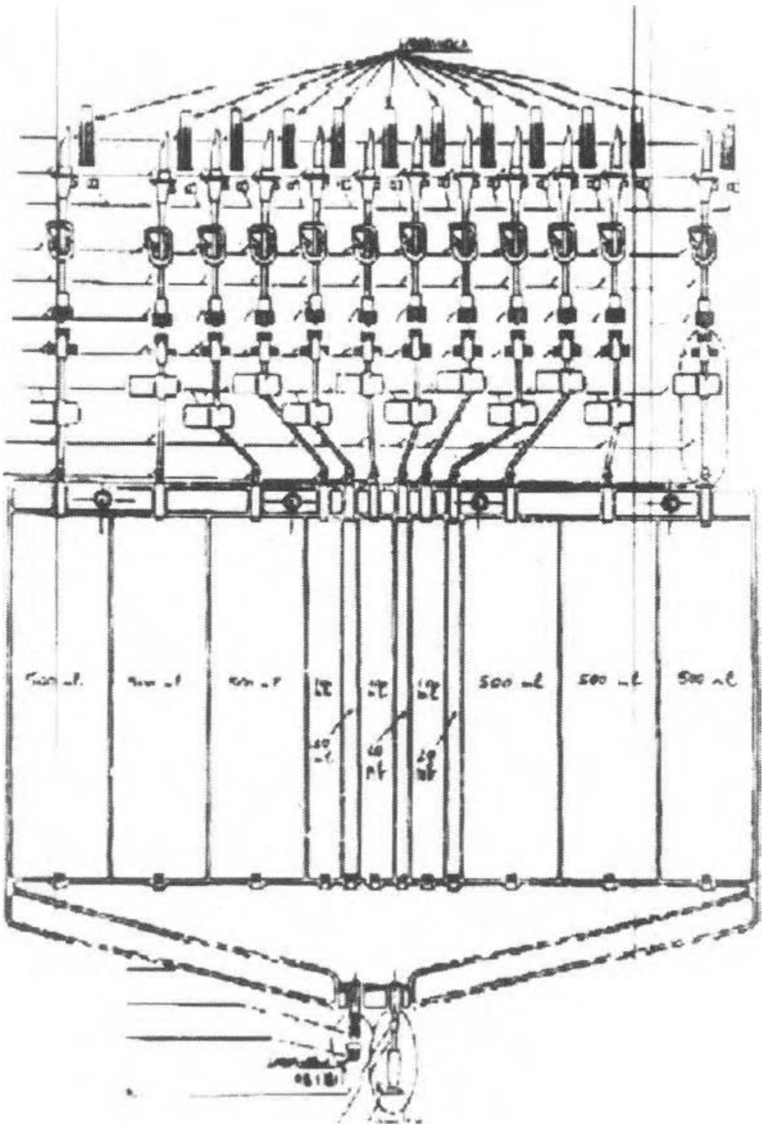

Figure 2. Distribution and capacities of the compartments

bem weight loss due to permeability; transparency may be poor; and there may be poor resistance to sterilization temperatures.

In Italy, the manufacture of plastic materials for the production of containers for infusion solutions is governed by specific regulations published in 'F.U. 9th Ed.', under the headings 'Plastic containers for pharmaceutical use' and 'Plastic containers for infusion solutions'. Tables 3 and 4 list types of thermoplastics and ideal properties.

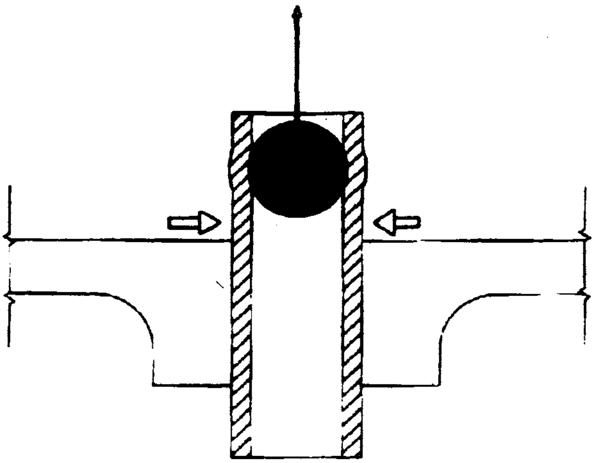

Figure 3. Detail of the ball valve

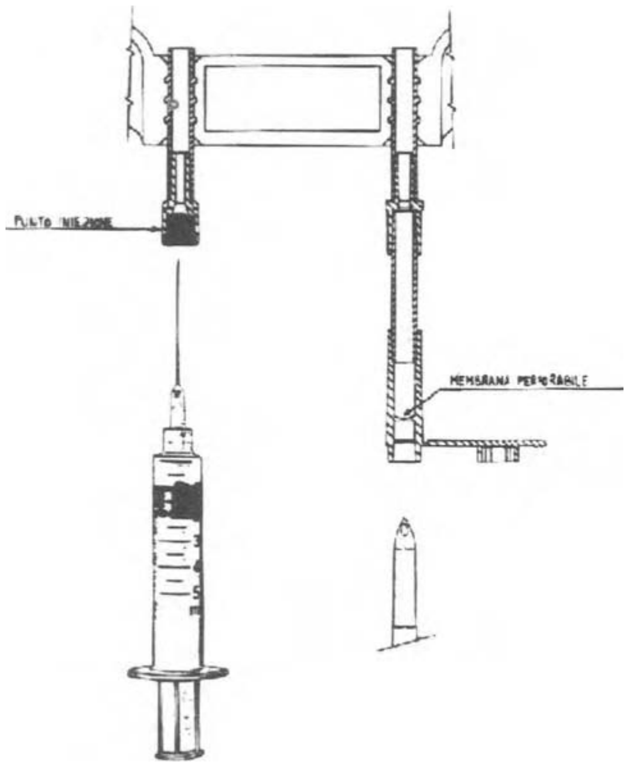

Figure 4. Detail of the spike insertion point and drug insertion point

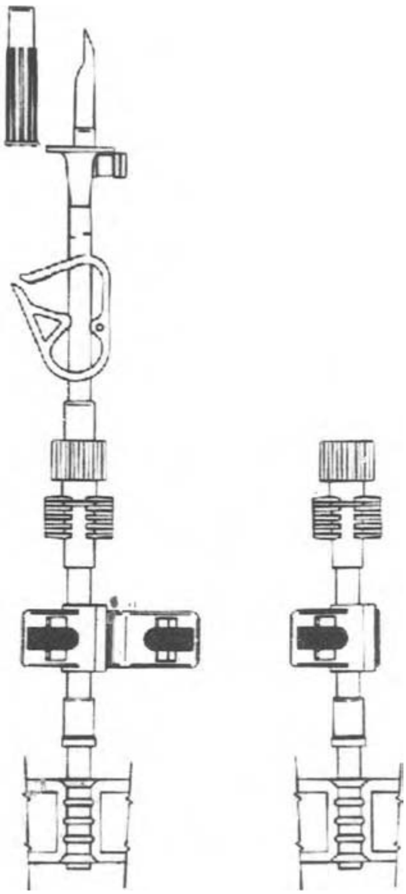

Figure 5. Details of the compartment filling point

Table 3. Principal thermoplastics

Low-density polyethylene
High-density polyethylene
Polypropylene
Poly(vinyl chloride)
Polyamide (nylon)
Polystyrene
Poly(methyl methacrylate)
Poly(ethylene terephthalate)
Poly(terafluoroethylene)
Polyolefines

If we take the characteristics of the ideal polymer and compare them with those of the traditional glass container, we can conclude that PVC (Table 5) is

Table 4. Characteristics of the ideal polymer

Chemical inertness
Biological inertness
Atoxicity
Transparency
Impermeability to micro-organisms
Relative impermeability to water vapour
Relative impermeability to gases
Good thermic stability
Mechanical resistance
Flexibility

Table 5. Characteristic of PVC

Good impermeability to water and gases
Thermal resistance between 75°C and 100°C
Versatility: it can be used alone to produce rigid objects or with additive plastifying agents to produce flexible objects
Good impermeability to oxygen, superior to polyethylene, polypropylene and polystyrene, and high impermeability to water
Transparency, flexibility and resistance

the polymer with the highest number of required properties. We discarded the possibility of using multilayer containers (produced by combinations of polymers, coextrusions of tubing, or the sticking together of different films of plastic by means of adhesives) because of the physical and chemical problems they may present.

The solutions available in the kit are given in Table 6.

The venous catheterization set contains all the necessary equipment to cannulate a vessel: needle, cannula, sterile gloves, and antiseptic sterile gauze.

The bladder catheterization set consists of a Foley catheter, urine collection bag, gel, sterile gloves, and sterile gauze.

The kit contains the following types of drugs: cortisones, sedatives, diuretics, bronchodilators, antibiotics, antiarrhythmics and myocardiokinetics.

A telescopic kitbag support makes it possible to administer infusion drip-therapy, without necessarily having to move the patient.

The 'clinical file' identifies the patients, defines their pathological state, and establishes their requirements for rapid administration of the correct infusion therapy according to the protocol described. The first part of the clinical file records the patient's general data and the circumstances of the disaster. This part can of course be completed only with the patient's compliance, which assumes an adequate level of consciousness. If it is impossible to identify the patient, he or she must be given a number. A numbered card must be securely attached to the patient corresponding to the number of the clinical file. The second part of the file defines the gravity of the patient's condition as a function of the extent of burned surface area and any associated trauma. Bearing in mind that 'severely burned' describes a child with burns on 15–20% BSA, an adult with 25–40% and an elderly person with 30%, the volumes to be infused in

Table 6. Solutions available in the kit

A. **Ringer's acetate**
Therapeutic category: rehydrating, electrolytic, alkalinizing

Composition			
Sodium chloride	6.00 g	Na^+	132
Potassium chloride	0.30 g	K^+	4
Calcium chloride dihydrate	0.20 g-mEq/l	Ca^{2+}	3
Sodium acetate trihydrate	400 g	Cl^-	109.5
Water for injections q.s.	1000 ml	Acetate	29.5

B. **Sodium bicarbonate**
Therapeutic category: alkalinizing

Composition
Sodium bicarbonate 14.00 g 84.00 g-mEq/l Na^+ 167 Na^+ 1002
Water for injections q.s. 1000 ml 1000 ml HCO_3^- 167 HCO_3^- 1002

C. **Potassium aspartate**
Composition. 1 ml of solution contains 3 mEq of potassium.

D. **5% stable isotonic solution of plasma proteins, available also in the solutions A, B, C**

3 × 500 ml compartments	Ringer's acetate
3 × 100 ml compartments	sodium bicarbonate (one of 1/6M; 2 of 1M
3 × 030 ml compartments	potassium aspartate (3 mEq/ml)
3 × 500 ml compartments	5% stable isotonic solution of plasma proteins

the first 12 hours are calculated using the formula

$$\text{Infusion volume (ml)} = \tfrac{1}{2}\,[\text{Percent BSA} \times \text{body weight (kg)} \times 2.5]$$

A final summary file accompanies patients when they are transferred to hospital.

CONCLUSIONS

The emergency kit is an instrument of medical relief to be used in the second phase of rescue operations. It is an important element in the relief chain in the event of natural disasters.

The most decisive factor, after the telecommunications phase, is the speed and efficiency, in terms of professionality and equipment, with which the first rescue operations are activated.

The kit makes it possible to treat patients completely and rapidly, thus filling the therapeutic gap that usually occurs in the first 24 hours after a disaster, during which period the mortality rate is at its highest.

Pharmacological and infusional therapy can be administered wherever patients happen to be, without having to move them, so that a minimum of assistance is required.

Use of the kit thus reduces the time of exposure to risk and assists in the overall organization of rescue work.

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Ready-to-use emergency kit for treatment of severe burns: definition and specifications

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Burns are a frequent pathology both in disasters involving the general public and in international conflicts. The requirement that disaster medicine should be in a position to provide adequate therapy for as many persons as possible has underlined the importance, in the case of severely burned patients, of the immediate performance on the scene of the disaster of procedures to stabilize their condition pending evacuation to specialized centres, if possible within 24 hours.

However, in our experience and as reported in the literature, even when means and personnel are available, there is generally a lack of specific materials. We have therefore attempted to create a practical kit for the various surgical procedures in the first few hours after severe burns. The experience of our burns centre helped us in the preparation of the kit, which has the following basic features:

- It is easy to transport to the scene of the disaster.
- It is easy to keep in good condition in medical-surgical posts.
- It is long-lasting.
- It is simple to use.
- It is robust enough for air transport.
- It is light-weight.

To achieve our objective we adhered to standard NATO air transport parameters for size and weight: standard 80 × 120 cm pallets with small, medium and large boxes.

The materials used in the kit were selected on the basis of their practical utility and our own direct experience, taking into account the most up-to-date international findings and the criteria of availability on the market, ease of practical use, relatively low toxicity of drugs, and limited cost. Any unused material can be recovered for later use.

The kit for one/two patients, which weighs 30 kg, is contained in a large box and individually palleted. Table 1 indicates the contents of the kit.

The state of the art does not permit precise recommendations on use of artificial membranes. Although the results of using some second- and third-generation 'artificial skins' are convincing and indeed very promising, the indications for their use are still unclear and poorly defined. For some of these membranes it is still necessary to ascertain their resistance and durability in particular climatic and environmental conditions.

Some recommendations can be made on the basis of our experience, however incomplete it may be. We suggest that the following are worth including in the rescue kit:

- Rolls of Lyoform or Layosheet foam bandage (e.g. two of 180 × 60 cm, cod. P95);
- Packets of hydrocolloid membranes (e.g. four packets of Duoderm);
- Packets of Biobrane-type glove dressings (e.g. three packets of various sizes);
- Packets of membranes derived from GAG (glucosaminoglycans), poly-cellulose or animal collagen (e.g. Bioprocess, derivatives of jaluronic acid, Condress, etc.)

It may soon be possible to make more precise recommendations.

Instructions for use of the kit are included in three languages.

To treat hypovolaemic shock with haemoconcentration in the first hours, the following must be available: physiological solution, 500 cc flask × 8; HSL (hypertonic saline lactate) 300 mEq/l, 500 cc flask × 8. The recommended method for calculation of the overall amount of fluid to infuse has been successfully used by the Burns Centre at the Niguarda Civic Hospital Cà Granda, Milan (modified Monafò formula):

$$\text{Quantity of fluid (litres) in 24 h} = [0.5 \times \%\ \text{burned area} \times \text{body weight (kg)}]/225$$

to be infused 50% as physiological solution and 50% as HSL 300 mEq/l. As normally recommended, 50% of the fluids are to be infused in the first 8 h, and the remainder in the next 16 h.

Topical treatment must be applied with closed-type medication material, because of the obvious difficulty of finding a sterile environment in the disaster area. In this kit we recommend liquid antiseptics and ointments to be used as compresses with sterile gauze on bloody areas.

Infusion therapy must be carefully monitored as this is essential for evaluation of its effectiveness; for this reason we have included bladder and venous catheters together with tables for the hourly monitoring of fluids infused and evacuated and for central venous pressure.

The kit also contains basic sterile surgical instruments to be used in various operations.

The drugs in phials (mainly analgesics, sedatives, diuretics, cortisones, platelet-suppressive agents and anti-H2) are easily obtainable and widely used. The task of the physician using the kit is facilitated by the trilingual instructions and a number of illustrative drawings.

Table 1. Contents of the emergency kit

	Quantity
24-h substitutive infusion therapy	
Physiological solution, 500 ml[a]	8
Hypertonic saline lactate (HSL) solution, 500 ml	8
30% glucose phial, 10 ml, in plastic shockproof containers	10
Infusion set	2
Drip-support (suspension cage)	2
Topical medication set	
Antiseptic acid soap	500 ml
7.5% liquid povidone iodine or sachets of iodosorb	500 ml/10
Sterile distilled water	2000 ml
5% silver nitrate solution, 5-g light-proof bags	2
Silver sulphadiazine with cerium nitrate (cream)	0.5 kg
Sterile tissue non-tissue gauze 70 × 90 cm	4
Antiseptic/analgesic aerosol spray	2
PAMBA (Marfanil 5%) 50-g sachets	1
2.5-cm canvas plaster	1
12-cm synthetic gypsum (Dynacast)	2
Disposable sterile gloves, sizes 7 and 8	2 pairs per size
Surgeon's gown	2
Caps	2
Masks	2
Lohmann metalline, 80 × 120 cm	2
Alpine-type metallized heating blanket	1
Sterile cotton gauze in packets	
5 × 5 cm	30
10 × 60 cm	30
15 × 80 cm	30
90 × 90 cm	10
150 × 50 cm	5
Sterile hemmed bandages (individual packs), width 20 cm	5
Tulle gras (boxes) Connettivina gel type	2
Surgifix gauze netting, no. 4, no. 6, no. 8	2 m per size
Bladder catheterization set	
Foley catheter in sterile pack CH14/16/18/20	2 per size
Syringes, 10 ml	2
Urethral syringe, 60 ml	1
Aerosol silicone spray	1
Physiological solution, 100 ml	2
Hourly urine collection bag, with support	2
Central venous system set	
Polyurethane venous catheters	
Centrecath 13015 30 cm	2
Centrecath 13515 50 cm	2
Centrecath 13715 75 cm	2
Disposable sterile gloves sizes 7 and 8	2 pairs per size
1% Procaine, 10-ml phial	4
Physiological solution, 10-ml phial	4
Ready medication 9 × 10 cm	2

(continued)

Table 1. *(continued)*

	Quantity
Venflon cannula needles, G17, G18, G20	1 per size
Cetavlon disinfectant, sachets	2
Sterile sheet 70 × 90 cm	1
Sterile surgical instruments	
Mayo medium straight scissors	1
Surgical forceps	1
Kocher forceps	1
No. 11 disposable bistouries	2
Needle holder	1
Sterile plastic bowl	2
Suture	
Dexon 4/0 cutting needle	3
monothread (Novafil) 3/0 c.n.	3
monothread (Prolene) 4/0 c.n.	3
10-ml syringes	5
Drugs	
Hydrocortisone (Flebocortid), 500-mg phial	5
Dopamine (Revivan), 200-mg phial	2
Noramidopirine methane sulphonate (Nisidine plus), 500 mg	2 phials
Ranitidine (Zantac), 50 mg	20 tablets
Lanatoside C (Cedilanid), 2-ml phial	2
Calcium heparin (Calciparina), 500-UI phial	4
Diazepam (Valium), 10-mg phial	2
Furosemide (Lasix), 20-mg phial	5
Calcium chloride, phial	2
7.5% sodium bicarbonate, phial	2
Theophylline (Tefamin), phial	2
Adrenaline, phial	5
Multitest, packet of 10 diagnostic strips	1
Accessory instruments	
Disposable phonendoscope	1
Sphygmomanometer, with 2 disposable armbands	1
Mayo cannula, sizes 0, 2, 4	1 per size
Nasogastric probes K 9, K 10	1 per size
Cream for Bioshield-type gloves	1 aerosol spray

CONCLUSIONS

This emergency kit, now being tested at the burns centre of the Chair of Plastic Surgery at Milan University, the Niguarda Cà Granda Hospital, the North-East Military Region and the Milan Military Polyclinic, is a preliminary attempt which in the course of time will be improved upon and perfected. We have considered it useful to devote our attention to the development of this idea, because of the lack of information and research in this field, not only in Italy but also in the rest of the world.

40
Physiopathology of burn disease during air evacuation

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The objective of this paper is to analyse the repercussions of air evacuation on the physiopathology of critically burned patients, and on this basis to recommend the therapeutic measures that should be kept in mind when this means is used.

MATERIAL

Critically burned patients evacuated by the Air Rescue Service (SAR) of the Spanish Air Force during the period 1987–1989 were considered.

During this period the SAR evacuated 36 critically burned patients (26 flights), with a mean flight time of 2 hours 16 minutes. The mean burned body surface area was 49.35%. Aircraft used were: Aviocar CASA-212 in 16 flights, HD-21 Superpuma in 6 flights and D-2 Fokker-27 in 4 flights.

CLINICAL REPERCUSSIONS OF AIR TRANSPORT

1. Acceleration is important during take-off and landing, and may worsen associated lesions such as craniofacial trauma, embolisms and multi-fractures.
2. Vibration may be severe in helicopter evacuation in the presence of craniofacial trauma.
3. Noise can reach high levels (80–90 dB) in helicopters, thus complicating auscultation, and blood pressure assessment.
4. Altitude modifies atmosphere pressure, partial oxygen pressure and water concentration of inhaled air.
5. Atmospheric pressure is around 532–550 mmHg at the normal flight altitude of the non-pressurized aircraft mentioned. This promotes body-gas expansion, thus facilitating vomiting and paralytic ileus. In the same

way, if there is a pre-existing pneumothorax, intrapleural air distends and increases lung collapse.

6. Partial pressure of oxygen in the air decreases to 100 mmHg at 10 000 feet (149 mmHg at sea level). Hypoxia seriously worsens any respiratory insufficiency which may have resulted from smoke inhalation.
7. Decrease of water concentration in inhaled air necessitates increased fluid perfusion. In high-altitude flights it may be necessary to increase the calculated perfusion volume 1–1.5 times to obtain good diuresis (50 ml/h).

MEASURES PRIOR TO AIR TRANSPORT

1. Burn wounds should be cleansed with saline and covered with light sterile dressings.
2. If smoke inhalation is suspected, a pre-flight thorax film and blood gas study must be done. During flight, oxygenotherapy must be available.
3. If pneumothorax is diagnosed, a chest tube must be placed prior to the flight to prevent in-flight expansion of intrapleural air.
4. Nasogastric and urinary catheters must be placed, and the balloon should be filled with fluid, never with air.
5. Plastic bottles must be used for fluidotherapy and blood administration in order to provide pressure infusion.
6. The aircrew should be informed of the characteristics of the evacuated patients.
7. Parenteral perfusion must be provided through a large-calibre vein. The perfusion volume can be calculated with Mahler's formula, but the best control parameter is urine output (50 ml/h; and 80–100 ml/h in electrical burns).

DURING TRANSPORTATION

Personnel in charge of patients during evacuation must be well instructed in cardiopulmonary resuscitation manoeuvres. The SAR aircraft are equipped with intubation and ventilatory support sets, cardiac monitor and emergency medication. Medical staff in flight are in charge of controlling respiratory airways, maintaining fluido-therapy, diuresis and temperature of the patient.

WHEN AIR EVACUATION SHOULD BE USED

On the day of the accident, aircraft can be employed if surface transport would take more than 1 hour. On subsequent days air transport can be used depending on patient status.

The most important consideration is that air evacuation of burned patients depends on availability of a safe, fast and well-equipped fleet of medical aircraft.

CONCLUSIONS

Air evacuation of critically burned patients to a burn unit has proved to be fast and to provide good facilities for in-route resuscitation manoeuvres during the resuscitation period.

The repercussions of air transport on burn disease must be well understood by the personnel in charge of air preparation and transport of the patients.

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The use of helicopters in integrated rescue work and medical transport

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This paper illustrates the history, the present condition and the prospects of the Italian Medical Air Rescue Service, with particular reference to its utility in the event of burns and fire disasters.

Numerous factors have led to the creation and development worldwide of medical air rescue services, and in particular to the widespread use of helicopter services. These no longer mean the sporadic use in emergencies of helicopters normally employed in other services; helicopters are now fully equipped flying ambulances, based permanently at hospitals and used exclusively for this purpose.

There are today over 300 hospitals in the world with their own helicopter ambulances, and fixed-wing aircraft used permanently and exclusively for sanitary transport are rapidly becoming more widespread.

There is one significant example in the Sicilian Region, on the island of Lampedusa, where a permanent service has been in operation for over a year, providing emergency transport throughout the year not only to specialized centres in Sicily but also to other destinations.

Even a small country like Switzerland, which for historical, social and topographical reasons has a unique tradition in this field, has 15 helicopter rescue bases and 4 air ambulances. The United States has over 200 helicopter medical bases and more than 30 flying ambulances. West Germany has 38 heli-ambulances, Austria 8 and Yugoslavia 7. In Italy there are about 20.

An efficient emergency air rescue service making integral use of all medical means of transport (heli-ambulances, air-ambulances, motor-ambulances) is extremely valuable, indeed essential, in the various mini-, macro- and maxi-emergencies related to burns and fire disasters. In this context, we give an account of the organization of Aci-Elisoccorso, which in Sicily has already begun to play an interesting and significant role, although still in an experimental phase.

'Sicilia Elisoccorso' was promoted and created by the Sicilian Region Health Office. Together with 'Piemonte Elisoccorso' and the Regional Services in

Emilia Romagna and Lazio, 'Sicilia Elisoccorso' is an excellent example of what is often defined as the 'Italian' model of helicopter rescue services, a model that is acquiring growing recognition and admiration all over the world.

In addition to respecting the various internationally codified standards and characteristics in relation to the organization of the individual bases, Sicilia Elisoccorso, as also the similar services in Piedmont, Lazio and Emilia Romagna, is responsible for the regional coordination of the bases and guarantees complete integration with all the other medical and non-medical structures involved in emergency rescue work.

The fulcrum of the system is the ACI (Italian Automobile Club) Regional Headquarters with its telephone number 116, which has been made available to the health authorities pending creation of the single nationwide telephone number 118.

Thanks to the system of automatic dialling set up in 1985 through the collaboration of SIP (Italian Telephones Corporation) and ACI, all calls to the number 116, from any part of Italy and without any area code number, are connected to the regional operative headquarters (Palermo in Sicily, Turin in Piedmont, Bologna in Emilia Romagna, Rome in Lazio, and so on).

The ACI-116 regional headquarters is staffed by highly qualified multilingual personnel (and by physicians and other specialists where the helicopter rescue service operates). By telephone or radio it immediately coordinates the ambulances, hospitals, civil and military authorities and all other organizations involved in disaster relief. In Sicily the number 116 also covers coordination between the helicopter rescue service and the air rescue service based on Lampedusa.

A sophisticated software system provides in real time all necessary information for rescue operations within the respective regions and if necessary for emergencies involving interregional coordination and transport.

At present there are two helicopter rescue stations in Sicily. The Palermo base, with an Aerospatiale Puma helicopter, is mainly responsible for emergency medical relief to and from the minor islands, with respect to which Palermo is in a central position. Caltanissetta, which is central to the territory of the main island of Sicily, performs 'routine' services in the central part of Sicily, with a predominance of transport after road accidents. This is an experimental arrangement and after the first year of activity it should develop along international standards, with an extension of the service to two or three new bases (Messina, Catania and a third in south-east Sicily).

The main aim of the helicopter rescue service is to guarantee the arrival (maximum time 20 minutes) of a medical team specialized in resuscitation and provided with all the equipment normally available in a hospital intensive-care unit. The necessary emergency therapy can be carried out on the spot or continued, if necessary, during transport of the patient. The transport is not necessarily to the nearest hospital, but to the hospital best equipped to receive the patient. This aspect is much facilitated by the use of a helicopter and by the communication and coordination systems activated by the regional operative headquarters, which if necessary can alert aircraft for long-distance transport.

We would like to conclude by expressing our willingness and that of the ACI-Elisoccorso organization (which is a sister organization of others in Austria, Switzerland, Germany and Yugoslavia and seven other important institutions operating in the field of disaster relief, such as the National Association of Public Assistance, the Italian Red Cross and the National Body of Alpine Rescue) to provide all possible collaboration in perfecting existing services and to extend the range of their operation.

We believe that we can make a valid contribution in this direction, thanks to over 35 years' experience in road accident emergencies and over 4 years' experience of helicopter rescue operations, during which time more than 12 000 rescue operations have been carried out.

42
Rescue of the burn patient and on-site medical assistance by a helicopter rescue service

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In the general framework of our activity of nearly 2000 requests for assistance (in the period August 1986 to June 1990), direct aid to burn patients represented 0.5% of cases. Though not a frequent occurrence, this is a very significant commitment from the technical and organizational points of view.

The complexity of this type of assistance is due not only to purely sanitary problems but also to operative protocols capable of responding adequately to the event. It is also necessary to liaise with other rescue organizations and experts and to observe all norms for the safeguard of the rescue workers.

In our experience the most frequent causes of burn accidents are to be found in the working environment and in the home (children and even babies frequently being affected); road accidents are less frequently involved. It is noteworthy that in the territory we cover (Provinces of Como, Varese and Bergamo) there are many industries at risk, particularly physicochemical industries, in addition to foundries and numerous artisan workshops where flammable materials and substances are commonly used without the scrupulous observance prescribed by the safety norms. There is also the question of road transport of flammable substances.

In the event of an accident, toxic substances may therefore be released that are capable of causing potentially fatal lesions not only in persons directly involved in the accident but also in those providing first aid if they do not have specific knowledge, training and equipment.

In its attempt to provide an organized and specific response to the burn accident in all its multiple aspects, our helicopter rescue service has evolved a number of phases, of which the following can be distinguished.

Preparation phase characterized by mapping of industries 'at risk' and of the potentially flammable or toxic substances most frequently used in our territory or which transit across it; collaboration with experts (engineers, chemists, physicists, toxicologists, etc.) to be contacted directly in case of need; acquisition of specific easy-to-consult bibliographical material kept in the operational centre library.

Training phase carried out in close collaboration with the District Fire Brigade, with the teaching of notions of self-protection and of the use of various extinguishing materials and substances.

Didactic phase, in which meetings are organized with voluntary personnel who provide relief but rarely have any specific training.

From the strictly operative point of view, the management of the call for help involves the application of a protocol in which the main role is played by the operational centre. The same applies to the activity of the helicopter rescue service. Here too we can distinguish various phases:

1. Receiving the call for help, with as many details as possible regarding place and dynamics of the accident; number of victims and their condition; identification, when possible, of any toxic substances liberated.
2. Coordination of other rescue organizations (Italian Red Cross, Fire Brigade) called in because of their specific competence, with diffusion of all information already acquired for purposes of self-protection.
3. Despatch of the helicopter (normally an AB-412) with the medical team. Medical treatment 'on the spot' means stabilization of the patient's vital functions, manoeuvres to reduce or limit lesions (direct intervention on the cause, removal of harmful substances, use of anti-burn blankets or thermic material) in addition to intubation of a 'safe' venous route, infusion of electrolyte solutions and pain sedation; all this must be done aseptically, as far as environmental conditions permit.
4. Transport of the victim to the nearest hospital, for more thorough assessment and treatment, pending transfer to a specialized centre. This phase is often particularly difficult because of the lack of beds for burn patients in the region, especially in the case of those requiring intensive care. These patients often have to be transferred to other regions, and this has other implications for our service.

In conclusion, relief for the burn patient directly on the spot appears to be well codified in the strictly medical sense but is still seriously affected by organizational malfunction and shortcomings in regional programming.

There also needs to be greater awareness of the problem of the self-protection of rescue workers because of the ever more frequent possibility of having to operate in dangerous environments in which it is imperative to ensure the complete safety of all those providing relief and hence of all those receiving it.

43
The burn patient and medically assisted helicopter transport

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The helicopter station at the Ospedale Sant'Anna in Como has been in operation since 1 August 1986. It covers the Provinces of Como, Varese and Bergamo, an area with 42 hospitals which contact our centre when critical patients require secondary transport between hospitals.

About 2.5% of the approximately 2500 flights effected as of 30 June 1990 concerned the secondary transport of burned patients, while 0.5% provided direct medical assistance to burned patients on the scene of accidents. Only 13 of the approximately 50 secondary transport flights had hospitals in Lombardy as their destination. The remainder of the patients were transported to burns centres in other areas (Genoa, Turin, Verona, Cesena, Padua).

The region of Lombardy, with a population of nearly 9 million, has only one centre for the treatment of severely burned patients (Ospedale Niguarda, Milan), with six beds. It must also be borne in mind that in the area we cover there are numerous industries at risk (chemical factories, foundries) and workshops which use flammable materials, perhaps not always in strict accordance with safety regulations.

The numerous problems related to the medically assisted transport of burned patients can be summarized as follows.

PROBLEMS RELATED TO PATHOLOGICAL CONDITION

These concern patients requiring lengthy and careful preparation by the hospital which has requested their transfer. Before transport, diagnostic tests must be performed in order to exclude any concomitant pathology (chest radiograph, blood chemistry, ultrasound, computer tomography).

We have prepared a special protocol for the preparation of such patients:

- Cannulation of several venous routes, of which one should be central if possible (followed by chest radiograph).

- Monitoring of diuresis.
- Insertion of nasogastric probe.
- Sedation and/or analgesia.
- Cleansing of wounds.
- Tracheal intubation (if necessary).
- Application of sanitary devices to prevent excessive heat loss.

PROBLEMS RELATED TO THE PATIENT'S DESTINATION

The hospital that has offered to accept the patient is responsible for finding a bed in a burns centre. This procedure can be extremely time-consuming, especially if the patient is intubated and requires intensive care.

PROBLEMS RELATED TO TRANSPORT AND THE TYPE OF AIRCRAFT

We use an AB-412 helicopter with IFR instrumentation. The size of this helicopter makes it possible to provide optimal therapy, guaranteeing infusion lines at the correct rate, access to the various anatomical parts, monitoring of blood circulation and cardiac activity and, if necessary, ventilatory assistance. Up to three patients can be transported at a time.

The helicopter has excellent airspeed and its advanced instrumentation has made it possible on several occasions to effect transport during adverse meteorological conditions and when up-to-date air almanacs were not available.

CONCLUSIONS

The medically assisted transport of burned patients is clearly a long and difficult operation to organize. It also follows that the lengthy time periods necessary for preparing the patient, finding a bed in a suitable hospital and carrying out the flight inevitably lead to the prolonged absence of the helicopter and the medical team and consequently to a reduction in the rescue base's operative efficiency.

44
The ARGO satellite system: a network for severe burns and disasters

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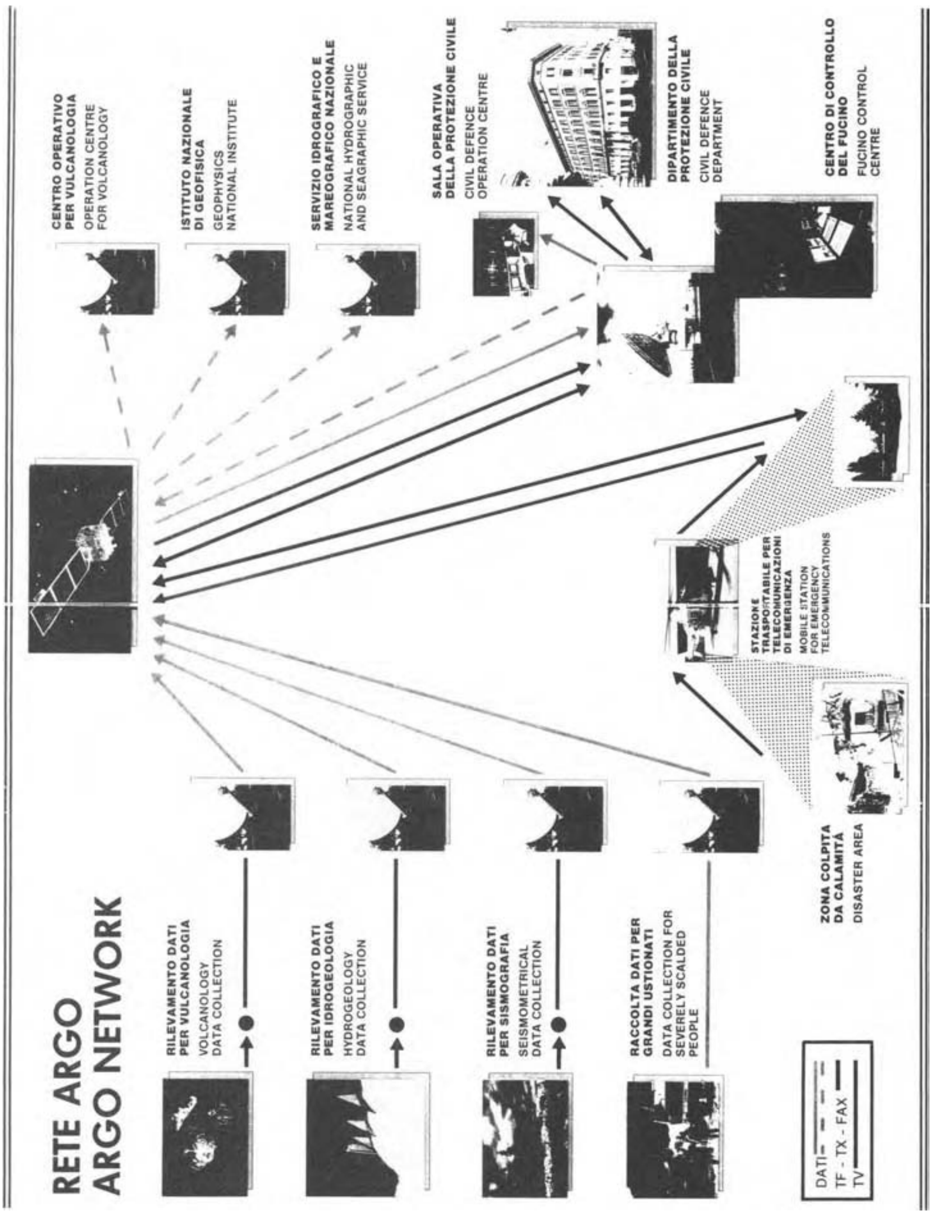
The specialized hospitals for the treatment of severely burned patients in Italy, in the declared opinion of the Technical and Scientific Sanitary Commission, can totally satisfy the country's day-to-day requirements. In the event of a disaster, however, there is a problem of exploiting them to maximum advantage because of inadequate information on their capacity and location. This lack of information makes it impossible to activate rapid transport of patients requiring hospitalization to the most appropriate facility.

To overcome this problem it is necessary to know in real time the situation of all the resources that are available, a *sine qua non* that has to be continually updated. It is also necessary to be able to refer to a national organization capable of rapid mobilization of the carriers for the transport of patients, particularly over considerable distances that are incompatible with the urgency of hospitalization.

The following steps have been taken to realize this objective (see Figure 1):

1. Division of the national territory into four operational areas each containing a number of hospitals organized for the treatment of severely burned patients.
2. The designation within each area of one of the hospitals as the coordination centre, in order to facilitate full exploitation of the resources for severely burned patients in the area, and also with a view to the regional and national transport service.
3. The creation at the Civil Defence Department of:
   - A patient transport centre (PTC) with the function of rapidly providing the most appropriate form of transport for patient transfer. The PTC is a component of the operational centre of the department information centre, operating 24 hours a day, and experienced in air courier services for needs similar to the peacetime operational centre (POC) of the Italian Air Force Command.
   - A severely burned patients data collection centre in the framework of


RETE ARGO
ARGO NETWORK
RILEVAMENTO DATI PER VULCANOLOGIA
VOLCANOLOGY DATA COLLECTION
RILEVAMENTO DATI PER IDROGEOLOGIA
HYDROGEOLOGY DATA COLLECTION
RILEVAMENTO DATI PER SISMOGRAFIA
SEISMOMETRICAL DATA COLLECTION
RACCOLTA DATI PER GRANDI USTIONATI
DATA COLLECTION FOR SEVERELY SCALDED PEOPLE
ZONA COLPITA DA CALAMITÀ
DISASTER AREA
DATI
TF - TX - FAX
TV
STAZIONE TRASPORTABILE PER TELECOMUNICAZIONI DI EMERGENZA
MOBILE STATION FOR EMERGENCY TELECOMMUNICATIONS
CENTRO OPERATIVO PER VULCANOLOGIA
OPERATION CENTRE FOR VOLCANOLOGY
ISTITUTO NAZIONALE DI GEOFISICA
GEOPHYSICS NATIONAL INSTITUTE
SERVIZIO IDROGRAFICO E MAREOGRAFICO NAZIONALE
NATIONAL HYDROGRAPHIC AND SEAGRAPHIC SERVICE
SALA OPERATIVA DELLA PROTEZIONE CIVILE
CIVIL DEFENCE OPERATION CENTRE
DIPARTIMENTO DELLA PROTEZIONE CIVILE
CIVIL DEFENCE DEPARTMENT
CENTRO DI CONTROLLO DEL FUCINO
FUCINO CONTROL CENTRE

the department computer science application centre, with the function of collecting data relative to severely burned patients in order to update information about the general and the particular situation, and to communicate this information to all users of the system on request. These operations are all automatic, thanks to the software programs developed by the data centre.

4. A telecommunications system with high standards of reliability and survival to link together the above-mentioned organizations (burns centres, coordination centres, patient transport centres) and to ensure continuous information flow to continuously update the situation and permit the early adoption of measures most suitable for the safeguarding of victims.

The Italian Minister of Civil Defence has instructed the department to take on the task of creating the data collection centre and the PTC, and also of setting up the telecommunication system.

In view of the fact that the department has developed, for its own command and control needs, a dedicated system of emergency telecommunications via satellite, known as ARGO, it was decided to make use of the same system for severely burned patients, extending it where necessary. This useful telecom resource is summarized in Figure 2.

The ARGO system for emergency telecommunications and territorial data collection was created to guarantee continuity of communications from and to the disaster areas, on the basis that disasters make existing links partially or totally inoperative, depending on the nature and intensity of the disaster. The system is divided into a telephone, fax and video telecommunications network and a territorial data collection network.

The first of these networks consists of an operative control centre at the Department of Civil Defence, a technical control centre at the Fucino Telespace Centre with the main antenna for contact with the satellite, a space segment of the EUTELSTAT organization, and 12 mobile posts which will be set up shortly in areas most at risk. In this way they can be deployed immediately in disaster areas.

The second network is used to collect data from territorial sensors at scientific agencies engaged in surveillance of seismic, volcanic and hydrogeological phenomena. It is divided into three subnetworks which connect the agencies to sensors or groups of sensors by means of about 100 small, fixed satellite stations located in the most sensitive areas for measuring seismic, volcanic and hydrogeological parameters.

As the ARGO system is expandable, projects are under way for the creation of other subnetworks for forest fires, radiological measurements and organization of the care of severely burned patients. The system for the severely burned consists of:

- A telephone and fax network (see Figure 3) comprising four star subnetworks, one for each operational area, to link together the burns centres and coordination centres; and a mesh subnetwork to link the coordination centres and the patient transport centre.
- A nationwide star network for data communication (see Figure 4) to link all the structures of the severely burned patients organizations to the

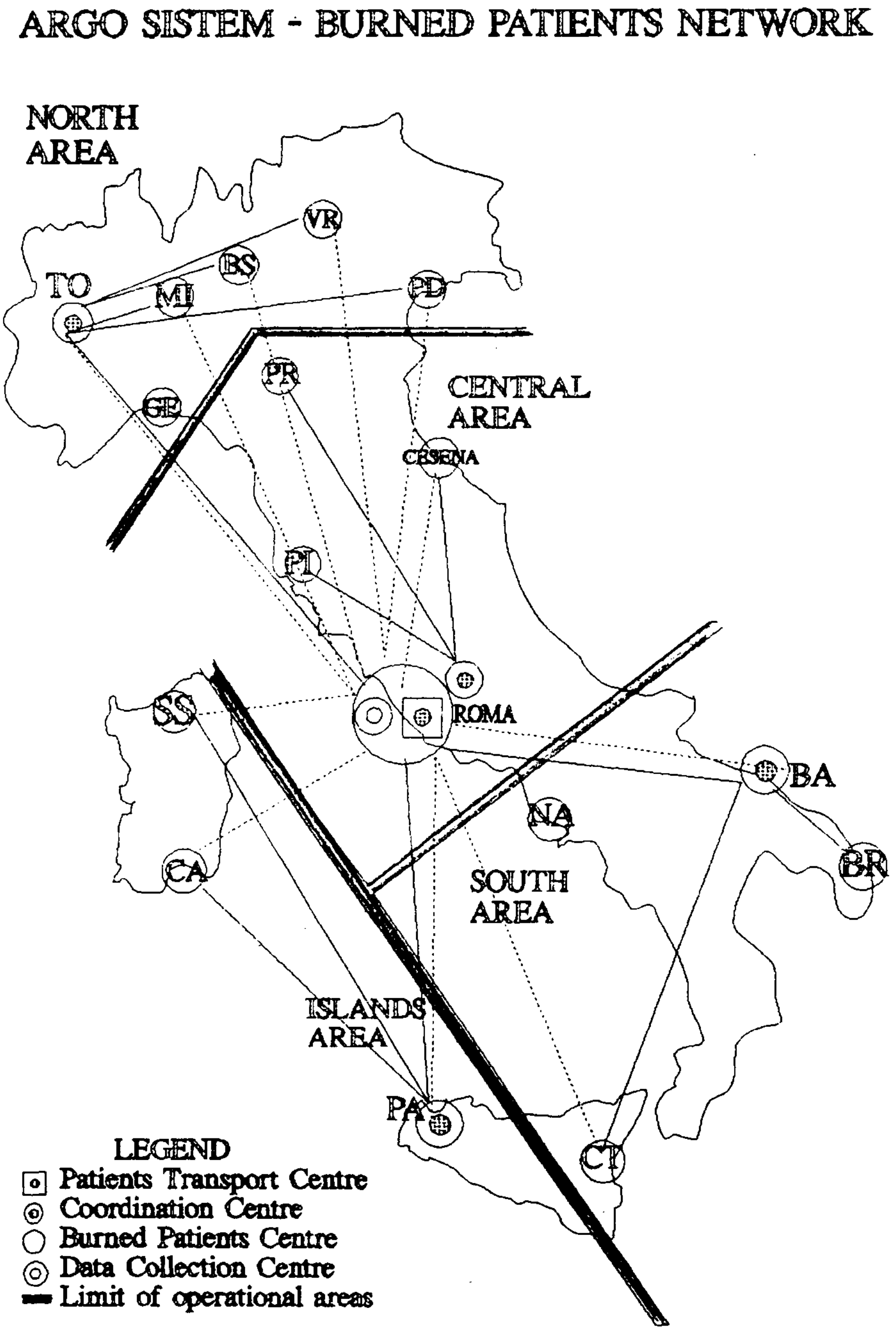

ARGO SISTEM - BURNED PATIENTS NETWORK
NORTH AREA
VR
BS
TO
MI
PD
PR
GE
CENTRAL AREA
CESENA
PI
SS
ROMA
BA
NA
BR
CA
SOUTH AREA
ISLANDS AREA
PA
CT
LEGEND
Patients Transport Centre
Coordination Centre
Burned Patients Centre
Data Collection Centre
Limit of operational areas

Figure 2.

ARGO SISTEM - BURNED PATIENTS NETWORK - VOICE AND FACSIMILE SERVICE -

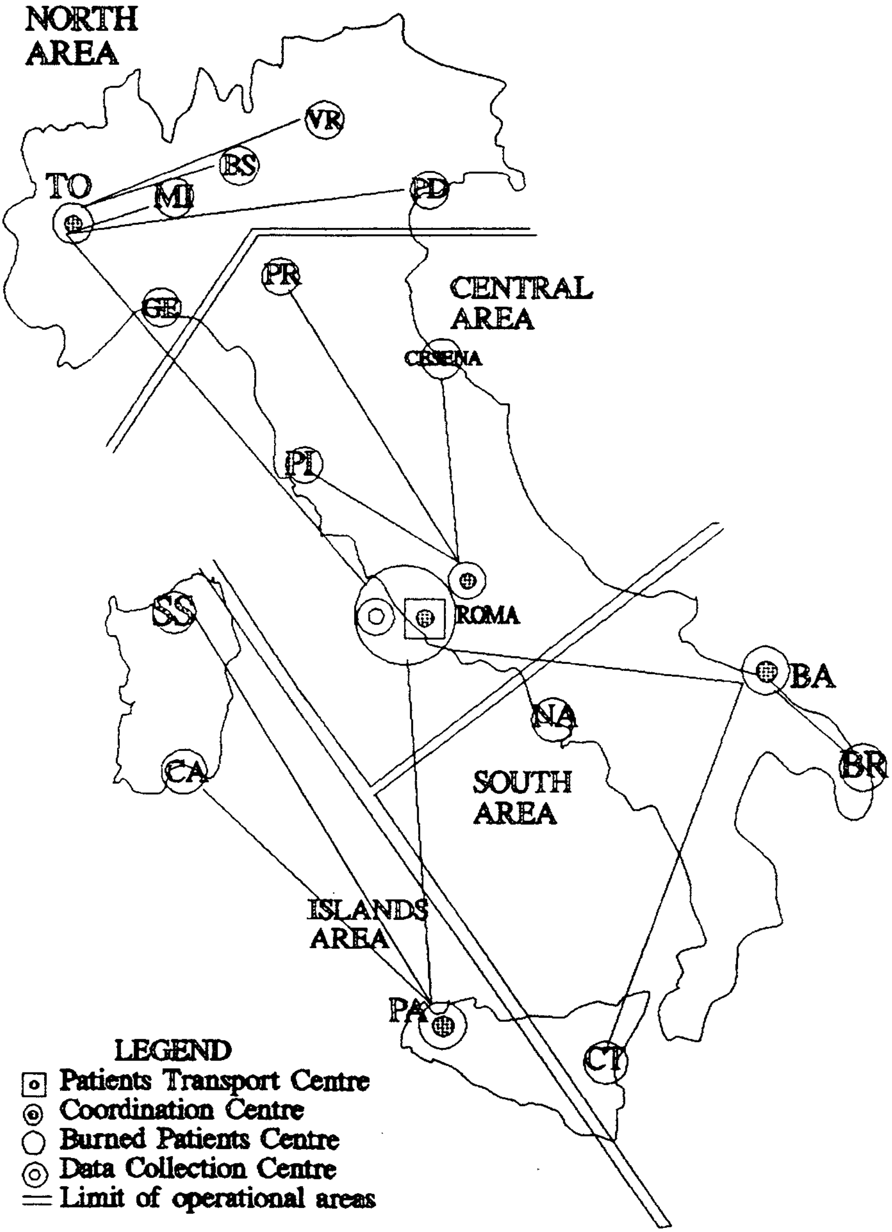
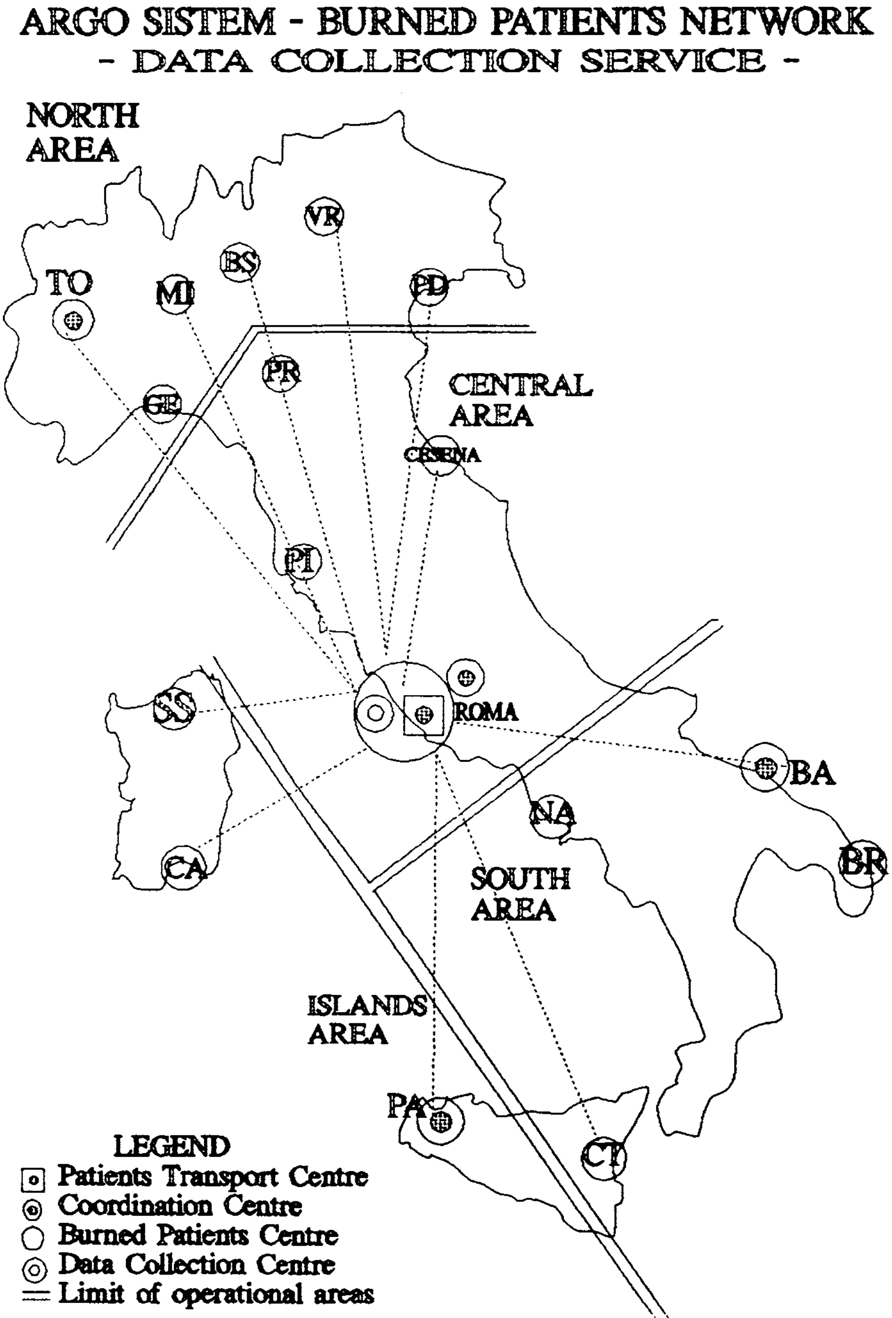


Figure 3.


ARGO SISTEM - BURNED PATIENTS NETWORK
- DATA COLLECTION SERVICE -
NORTH AREA
TO
MI
BS
VR
PD
GE
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CENTRAL AREA
CESENA
PI
ROMA
SS
BA
NA
CA
BR
SOUTH AREA
ISLANDS AREA
PA
CT
LEGEND
Patients Transport Centre
Coordination Centre
Burned Patients Centre
Data Collection Centre
Limit of operational areas

Figure 4.

department data processing centre, to which all users of the systems must communicate continuously updated data about the situation in their particular structure. It is thus possible to possess all data regarding the situation in the connected agencies.

This structure has proved to be the most favourable compromise between the financial resources available and the minimum information requirements of the organization. Depending on resources, it is possible to link up all the structures in the system by telephone and fax.

The possibility is already being examined of installing parabolic aerials of greater diameter in all the peripheral terminals in order to prepare them for the expected developments.

To complete this system, and to satisfy the need of medical staff to be able to establish immediate contact between specialized centres and the physician treating patients in the disaster area, it is recommended that all ambulances be equipped with a radiotelephone system. This functions as a radiotelephone when in the ambulance and as an ordinary portable telephone when carried by the physician.

The services offered by the ARGO Severely Burned Patients Network are one telephone channel, one fax channel and one 1200 b/s data channel. The cost of the system is about 4 billion lire (about $3.2 million), while annual expenses for management and maintenance, including the space segment, are about 0.5 billion lire ($400 000).

The time required to set up the system is 8 to 9 months after the signing of the contract. This period can be reduced to 6 months if the contract is stipulated between November and February.

45
The Italian Army Medical Corps in the field: flexibility of mobile organization

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The health emergency occurring after a public disaster has wide-ranging dimensions and characteristics, since emergencies can be of large, intermediate or limited extent. Apart from this, emergencies can be categorized on the qualitative level, for different relief measures are necessary in disasters due to armed conflict, earthquakes, fire, flooding or nuclear contamination.

The Italian Army Medical Corps, which has methodically directed its attention to these matters, has adopted a series of technologically advanced solutions and studied new and appropriate means to make its mobile unit as versatile and efficient as possible. This mobile unit is easy to manage and easy to transport; it is well equipped, and above all flexible to use because of its modular structure.

The unit consists of a containerized surgical nucleus in a complex of 14 tents of rubberized material supported by tubular pneumatic arches. The surgical nucleus can be of the 'light' type, i.e. transportable by helicopter. In this case it consists of two shelters of variable shape, each offering an inside working area of 16 m^2, one functioning as an operating room and one as an intensive-care unit. The nucleus can also be of the 'heavy' type. This has only one shelter, of larger dimensions. It offers a working area of 24 m^2 (and can therefore contain a second operating table), together with space for 6–8 critical patients in a pneumatic tent. The other tents completing the hospital are used mainly for diagnostics, patient beds and services.

The entire complex is based on the philosophy of continuous canvas and integral structure, in order to achieve the best conditions of isolation and 'monoblock' logistical rationale. It can be compared to a central trunk into which it is possible to insert chains of accessory modules which either offer specialist services (paediatrics, gynaecology, etc.) or extend bed capacity. The main part is not absolutely rigid. The distribution of the functions in the various parts has been designed to ensure that the unit can also be used as single tents or small groups of tents. The hospital is based on a fundamental nucleus consisting of admissions and first aid, which can subsequently be extended in three directions: radiography and echography, operating room with intensive-care unit, and patients' wardroom with services.

Thanks to its modular structure, this type of unit also proves useful in emergency situations where the use of the full-scale sanitary complex is not advisable because the number of victims is limited, or because of the particular seriousness of their condition, or because of geographical difficulties of access. The modular structure, by permitting deployment of the entire unit for successive subunits, is also important because of its rapidity of use: it is not necessary to wait for the assembly of the operating room or ward tents before proceeding to first aid and summary diagnostic screening of the first victims.

This principle was the basis of the creation of a 'mini sanitary unit' which can be put into operation extremely rapidly, to be used as the first-choice facility for first aid in fire disasters. The mini-unit consists of the first four tents of the mobile unit, i.e. admissions–resuscitation, triage, surgical and orthopaedic first aid, and the first of the ward tents. This structure permits the simultaneous treatment of four critical patients, and/or injured patients requiring immediate care. At the same time it is also possible to treat 16 other patients with intravenous therapy. It is therefore possible to treat 20 patients with appropriate ventilorespiratory and cardiocirculatory equipment that can be put into operation within about 30 minutes by a team of four physicians and six paramedics.

As it is possible to keep and transport all the material and tents in special palettized, impermeable, parachutable boxes, the disaster area can be reached very rapidly by any means of transport. It is known that most seriously burned patients die within the first hours after trauma because of respiratory failure provoked by inhalation of smoke or toxic gases, or because of serious shock syndrome. It is therefore of the greatest importance to be able to reach the disaster area with means of cardiorespiratory resuscitation and fluid therapy with the required osmotic substances.

The unit should not be thought of as a long-term hospital structure — 20 beds would be too few in a serious fire disaster. It should rather be seen as a temporary post for preliminary treatment and above all for final triage. There must therefore be a radio link with the civil defence bodies, which are in a better position to locate appropriate places for hospitalization throughout the national territory.

To reduce the time delay in the intervention of this mini-unit, the load plan of the various modules has to be carefully programmed. The value of a single module as an individual element depends on its complete functional autonomy: every tent is thus transported with its own electrical plant and equipment, both technical and structural.

The programme is still encountering notable difficulties in its realization, as regards both storage and transport. The general tendency is to store materials together according to their nature. This means that tents, for example, are kept in one place, quite separate from medical material or lighting equipment. The same criterion generally applies to transport, which has similar methods of storage.

It is unreasonable to expect that operational plans will be rigidly carried out in the inevitable conditions of great excitement in the event of an emergency.

Nevertheless, in order to make full use of the modular structure of our modern units it is essential that container systems be designed containing single modules with all the logistics and technological equipment necessary for their complete functional autonomy. These structures, like those already created for the transport of service systems to the surgical nucleus, could consist of metal mini-containers capable of being loaded by an integrated system or by means of special jacks on to trucks, aircraft, ships, etc.

Relief work in every type of emergency would be greatly facilitated using these systems, with due respect for essential priorities, and with considerable gains in rapidity of intervention and efficiency.

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46
Burn treatment facilities in Turkey

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Burn treatment is a major problem in Turkey for two reasons. First, the number and composition of burn victims, and second, the number, capacity, and resources and organization of burn care centres and units over the country.

The composition of the burn patients who are treated by our burn centres differs from that of other western centres in that there is a significant proportion of electrical burns and of paediatric patients in general. At the Hacettepe Medical Centre, an average of 17% of admissions to the burn unit were electrical burns, and 57% of all admissions were patients between 0 and 15 years. The explanation of this is that electrical energy is used widely but often inappropriately in our country. The resulting incidence of electrical burns causing severe complications, sequelae and death is considerably high. The lack of appropriate public education is the cause of the high number of burns in children.

The second and perhaps more important problem in terms of proper burn care is the shortage of special burn care units and centres and their proper coordination.

The first contemporary burn centre was established in Ankara at Gulhane Military Academy Hospital in 1975, which also served civilian patients. Subsequently, a 10-bed acute-care burn unit was established by our team of the Department of General Surgery at Hacettepe Medical School, also in Ankara. Currently six hospitals in different cities have special burn units and in 107 hospitals burn therapy is being offered, although there is usually no special burn unit or any departmental organization in these last mentioned hospitals. The six burn centres are located in Ankara (3), Istanbul, Izmir, and Adana.

The Turkish Transplantation and Burn Foundation was established in 1980. This organization supports research and educational studies and provides financial support for burn victims who are in need. The foundation also runs a 100-bed hospital, specialized in transplantation, open-heart surgery and neurosurgery. This hospital gives burn care on an outpatient basis. The plan for the future is to build a competent high-tech burn and research centre for care of patients and studies on burn care.

The Haberal Education and Research Foundation in addition gives support for research, and scientific meetings, burn care, with preventive social education programmes.

With these units and organizations, we are trying to introduce safety measures and first aid to society through public educational programmes and to improve burn care in the country by providing specialist education, good facilities, and by the coordination of these efforts throughout the country.

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47
The establishment of a burns centre at a general hospital: the Naples experience

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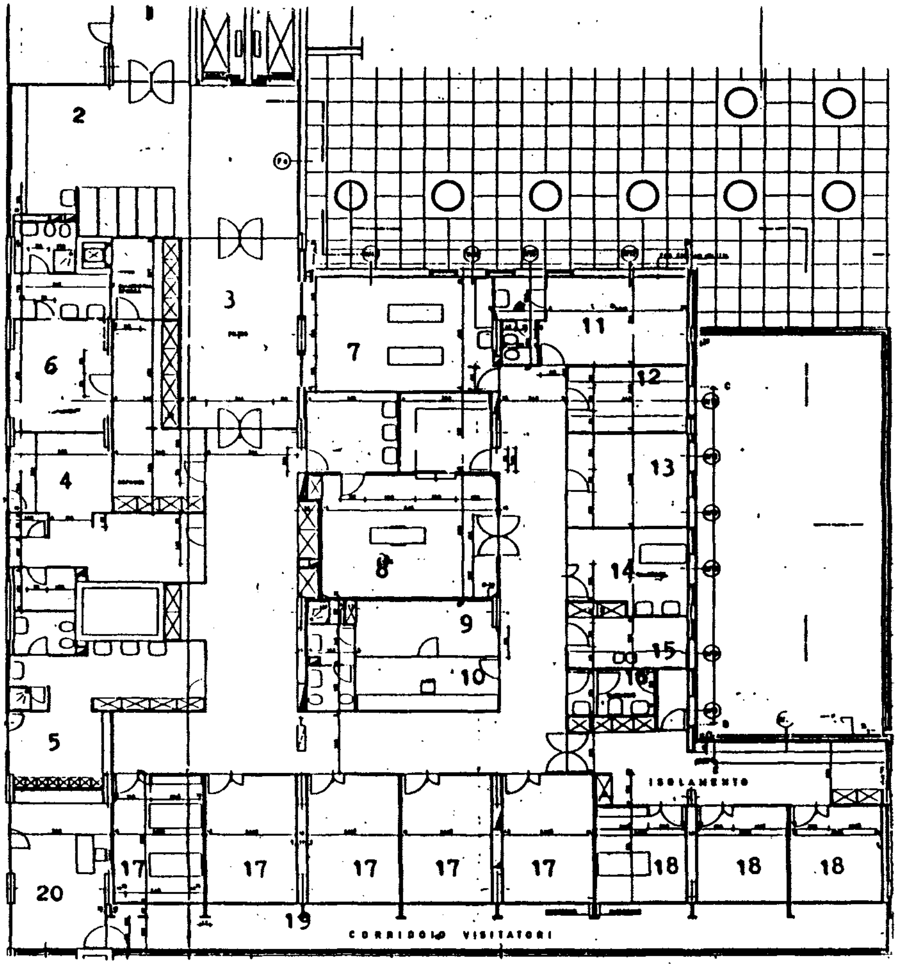
Nearly 30 years ago, in 1962, the Department of Plastic Surgery and Burns Therapy was created in what was then known as the Ospedali Riuniti di Napoli. The problem of the admission and therapy of burn patients had already been recognized that long ago. Subsequently, the simultaneous creation of the Division of Plastic Surgery (i.e. without 'burns therapy') and of numerous resuscitation and intensive-care centres affected the passage through these centres of patients requiring resuscitatory treatment.

After overcoming the shock phase the majority of burn patients were naturally transferred to our Division of Plastic Surgery, while the more serious patients, or those for whom no bed was immediately available, were transferred to appropriately equipped centres in other regions. This situation was counter-productive for three reasons:

1. The administration of intensive care in an inappropriate environment (resuscitation centres are notorious for their high bacterial content).
2. The fragmentation of therapy into several phases, prejudicing or delaying healing.
3. In addition, the transfer of burn patients to centres in other regions of Italy, because of the lack of appropriate facilities in the Campania Region, always caused great problems both for the patients and for their families.

For these reasons a project was drawn up 15 years ago for the construction of a burns centre; the original intention was to build it rapidly, but, as a result of bureaucratic delays and in particular of the expansion of the project into a full-scale 'medical and surgical emergencies pavilion' programmed to have over 300 beds plus diagnostic services, the time necessary for its creation increased and the scheduled date of completion became 1990.

This burns centre, the only one in our region, will fill a gap in the national organizational network of health facilities for burn patients. For this reason it



1 - Patients' entrance
2 - Primary care
3 - Filter
4 - Female staff's entrance
5 - Male staff's entrance
6 - Nurses' sitting room
7 - Consulting room
8 - Operating room
9 - Head nurse
10 - Monitoring station
11 - Doctors' room
12 - Pharmacy
13 - Laboratory
14 - Bathing room
15 - Kitchen
16 - W. C.
17 - Patients
18 - Isolation
19 - Visitors' corridor
20 - Visitors' waiting room

Figure 1.

might be useful to illustrate its progression and main characteristics, even if only in preliminary form (Figure 1).

The centre is situated in the Ospedale Multispecialistico 'Antonio Cardarelli' in Naples, which is easily accessible from the other provinces of Campania both by motorway and by the Naples bypass road. The hospital also has its own helicopter port. There is an intensive section with 13 beds, and a post-intensive section with 20 beds. The structures and characteristics of the intensive section are similar to those of other centres and consist of:

- First-aid rooms.
- The patient care area reached through a filter zone.
- Acclimatization plant regulating temperature and relative humidity.
- Five two-bed rooms, plus three single-bed rooms suitable for isolation.
- Various specialist equipment, including two air-cushion beds (Clinitron) and two balneotherapy baths.
- An operating theatre with a skin and skin-substitute bank.
- An external corridor fitted with intercom phones to enable visitors and patient to see and speak to each other.

The post-intensive section is directly adjacent to the intensive section. It has 20 beds plus a second operating theatre and is used for burn patients not requiring intensive treatment or at least not needing the sophisticated equipment available in the intensive section; it is also equipped for first admission of patients with limited lesions but presenting particular characteristics making admission advisable.

The post-intensive section is completed by an emergency plastic surgery service which, when required, makes use of the operating theatre, pending subsequent transfer of the patients, if necessary, to the Plastic Surgery Division that already exists at the Cardarelli Hospital.

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Cyanide compounds in fire gas toxicity and the role of hydroxycobalamin

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In France each year firemen are called out some 250 000 times to extinguish fires. On about one occasion in three the fire is in a residential building. Every year about 400 lives are lost and more than 4000 casualties need hospital treatment. The death rate in Paris due to fires is 1.35 per 100 000 inhabitants per year. These deaths have three causes: burns, trauma and intoxication. The last category is responsible for more than half the deaths and this proportion, already reported by Kimmerie and corroborated by research conducted at the University of Stanford and by Japanese studies, was also found in our studies in Paris.

FIRE GAS TOXICITY

The involvement of fire gases is both indirect and direct: indirect because of the state of stultification it induces, which may hinder or totally prevent any attempt to reach shelter; direct because of chemical characteristics such as oxygen depletion which causes incapacity at a 16% oxygen level and death if the oxygen rate is lower than 6%, and the presence of toxic agents — these are toxic gases produced by combustion or by pyrolysis of materials. The toxic agents include:

- Carbon dioxide, which can cause carbon dioxide narcosis at 80 000 ppm and death at 150 000 ppm or more, favours penetration by other toxic agents because of the hyperventilation it induces.
- Carbon monoxide, which results from the incomplete combustion of carbon and causes haemoglobin and myoglobin blockage.
- Cyanohydric derivatives, whose involvement in fire gas toxicity is a recent finding, cause a blockage of the cellular mitochondrial carriers.
- Other components (nitrous oxide, ammmonia, nitriles).

The presence of cyanides is demonstrated by experimental studies carried out in combustion chambers. Analysis of the gases produced showed that in a 15.6-litre combustion chamber 1 g of paper did not produce HCN; 1 g of rubber produced 120 ppm of HCN; 1 g of wool produced 200 ppm of HCN; and 1 g of polyacrylonitrile produced 1500 ppm of HCN.

Numerous materials, such as apparently harmless silk, wool and cardboard, are in fact liable to produce cyanides provided they contain nitrogen. It is certain that the use of plastic polymers in furniture and building materials has increased the frequency and gravity of cyanide intoxication. This intoxication has been confirmed by the results of blood tests carried out on patients before hospitalization and on arrival in hospital. The nature and quantity of the products released is a function of the nature of the material, the ambient temperature, and the percentage of oxygen in the environment.

DIAGNOSIS OF HYDROCYANIDE INTOXICATION

The clinical diagnosis is based on the context; the presence of soot on the face, nostrils and oropharynx; the presence of neurological imbalances (Glasgow 10 or less); and hoarseness.

Biological confirmation can be made on the basis of blood tests performed before hospitalization or on arrival in hospital. These show cyanide higher than 30 mmol/l, and lactate higher than 2 mmol/l.

Recent studies have shown that hyperlactacidaemia is an excellent indicator of hydrocyanide intoxication, and it appears that plasma lactate higher than 10 mmol/l is a sure indication of hydrocyanide intoxication.

CHOICE OF ANTIDOTE

There are three types of effective antidotes: methaemoglobinizing agents, dicobaltic EDTA, and hydroxycobalamin. However, methaemoglobinizing agents induce methaemoglobinaemia, the anoxic effects of which are added to the effects of carbon monoxide, and dicobaltic EDTA causes serious cardiovascular effects. It therefore appears that in view of its innocuousness only hydroxocobalamin can be used.

A derivative of vitamin B_{12}, hydroxycobalamin chelates cyanide ions and forms cyanocobalamin.

THERAPY OF SEVERE FIRE GAS INTOXICATION

On-the-spot prehospital phase:

- High-pressure oxygen inhalation, up to maximum levels; intubation and ventilation with pure oxygen.
- Blood tests for carbon monoxide, lactates, and cyanides.
- Perfusion with 5 g hydroxycobalamin.

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- Maintenance of haemodynamic stability (vascular pressure, positive inotropic drugs, etc.)

On arrival in hospital:

- Continuation of initiated therapy.
- Early hyperbaric oxygen treatment (45 min at 2.8 atm).

CONCLUSION

Although fire gas intoxication is the most frequent cause of mortality and morbidity in fire victims, it is often neglected in conditions that combine burns and trauma. The presence of cyanides in the composition of fire gases has been demonstrated by recent research.

The extreme gravity of this form of intoxication requires early diagnosis and emergency treatment initiated systematically on the spot, combining oxygen therapy and the administration of hydroxycobalamin.

Section V

Clinical Problems

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Early management of the critically burned patient

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In the general evolution of critically burned patients we can distinguish, at least for didactic purposes, three phases: resuscitation phase, pre-sepsis phase, and sepsis phase.

The intensive and aggressive therapy to which critically burned patients are subjected, together with their other characteristics and pathologies, provokes a considerable reduction of their defences: the basic problem is the lack of a protective barrier, i.e. the skin, which plays a major role in treatment.

Each of the layers of the skin has a specific function, and each has a fundamental importance for the understanding and recognition of burns, the consequences for the organism, and classification. The skin's first function is protection, and in the event of a severe burn lesion this function is impaired. The skin regulates body temperature and controls the intake and output of fluids. It also plays an important role in the individual's aesthetic appearance and therefore in the psychological consequences that may develop in the burned person.

The percentage of body surface area (BSA) burned, the depth of the burn, the burn mechanism and subsequent pathologies determine a series of overlapping problems and complications, for which reason these patients require special attention.

RESUSCITATION PHASE

The resuscitation phase of the burn patient lasts about 72 hours. This period is characterized by hypovolaemic shock, caused by the presence of vascular damage both near and far from the lesion. This provokes leakage of water, ions, proteins, etc., into the extravascular space, producing hypovolaemia, which manifests itself with clinical signs of oedema, oliguria, tachycardia, sweating and disorientation.

First aid for critically burned patients must be initiated quickly and efficiently. The patient must be completely stripped in order to arrest the process of burning, especially if the clothes are of acrylic. The burns are then examined and assessed for extent and depth, as well as for any associated lesions. It is important to know whether there is any previous associated pathology. All these details must appear in the clinical file that is prepared immediately. Certain procedures have priority as detailed below.

1. Patency of airways

The upper airways must be examined to check and prevent any signs of inhalation lesion. If necessary, orotracheal intubation may have to be performed. (An emergency tracheostomy must be performed only if intubation is technically impossible.)

The expansion of both hemithoraces must be checked, as also the presence of burns in this area. Deep burns of the neck can interfere with ventilation because of oedema of the glottis.

2. Rehydration

Cannulation must be done by a central route, preferably near the superior vena cava. Ringer's lactate solution must be administered as Modified Mahler's formula:

$$1.5 \text{ Ringer's lactate} \times \text{kg body weight} \times \% \text{ burned BSA} +$$
$$0.5 \text{ fresh frozen plasma} \times \text{kg body weight} \times \% \text{ burned BSA}$$

Half the total should be given in the first 8 hours and the remainder in the following 16 hours.

3. Bladder catheterization

This is important in order to guarantee good fluid equilibrium. Once rehydration has been initiated the following hourly diuresis rates should be obtained:

30–50 ml/h	in patients with thermal burns
80–100 ml/h	in patients with electrical burns
15–25 ml/h	in children over 2 years of age
1 (ml/kg)/h	in children under 2 years of age

The colour of the urine must be watched in electrically burned patients. The presence of haemochromogens is a sign of renal distress. In this case hyperdiuresis must be maintained in order to prevent precipitation of these pigments into the renal tubules and the renal insufficiency that may follow.

4. Nasogastric probe

This is a priority procedure if there are mouth burns and in cases of nausea, vomiting, abdominal distension, or burned BSA over 20%.

5. Measurement of physical parameters

The following parameters must be carefully measured: body temperature, arterial tension, cardiac and respiratory rate, and central venous pressure. For the latter the catheter must be correctly positioned, otherwise the values are not reliable. It is therefore necessary to perform a chest radiograph.

6. Laboratory tests

It is necessary to perform the following tests: haemogram, blood gases, ions, urine, and carboxyhaemoglobinaemia if there are signs of inhalation lesions. Chest radiography and ECG should be performed as complementary tests.

PRE-SEPSIS PHASE

This phase falls between day 3 post-burn and approximately day 13. There are two significant alterations: hypercatabolism and acquired immunodeficiency syndrome.

In metabolic alterations there is an increase in cardiac output and in water evaporation and, if there is infection, also in body temperature. This causes an increase of caloric consumption and therefore a hypermetabolic response, with considerable consumption of fat and muscle and consequent loss of weight, and also an increase in heat production with loss of urinary nitrogen and excretion of creatinine.

There are two methods of reducing basal energy expenditure: increasing the environmental temperature to 31–33°C, with heating lamps, and reducing pain, which increases metabolic and energy expenditure.

Two options are open to counteract the negative nitrogen balance: (1) parenteral nutrition with carbohydrates, vitamins, oligoelements, lipids and amino acids which introduce 30–40 g of nitrogen per day; (2) enteral nutrition replacing parenteral nutrition on day 3 post-burn at a rate of 1 cal/ml, if there is peristalsis.

Parenteral nutrition requires basic care in administration; the infusion must be as aseptic as possible, and system changes and care of the vein puncture must be checked every day. As a safeguard, preserve the nutrient in a cool and dark place until needed.

The burn eschar produces immunodepressive substances continually. When these enter the circulation they cause inhibition of the humoral and cellular immunological response, leading to acquired immunodeficiency syndrome.

Therapy consists of:

1. Early surgical debridement: removal of the eschar eliminates the main source of the substances interfering with the immune system.
2. Plasmapheresis: washing of toxic factors in the patient's blood and substitution with fresh frozen plasma: 2 litres interchange per session in burns exceeding 40% BSA.
3. Immunity-promoting drugs: their use is still in an early experimental stage.

SEPSIS PHASE

Infection, the main cause of morbidity and mortality in burn patients, can be kept under control only by the application of preventive measures and the collaboration of all health personnel.

For this reason it is important to know the centres and paths of the transmission of infection so that effective steps can be taken to prevent propagation. It is also important to understand the difference between infection and colonization, as they do not always correspond. Infection may be: *exogenous* (health personnel, nosocomial) or *endogenous* (patient reservoir).

The epidemiological chain and the investigation of the organism can inform about the causative agent, the source of infection, the mechanism of transmission, and the host.

The factors favouring the onset of septicaemia include:

- Destruction of the mechanical barriers (skin and mucosa).
- Destruction of the resident flora.
- Immunodepressive syndrome.
- Nursing errors, causing dissemination of infective agents from one zone to another (iatrogenic disease).

The most frequent agents are *Streptococcus pyogenes, Staphylococcus aureus, Pseudomonas aeruginosa*, anaerobic organisms, and fungi.

AIMS OF NURSING

The patient does not die because he has no skin but because his skin is burned and, above all, because he keeps his burned skin.

Surgery and control systems of the endogenous contamination reservoirs in the patient will help maintain flora at a subnormal level by means of a standard contamination guide used from the day the burn occurred, with particular reference to the nasopharyngeal area (fusidic acid and hexetidine); the intestinal area (colistin, histidine and tobramycin), and the burned area (rotation of creams every 72 hours).

The insertion point of the venoclysis is decontaminated by observation of strict aseptic norms. Decontamination of the bladder catheters is performed avoiding urine reflux and damage to the bladder system. Thorough hand-washing before and after each manoeuvre in each patient gives excellent results.

All material used must be properly: sterilized if in contact with the blood circulation and/or sterile organic cavities; disinfected if in contact with mucosae and/or non-sterile organic cavities; washed in other cases.

On the basis of some studies, certain departments of preventive medicine have recommended that caps and masks need not be worn during routine care of the patient. These protective devices are necessary only when the burn is exposed and being treated. A better relationship between patient and nursing staff can then be developed.

SUMMARY

1. Increase the use of low-cost high-efficiency preventive measures.
2. Maintain strict asepsis as a discipline in every activity, task and technique.
3. Obtain from all members of the nursing staff individual and collective commitment to achieving the desired objectives.
4. Ensure adequate treatment and specialized technical preparation of all staff involved in burns therapy.
5. Obtain generalized institutional recognition of the particular needs of the burn patient.

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Psychological reactions in fire disaster emergencies: hypotheses and operational guidelines

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Fifty years ago Orson Welles caused panic throughout the United States when he announced on the radio that Martians had landed on Earth. His audacious and brilliant intention was to stir up interest in a series of radio adaptations of novels that so far had not had much success with the listeners. This episode has continued to be particularly significant because it was a foretaste of the ruthless way in which the mass media would later exploit certain news items. It was also a demonstration of the psychological and other effects which a hypothetical disaster could have on individuals and on institutions.

The type of event that we wish to analyse from the point of view of psychological reactions is a disaster which affects at least 40 persons and is caused by fire. Our purpose is to provide useful guidelines, both for prevention and, in the event of a disaster, to assist the affected persons and rescue teams. The two main elements in this drama that have to be understood are the mass of people and the actual fire, and it is impossible to control the effects of either unless there is full knowledge of certain characteristics they have in common. These characteristics double their potential power, an ambivalent power that may be both useful and destructive.

It was the Nobel prizewinner for literature, Elias Cannetti, who said that a mass of people and fire have similar qualities: they sweep forward, they spread rapidly and insatiably, they are swift-moving, they change direction unexpectedly, and their effects seem to die down and suddenly come back to life. They are frightening and destructive, and they both need to be surrounded and guided.

Let us hypothesize the psychological reactions of a mass of individuals caught in a fire disaster, whether indoors, in the open air or in a means of transport. When a dangerous situation occurs unexpectedly, as for example in a fire, there is no time for emotional preparation for the crisis, that is it is impossible to set in motion any of the defence mechanisms typical of the state of anxiety. In most persons the result is a state of emotional paralysis, better known as panic. According to Freud, panic may be considered either a collective or an individual fear, but always greater than the circumstances justify. This is a result either of the extent of the danger or of the negation of the emotional links that hold a mass of people together. Panic is sometimes not proportional to the real extent of the impending danger, and is triggered by other insignificant causes.

Panic may manifest itself as a collective fear that grows unduly in a mass of people by contagion or as the total sum of individual fears. When the people have no previous emotional ties, as for example in a place of entertainment (sports stadium, theatre, cinema, etc.), fear immediately nullifies the reciprocal respect that previously held the mass together. The mass thus breaks up very easily and individuals begin to think exclusively of themselves, thus multiplying the risk of disaster.

If, on the other hand, a fire breaks out among a mass which has previous ties, e.g. families in a holiday camp, clubs, groups of schoolchildren, in factories, etc., the break-up of the endangered group is to some extent prevented by the ties which exercise certain limitations on personal egoism.

When fire breaks out in a closed environment or in a means of transport, people's immediate reaction is to escape, a desire to get away from the danger as fast as possible. Escape from flames in the open air is usually less dramatic for a number of reasons — it is easier to flee from the danger, there is less psychological pressure, and people are in better physical condition. In a closed environment people inevitably breathe the toxic gases produced by the fire.

Research on personal behaviour in critical situations has identified three different kinds of reaction: panic, rational action and resignation. When positive action that will lead to safety is possible, resignation can be considered a pathological form of behaviour. Thus, when a way of escape can be seen, there are two normal reactions, panic or rational action.

The flight from danger can be made more effective by using combined energy in an organized and concerted move in the same direction towards safety. This theoretical situation rarely occurs in practice, however, partly because of lack of training and the heterogeneous nature of the persons fleeing — men, women, teenagers, elderly people and children all move at different speeds and with varying vigour. If a form of rational behaviour is adopted and these differences are taken into account, the combined energy for compact flight is multiplied; the dominant emotional state is panic, people will begin to think only of themselves and to look upon others as obstacles to their own escape. Flight thus becomes a 'free-for-all', with everybody pushing anyone else who prevents or delays escape. A mass of people in such a state of panic breaks up completely, and loses all its compact energy.

Flight from danger also offers the individual and the mass of people in which he finds himself an immediate satisfaction of feelings of frustration, through the natural discharge of tension in motor activity, prevention of which may lead to an uncontrolled and violent attack. The English psychoanalyst W. R. Bion has stated that panic, flight and attack are really similar and interchangeable emotional states. A group that shares an emotional situation of danger, and which is therefore in an 'attack–flight' state, will follow any leader who gives orders to flee or attack, and in this way the mass maintains its cohesion.

These considerations should be the basis for any guidelines aimed at controlling the impetuous behaviour of a mass of people in the event of a fire disaster. Both in the phase of prevention and in the actual emergency situation, it is essential to stimulate rational thought patterns oriented towards action, collaboration and collective solidarity. At the same time the mass must be provided as rapidly as possible with leader-figures — fire experts, rescuers, and relief teams.

Among the different approaches to this problem, we underline the importance of preventive information. This will help people to comprehend the situation and characteristics and implications, and it is our opinion that this is the best psychological preparation for emergency situations in a fire disaster if panic is to be prevented and irrational and violent modes of behaviour are to be avoided.

In the recent San Francisco earthquake it was reported that the incessant campaign of information about the earthquake, directed at a population inhabiting a territory with a high seismic risk, completely eliminated panic reactions.

A good prevention campaign must be directed at the citizens involved, rescue workers and relief teams. It can be effected by means of an appropriate programme of civic education in the schools, by the mass media, and through simulated fire exercises which will provide useful information about crowd behaviour in urban environments, factories, schools, hospitals, etc.

Reports on real or simulated fire disasters should contain practical suggestions:

1. When everyone is running away from a disaster, people must keep a cool head and remember other people's needs and the importance of staying together — in this way panic can be avoided, people will not lose their sense of direction and they will remain a compact mass.
2. People must put their trust in the rescue workers and be guided by them; this is indispensable to guarantee escape from the disaster and it will reduce possible psychological interference that might hinder the organization of rescue work.

To conclude we would like to make some suggestions as to first aid, organized relief and rescue workers.

First aid: People in the disaster area can make themselves very useful, pending the arrival of organized relief, by assisting and organizing escape from the disaster, and not simply observing the sight offered by the disaster. It is necessary to evacuate homes and familiar places. It can be more useful to give the first rescue workers to arrive on the scene reassuring information about one's own personal safety than to describe the loss of property one may have suffered.

Organized relief: For the disaster situation to be brought under control it is essential that there should be professional trained teams of experienced rescue workers. These teams know how to handle practical difficulties and they are also trained in controlling emotional problems such as may be caused by panic.

Rescue workers: Medical and paramedical personnel must be carefully selected — they make up a motivated and psychologically well-balanced pilot group.

Psychological training will be given by expert psychoanalysts using group work techniques.

It may happen that the physician's possible action is limited, considering the large number of casualties, so that he is obliged to make a series of difficult choices. These choices are of course based on precise codes of conduct, but at the same time the physician is obliged to take direct responsibility in full awareness of his operational limitations. But as he will have been previously technically and psychologically prepared for such a situation, he will not be paralysed by the choices that he has to make and he will not suffer emotional stress at the precise moment when there is most need of his technical skill and emotional equilibrium.

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Prevention and treatment of acute renal failure in the severely burned patient

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Acute renal failure is one of the most frequent and most feared complications in the severely burned patient. Mortality in such cases is over 60% and it is therefore of extreme importance to follow diagnostic protocols that make it possible to initiate all therapeutic measures as soon as possible in order to prevent the onset of renal failure. In our intensive-care unit we have long been using a computer program that monitors renal function. The software permits the calculation of all parameters and indices that are useful for the differential diagnosis of renal and prerenal failure, such as creatinine clearance, free water clearance (WCl), the sodium excretion fraction (NaEF), the renal failure index (RFI), serum and urine osmolarity and their relationships (Miller *et al.*, 1978).

Among these we will consider only those which in our experience have proved to be early and reliable indices for the diagnosis of possible impairment of renal function. The first is WCl, which in acute tubular necrosis always exceeds −15 ml/h because of the reduced capacity of renal tubule concentration. Sodium excretion may provide further information. Sodium concentration in the urine should be measured daily and, in the case of oliguria, a concentration of less than 20 mEq/l is an indication of prerenal failure and in particular a state of hypovolaemia. A concentration of more than 40 mEq/l is characteristic of tubular necrosis. This indicator therefore has a wide area of indeterminacy. NaEF was introduced for this reason. NaEF is defined as the percentage excreted in the urine of sodium filtered at glomerular level, which in normal circumstances is 1%. In acute tubular necrosis the NaEF exceeds 3%, and it can therefore be considered a very early and accurate indicator. RFI has the same significance as NaEF. Its predictive value is comparable but it is easier to obtain as its calculation does not require knowledge of the patient's natraemia.

Functional tests for the assessment of renal damage in severely burned patients are of limited use because of the difficulty of interpreting the results, owing to the acute alterations in hydroelectric homeostasis and the effects of water and diuretic therapy.

An attempt has recently been made to overcome these difficulties by measuring the activity of certain enzymes at urinary level. This can help to make the assessment of renal damage more reliable and permits early screening of subjects at risk (Kunin *et al.*, 1978).

The enzyme that we use for this purpose is *N*-acetylglucosaminidase (NAG), which originates in the tubular cells. Our case histories also show that enzymuria is observed early when there is ischaemic or toxic damage to the tubular epithelial cells. As this parameter is a direct indicator of tissue damage, it has the advantage of not being affected by the alterations caused by haemodynamic or hydroelectrolytic modifications.

Regular and frequent assessment of renal function makes it possible to take all the specific therapeutic measures necessary to prevent the onset of acute renal failure. We will not dwell on the classic therapeutic methods designed to re-establish a good blood volume and to correct the hydroelectrolytic alterations by infusion of small doses of dopamine (3 g/kg per min), which is known to have a vasodilating effect at renal level (Henderson *et al.*, 1980).

The cornerstones of renal failure therapy are the removal of uraemic toxins and the normalization of the nutritional state. There is a considerable amount of evidence regarding the advantages of some complications of uraemic intoxication, and either postpone the beginning of dialysis or reduce its frequency (Lang, 1987).

Adequate oral nutrition is often prevented by anorexia, vomiting, gastrointestinal failure or respiratory failure. In these cases, if artificial nutrition is not immediately initiated the fasting and the increased catabolism rapidly determine a state of severe malnutrition which has significant effects on the development of the pathology.

The choice of the energy support is fundamental for the creation of a safe and effective nutritional protocol. There are two alternatives: either glucose alone as a source of calories (glucose system) or glucose with lipids (glucose–lipid system). The glucose system uses 50–70% solutions to infuse high quantities of calories in small volumes. It is thus recommended in patients with water overload, until this is resolved by dialysis. The combined glucose–lipid system offers the following advantages: lower metabolic overload than with the glucose system, input of essential fatty acids, reduced frequency of hyperglycaemia and hepatic steatosis, lower CO_2 production and O_2 consumption.

The input of nitrogen must be sufficient to satisfy the needs of the organism. For many years low-protein high-calorie diets were used which were intended to reduce the accumulation of potentially toxic protein degradation products and to favour the use of urea as a source of nitrogen for the organism. But in the majority of cases this method prevented control of toxic symptomatology and in fact regularly aggravated the condition of malnutrition.

It is now thought that the correct nutritional choice together with adequate dialysis make it possible to increase the quantity of protein input, with the effect of rapidly re-establishing and maintaining a good nutritional balance. This objective is more easily achieved if proteins of high biological value are used and for this reason the essential amino acids/total nitrogen ratio must always be greater than 3 : 1.

Our policy is to attain high calorie (50 kcal/kg per day) and protein (1.5 gm/kg per day of amino acids) inputs as rapidly as possible, which in association with intense dialysis permits the adequate nutrition of even extremely hypercatabolic burn patients.

To conclude, a quantitatively and qualitatively balanced diet associated with dialysis to remove endogenous toxins should be able to

- Improve the endotoxic picture.
- Enhance the psychophysical state and nitrogen balance.
- Re-establish the plasmatic and cellular content of the amino acids.
- Normalize proteinaemia, albuminaemia and haematopoiesis.
- Correct metabolic acidosis and hydroelectrolytic imbalances.

In the majority of cases the success of therapy depends on the achievement of these objectives.

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Early and late immunological changes in burn patients

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Burn injury causes many defects in the mobility and functions of the two leukocyte subpopulations, granulocytes and lymphocytes, and these abnormalities have been described by many investigators as the cause of post-burn infection. Sakai (1974) has observed that the peripheral blood lymphocyte count is at the lowest normal limits during the first post-burn week, the count then gradually returning to normal. Arturson (1969) and Andrew (1970) have demonstrated that immediately after thermal injury all immunoglobulins in the patient serum are decreased and reach the lowest values at about 2 days post-trauma; the level then rises again to normal levels at the end of the first week for IgM, during the second week for IgA, IgG and IgE, and at the end of the first month for IgD.

Immune depression induced by thermal injury was investigated in our burn unit in 49 acute burn patients with second- and third-degree burns in more than 20% body surface area (30 females and 19 males, age range 11–81 years). Twenty normal healthy individuals were selected at random as regards age and sex and used as a control group.

The Muir and Barkly formula was followed as a guide for plasma substitute transfusion in the first 48 hours, and the necessary electrolyte solutions were administered after admission. Antibiotics were administered in the presence of local or systemic signs of infection according to antibiogram.

The patients were classified in three groups according to the time needed for complete healing to occur. In group I (30 patients) healing was completed before 1 month, in group II (10 patients) healing was completed in 1–3 months and in group III (9 patients) healing was delayed for more than 3 months. The mean values of burn wound extent and depth in each of the three groups were found to be the same. Blood samples were obtained 48 hours post-burn in all groups, 1 month later in the second and third groups and 3 months post-burn in the third group. The values of immunoglobulins IgG, IgM and IgA were investigated using tripartigen immune diffusion plates.

Active E1 and total E2 T lymphocyte populations were estimated using the

Table 1. Changes in immunoglobulins G, M and A and T lymphocyte E1 and E2 populations

Parameter	*Mean*	*SD*	*Significance of change*
IgG			
Control	1228	233.5	
Group I	922	339.6	Significant decrease
Group II	1318	314.0	Non-significant increase
Group III	1448	301.7	Significant increase
IgM			
Control	120.5	32.7	
Group I	206.1	44.4	Significant increase
Group II	263.0	57.4	Significant increase
Group III	276.0	66.3	Significant increase
IgA			
Control	212.6	61.7	
Group I	194	62.7	Non-significant decrease
Group II	242.0	48.3	Non-significant increase
Group III	233.0	54.2	Non-significant increase
E1			
Control	32.0	7.2	
Group I	29.2	12.8	Non-significant decrease
Group II	35.0	15.6	Non-significant increase
Group III	33.0	10.0	Non-significant increase
E2			
Control	48.8	14.4	
Group I	40.0	17.3	Significant decrease
Group II	48.0	18.1	Non-significant decrease
Group III	52.0	32.0	Non-significant increase

Table 2. Changes in parameters in relation to burn wound extent

Parameter	*Correlation coefficient, r*
IgG	−0.27
IgM	+0.01
IgA	−0.265
E1	−0.06
E2	−0.21

rosette test.

The changes of the parameters and their statistical significance are demonstrated in Table 1. Table 2 shows the changes in relation to burn wound extent.

DISCUSSION

In the early post-burn period the escape of globulins from intravascular to extravascular compartments is attributed to the increased capillary permeability.

In this study IgG and IgA showed a statistically significant decrease 48 hours post-burn, which is consistent with previous reports (Arturson, 1969). IgM in this study showed an increased serum level 48 hours post-burn which can be attributed to its high molecular weight, which may limit its leakage to the extravascular spaces.

The increase of serum immunoglobulin level 1 month and 3 months later in this study coincides with previous reports, and may be due to general supportive measures and the antigenic stimulation of the burn wound flora (Munster *et al.*, 1970). Active and total T lymphocytes forming rosettes in the peripheral blood showed a statistically significant decrease in number 48 hours later, which coincides with the previous studies of Sakai (1974). T lymphocyte functions were also depressed in burned patients (Daniels, 1975); on the other hand, Alexander (1979) reported that fungal and mild bacterial infections hardly affect T lymphocytes. Recently the successful use of immune modulating agents such as thymostimulin to counteract the reduction of T lymphocytes (Visentini, 1989) has proved to be a step forward in the support of severely burned patients.

In conclusion, the humoral and cellular components of the immune response, after an initial decrease early post-burn, return to normal 1 month later and remain high up to 3 months post-burn. They cannot therefore contribute to the delay of healing in some burn patients having the same extent and depth of burn wound; most probably the delay was due to other general and individual causes.

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An approach to the management of hand burns using semipermeable membranes

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In large disaster situations medical staff are often presented with large numbers of casualties over a short period of time. In a burn disaster, hand burns are a frequent injury. We outline a method of protecting hand burns by the use of bags made from a semipermeable membrane. The ease of application and use, and the fact that, where appropriate, the patients and relatives can do their own dressings, make the bags particularly useful in a disaster situation. The bags have been studied in two separate studies, which will be reviewed.

The management of burned hands, particularly in cases of superficial and dermal burns, should be directed at the prevention of swelling, the preservation of mobility and protection of the wound so that healing can occur. In cases of deeper burns, surgical intervention may need to be considered.

Dressings can, in general terms, be of two types: occlusive, which protect the wound adequately but at the price of diminished mobility, and non-occlusive. The main non-occlusive dressing in use in Britain is a bag. Plastic bags are commonly used. They have the advantage of ease of use and effectiveness in providing a good healing environment with good hand mobility. Disadvantages are their delicate nature, as they can break easily, and the facts that they are messy and cause maceration of the skin. Many bag changes are needed, and they are not very well suited to outpatient use. Here we describe a semipermeable membrane-based bag that shares the ease of use and effectiveness characterized by plastic bags. In addition it is robust, cleaner to use, causes significantly less maceration of skin, requires fewer bag changes and is well suited for outpatient use.

In Figure 1, the left hand was treated in a plastic bag, with the result that the hand has the typical white macerated appearance which makes assessment of the burn difficult. The right hand, in contrast, was treated in a membrane bag and it is much easier to see where the normal skin ends and burn begins.

The membrane we use is made from expanded polytetrafluoroethylene and

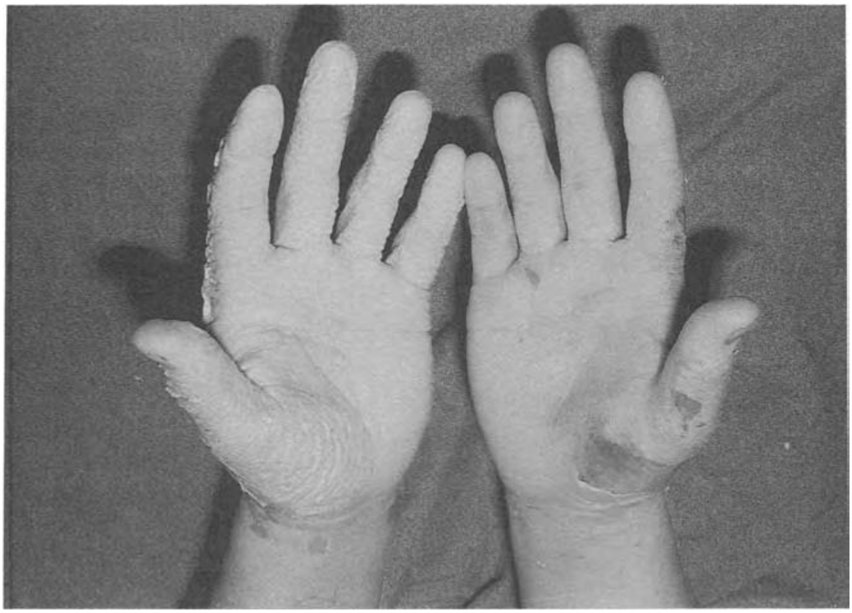

Figure 1. In this figure the left hand was treated in a plastic bag and the right in a membrane bag. The right hand does not have the white, macerated appearance of the left and the areas of burn are much easier to identify

is more commonly known as Gore Tex*. It is vapour-permeable but will not allow the transmission of bacteria. The membrane was used to separate inoculated medium from a sterile medium. No growth occurred in the sterile medium and on electron microscopy organisms were seen only on the inoculated side.

The bag needs to be used in conjunction with a cream to prevent excessive drying-out of the burn. Hoffmann (1984) has demonstrated the effectiveness of Flamazine cream and that is what we use. A layer of Flamazine cream is put onto the burn and the hand is put into the bag. It can be left for 24 to 48 hours; it is then removed for a betadine bath and physiotherapy and the bag is reapplied. The hand can be removed from the bag at any time to review the progress of the wounds (Figure 2). Bags with thumb extensions have been made to encourage the patients to use their hands (Martin, 1990).

In a study we conducted at the burns unit in Nottingham, comparing plastic and membrane bags, we found good healing, low rates of bacterial contamination with no overt infection, and a good range of motion in both bags. The membrane bag rated more favourably for comfort and ease of movement; there was significantly less maceration, making assessment of the burn easier; and it was preferred in the majority of patients who had bilateral

*Gore Tex is a registered trademark of W. L. Gore & Associates, Inc.

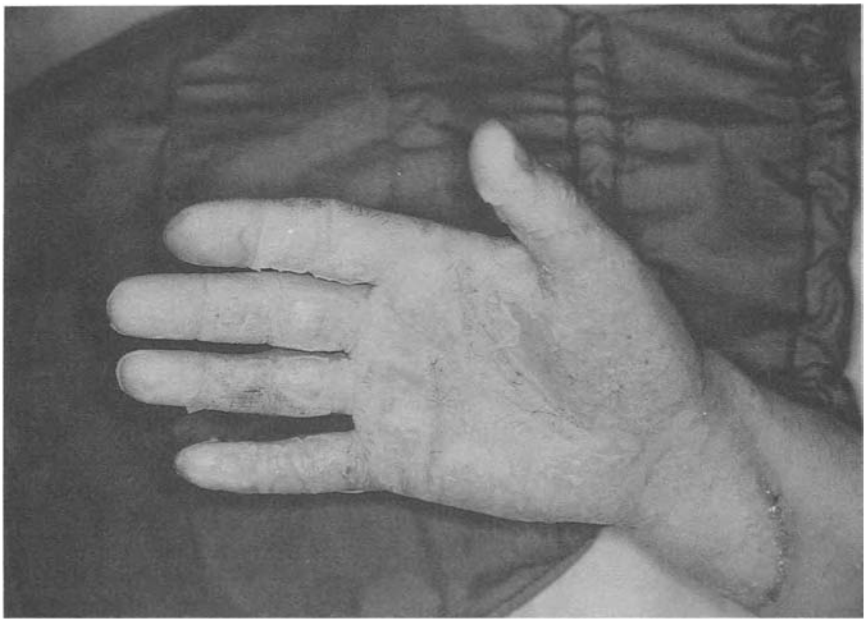

Figure 2. This hand has been treated on an outpatient basis in a membrane bag for a week (bag in the background). The bag is easily removed to examine the progress of the wound. Areas of burn in the fingers have healed; the palm and wrist have yet to heal

burns with one of each type of bag on their hands (Martin, 1990). It rapidly became evident that it was very useful as an outpatient dressing.

The use of the bag as an outpatient dressing in children was studied in the Queens Medical Centre in Nottingham (Henley, 1989). The membrane bag was compared to the occlusive dressing made from tulle gras, swabs and a bandage, the dressing normally in use in that department. An in-depth questionnaire was used to obtain parents' and staff's views. A total of 100 patients were studied.

Many parameters were studied but the salient findings were as follows.

The membrane dressing took less time to apply and explain. The observed discomfort was less. In the membrane bag, 100% of patients did not observe any discomfort, which compares with 61% in the tulle dressing.

Eleven patients in the tulle group had to return to hospital between scheduled visits to have dressings reapplied. None of the membrane group did.

There were fewer problems in general with the dressing while it was in use. The para tulle dressing tended to be disturbed more and there was more likelihood of adherence to the wound. We tried to get some idea of how the parents felt about the dressing by asking whether they would rather have had different dressing. None of the membrane group would have opted for the tulle gras dressing if given the choice, while 30% of the tulle patients would rather have had a different dressing.

We tried to get some impression of how the parents felt about being involved directly in the care of the wound by asking whether they felt that the care should be left exclusively to the medical staff. Parents of children whose burns were treated in a membrane bag felt satisfied they had been directly involved in the care of the child. The dressing was not a problem, the child tended to have a normal range of activities, and on the whole they were more satisfied with the membrane bag.

The membrane bag was quicker to apply and remove. It proved to be acceptable to parents for use on their children, they were generally pleased to be involved with the management of the burn and it required less time on the part of the hospital staff.

The bag has also been used for burns of the legs and burns of the feet, demonstrating its versatility.

In a disaster situation with many casualties this rapidly applied, easy-to-use dressing which requires less time commitment by staff with limited time and resources might be a very useful off-the-shelf dressing to have available. It is a dressing that is quick and easy to apply and requires very little aftercare once applied. If the patient is fit enough to do so, the subsequent dressings can be done by the patient himself, which considerably eases the pressure on the medical staff.

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Care of traumatic tattoos associated with gunpowder explosions and blast burns

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Traumatic tattooing is the embedding of myriad particles driven deeply into the skin. The pigment granules will leave permanent dark blemishes if not removed immediately, and can cause tattoo deformities of such magnitude that the patient's future life is gravely affected.

If the particles are not removed within the first days after injury, it becomes impossible to trace the path of individual particles into the depths of the dermis and no fully satisfactory treatment is available. This can be obviated by a relatively simple manoeuvre if tattooing is recognized and immediately treated at the time of injury, thus eliminating subsequent disfigurement and the necessity of additional surgical procedures with results that leave something to be desired (Figures 1–4).

Traumatic tattoos may be classified into abrasive and explosive types. The abrasive form (damage to the skin by friction, scraping or scratching following accidents such as falling on blacktop surfaces or cinder tracks and falling from vehicles) leaves pigment deposit in the more superficial layers of the skin. The explosive form (usually from a forceful impregnation of gunpowder associated with firearms, firecrackers, home-made bomb accidents, dynamite and industrial mining as well as military operations) often has a central focus of deeply embedded detritus with more superficially placed particles radiating from the central focus.

In the treatment of a patient with traumatic tattooing the management depends on three local factors: the blood supply, the integrity of the dermis and the presence of specialized dermis in the wound — for example, fingertip, nail bed, eyebrows, sole of the foot, vermilion and glans penis. After making an assessment of the patient's general condition and the state of associated injuries, and after making a judgement based on balancing the three local factors listed above, the surgeon should elect to treat injury by one of the following methods:

Figure 1. Close-up view of tattoo marks on the skin produced by a 7.62-mm blank cartridge during military training exercises

1. Debridement alone.
2. Debridement and excision of avulsed tissue with primary or secondary closure.
3. Debridement and excision of avulsed tissue with the use of the excised tissue as free graft.
4. Debridement and excision of avulsed tissue and the use of split-thickness skin graft.
5. Debridement and excision of the avulsed tissue and the use of pedicle flap.

However, the most basic technique is not difficult to apply and requires local anaesthesia, soap and water and at times a scrub brush, scalpel and forceps. There is no excuse for neglecting to apply it even in patients who have serious associated injuries. Early and thorough cleansing will reveal the presence of impregnated foreign material, which in many wounds can be removed without anaesthesia or, in the most complicated wounds, by infiltration of the dermis with weak local anaesthetic and then by scrubbing with a brush or by scraping with a knife. The wound should be dressed either with fine-mesh greased gauze or antibiotic ointment that is exposed to the atmosphere and which requires no further surgical care.

Agris (1976) recommended the use of a sterile hard natural-bristle toothbrush for the purpose, whereas Furnas and Somas (1976) use an operating microscope, high-powered loupes, very fine-toothed eye forceps and beaver 65 and 67 blades.

Figure 2. Fresh traumatic tattoo from mine explosion before treatment. Note enucleation of both eyes

In cases of blast injuries caused, for example, by very low-velocity particles, the dermis may be barely penetrated. In these the tattooed skin may be carefully shaved down to the normal dermis with a bowed double-edged razor blade or by dermabrasion. Upon hearing that gunpowder solvent might be effective in removing gunpowder (Shepard 1969), we inflicted powder tattooes on fresh cadaver skin and applied solvent to the wound. This agent dissolved only the powder on the surface; it was completely ineffective for the powder in the depths of the wound and was irritating to the investigators' skin.

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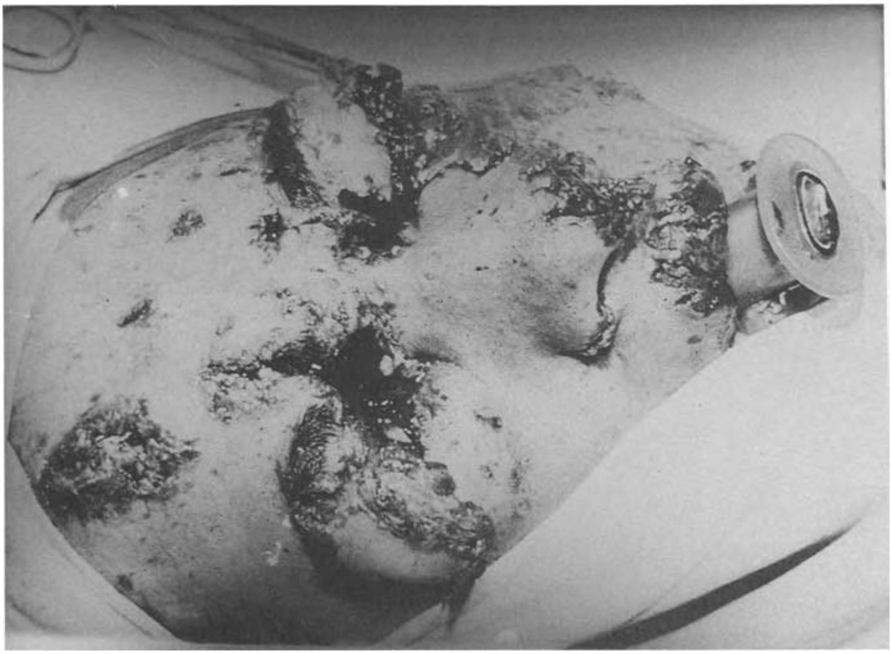

Figure 3. Same patient 6 hours later following aggressive debridement and sutures

Figure 4. End result 3 months later

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Clinical technology in small hospitals

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Major advances in medicine, especially in surgical treatment and critical care, are inevitably closely related to developments in modern technology. Health care is rapidly becoming technology dependent, yet technology can be expensive and, for countries with limited resources, the assessment, selection, cost, absorption and maintenance of technology (particularly imported technology) are crucial issues. Moreover, high technology, including equipment and treatment methods, may not necessarily be appropriate. There is therefore a continuing awareness of the need to consider carefully the transfer and/or adaptation of health technologies. To address these needs WHO has, for example, fostered the development of certain equipment and has prepared a series of handbooks which provide illustrated guides to laboratory, radiological and surgical techniques and procedures.

OXYGEN CONCENTRATOR

The recent development of an oxygen concentrator suitable for small hospital use illustrates what can be achieved through a concerted collaborative effort.

First, a meeting was held in May 1989 which brought together specialists in anaesthesia, intensive-care therapy, medicine and paediatrics, as well as from international organizations, aid/charity associations, and medical equipment manufacturers.

The available single-use domiciliary oxygen machines were reviewed and recommendations were drafted containing specifications for an oxygen concentrator capable of delivery oxygen to individuals or small groups of patients (up to four) in countries where unfavourable conditions of climate and power supplies may be experienced. Such a machine may be used to deliver oxygen in the operating room or for therapy in intensive-care units or wards.

The requirements for the machine, while including all those specified by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC) for concentrators for domiciliary use (in temperate and stable environments), are more stringent. There are recommendations for robustness and for safe use of the concentrator in the presence of flammable anaesthetic agents.

The industry responded enthusiastically. Currently, four prototypes from different manufacturers are being tested.

WHO BASIC RADIOLOGICAL SYSTEM (WHO-BRS)

This specially designed radiology unit, which can operate under adverse climatic conditions and despite erratic power supply, is easy to operate and to repair, yet capable of demonstrating all the most common conditions needing radiographic diagnosis. Utilization is restricted to general radiographic examinations not requiring fluoroscopy, tomography, or serial film changes. The manufacturers provide a comprehensive maintenance manual.

A set of manuals has been produced covering radiographic technique, film processing and film interpretation (Palmer and others, 1985, 1986).

LABORATORY EQUIPMENT

In the area of laboratory equipment, a simple photometer, instruments for blood-cell counting and for detection of malaria parasites, a haemoglobinometer, and serological kits, all of which have been specially designed, are being evaluated.

A manual of basic techniques for a health laboratory (WHO, 1980) is available which is intended mainly for the use of laboratory assistants in developing countries during their training and thereafter in their work. It can also be used for routine work in clinical or health laboratories. In the selection of techniques, particular attention has been paid to the low cost, reliability and simplicity of the methods and to the availability of resources in small laboratories.

Similar efforts are required for the development or modification of other selected diagnostic, anaesthetic, resuscitation and operating-room apparatus and equipment.

CLINICAL TECHNOLOGY

Emergency, life-saving surgical and medical care is still lacking in many small rural hospitals which, in developing countries, serve over 80% of the population. Central and larger hospitals are correspondingly overburdened with work that should be undertaken at a lower level of health care. For example, on a four-point grading of complexity of surgical procedures, a survey (Gil *et al.*, 1983) revealed that up to 70% of operations undertaken at the university hospital were of the lowest two grades. In a study (Nordberg, 1984) undertaken in three developing countries, it was estimated that the average annual need for basic life-saving operations was about 1000 per 100 000 population but that only 60 of these emergency operations were actually carried out. Information

on practical methods of transfer of identified technologies which could improve the performance of small hospitals with limited resources is not readily available, e.g. clinical technologies, including those for resuscitation such as in burn patients.

In collaboration with non-governmental organizations, WHO has therefore published a series of handbooks (Cook *et al.*, 1988; Dobson, 1988; WHO, in press) containing guidelines for district hospital clinical technology (surgery, anaesthesia and equipment). These handbooks are being widely used and supervized field trials will detect local variations and the need for adaptation to regional or local needs. Such trials, under the auspices of national health authorities and/or non-governmental organizations, including church-run hospitals, are being conducted in countries in Africa, South-East Asia and the Western Pacific.

It will be appreciated that close coordination with other programmes of WHO and with activities of non-governmental organizations and aid agencies is essential to ensure a balanced approach to health-care delivery. The organization therefore welcomes support of our goal.

WHO has also published guidelines for emergency essential drugs and equipment to be used in disaster situations (WHO, 1984).

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Section VI

Information and Communication National and International Organizations

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Mass media and serious emergencies

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The level of organization and technological preparedness of the state organs (ministries, prefectures, municipalities) responsible for civil defence, along with the level of the voluntary service, assumes great importance in the event of serious emergencies. We deem essential the greatest possible systematic emotional involvement of the population. For this a precautionary development of a widespread civil defence consciousness is indispensable and this is possible through information programmes and through preparation for general security problems concerning both natural and technological disaster. The most effective programmes for disseminating information in schools are those which teach the pupils how to act in various circumstances and how to become useful information sources for their families. The same approach can be applied to workers in factories, offices, and so on.

Ever greater importance is placed on visual, auditory and written information by the media, both to prepare a consciousness base and to provide proper information in the event of a disaster. Media information has four basic characteristics: (1) extreme rapidity of diffusion; (2) deep penetration; (3) a wealth of detail and the width of its coverage; and (4) the realism of its images and verbal and written description of events. These characteristics strike people so forcefully that there is an emotional response to the event — all the more so because information obtained from modern technological channels is largely a passive phenomenon that cannot be controlled by the receivers. Even if in theory a person can avoid buying a newspaper or switching on the radio or TV, today's mode of life makes the modern information culture necessary for everyone who is not to feel isolated.

It is also true that cultural and critical attitudes allow everyone to make a personal screening of information and to argue against it. The personal interpretation is always conditioned by the editorial stance and presentation of the information — e.g. a very long article and the priority assigned to it over others, the drama in the event and the enhancement of it with appropriate archives or update images; reiteration of the information; contradictory interpretations from different sources; commentary that might be driven towards a tendentious interpretation according to a political creed or the specific 'agenda' of the editor.

Information is unlikely to leave the receiver neutral because its emotional content, which may be evident or latent, sublimated or intense, generates an immediate or delayed response. The aroused response can often be unconsciously repressed and act indirectly to reawaken other emotions, with consequent inappropriate results. This can also apply to information that is commonly considered as having only slight emotive resonance for the modern information user. For information of great moments such as that relating to disasters, personal involvement and the expressive modalities of the supplier, in addition to the crude descriptive detail of the event, can deeply move a receiver's emotional responses and produce immediate irrational behaviour.

The ultimate response is the product of the interaction of the event itself and the method of the presentation with the emotional make-up of the subject and his or her 'personal equation' in the event.

The complexities of contemporary life can lower the emotional threshold even of those whose normal behaviour is grounded in rationality to the point where an event with powerful emotional resonances can sweep away rational, cultural and social frameworks. When information that is overloaded with explicit content that generates emotion impinges on a subject lacking the normal adequate filters and the appropriate expressive modalities, it takes over the imagination and dominates his affective world, bypassing the normal, considered response.

In this way passionate individual and collective responses become easy. Many examples relating to dramatic events show how the collective imagination has been powered by the media, dragging along a procession of individual phobias, fears and irrational interpretations.

As an example of collective emotional involvement driven by the power of the media, we mention the media excesses seen in the Vermicino tragedy in Italy a few years ago. Although it was an individual event, the tragedy gripped the whole country: people were eager for news, even if already stated by the numerous channels of information and media reporters on site. According to some commentators, the excessive involvement of the media overemphasized the rescuers' sense of responsibility and reduced the clarity of concentration on the operation. This points up the need to assess the influence that media pressure can have on the decision-making capacities and on the behaviour of people in serious emergencies.

The Vermicino case was highly dramatic, but it concerned only one person: public opinion was aroused because of the youth of the victim, which dramatically stimulated parental instincts. Let us try to imagine a catastrophe of vast proportions. What will promote a lesser or a greater sense of drama in the event? Surely the number of victims; the way children, teenagers, adults and elders die; the extent of the disaster; the level of social disruption involved, and so on. But the nature of the catastrophe has the greatest negative influence. It seems that the greatest emotional involvement is caused by natural disasters (earthquakes, volcanic eruptions, floods, etc.), because they evoke a deep fatalism and ancestral dread in the face of the presumed inability of the human race to contend with the power of nature or the anger of a merciless divinity.

In contrast, technological disasters due to human error (negligence, unorthodox operation, leaders' lack of foresight) diminish fear and emotional drama, because of instinctive reactions such as anger or desire for revenge against someone who can be punished and against inanimate mechanisms that should be subordinated to human intelligence.

Another element is the physical distance from the event, so that the closer it is to one's own neighbourhood, town or country, the higher is the participation; the farther away the event, the lower the participation.

Temporal distance from the event also has its influence; during the first days attention is massively focused on the catastrophe, with evocation of fear, sorrow and horror, and interest in aid mobilization, the search for causes and the allocation of responsibilities. As the days go by, if nothing more to sustain interest is brought to our attention, the event is gradually abandoned by the media and put on an inside page with smaller headlines and less pathetic emphasis. Therefore, even if the tragedy becomes larger and larger in its social and human dimension on site, it 'cools down' for an audience not directly involved, who eventually even treat such news with indifference or irritation, turning to other news, perhaps less dramatic but surely 'warmer'.

We know that in certain countries politically controlled information is 'diverted' with the intention of distracting the attention of the masses from the leadership's responsibility for deficiencies in preparedness and management.

Emotional responses to events are ambiguously manipulated by the media's presentation of strikingly emotive images of great symbolic power — shattered human remains, the corpses of mother and child locked in an embrace, corpses 'frozen' in their activities at the time of death, or close-ups of terror-stricken victims' faces.

A separate mention is due to the terrifying fascination evoked in people by flames. The fear and fascination that flames excite in human beings and the enigma of the opposing symbols of annihilation and of the existential spark have been evoked from ancient times (the myth of Prometheus) to the present day and by great poets and philosophers, represented by Plato, Aeschylus and Dante, and Quasimodo. Their interpretation of fire as a symbol of destruction and purification referring to life and death corresponds to everything that is deeply and intimately felt in the human collective unconscious.

We can conclude that the visual, auditory and print portrayals of calamities by the media often assume destructuring meanings not just for 'frail' personalities but for anyone, as they can awake evocative potentialities of the collective unconsciousness and the most primitive dreads, with attendant abnormal reactions that generate emotional and uncontrolled behaviour.

We certainly do not wish to throw the whole responsibility on the 'suppliers' of the media, as most of them are generally very prudent and critical in the exercise of their profession. What becomes dreadful is the nature of the calamity itself, as its dramatic quality produces a sort of natural complicity, through unconscious paths, between receiver and supplier of news. This news can even evoke the ancient need for suffering connected to the ancestral self-expiatory search for guilt, a need that has been felt since the beginning of human conscience. This is a sort of witchcraft that intimately connects the media and their consumers: Croce properly defined it as 'mèsinformation vraie: mass media are to people an open window on the external world and at the same time the mirror reflecting the secrets of the collective Ego.'

It is up to the reporters' undoubted professionality and conscience to accomplish the difficult task of selecting the news and the technique of diffusion, naturally respecting the people's right to the truth but also bearing in mind that some of them are passive receivers, with affective–emotional vulnerabilities that can often be alarming and uncontrollable.

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The mass media and fire disasters — information according to medical and psychological criteria

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We consider how the mass media may be used to promote scientific information in the field of fire disasters. Any attempt to create a constructive dialogue between scientific information and the mass media is bound to present certain difficulties, but the various sources of information — newspapers, radio, TV — have become so indispensable that we cannot do without them.

Originally the word communication meant 'transport', and in order to communicate people used roads, rivers, seas and bridges. But with the advent of the electronic era and the mass media a new form of communication has come into being — the movement of information.

The use of modern means of information transfer has completely revolutionized our way of life because their speed has so greatly increased and consequently so has our ability to exchange messages. This acceleration of communication as a consequence of its instantaneity means that it can extend its influence and capacity for involvement ever further — the world has truly become a 'global village'.

Speed and the capacity to involve and influence others are among the features of the mass media that can be used in the field of scientific information, with a view to preventing disease and promoting health.

One preliminary remark must be made: fire disasters involving the environment, unlike natural disasters such as earthquakes, floods and volcanic eruptions, are rarely accidental and are generally caused by people. It is important to emphasize human responsibility as this is an essential starting-point for an information campaign to influence public opinion. It is necessary to discourage the kind of fatalistic reaction that is common in natural disasters, when, for example, divine wrath is taken to be the cause. The factors that induce people to cause fire disasters must be thoroughly investigated.

In fire disasters we can make the distinction between open-air disasters with

CRONACHE ITALIANE

Dopo cinque giorni le fiamme che hanno devastato le colline attorno a Livorno sono state domate; danni enormi, ancora polemiche

L'Italia brucia, il soccorso fa acqua

Creare un'Autorità sola per proteggere i boschi

Il vicesindaco: «La risposta della Protezione civile doveva essere adeguata» - Il racconto e la paura della gente a Quercianella - Un volontario: «Troppo in ritardo la prima riunione operativa» - Ruffolo: «Disponiamo di quattro aerei e due in leasing contro 50 Canadair della Francia» - Fermati due ragazzi - I pompieri hanno trovato tracce di stracci imbevuti di benzina avvolti in carta di giornale

La terra ha tremato: danni all'acquedotto e panico

Figure 1.

destruction mainly of animals and plants (e.g. in forests, woods and plains); open-air disasters with some involvement of human life (e.g. in camps, stadiums, woods and forests, and open country); and indoor disasters with considerable involvement of human life (e.g. in cinemas and theatres, discotheques, and domestic houses).

Consider the way the Italian press reported news of fires in the summer of 1990, a period when there were numerous outbreaks of fires in various regions of Italy. The press reports concentrated on accusations of delays by the authorities in extinguishing the fires. The press also drew attention to the complicated legal aspects of conflicting responsibilities. The tone of some newspaper and magazine headlines was ironic or derisive:

Italy burns while fire brigades fiddle
Firemen attack in open order
If the wind changes get packing!
Fire? Forget it
State firebug
Minister accuses State of criminal negligence

This technique draws the public's attention to the slowness of bureaucracy and the confused conflicts between authorities. All this provokes disagreement between the various organs responsible for rescue and fire-fighting.

These public quarrels, as reported by the press and on TV, seem to amuse the readers and increase the number of viewers, taking their minds off more important matters. If the mass media adopt this ironic approach towards the responsibilities of ministers, mayors and prefects, ordinary citizens will tend to take their own responsibilities lightly and simply ignore certain problems as if they did not concern them.


CRONACHE ITALIANE

Lingue di fuoco alte cento metri e colonne di fumo di due chilometri a sud di Livorno dove l'abitato di Quercianella è direttamente minacciat

Valigie pronte, se cambia il vento

La gente aspetta sull'Aurelia ridotta a un cimitero di pini marittimi secolari - Sta sulla soglia di casa con i bagagli già sulle auto in attesa dei capricci delle fiamme - Il calore ha piegato ogni struttura, polverizzati anche i cartelli stradali - Un pilota che ha volato per sette ore: «Non si fa in tempo a localizzare un focolaio che s'incendia un'altra area» - Il giallo della mancanza di carburante a Pisa - Sgomberato in tutta fretta il campeggio Mirama

Il calendario del fuoco nell'89

Dalla Francia partiranno tre Canadair, ma tra la città e lo Stato è rissa

Figure 2.


ESTATE ROVENTE L'Italia brucia ma i Vigili del fuoco non possono intervenire dal cielo. Lo vieta la burocrazia

Fuoco a perdere

Figure 3.

There are other dangers in the mass media's manner of reporting fires. We are all continuously exposed to a bombardment of news that none of us can completely assimilate, with the result that we become impervious and uninterested and in the end simply dismiss them. Umberto Eco has said very aptly that the mass media are 'instruments of oblivion', which provide too


SCIENZA E AMBIENTE

Stato piromane

Una legge sbagliata. Competenze confuse. E così vince il fuoco. Ma si può, volendolo, cambiare strada.

Figure 4.


Mentre la pioggia spegne gli incendi divampa rovente la polemica tra le varie autorità

E il ministro disse: brucia, governo ladro

Caso Orfei: la Procura chiede nuove indagini

Antonio Padellaro

Figure 5.

much or too little information, exaggerating or underplaying the news with undue ease, not investigating the problems involved but glossing over them. The great amount of information we are exposed to daily in the press and on TV does not therefore necessarily help us understand things better, act accordingly or be socially more aware — it may instead induce us to put such matters out of our mind as quickly as possible.

A scientifically useful information campaign aimed at the prevention of fire and the promotion of public health must make use of information techniques stressing the following points.

The gravity of the 'fire disaster' phenomenon. In 1989, forest fires in Italy caused the death of numerous persons and about a hundred cases of burns, apart from damage to the environment; the science page of the *Corriere della Sera* newspaper informs us that this year in Italy (1990) there have been 4400 fires affecting 51 700 hectares of land (20 500 hectares of woodland, the rest maquis and pastures). This is likely to be a record year as regards both the number of fire outbreaks and the land area affected. These data indicate how dramatic the problem is for the natural environment and how dangerous it is for the ordinary citizen.

Prevention. Information must be preventive, it must precede the occurrence of the phenomenon and thus reach the public before the disaster actually happens.

Education. Information must promote dialogue about the social aspects of health and, in our particular case, knowledge of the burn pathology and its devastating consequences.

Involvement. Information must involve the responsibilities of ordinary citizens and the authorities.

Effectiveness. Information must be incisive, it must draw attention to precise facts, making use of the technique of repetition of reports and pictures.

Reliability. Information must guarantee the reliability of the news, bearing in mind that in our present-day system of information the relationship between true and false has been considerably degraded because of the newspapers' desire for 'scoops' and the TV networks' need to increase their audiences.

Investigation of causes. Investigation of the causes must get to the heart of the problem without any reticence or connivance and without creating polemics that quickly die down leaving the problem just as it was before. Press sources inform us that 'beyond any doubt' the recent fires that have broken out almost simultaneously in many regions of Italy have been of criminal origin. Although the motives for such crimes are of particular interest, they have not been adequately researched and publicized. The reasons commonly given are building speculation, land improvement contracts, the creation of regional parks, and the acts of criminals and psychopaths. We read of incendiary rockets fired from passing cars, of crazy firebugs, of arsonists almost being lynched, of enthusiastic spectators admiring the flames. One illuminating example is reported in the *Corriere della Sera*: volunteers extinguishing the flames told reporters that numerous people had rushed to the scene of the fire, not to help to put out the flames but to enjoy the sight. It then happened that two of the 'spectators', who were 'in the front row', slipped into a canal. The firemen were obliged to abandon the fire in order to save them from drowning.

The focus and thus the manner of scientific information presentation must concentrate on the real causes:

Accidents	Very rare. According to a university professor of forestry: 'Self-combustion in our climate can be totally excluded.'
Criminal acts	Speculation. Protest.
Negligence	Forest maintenance, clearing and removal of dry wood and easily flammable material.
Carelessness and lack of civic education	No civic education at school and no information campaigns about the danger of open fires

	near woods and of carelessly throwing away cigarette-ends.
Pyromania	Irrational fascination by fire.

The way the mass media use this last term has engendered a great deal of confusion: speculators, criminals and maniacs are all lumped together so that it is extremely difficult to identify and prosecute them. It is the duty of the mass media to distinguish between the deliberate act of a speculator and the irresponsible act of a pyromaniac. Only in this way will it be possible for the general public to understand the phenomenon. The motivations of the pyromaniac are not the same as those involved in criminal speculation or the other causes outlined.

Information about a disaster that involves victims requires special care. The news is sometimes exploited to stimulate the public's attention, by playing to people's morbid interest in death and disasters. The basic news of the disaster, which may arrive from various sources, should be processed before its general diffusion by a team of experts, in order to make it more acceptable to the public and to prevent negative morbid reactions and panic. The news must be communicated in a clear and calm manner, using the appropriate tone of voice and the correct terminology; it must also be repeated as often as necessary.

Proper use of the mass media's speed of diffusion and the variety of channels of information should afford valid assistance in relief work by direct contact with the operations centre. If a disaster area has to be evacuated, radio and TV can provide indispensable information about transport conditions and escape routes. They can persuade people to leave their homes, issue appeals to remain calm and behave rationally, and underline the risks of burns and their consequences.

We also believe in the importance of 'after-the-event' reporting, which describes the event in its entirety with an assessment of the final damage, and gives the number of victims and the names of the persons responsible, if identified.

It is also useful to society to inform readers or TV viewers about the evolution of the burn pathology, which is little known to the general public. Because of its serious disfiguring consequences, it can be considered a social disease with considerable and dramatic difficulties for those affected.

In the context of a wide-scale health education campaign, the mass media should show pictures of burns sequelae so that the general public can become accustomed to the sight of seriously disfigured people who are emotionally and intellectually undamaged.

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The role of the mass media in burn prevention campaigns — psychological considerations

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All citizens in a civilized country have a feeling of social responsibility. Some, owing to their professional activity, are more involved than others in this moral commitment. Physicians no longer restrict their interest to the pathology of cases, but increasingly relate this to the patient's social, cultural and psychological background, setting themselves the important objective of a continuous effort of prevention.

Having acquired this awareness of the interrelation between sanitary, social and psychological factors, the physician is increasingly required to include a variety of activities in his or her professional work, knowing very well that all efforts directed at the improvement of health must be extended beyond the scope of routine medical services.

One of these indispensable activities concerns the study of the appropriate means for health education and prevention campaigns. The objective is to arouse interest in the field of public health and to create an ongoing dialogue about the social dimensions of health problems.

The physician can be helped in this task by the correct use of the mass media which, if appropriately used, can transmit a message simultaneously to a large number of persons in a very effective manner.

Burns are a pathology that lends itself very well to a prevention campaign, as the identification of its causes is easier than that of other pathologies. Some causes of burn accidents may appear obvious, but for that very reason they are the most insidious, as they escape the diverted attention of adults and children. Danger is lurking in the most ordinary situations in the home and particularly in the busiest part of the home — the kitchen. Pots and containers with hot food and liquids, gas ovens and electric oven fronts, a hot iron, caustic substances — these are the most frequent causes of burns in children, who are statistically the most exposed age group. The traditional concept of mother being a 'guardian angel' is pure fiction — the truth is in fact just the opposite.

At work, the risk of burns due to carelessness or lack of caution increases if the choice of work was not made voluntarily, if motivation is low, if the worker's emotional state is disturbed by personal or family worries, or if there is a situation of conflict in the working environment. All these factors reduce the capacity for concentration and consequently increase the risk of an accident. Many accidents are also caused by inexperience and a lack of sufficient training for a dangerous activity.

When an outdoor bonfire is lit, the general convivial atmosphere tends to lead people to underestimate certain risks such as wind direction, the nearness of the fire to flammable materials such as dry grass and undergrowth, and the classic lighted cigarette end. Children are attracted by 'forbidden games' with fire in the open air, when their parents are not present. Their fantasy also stimulates them to reconstruct situations they have seen in films or read about in books.

Some causes of accidents are related to man's relationship of attraction/destruction with fire. Man's encounter with fire as related in Greek mythology is significant as a constitutional movement of thought and fantasy. Prometheus, who steals fire from Jupiter in order to give it to mankind, sets off the desire for knowledge which distinguishes *Homo sapiens* from animals, providing an incessant drive for the perfection of his understanding. The expression 'spark of intelligence' is for this reason very significant. But fire was stolen — its origin was linked to an act of violence for which Prometheus was cruelly punished. This gift–theft reflects an original symbolic ambivalence, an independent, dangerous and destructive use of fire that ultimately led to its getting out of control.

The struggle between man and forest for their mutual coexistence has always been significant. In ancient times the forest was burned in order to create fields to cultivate and villages to live in; today the struggle continues with the intensification of forest fires for purposes that are destructive for both forest and man alike.

Man's magical attraction by fire can transcend the mere pleasure of watching it and controlling it and lead to a kind of identification or fusion with fire. In our experience, persons with behavioural disturbances or those socially maladjusted are dangerously attracted by fire to cause either death or physical harm. Death in flames, writes Bachelard, 'is the least lonely of deaths': it is a way of drawing attention to oneself by means of the flames with which one is seeking a kind of fusion. Death by burning can also be a search for relief from suffering, an unconscious attempt to seek health in a cathartic act of purification.

These and other considerations, based on our working experience with patients, can be used by the mass media to make an appropriate contribution towards the prevention of this pathology. We refer here to the use of videotapes, TV spots, cartoons, films and illustrated leaflets aimed particularly at children. These must be prepared by experts in child psychology with the assistance of experts in graphics technology and they must be shown at children's peak viewing times. In all cases, care must be taken not to arouse excessive fear, not to induce the child to imitate precisely the danger that is to be avoided, and to develop the sense of responsibility that even children possess.

Campaigns aimed at adults should provide accurate information about the causes of burn accidents and burn pathology in all its various phases. With regard to burns in the home, which are the most frequent cause of burns, one must consider the alarming element of parental carelessness, even when children are at an age when they are totally dependent upon their mothers. Various hypotheses may explain this: (1) poor social, economic and cultural level; (2) inadequate sense of responsibility towards helpless individuals; (3) ignorance of infant psychological development and of children's curiosity about their environment.

The diffusion of television and its great impact on all social and cultural levels make it the most effective means for the prevention of accidents in the home. The language used must be clear and comprehensible to all.

As regards industrial accidents, the press and TV must resist the temptation of sensationalism and contribute to prevention campaigns by taking a position of social responsibility in the denunciation of cases in which workers without the proper precautions are exposed to the risk of burns, together with cases of arson for speculative reasons, as for example in forest fires.

With reference to information about burn pathology, we would mention the complaints of patients and their families who have confessed to us their utter ignorance of burns, of their gravity and of the physical and mental suffering they involve. We consider this lack of knowledge a severe handicap and an indication of the non-existence of prevention campaigns. The patients are caught unawares by an unknown event which completely overwhelms them. Very often they underestimate the seriousness of their condition and manifest a certain resistance to prolonged hospitalization, surgical operations, periods of isolation and rehabilitation exercises.

The victim's family also suffers from the same ignorance and creates all sorts of obstacles to the medical team's therapeutic activity. Here too the mass media can play an effective role, both in the field of prevention and in spreading constructive information about burn phenomena.

The better the understanding of a danger the greater the care taken to avoid it. The mass media must therefore not hesitate to publicize realistic images of burn patients. In this way burn victims will also be more readily accepted by the rest of society. Our patients report that after the accident which has left its visible marks on them they live as it were in a state of hiding, concealing their scars from themselves and from others, avoiding at all costs any contact with the rest of society, which looks upon them with curiosity and with little sympathy for their condition.

In our opinion, the function of the mass media is to help patients come to terms with this kind of protective defence, which transforms burn victims into social outcasts, and to familiarize public opinion with their damaged physical appearance.

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The philosophy of a burns prevention campaign

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Although natural disasters cannot be avoided and can only be partly prevented by modern technology, accidents caused by man, by everyday routine and by habits in the home or at work, can be avoided, or at least their effects can be reduced with a large margin of safety.

Everyone has the duty to protect his own safety and that of others in the working environment, in the family and in leisure activities. Risk is all around us, concealed behind the objects we most commonly use. Above all, we must be aware that more often than not the dangerous situation and its damaging and sometimes lethal effects may be caused by a moment's forgetfulness, carelessness, lack of concentration, rashness, overfamiliarity or sheer ignorance. We must also learn the rules of behaviour that emergency situations require.

For this reason prevention campaigns are of fundamental importance. Such campaigns must make use of different means at different moments, according to a well-defined programme. They must concentrate above all on two basic points: first, they must teach people how accidents can be prevented by observing certain techniques and guidelines; and second, they must illustrate in detail what to do when an accident has actually happened.

With this philosophy in mind the Mediterranean Burns Club (MBC) has since 1985 produced six videotapes dealing with the prevention of burns and disasters due to fire or electricity. These are entitled:

The prevention of burns in children
The prevention of burns in industry
The prevention of electrical burns in everyday life
The prevention of electrical burns in industry
How to defend ourselves from fire
Defending our forests from fire

In Italy it is calculated that about 50 000 people suffer accidental burns every year, and that about 45% of these are children under the age of 12 years. An analysis of statistics in numerous countries reveals that 30% of accidents involve children under the age of 5 years and that the majority of the accidents occur in the home.

The domestic environment, especially the modern home, is becoming more and more a source of risk, both as a result of technological progress (electricity, gas, chemical substances) and because parents are nowadays more often engaged in work away from the home and have less time to look after their children. The most frequent causes of burn accidents are boiling liquids, followed by contact with hot objects (oven front, electric hot-plate, iron) and electricity.

An extensive burn can kill and even when it is not fatal may leave marks and scars for life. Hence the need to promote prevention campaigns aimed not at the unrealistic objective of eliminating all accidents, but at reducing the number of accidents that lead to invalidity and death. The prime objective that we in Palermo, in the ambit of MBC activities, have set ourselves is the promotion of a campaign for the prevention of domestic burns and electrical lesions, accidents which above all involve children.

Four objectives guide our philosophy, as follows:

1. To encourage accurate investigation and research.
2. To promote a wide-reaching information campaign.
3. To promote a government legislation regulating safety.
4. To promote the production of safe equipment and methods at industrial level.

Let us examine these objectives in turn.

(1) Epidemiological and statistical investigation will extend our understanding of these accidents and of the real causes underlying them. It will also contribute to in-depth research on the questions of to whom these accidents occur, how, where and when. In our opinion this is the only way to achieve prevention which is not limited to a merely generic exhortation but is, rather, a specific form of prevention in the family and in the domestic environment.

(2) The basic factors in all accidents involving children are a combination of imprudence, lack of experience, impulsiveness, curiosity and a desire to imitate adults. The MBC prevention campaign makes use of these same factors to reach both children and adults.

Children must learn to understand the consequences of certain actions; in this way their capacity to learn through direct experience will not be limited, and at the same time their curiosity will be satisfied.

Adults, including not only parents and educators but also university and senior school students, teachers and all persons who may find themselves in a position of responsibility for the safeguard of children, must become safety-minded. They must be made aware of the possible risks that exist in the domestic and outdoor environment and of how to neutralize them. They must be trained in basic first-aid procedures to be carried out immediately at the scene of an accident.

(3) and (4) Legislation is crucial. The intention is to obtain modifications in the relevant laws by promoting prevention at national and local levels, together with the promulgation of safety standards to be observed in the planning and realization of particular structures and buildings, and also in the legal regulation of industrial production, especially in the field of children's clothing, baby clothes, electric household appliances and toys.

THE PROGRAMME

The videotapes prepared by the MBC are part of a wider programme for the prevention of burns in children and adults. The programme provides for the use of further videotapes and the distribution of illustrative booklets, picture-cards and stickers for younger children, all of which are to be used — in schools of every level and type, public places, factories and clubs — to publicize as widely as possible the damage that burns can cause and, above all, the steps that can be taken to prevent them.

The poster to be displayed in schools, public places, hospitals and streets represents a badly disfigured child burn victim and a series of drawings which illustrate the contents of the videotape. There are two booklets: one for children in the style of a drawing album, to be distributed in primary schools, and another for adults. The children's pamphlet contains a series of drawings representing the various situations in which a burn may occur. Some of the drawings are in colour, others in black and white for the children to colour. In this way the children's imagination is stimulated and, as they have to concentrate for a certain length of time on the pictures that they are colouring, the dramatic nature of the situations illustrated will be better impressed on their memory.

At school level the campaign also provides for direct conversations with the children and a series of meetings with parents and teachers, who must be instructed on how to continue the work initiated by the videotape.

The adults' booklet consists of a series of pictures, some representing the various situations that may occur in the home, while others, through the presentation of photographs of burned children, are intended to stress the gravity of the consequences that a moment's carelessness may cause in children. The booklet contains a list of useful tips on how to prevent burn accidents and on what to do immediately in the event of an accident.

The whole campaign is aimed at protecting society from burns and fire disasters.

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Communications in the prevention of natural and man-made disasters: the role of the national and international Red Cross and Red Crescent organizations

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Communication, whether in the sense of the relationship between individuals, groups or communities or of the distribution of information and knowledge, plays a particularly important role in the transmission of the message of the International Red Cross and Red Crescent movement*, which is to protect human life and dignity, and in the humanitarian mission that it performs in both peacetime and wartime through its various components.

The movement's humanitarian activities spread over a very wide range, particularly in the sociomedical field. Without having specific competence in problems related to fires and burns, the Red Cross has acquired long experience of human suffering in all its forms and of ways of relieving it.

We will attempt in this paper to describe the Red Cross's activity in the field of prevention and training, two key words which depend on dialogue and information.

COMMUNICATION AND ACTIVITIES OF THE RED CROSS IN PEACETIME

Sociomedical activities

The activities of the Red Cross in the sociomedical field are inspired by the

*The International Red Cross and Red Crescent movement is composed of the International Red Cross Committee, the recognized National Red Cross and Red Crescent Societies and their Federation and the League of Red Cross and Red Crescent Societies. It is also called the International Red Cross.

concept of the participation of the citizen in the development of the community; they are based on the principle of voluntary service.

Participation and voluntary service

It is now well established that the development of the community (community services) implies that preventive measures in the medical and social fields must be based on the properly motivated wide-scale participation not only of the permanent technical personnel but also of the general population. This motivation cannot be ordered by the authorities, it must be encouraged by organizations which believe in what they are doing and whose members must necessarily be volunteers.*

But the problems of modern society can no longer be satisfied through a voluntary body that would distinguish the active volunteers in passive communities. Modern voluntary service implies a wider opening throughout the community, a commitment of individuals who are aware of their responsibilities towards society and eager to participate with the other members of the community in the solution of these problems. This profoundly modifies the relationship between the volunteer and the members of the community: to help others to help themselves becomes the motor force of the action of volunteers who no longer act *for* people but work *with* people in order to release new energies and to operate together innovatively.†

This is notoriously the case in the developing countries and in underdeveloped areas in developed countries, whether it is a question of neglected rural populations or 'marginalized' groups. All action aimed at improving sanitary and social conditions must be directed from the outside, i.e. by persons belonging to these underprivileged communities, experienced in the techniques that can be popularized, and capable of gaining the confidence of sometimes distrustful populations and of arousing in them the capacity to solve their own problems and improve their living conditions.‡

The committed volunteer, a motor force integrated into the community, has the task of diagnosing needs together with the members of the community and of preparing a programme of activity with them to respond to these needs.

Since the early 1970s the Red Cross has adopted this approach of dialogue through interpersonal communication and this concept of self-help. The programmes of activity in the field of primary health care, first aid and accident prevention have been prepared with the intention of encouraging members of the community to help themselves and of motivating people to take their own initiatives to solve their problems.

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*On the question of voluntary service in general, see Jacques Meurant, *Le service volontaire de la Croix-Rouge dans la société d'aujourd'hui*, (Geneva: Institut Henry-Dunant, 1984).

†This is the opinion of the Chilean sociologist Mario Espinoza Vergara, author of *Teorìa y pràctica del servicio voluntario* (San José, Costa Rica: Asociaciòn demogràfica costarricense, Ministerio de Cultura, Juventud y Deporte, 1977, pp. 15 et seq.).

‡Dr Pierre Dorolle, *Sociétés nationales de là Croix-Rouge: Santé et bien-être social*, Comité conjoint pour la réévaluation du rôle de la Croix-Rouge, document de référence No. 4, 1975, pp. 40–41.

Primary health care

Since the early 1980s the programmes of primary health care have become a constant factor in the sociomedical activity of numerous national Red Cross and Red Crescent societies, particularly in the Third World. These programmes, which mainly concern preventive aspects of health, take into account the following considerations, *inter alia*: education about local health problems and methods of preventing and fighting them; improvement of nutritional conditions and dietary habits; adequate clean water supplies and basic water-purifying measures; maternal and infantile care; vaccination against the main infectious diseases; prevention and control of local endemic diseases; appropriate treatment of common diseases and lesions; supply of essential medicine; and the prevention of accidents in the home.

To cite an example, the Senegalese Red Cross in the early 1980s launched a programme of primary health care in rural zones in the form of 'Health Huts' in rural communities, having already created throughout the territory a number of sociomedical centres at regional level. These health centres are managed by volunteers under professional medical and social supervision.

First aid and accident prevention

The traditional fields of first aid and accident prevention are still the bastion of voluntary activity, in Societies in both developed and developing countries, in peacetime and during armed conflicts.

Several national Societies have developed more specialized relief activities, such as sea rescue, mountain rescue, first-aid posts at public meetings or demonstrations, auxiliary civil defence and fire brigade services, and first aid in industry and rural areas.

Rescue in natural disasters

National level: role of the Red Cross and the Red Crescent

Rescue action in disasters, the primary activity of the movement, is governed by a body of principles and rules adopted by its supreme authority, the International Red Cross and Red Crescent Conference (IRCC).

If the responsibility for the prevention of disasters, relief to victims and reconstruction belongs in the first instance to the public authorities, the aid of the national Societies which have the status of auxiliary to the public authorities is complementary and expresses itself first of all in the emergency phase.

To tackle any disaster, whether natural or technological, every country must in principle prepare a national plan that provides for an efficient relief organization and assigns to the various elements of its population — public services, Red Cross, volunteer agencies, social organizations and qualified persons — precise tasks in the field of disaster prevention, relief and reconstruction.

As a general rule, the Red Cross programme is limited to the following elements: first aid (the first saving gesture), medical and nursing care, food supplies, clothing, shelter, prevention of epidemics (including health education), social assistance, search and rescue services, and other forms of primary assistance.

Each national Society must be prepared to assume the responsibilities that are incumbent upon it in the event of a disaster. It must establish its plan of action, adapt its organization accordingly, recruit, train and lead the necessary personnel and guarantee, in cash or in kind, the reserves it may need in the emergency phase of a rescue operation.

It is not our purpose here to deal exhaustively with the different measures that such a plan must contain in its various phases before, during and after a disaster.*

What is more important for us here is to underline, in the framework of these plans, the specific contribution of national and international Red Cross organizations on the level of information for the purposes of prevention.

In the creation of alerting systems national Society volunteers help to spread information, for example by establishing radiocommunications posts in regions exposed to disasters and by giving individual persons the necessary training to ensure that it functions adequately.

Evacuation: the volunteers must set up shelters and places of refuge in the immediate vicinity of the threatened area, provide information as to the location of the shelters, create first-aid teams in relation to the number of persons evacuated, and organize the transport to places of safety of persons unable to look after themselves.

Shelters: the volunteers help to locate buildings to be used as shelters and canteens (schools, warehouses, etc.) away from the threatened area, and provide tents for camps. They keep the disaster victims informed about the general situation in the disaster area, telling them, for example, about what services are still functioning in the community, curfew hours, authorizations to families to return to the disaster area, the date and place of food and clothes distribution, the opening hours of medical posts, and so on.

Hospitals: the volunteers have the task of obtaining information from hospitals and medical posts about hospitalized persons.

Blood donation: one of the major activities of the national Societies is to prepare and promote campaigns for voluntary blood donation and for the recruitment of donors.

Information to the public: the national Societies have a general role to play in the education of the public. This consists in training the population to avoid all panic and to act in a disciplined manner, and in publicizing methods of self-protection that are within everybody's capabilities, including first aid. To achieve this aim, the national Societies organize courses and conferences and make use of the press, radio and television.

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*On this point, see *Manuel des secours de la Croix-Rouge et du Croissant-Rouge en cas de désastre* (Geneva: Ligue des Sociétés de la Croix-Rouge et du Croissant-Rouge, 1984).

International level: the role of the League of Red Cross and Red Crescent Societies

The League — the federation of the national Societies — acts as an information centre regarding disaster situations and coördinates at international level the assistance provided by the national Societies and by itself, as well as assistance through their intermediation.

To enable the League to act as an information centre in the event of a disaster, the national Societies inform it immediately of any large-scale disaster occurring on their territory, particularly with data about the extent of the damage and the relief measures taken on a national scale in order to assist the casualties.

Every request for international assistance coming from the national Society of a disaster-stricken country must be addressed to the League, which immediately addresses an appeal containing all necessary information about the disaster to the whole body of national Societies or to a number of them, depending on circumstances.

The national Society of the stricken country keeps the League informed of the evolution of the situation, the relief given and the needs still remaining to be satisfied. This information is relayed to the national Societies to which the appeal has been addressed.

It is hardly necessary to speak of the fundamental role of information by the media in heightening public awareness and obtaining from the general population the necessary funds and assistance.

As examples of fire disasters, we mention the forest fire in the state of Parana in Brazil in 1963, which affected 100 000 persons; the fire in the Yacoub-El-Mansour quarter in Rabat in April 1969; the fire that ravaged the Douar Goura quarter in the same town in July 1971, leaving 15 000 persons homeless; and the Los Alfaques disaster in Spain in July 1978.

COMMUNICATION AND ASSISTANCE IN ARMED CONFLICTS

Prevention and diffusion of humanitarian rules

The states that were parties to the Geneva conventions of 1949 undertook to diffuse humanitarian international law in their respective countries, both in peace and wartime. In their desire to help to ensure better respect for the rules of humanitarian law and for the principles of the Red Cross, the Red Cross institutions contribute to their diffusion in the various populations concerned, the chiefs of the armed forces, government authorities, academic and medical circles, young people and the general public.

The common goal of the IRCC, the League of national Societies, is to circulate and apply throughout the world basic humanitarian rules, to create what might be termed 'the humanitarian reflex'.

Assistance to the victims of armed conflict

The concept of assistance has evolved and no longer corresponds solely to the organization of medical care to the war-wounded. It now corresponds to a much wider field ranging from the protection of casualties to the provision of basic needs like food and water. For this reason medical assistance must be part of an assistance programme that goes far beyond the strictly medical sphere.

The notion of 'victims' in the IRCC meaning of the term has expanded. It no longer refers only to the war-wounded but also to the civilian victims of a conflict. As a result there is an important diversification of the victims' needs.

The inherent philosophy of the IRCC's medical activities is conditioned by several factors which in some way recall the principles of volunteer action:

- The classic medical approach is replaced by a broader approach that considers the general health of individuals. The physician's role is not limited only to care but must also extend to all health-protecting activities.
- This consideration of general health necessitates a community-based approach rather than one based on the individual person. This strategy, while certainly having an impact on the health conditions of the victims in general, does not exclude — far from it — humanitarian gestures towards individual victims.
- 'Get others to act rather than act yourself' — this might be the motto of IRCC physicians. They must continually persuade the local authorities to take charge of the victims' problems, their role being to assess whether the necessary means exist, to listen to the victims' requests, and to act as the intermediaries between victims and local authorities. Only when local human resources are incapable of performing their duties does the IRCC physician personally go into action.

The medical activity of the IRCC is aimed at four categories of casualties: the war-wounded, prisoners, civilian populations and the war-disabled.

The war-wounded

The main problem regarding war-wounded is that they rarely benefit from adequate first aid and their hospital stay is protracted and dangerous. The wounded, especially in guerilla warfare conditions, may be several days' march away from care centres, which they are often prevented from reaching for security reasons. The IRCC in these cases endeavours to improve the training of combatants and civilians in the field of first aid and transport of the wounded. At the same time it seeks to spread among the combatants the basic Red Cross ideas by inculcating into them the notion of respect for the wounded enemy.

The IRCC is often called upon to reinforce the operational capacity of existing surgery centres and after due assessment is able to provide them with surgical and medical material.

When the crisis is acute and local personnel are unable to cope with the situation, the IRCC can send emergency support teams.

It sometimes happens that the only possibility for the proper care of the wounded in safe conditions is to admit them to a hospital on the frontier of a warring country. Approximately 10 000 war-wounded per year are treated in this way, under the responsibility of the IRCC, by teams that are often composed of volunteers from national Red Cross or Red Crescent national Societies.

If local teams are insufficient or if the presence of a neutral and independent organization is necessary, it is the IRCC's responsibility to organize facilities for evacuation and care that can meet the needs.

Surgery in wartime can be performed with basic materials but it requires a relatively stable condition as regards safety and water and energy supplies. Quality of care cannot, however, be ensured without a highly qualified surgical team trained in the specific problems of wartime surgery, which differ considerably from peacetime surgical problems. For example, wounds caused by high-speed projectiles and serious burns must be treated according to particular techniques if the casualties are to receive the care they deserve.

The problem of triage of the injured when they arrive in great numbers is also a very important and specific subject for which every surgeon must be carefully prepared.

As surgeons with a varied training and experience of wartime surgery are rare nowadays, as a result of the high degree of specialization in this discipline, the IRCC has to give experienced surgeons complementary theoretical training in order to prepare them for the new problems they will encounter. Relevant didactic material is constantly updated by the IRCC Medical Division and exchanges take place with surgeons who are experienced in this field.

The IRCC has nine surgical hospitals around the world which care for thousands of injured patients; it has thus acquired a unique experience in this field that is worth exploiting and diffusing. As Dr Appia, co-founder of the Red Cross, said in 1863, 'Soldiers may have to keep the secret of how to wage war, but physicians have to tell everybody how to cure its effects.'

In April 1990 the IRCC organized a war surgery seminar with the following aims:

- To stimulate the recruitment of surgeons in the light of the growing needs of care to the war-wounded.
- To train surgeons for medical missions on the battlefield, with particular reference to war surgery.
- To establish a rigorous system of injury classification in relation to projectiles, their consequences for the human organism and their surgical implications.

Civilian populations

Food supplies for civilian populations are seriously disrupted during situations of armed conflict. Insecurity due to battles between the armed contenders and to the random distribution of antipersonnel mines may considerably reduce access to cultivated land, which inevitably limits agricultural production. In certain situations, populations have been known to starve even if the region they inhabited was traditionally fertile.

Means of communication are often paralysed, which exacerbates the economic asphyxia, hinders access to health services and prevents normal restocking of medicine and material.

The health activities that the IRCC undertakes for civilian populations are manifold:

- Primary health care: vaccination campaigns, health education, essential medical supplies, training of community health workers, drinking-water supplies, construction of latrines, the fight against transmissible diseases.
- Medical care: medical consultation, supply of medicine to hospitals and medical posts, care of hospital patients, care of war-wounded in surgical hospitals.
- Rehabilitation of persons disabled by war action.

Prisoners of war and political detainees

In its visits to prisoners of war and detainees, the IRCC is exclusively concerned with the material, psychological and moral conditions of the detention. The reasons for the imprisonment are not questioned.

It is necessary to be able to speak to the detainees without the presence of witnesses in order to receive any allegations of ill treatment. IRCC delegates, and in particular physicians, must ascertain that detainees have access to health services and that the quality of the care provided corresponds to local standards. They must also judge whether the detainees' living conditions (food, water, hygiene, living space) are satisfactory. Suggestions for the improvement of the prisoners' conditions are transmitted to the authorities so that the necessary steps may be taken.

The role of the IRCC in fact extends beyond these basic principles. It happens in many countries that the authorities are not in a position to guarantee their prisoners a minimum of assistance, and the IRCC is therefore compelled to take on the detaining power's role and assist the prisoners directly, for example in the form of food and sanitary and medical material, on as temporary a basis as possible.

The war-disabled

The IRCC has for many years been concerned with the conditions of the war-disabled, undertaking actions aimed at ensuring that they have the benefit of long-term treatment.

The Medical Division, with the collaboration of qualified prosthetist technicians and physiotherapists, has been engaged for ten years in the search for lasting solutions in the field of 'rehabilitation' of amputees and paraplegics, according to principles of self-sufficiency and with the appropriate technology.

Since 1980 the IRCC has developed orthopaedic activities in 13 different countries and its 20 manufacturing and rehabilitation centres have enabled 20 000 war-disabled persons to walk again and regain their independence and dignity.

Numerous exchanges have taken place between the Medical Division and various governments and organizations with a view to promoting the diffusion of such projects in as many countries as possible.

Between 1979 and 1987, 14 289 prostheses were made for 12 387 patients in ten countries (Ethiopia, Nicaragua, Angola, Mozambique, Chad, Pakistan, Lebanon, Syria, Sudan, Zimbabwe). In 1989, 7975 prostheses were made and 4702 new patients were fitted out. But this important effort by the IRCC covers only a meagre part of overall needs, which are difficult to estimate precisely because of difficulties of access to victims in isolated regions that are cut off by armed conflicts. The IRCC apparatus centres also produced locally in 1989 14 490 pairs of crutches, 613 wheelchairs and 2432 ortheses.

This work is supervized by 31 expatriate prosthesists and 9 physiotherapists, and carried out by 234 local prosthesists, physiotherapists and trainees trained by IRCC experts. There are also 252 local semiskilled workmen employed in these centres.

COMMUNICATION AND TRAINING

Communication in the form of dialogue between voluntary services and the community, between the physician and the patient, together with information to the public in the form of prevention campaigns and programmes for the diffusion of humanitarian rules are essential factors in humanitarian action. It implies a will for commitment, a strong motivation and a capacity of adaptation, and it requires adequate and rigorous training of individuals within humanitarian institutions.

This has been the preoccupation of the Red Cross as it faces new needs requiring additional services, which themselves require ever more demanding qualifications. Hence the importance accorded to training programmes.

This training has taken various forms, from simple guidance about the goals and activities of the Red Cross to the more sophisticated training in techniques of rehabilitation and prosthetics in the disabled, as well as the more classic training of first-aid workers, stretcher-bearers, ambulancemen and medicosocial workers. An example is a typical training programme for a group of volunteers in charge of assistance in the field of first aid and relief in disasters:

- First-aid course: 32 forty-minute lessons. Examination and certificate necessary.
- Basic training course: 38 lessons. Instruction in hospital patient care, hygiene, pathology, techniques of disaster relief, transport of the injured, organization and activity of the Society.
- Training course in a handicapped persons' care centre or holiday house. Examination.
- Optional: course on disaster relief (28 lessons), care of patients and handicapped persons (50 lessons), ambulance service (120 lessons), resuscitation (6 lessons).

These course are given at local centres by first-aid instructors, physicians, nurses and trainers.

This training takes on particular importance in the event of disasters and conditions of armed conflict. It involves medical and paramedical personnel in the medical, sanitary and social fields — e.g. the techniques of rescue and evacuation of victims of air-raids, cluster bombs, toxic gases and radiation; techniques of prosthetics and rehabilitation of the disabled; the sanitary problems of displaced populations and detention and internment centres; and surgery in wartime.

However, this training — whatever the level of development or technical know-how that may be achieved — must above all enable persons and institutions voluntarily involved in preventive action to teach the population to become self-sufficient. We must assess the relevance of this axiom by examining in conclusion the role of the humanitarian institutions in the face of the 'nuclear syndrome'.

CONCLUSION — COMMUNICATION AND THE 'NUCLEAR SYNDROME'

If we exclude full-scale nuclear wars, research has shown that there are ways of combating nuclear accidents and that it is within our power to reduce their effects. Without going into great detail, it may be said that in the event of a nuclear accident the fundamental needs remain much the same as in any other disaster as regards medical care, basic food supplies, shelter and clothing. Similar problems arise regarding the search for the missing, the reuniting of families and information to the community. These needs have to be tackled by the government, which must become operational as soon as possible. Hence the importance of the national relief plan accompanied by a series of preventive measures applied during and after the disaster and as a consequence of measures taken by organs such as civil defence, a key element of a consistent strategy whose action manifests a humanitarian will and a social obligation to save populations in eventualities that we are powerless to prevent.

In the event of an explosion with radiation, priority must be given to the evacuation of the population to safe areas. Civil defence volunteers help to administer emergency relief, perform triage of the casualties according to the gravity of their condition, and assist in the evacuation of the casualties with the creation of networks of first-aid stations stretching as far as distant hospitals. The training of volunteers at this level must be more demanding, as they have to be able to manage cases of serious lesions, burns, traumas, radiation sickness and so on.

In the case of explosion in a limited nuclear war, priority must be given to shelters. This is one of the basic tasks of the Swiss Civil Defence, one of whose aims is to provide nuclear shelters for all its citizens (85% built in 1985). According to this plan, volunteers supplying shelters with food and medical equipment, manage the population's psychological problems, and are posted to early-warning-system stations, which requires trained personnel and if possible scientific advisers capable, for example, of advising the population when they can leave their shelters.

The role that the national Red Cross and Red Crescent societies will be called upon to play in the context of serious technical or nuclear disasters was underlined at the First International Red Cross Conference (Geneva, 1986). The Harrisburgh disaster in 1979 and the Chernobyl disaster in 1986 in fact made the movement more aware of the new tasks that must be entrusted to the Red Cross in such circumstances. This led to the adoption of two resolutions.

The first of these, on relief in the event of technical or other disasters, recommends *inter alia* the realization of 'a study of the possibilities and needs of better assistance by the movement in the event of technical or other disasters'. The second resolution, on Red Cross and Red Crescent voluntary service in the contemporary world, recommends *inter alia* that the national Societies should, in collaboration with the appropriate authorities or organizations in their respective countries, define precisely the type of cooperation that volunteer health personnel could offer to the armed forces health services, the civil defence services, and other health institutions in the event of armed conflict.

The problem is difficult to solve since we must not lose sight of the fact that as the action of the national Societies depends essentially on volunteers it is difficult to identify precisely the concrete roles that can be assigned to them until there is sufficient perception of the effects of nuclear disasters or conflicts on the population.

The national Societies will be able to feel concern for these problems only if they can be informed as to the type of needs that might arise following an act of nuclear terrorism, a disaster or nuclear warfare. They need to know to what extent and in what way they will have to face the increased demand for blood in the hospitals, how they should proceed in the triage of the injured, by what signs they are supposed to recognize patients with a chance of survival, and how to combat the simultaneous shortage of physicians and medical staff and their overload of work.

All these challenges are thrown down to the volunteers, who may be stimulated by them to further motivations. It is certainly true that in the event of a nuclear accident it will be the volunteers who more than ever will be called upon to help others to help themselves and to teach people to be their own policeman, their own fireman and their own doctor.

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The action of the European Community for civil defence

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Cooperation among European countries in the field of civil defence is a comparatively recent development: it was only in 1985 that the first guidelines were traced out in an informal meeting of the European civil defence ministers; in 1987 and 1988 the first two European Council meetings were held which gave the go-ahead for European cooperation in this field and indicated the first general developments in two political resolutions.

At that time it appeared that the best approach to the issue in a European context was to begin with an investigation of the actual situation in the 12 member states in terms of the legislation and organization of disaster preparedness and prevention and the management of emergency situations.

The interest of the Twelve was thus concentrated from the beginning on the exchange of information and on systems of communication — two basic concepts without which no cooperation would be possible. The exchange of information presupposes a system of national databank link-ups. Such a programme has already been initiated in order to inform the various member states of each other's human, scientific and technological resources.

At its next meeting the Council will have to authorize the Commission to progress from the study phase to the experimentation phase of the project in a pilot scheme. To facilitate this interchange the Commission is preparing a multilingual dictionary which should help to resolve language problems. This dictionary is being edited by leading experts in the field.

A study has been initiated in order to define the requirements and actual equipment in the telecommunications field, bearing in mind the possibility of using satellites, which could improve the prediction and therefore the prevention of disasters, and facilitate the management of emergency situations. The Council will have to authorize the continuation of this study in order to implement it in due course.

In addition to these two major initiatives, a meeting will have to decide on a standard telephone number to be used throughout Europe for emergency calls. The date for the inauguration of this telephone number will also have to be decided, which is expected to be before the end of 1992, or 1995/1996 at the latest in certain countries. This standard number will enable any citizen of the 12 member countries who happens to be in another Community country to make an emergency call. Other countries outside the Community have shown an interest in this initiative and would like to adopt it in their own national territories.

Parallel to these initiatives, a proposal was advanced during the Italian presidency of the Community for a multilateral agreement of the Twelve in the field of civil defence in order to offer the Community the organic and institutional structure that is felt to be needed. This consists of an agreement which absorbs the contents of existing bilateral agreements between certain Community countries and in some cases undersigned by non-Community countries.

The agreement lays down that the 12 member countries should establish cooperation both in the phase of preparedness and prevention of disasters — through the exchange of all available scientific and technological information as well as by training courses for specialized personnel — and in the emergency phase, through aid management. The agreement also defines the question of reciprocal responsibilities in the event of accidents occurring during rescue operations and other aspects facilitating the supply of aid. The agreement further provides for a mixed committee which would have the task of dealing with all aspects of civil defence that are intended to be developed in common, including those aspects that are currently treated in a non-institutional manner.

A second proposal advanced by the presidency concerns the possibility of instituting a 'European civilian service', as an alternative or complementary form of the military service that young people can be called upon to perform.

On a request from Italy, the Commission has prepared a feasibility study based on a comparative analysis of the various systems in force throughout the Community. It is necessary now to find a common agreement on this proposal and then to proceed together towards its operative realization.

I believe that this could be one of the responses to the increasingly insistent demands that public opinion makes on civil defence for an ecological objective. It would be an answer to give to young people and their need to work concretely and usefully for certain ideals. It would also be an answer to the problems of the reconversion of personnel posed by the situation of progressive East–West disarmament.

I cannot conclude without mentioning a particular kind of disaster that has become only too frequent — forest fires. This form of disaster is well known, especially in the Mediterranean countries of the Community, throughout the year and particularly in summer. It is the Commission's intention to examine every possible measure that can be identified through the collaboration of all the Member countries.

The Commission is profoundly convinced that the key-word for better qualified and more economic civil defence is 'coordination'. The coordination that we should like to see established in the Europe of the Twelve does not consist in substituting the Community for the member states or in letting it intervene in the preparation and management of individual emergency plans, but rather in amplifying to the greatest possible extent the benefits that can be obtained by national action, creating all the conditions that are indispensable for adequate support at Community level, at the same time guaranteeing the indispensable bases of efficient cooperation at the level of the Twelve.

In other words, European cooperation would avail itself of the subsidiary contribution of the Commission with the purpose of rationalizing the national systems and of improving their combined action. This is how the Commission intends to help 'Europe of the citizens' to progress and to make a quality jump in the field of the particular 'values' that civil defence policy intends to affirm in the service of European and international solidarity.

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Japan's international disaster relief

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OUTLINE OF JAPAN DISASTER RELIEF TEAM

The Japan Disaster Relief team (JDR) was established with the aim of providing international emergency relief operations in response to requests from disaster-affected countries and/or international organs when large-scale disasters strike, especially in developing areas.

As a country which often suffers from natural disasters, such as earthquakes and typhoons, Japan has accumulated much experience and technical know-how in coping with such disasters. The aim of establishing JDR is to expand and strengthen international cooperation by promptly despatching experienced disaster relief teams upon request of the government of disaster-affected countries and/or international organs after large-scale disasters occurring overseas.

Japan's overseas disaster relief activities in the past consisted mainly of providing financial aid and despatch of medical teams. As the law concerning despatch of JDR teams was legislated in 1987, a more comprehensive cooperation system was formulated, including despatch of rescue personnel and experts in various fields such as rehabilitation, prevention of the second disaster, etc. Figure 1 shows Japan's overall disaster relief system, which includes JDR.

JDR consists of a rescue team, a medical team and an expert team. These specialized teams are despatched through the Japan International Cooperation Agency (JICA) in appropriate combinations in accordance with the requests of disaster-affected countries and/or type of disasters. (The medical team was organized in March 1982, a few years prior to the establishment of JDR, under the name of the Japan Medical Team for Disaster Relief (JMTDR). It has been effectively engaged in medical activities on various occasions. JMTDR was incorporated into JDR when the latter was organized.

JDR's effectiveness lies in prompt arrival at the disaster-affected area after receipt of request for relief. To ensure this, an emergency coordination system

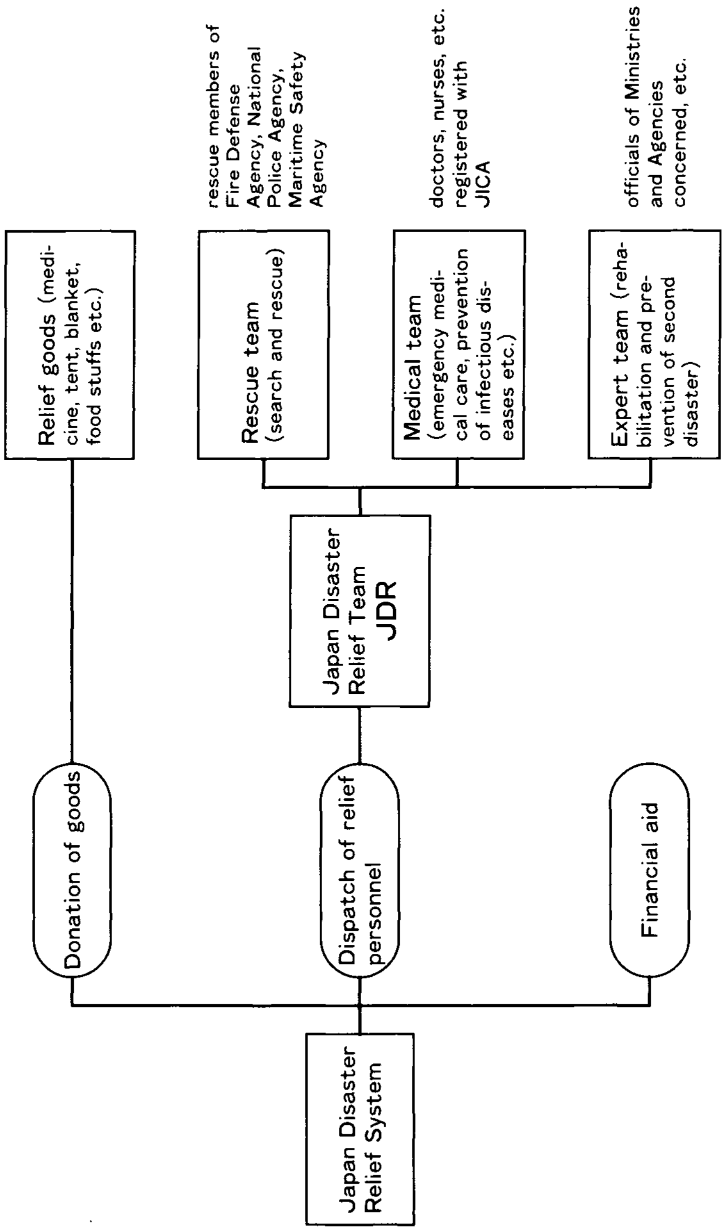

Figure 1. Outline of Japan Disaster Relief system

has been established between the Ministry of Foreign Affairs, JICA and other agencies concerned (Figure 2).

ACTIVITIES OF JAPAN DISASTER RELIEF TEAM

Search and rescue activities. Rescue operations are carried out by JDR's rescue team. Since prompt response is essential in search and rescue activities, special arrangements have been made so that the rescue team can be despatched without delay.

The rescue team is equipped with such tools as fibrescopes, acoustic ground detectors, night goggles, thermal imaging cameras and rock drills which will help them to find, rescue, treat and transport to safety the victims of earthquakes and other disasters.

Emergency medical care activities. Emergency medical care is carried out by JDR's medical team. This team provides treatment for the victims requiring clinical assistance, and also implements measures to prevent the occurrence and spread of infectious diseases by sterilizing drinking water and dwellings.

A total of about 320 doctors, nurses and medical engineers who ordinarily work at government, municipal and private organizations are registered with JICA on a voluntary basis. JDR's medical team is organized by these people.

Restoration and rehabilitation activities. Emergency restoration and rehabilitation are carried out by JDR's expert team. Emergency measures are designed to prevent the escalation of initial disasters and continuing occurrence of disasters. The aim is to restore disaster-affected facilities and people to normal conditions.

The expert team is composed of officials of ministries and agencies concerned, depending on the nature of the disaster.

EQUIPMENT PROCUREMENT AND STOCKPILING

As part of disaster relief activities, storehouses have been established both in Japan and abroad with the aim of facilitating prompt relief. These storehouses stockpile relief goods (e.g. blankets, tents, water purifiers, generators, communication devices, medicines, medical instruments) which are required for relief activities. The materials are ready to be supplied to the disaster-affected countries at a moment's notice.

The domestic storehouse is located near Tokyo International Airport (Narita). Overseas storehouses are located in Singapore, Mexico (Mexico City), Italy (Pisa), and the United States (Washington, DC).

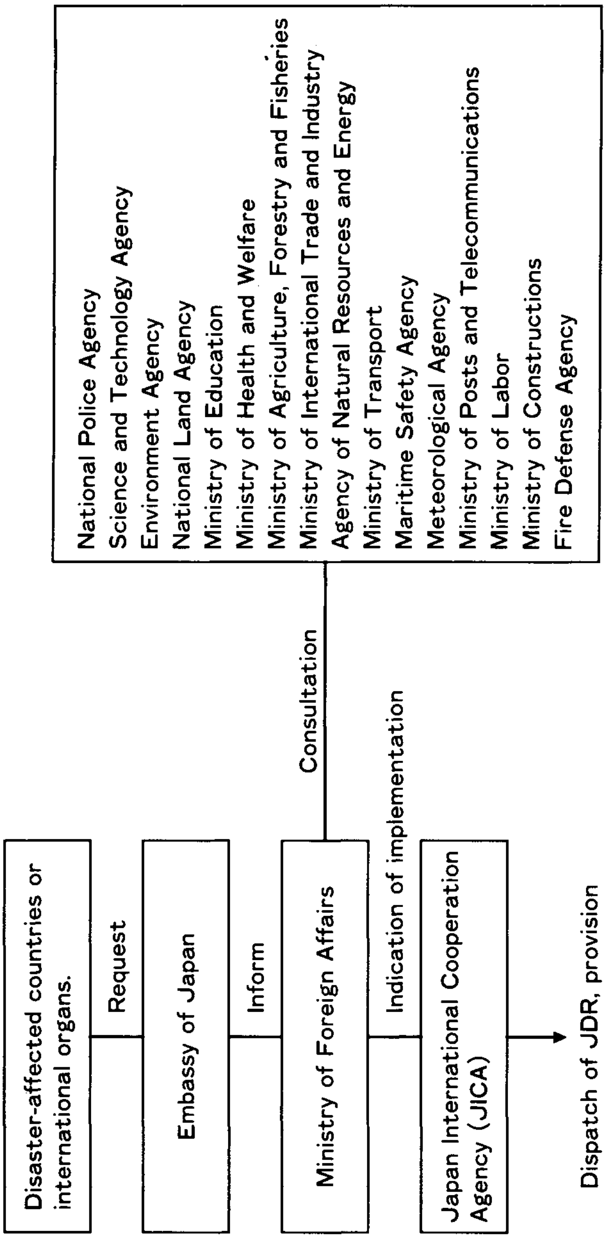

Figure 2. Despatch procedure

TRAINING PROCEDURES

Owing to differences in manners and customs, languages, ways of thinking, etc., there are various restrictions in extending overseas relief activities. JICA provides various training courses to help JDR members acquire the basic knowledge required for carrying out relief activities smoothly.

Training includes case studies of specific types of disasters, exercises in first aid and transport of the injured, operation of such special devices as fibrescopes, acoustic ground detectors, etc., disassembling and assembling of helicopters, loading and unloading of cargo, and foreign language training. A disaster dictionary is in preparation.

Japan is at the embryonic stage of international assistance for disaster relief. We hope that we will soon be able to contribute more to international assistance around the world.

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The role of the Italian Red Cross in emergencies

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The role of the national Red Cross societies in everyday life, a role that proves indispensable in the event of disasters, is known to all. The importance of the Italian Red Cross (IRC) is an example.

The IRC, founded some 130 years ago, continues to provide relief and assistance on the international level as well. Constituted as a non-profit-making agency in 1886, the IRC was in fact created in 1864, after the international conference in Geneva. Among the originators of this organization which assisted the war-wounded (thus establishing the principle of the neutrality of the wounded soldier) was an Italian, Ferdinando Palasciano. A Swiss, Henry Dunant, committed himself to the creation of the International Red Cross after being an eye-witness to the bloodshed at the battle of Solferino in the Second War of Independence.

The tasks of the IRC include emergency medical care to victims of accidents, and disaster relief. In the event of a disaster the IRC can intervene, without any prior agreement with the civil defence organization, and on its own initiative send personnel and equipment to the scene of the disaster.

With its operational centres, the IRC is part of the Emergency Operational Committee (EMERCOM), which was set up in 1984. EMERCOM, through the International Red Cross, manages all aid arriving from abroad in collaboration with the Ministry of Civil Defence.

When necessary, the IRC provides personnel and emergency relief equipment, including field hospitals, mobile medical teams, trains and ships from the auxiliary structure of the state railways and of the IRC Military Body.

In fire disasters the speed and efficiency of relief work are fundamental elements: the burn lesion is without doubt one of the most serious that the organism can suffer. The treatment of burned patients is a primary problem for the IRC organization, which has to provide relief both 'on the spot' and 'en route'. There are crucial moments when the proper training of the medical personnel is of extreme importance.

Palermo and Sicily are particularly favoured by the efficiency of the Hospital

Division directed by Professor Masellis and by the activity of the Regional IRC which, also by virtue of Regional Law No. 8/86, has initiated a programme to amplify structures and equipment. This includes an information network capable of communicating in real time the availability of hospital beds in Sicily. One of the first objectives in this field that have been set by the regional administration is in fact real-time knowledge of bed availability in all the hospitals in the Sicilian Region.

For these purposes the regional government, by Decree No. 159/86, granted the IRC the necessary resources (26 bn lire) for the planning and creation of sufficient pools of motor vehicles and ambulances for the transport of the injured. The objectives of this Decree have nearly all been achieved or are well on the way to realization, as for example the information network operational centre, which is equipped with radio links for communication between the operational centre and all mobile means (ambulances, heliambulances) located throughout the region.

The Centre and the information network will be able to manage and process not only data necessary for proper organization in emergency conditions but also the vast amount of data regarding the entire Sicilian sanitary effort. If properly used it will thus represent the basis of the entire health information system.

Generally, it is still necessary in all parts of Italy to organize a programme of 'professional emergency training' directed not only at IRC and civil defence sanitary personnel, both medical and other, but also at non-sanitary personnel (firemen, local police forces, highway patrol, carabinieri, etc.) The future plans of the IRC also include the creation of special schools for paramedical personnel, following the example of experiences in other countries which have had good results.

The need to improve emergency preparedness throughout the country has increased in recent years, partly as a consequence of the dramatic experience of earthquakes. The problem has been set in concrete terms in Sicily: the regional government has prepared a bill for the institution of an emergency department capable of providing all medical and surgical care necessary in emergency conditions. The Sicilian IRC has been given a primary role in this undertaking.

This objective is fully in line with the themes of disaster medicine; in the event of emergency situations and severe trauma, particularly burn lesions, an immediate and efficient response is imperative. If we all pull together, many lives can be saved every day.

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