

MITIGATION OF DISASTERS IN HEALTH FACILITIES



ADMINISTRATIVE ISSUES

VOLUME 2

Pan American Health Organization
Regional Office of the
World Health Organization

MITIGATION OF DISASTERS IN HEALTH FACILITIES

**EVALUATION AND REDUCTION OF PHYSICAL
AND FUNCTIONAL VULNERABILITY**

VOLUME II: ADMINISTRATIVE ISSUES



PAN AMERICAN HEALTH ORGANIZATION
Regional Office of the
WORLD HEALTH ORGANIZATION



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PREFACE

The series of documents entitled *Mitigation of Disasters in Health Facilities: Evaluation and Reduction of Physical and Functional Vulnerability* has been prepared by the Pan American Health Organization for national, provincial, or municipal authorities (Volume I: General Issues); owners of buildings, administrators, staff members, and other personnel connected with health installations (Volume II: Administrative Issues); designers, architects, builders, and educators (Volume III: Architectural Issues); and for design engineers, planners, builders, and educators (Volume IV: Engineering Issues).

The purpose of this series is to inform the people involved in the planning, operation, management, and design of health services concerning possible effects of natural disasters on health installations. The idea is to provide a useful tool that makes it possible to incorporate risk mitigation procedures both in the inspection of existing installations and in the design and construction of new buildings and services.

Each volume in the series deals with specific subjects related to the potential problems that can arise when a disaster occurs and, also, discusses the measures that should be taken to mitigate risk, placing special emphasis on the necessary requirements to ensure that installations can continue functioning during and immediately after a sudden impact disaster.

Although health installations can be affected by a broad spectrum of natural phenomena such as earthquakes, hurricanes, landslides, volcanic eruptions, floods, etc., as well as by man-made disasters, such as fires, explosions, gas leaks, and others, the series emphasizes the seismic problem, given that it is the natural phenomenon that has most affected health installations in the world and since, if its direct and indirect effects can be reduced, the risk posed by other phenomena, whose impact is normally less than that which earthquakes can cause, will also be lowered.

The manuals for architects and engineers address professionals familiar with architectural design and with structural analysis and design, respectively. Their approach is to raise concern about traditional techniques and to contribute proposals that are not usually to be found in the standard, specialized reference books.

The Pan American Health Organization/World Health Organization has chosen to promote the preparation and publication of this series, as a contribution to the goals of the International Decade for Natural Disaster Reduction (IDNDR).

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On the cover: The earthquake that ravaged Mexico City on September 19, 1985, was the strongest one recorded in Latin America in the last hundred years. It killed or injured thousands of people and caused severe structural damage. The institutions of the health sector were also very badly hit, including the General Hospital of the National Medical Center of the Mexican Social Security Institute, shown in the photo.

Photography: Julio Vizcarra/PAHO.

INTRODUCTION

The planning, design, and construction of hospitals in areas prone to natural disasters poses numerous challenges for the different professionals involved. Such buildings are important to life under normal circumstances and even more so in the event of having to look after the victims of a disaster. Given this importance of hospitals for the recovery of a community hit by a disaster, for example a strong earthquake, great care has to be taken with the way they are designed. Numerous aspects have to be considered, from the way they are planned to deal with disasters, up to the installation of equipment and various non-structural elements, in addition to the requirements of architectural design, and structural resistance and safety.

Numerous hospitals have in fact suffered serious damage or even functional or structural collapse as a consequence of disasters, particularly following strong earthquakes, depriving their respective communities of adequate care for the victims.

Hence the need to review existing standards for the design and construction of hospitals, orienting them towards the mitigation of disasters, and suggesting a series of possibilities that encourage changes in hospital infrastructure, from conception up to the actual construction and operation of the building.

This document aims to present a series of reflections on the criteria governing design and construction of health infrastructure and puts forward recommendations about ways to mitigate risk to the population and to the investment made in construction of health infrastructure.

The hospital system constitutes one of the fundamental components of the health sector. Although the primary health care level has received special attention in recent years, this document refers essentially to infrastructure of the second and third level.

Chapter 1 of this manual examines briefly the concepts relating to the characteristics of disasters and in particular seismic hazards and risks. Chapter 2 discusses cases of hospitals in the Americas hit by disasters. It describes some cases that have occurred, the type of damage done, and in general the losses that have been caused by earthquakes in hospitals in recent years. Chapter 3 deals with the importance and function of hospitals in situations of disaster, the social and economic costs of a loss of this vital service, and the responsibility of health administrators in this regard.

Chapter 4 looks at the various aspects of mitigation of risks in hospitals. It deals with functional vulnerability that can lead to the collapse of hospital services after a disaster, and the potential harm to installations, equipment and non-structural elements. It also discusses structural vulnerability, which can cost the lives of the occupants of the installation and lead to the total loss

of everything inside the building. Chapter 4 also points out the importance of reducing existing vulnerability and indicates how to do so depending on whether the vulnerability is functional, non-structural, or structural. It comments on the cost-benefit ratio of alterations to existing installations and indicates the importance of taking such recommendations into account in the design of new hospital buildings.

Chapter 5 provides ample details of emergency preparedness, a hospital emergency plan, its various components, and aspects to consider depending on whether the emergency is external or involves the hospital itself.

Finally, Chapter 6 deals with professional training in the health sciences. It makes suggestions regarding adaptation of the curriculum and the programming of on-the-job courses incorporating these unconventional aspects in the training of designers, architects, and builders.

This document is the result of adapting and generalizing from the subjects dealt with in the volumes of this series prepared for architects and engineers. It aims to be sufficiently simple and complete so that any health professional will be able to grasp the problems of hospital vulnerability to natural hazards and the way in which it can be reduced. Given that this document is not intended to be a manual for the evaluation and mitigation of risks, the reader who would like more information on the subjects dealt with is recommended to refer to the other documents in this series prepared for each of the professional disciplines involved.

CHAPTER 1

CHARACTERISTICS OF DISASTERS

TYPES OF DISASTERS

A disaster can be defined as an event that occurs in most cases suddenly and unexpectedly, causing severe disturbances to people or objects affected by it, and resulting in loss of life and harm to the health of the population, the destruction or loss of community property, and/or severe damage to the environment. Such a situation causes a disruption in the normal pattern of life, generating misfortune, helplessness, and suffering, effects on the socioeconomic structure of a region or a country, and/or the modification of the environment, to such an extent that there is a need for assistance and for immediate outside intervention.

Disasters can be caused by a natural phenomenon, by man, or can be the result of a technical failure of industrial or military systems.

Some disasters of natural cause represent threats that cannot be neutralized since their origins can hardly be forestalled, although in some cases they can be partially controlled. Earthquakes, volcanic eruptions, tidal waves (tsunamis), and hurricanes are examples of hazards that still cannot be prevented in practice, while floods, drought, and landslides can sometimes be controlled or mitigated by applying drainage systems and stabilization of soils.

Here is an extensive list of natural phenomena that can cause disasters or calamities:

- Earthquakes
- Tsunamis (tidal waves)
- Volcanic eruptions
- Hurricanes (storms, gales)
- Floods (slow, rapid)
- Massive land movements (landslides, collapses, mudflows)
- Droughts (desertification)
- Epidemics (biological)
- Pests

These are what might be called basic phenomena, since occasionally they generate other effects, as is the case with avalanches or mudslides, and the ash rains or lava flows that are directly associated with volcanic eruptions, or other kinds of phenomena that may be considered equivalents, such as tornados, tropical cyclones, or hurricanes. Most of these phenomena are cataclysmic, that is, they occur suddenly and affect a not very large area. However, there are cases such as desertification and drought which occur over a long period and affect extensive areas in an almost irreversible way.

Man-made disasters can either be deliberate or due to a technical failure, which can trigger a series of other breakdowns and cause a major disaster.

Other man-made disasters include:

- Wars (terrorism)
- Explosions
- Fires
- Accidents
- Deforestation
- Contamination
- Collapses (impacts)

In general there exists a broad range of possible disasters of technological origin. At present, urban centers and ports are highly vulnerable to this type of disaster due to the high density of industry, building, and mass cargo and passenger transport systems.

EFFECTS OF DISASTERS

The effects of a disaster vary depending on the characteristics of the exposed elements and on the nature of the event itself. In general, the

elements at risk are the population, the environment and physical structures in housing, industry, trade and public services.

The effects can be classified as direct and indirect losses. Direct losses are related to physical damage, expressed in the number of victims, in damage to the infrastructure of public services, damage to buildings, the urban area, industry, trade, and deterioration of the environment, that is, physical alteration of the habitat.

The indirect losses can usually be broken down into social effects such as the interruption of transportation, public services, and the media, and the unfavorable image that a region may acquire with respect to others; and economic effects such as disruption of trade and industry as a consequence of the decline in production, disincentives for investment, and the expense of rehabilitation and reconstruction.

In numerous developing countries, such as the countries of Latin America and the Caribbean, there have been disasters in which thousands of people have died and hundreds of millions of dollars have been lost in twenty or thirty seconds. Often the direct and indirect costs cannot be calculated, but amount to a huge percentage of a country's gross domestic product. Due to the recurrence of different types of disasters, in several countries of the Region average annual losses due to natural disasters amount to a significant percentage of the gross national product. Obviously, this translates into impoverishment of the population and stagnation, because it entails unforeseen expenditures that affect the balance of payments and in general the economic development of a country.

If existing levels of risk are to be reduced, preventive measures against the effects of disasters should be considered a fundamental part of comprehensive development at the regional and urban level. Given that disasters of the magnitude referred to above can have a serious impact on the development of affected communities, the cost of carrying out preventive measures ought to be measured against that of recovery from disasters, and risk analyses ought to be included in the assessment of the social and economic aspects of every region or country.

CONCEPTUAL FRAMEWORK

The impact of disasters on human activities has in recent years been dealt with in a wide range of publications produced by various disciplines that have each taken a different, although in most cases similar, conceptual approach. The Office of the United Nations Disaster Relief Coordinator (UNDRO)—currently the United Nations Department of

Humanitarian Affairs (UN/DHA)—jointly with the United Nations Educational, Scientific and Cultural Organization (UNESCO) sponsored a meeting of experts for the purpose of proposing standardized definitions that have been widely accepted in recent years. The report of that meeting, which was entitled "Natural Disasters and Vulnerability Analysis" included the following definitions, among others:

Hazard (H): the probability that a potentially disastrous event might occur during a certain period of time in a given site.

Vulnerability (V): the degree of loss of an element or group of elements at risk as a result of the probable occurrence of a disastrous event, expressed on a scale going from 0 or no damage, to 1, total loss.

Specific Risk (R_s): the degree of loss expected due to the occurrence of a specific event, as a function of the hazard and vulnerability.

Elements at Risk (E): the population, buildings and public works, economic activities, public services, utilities, and infrastructure exposed in a given area.

Total Risk (R): the number of people killed or injured, damage to property, and the impact on economic activity due to the occurrence of a disastrous event, in other words the product of the specific risk (R_s) and the elements at risk (E).

Hence risk can be calculated using the following general formula:

$$R_s = E \cdot R_s = E \cdot (H \cdot V)$$

Taking the elements at risk (E) implicit in vulnerability (V), without modifying our original approach, it could be said that:

Once the hazard (H_i), understood as the probability that an event will occur with an intensity greater or equal to (i) during exposure period (t) is known, and once vulnerability (V_e), understood as the intrinsic predisposition of an exposed element (e) to be affected by or to suffer a loss should a disaster occur with an intensity (i), is known, risk (R_{ie}) can be understood as the probability of a loss in element (e) as a consequence of the occurrence of a disaster with an intensity greater or equal to (i),

$$R_{ie} = (H_i, V_e)$$

that is, the probability of exceeding a certain level of social and economic consequences during a given period of time (t).

Thus, we can now distinguish more precisely between two concepts that have occasionally been mistakenly considered synonymous but which are definitely different from both a qualitative and a quantitative point of view:

- ▶ **The hazard**, or external risk factor of a subject or system, represented by a latent danger associated with a physical phenomenon of natural or technological origin that may occur in a specific place and at a given time producing adverse effects on people, property, and/or the environment, mathematically expressed as the probability of a disaster greater than a certain intensity occurring in a certain place and over a certain period of time.
- ▶ **The risk**, damage, destruction, or expected loss derived from a combination of the probability of dangerous events occurring and the vulnerability of the elements exposed to such threats, mathematically expressed as the probability of exceeding a certain level of economic and social consequences in a certain place and over a certain period of time.

In general terms, *vulnerability* can be understood, then, as the intrinsic predisposition of a subject or element to suffer damage due to possible external events. As a result, its evaluation is a key part of assessing the risk derived from interactions of a susceptible element with a hazardous environment.

The fundamental difference between hazard and risk is that hazard is related to the probability of a natural or an induced event occurring, while risk is related to the probability of certain consequences occurring that are closely related not only to the degree to which those elements are exposed but also to the vulnerability of those elements to the impact of such an event.

HAZARD AND SEISMIC RISK

Earthquakes consist of sudden releases of energy due to stresses that have accumulated for years in parts of the earth's crust. The main causes of stress in the crust are found in the forces pulling at its component parts (the tectonic plates), which are countered by opposing forces in adjacent plates. Not much is known about these forces, but it is thought that they are due to either the high temperatures inside the earth, or to the force of gravity. Earthquakes originated in this way are usually of intermediate depth or deep-seated.

The forces generated in the tectonic plates in turn produce cracks in the plates themselves, which are known as geological faults. Forces derived from tectonic activity can then arise within those faults and tend to move a sector of the fault, generating contrary forces in the opposite sector. This is the origin of the process of accumulation of displacement

energy. Earthquakes caused by active geological faults are generally shallow or of intermediate depth and are consequently very dangerous.

The usual ways to measure an earthquake are related to their strength, their location, and their surface manifestations in cities or sites of interest. The energy or strength of an earthquake is measured as its magnitude, a simple numerical scale developed by Charles Richter.

Measurement of the magnitude, as well as the identification of the site at which the phenomenon occurred (epicenter) is carried out using seismographs. As such, the magnitude is a measure of the earthquake at the point at which energy was released. In places far away from the event, such energy is attenuated due to the cushioning effect of the rocks through which the seismic waves travel. It is for this reason that it is more desirable to measure the effect on sites of interest in terms of ground motion. This measurement, carried out by means of accelerometers, usually records ground movement in the three spatial directions, in terms of its acceleration, since this information tells us about the ground velocity and ground displacement.

Ground motion is, accordingly, a function of the magnitude of the earthquake, its distance from the point at which energy was released, and of the properties of attenuation of that energy associated with the geological province in which the earthquake occurs. Studies of seismic hazard seek to establish, for each site of interest, an earthquake unlikely to be exceeded in a period that is considered adequate as the average life of the building or buildings to be constructed, on the basis of available information on the seismic sources that might affect that site.

In addition to the factors already mentioned, the following can also influence the impact of an earthquake in cities:

- ***The amplification of seismic waves by the soils.*** This fact is currently the object of much attention on the part of researchers, since the energy unleashed in earthquakes can be greatly amplified depending on the characteristics of the soils which support the buildings in cities. Earthquakes occurring far from a city and which are practically insignificant on hard or rocky soils are amplified destructively when the seismic waves encounter soft soils, usually lacustrine.
- ***Liquefaction.*** In certain cases, especially in that of saturated sandy soils of uniform gradation, liquefaction of the soil can occur, a phenomenon that consists in the sudden sinking of the soil because

of the increase in the pressure of the water contained in the soil when a seismic vibration occurs. It can be catastrophic.

- **Mass land movements.** Mountainous land can suffer landslides or collapses as a consequence of the seismic thrust of the earth. Sometimes the mass movements do not occur immediately after an earthquake, but after several hours or days.
- **Ground settlement.** This can occur with loose soils, or with soils supported by layers of soils that have undergone liquefaction, etc.
- **Tsunamis or tidal waves.** Ocean waves generated by seismic activity on the ocean floor can cause floods in coastal areas and may affect areas located thousand of kilometers from the earthquake epicenter.
- **Indirect hazards.** The force of the earthquake can cause cracks in dams, which can aggravate the effects of the disaster downstream from reservoirs, or contamination caused by damage to industrial plants, such as leaks of gases or dangerous substances, explosions and fires.

Most of the damage caused by earthquakes is due to the strong movements of the earth. Strong earthquakes have been felt in areas up to five million square kilometers. For this reason, engineering decisions are normally made on the basis of evaluations of large movements, expressed in terms of the maximum acceleration to be expected for ground movement in each site.

Central and South America, especially on the Pacific coast, are areas prone to earthquakes and present a high level of seismic hazard. Major earthquakes have occurred on the border between Costa Rica and Panama (measuring 8.3 on the Richter scale; 1904), on the border between Colombia and Ecuador (8.4 on the Richter scale; 1960), in Peru (8.6 on the Richter scale; 1942), to the north of Santo Domingo, Dominican Republic (8.1 on the Richter scale; 1946) and in Chile (8.4 on the Richter scale; 1960). In general, all the countries of Latin America present some degree of seismic hazard given that earthquakes have occurred in many provinces that may be not recalled as being particularly strong but did indeed frequently cause large-scale catastrophes and damage. Approximately 100,000 inhabitants of this region have died as a consequence of earthquakes during the 20th century, and 50,000 as a consequence of volcanic eruptions; the number of injuries far exceeds the number of deaths.

Hospitals and health installations in general are exposed elements that can suffer serious damage as a consequence of the occurrence of strong earthquakes. Since the seismic risk to health installations can be very

high, it is necessary to construct any new building with a level of seismic resistance in accordance to the seismic hazard in its area. It is also necessary to evaluate the seismic vulnerability of existing buildings, in order to identify their weaknesses and to design and carry out the alterations or retrofittings that may be necessary.

CHAPTER 2

EXPERIENCES OF HOSPITALS AFFECTED BY DISASTER

DAMAGE TO HOSPITALS

Although the administration in the hospital sector has considered disaster situations, its concern has been almost exclusively with "emergency preparedness", considering for the most part cases external to the medical assistance center and, in some cases, situations in which the hospital itself is affected. The concept of mitigation of risks or disaster-reduction in the functional architectural design of hospitals and the ability of the buildings, equipment, and structural and non-structural elements to resist earthquakes have usually been ignored in hospital construction, despite the fact that the capacity to provide service once a disaster has occurred depends on the degree to which the building and its components can continue functioning.

The need for health installations to be prepared and able to act in emergency situations is widely recognized in Latin America and the Caribbean as a matter of major importance. In the past, the impact of earthquakes and hurricanes along with other natural hazards has demonstrated that hospitals and health installations can be vulnerable to these events, and as a result are not always able to respond adequately.

For example, the planning, design and construction of hospitals in areas of high seismic activity requires means for protecting the different

professionals working in them, due to the importance that these facilities have in the normal life of a community and ever more so in the event of a seismic event when victims need treatment. Given the importance of hospitals for the recovery of a community hit by a strong earthquake, it is clear that numerous aspects have to be considered very carefully in their design, ranging from planning how to maintain treatment during disasters, up to the installation of equipment and various non-structural elements, including the structural capacity to resist earthquakes.

Despite those considerations, a large number of hospital have in fact suffered serious damage and even functional or structural collapse as a consequence of natural disasters, depriving their respective communities of adequate care for the victims.

HOSPITAL	COUNTRY	EARTHQUAKE
Kern Hospital	U.S.A.	Kern County, 1952
Hospital Traumatólogo	Chile	Chile, 1960
Hospital de Valdivia	Chile	Chile, 1960
Elmendorf Hospital	U.S.A.	Alaska, 1964
Santa Cruz Hospital	U.S.A.	San Fernando, 1971
Olive View Hospital	U.S.A.	San Fernando, 1971
Veterans Administration Hospital	U.S.A.	San Fernando, 1971
Seguro Social	Nicaragua	Managua, 1972
Hospital Escalante Padilla	Costa Rica	San Isidro, 1983
Hospital Juárez	Mexico	Mexico, 1985
Centro Médico	Mexico	Mexico, 1985
Hospital Bloom	El Salvador	San Salvador, 1986
Hospital San Rafael	Costa Rica	Piedras Negras, 1990

TABLE 1. SELECTED HOSPITALS AFFECTED BY EARTHQUAKES IN THE REGION OF THE AMERICAS

It is worth noting that many of the affected hospitals were designed in accordance with standards of earthquake-resistant construction. This

leads us to believe that the structural design of hospitals should be carried out with greater care than is usually devoted to more conventional designs, and that it may not be enough simply to make structures stronger than those used for housing or office buildings. The safety considerations built into the architectural and structural design should be based not only on purely physical aspects of the disaster that could strike the building but also on the social, economic and human criteria involved in the planning of the hospital.

Table 1 presents a list of some hospitals that have suffered severe damage or structural collapse as a result of earthquakes.

SOME ILLUSTRATIVE CASES

During the last two decades, more than 100 hospitals in the Americas have suffered severe damage and even total collapse as a result of earthquakes. For example, during the earthquake at San Fernando, California, on 9 February 1971, four hospitals suffered damage so severe that they could not operate normally when they were most needed. Moreover, most of the victims of the earthquake were patients in two of the hospitals that collapsed. Ironically, the most dangerous places in San Fernando during the earthquake were the hospitals.

During the earthquakes of 19 September 1985 in Mexico City three of the largest health institutions in the city were seriously affected: the National IMSS Social Security Medical Center, the General Hospital and Benito Juárez Hospital. What with the number of beds destroyed and those which had to be evacuated, the earthquakes produced a sudden deficit of 5,829 beds; 295 people died in the General Hospital, and 561 in the Juárez Hospital, among whom were patients, doctors, nurses, administrative personnel, visitors and newborns.

Table 2 provides some statistics concerning post-earthquake effects on hospitals in Latin America.

To repeat what was mentioned in the introduction, in the last 20 years more than 100 hospital installations, serving an estimated population of between 10 and 12 million people in 9 countries of the Americas, have been affected by earthquakes. Nearly one fifth of those installations collapsed catastrophically or had to be demolished as a consequence of the damage suffered during disasters. This meant a great toll in human lives and the disappearance of more than 10,000 hospital beds. At current costs, the replacement value of those beds amounts to more than US\$700 million. Such statistics underscore the need to review

the design and criteria for the construction of hospital installations in earthquake-prone areas.

PLACE AND YEAR	MAGNITUDE	GENERAL EFFECTS
Managua, Nicaragua, 1972	5.6	The General Hospital was severely damaged, evacuated and subsequently demolished.
Guatemala City, Guatemala, 1976	7.5	Several hospitals were evacuated.
Popayán, Colombia, 1983	5.5	Damages and interruption of services in the San José University Hospital.
Mendoza, Argentina, 1985	6.2	Approximately 10% of the total number of beds (state + private = 3,350) were lost. Of the 10 installations affected, 2 were demolished and 1 evacuated.
Mexico, D.F., Mexico, 1985	8.1	5 medical installations collapsed and another 22 suffered severe damage; at least 11 installations were evacuated. The direct losses were estimated at US\$ 640 million.
San Salvador, El Salvador, 1986	5.4	Over 2,000 beds were lost. More than 11 hospital facilities were affected, 10 were evacuated and 1 was totally destroyed. Estimated damage totalled US\$ 97 million.

Table 2. Post-seismic effects on hospitals.

CHAPTER 3

IMPORTANCE OF HEALTH CARE FACILITIES

HEALTH FACILITIES IN DISASTER SITUATIONS

Most health services are found in hospitals, clinics and medical centers run either by the government or the private sector. Hospitals normally provide emergency, secondary, and tertiary medical services while health centers provide primary care and some basic treatment or first aid.

Health facilities play a very significant role in the mitigation of disasters because of their particular function in treating the injured and handling outbreaks of disease.

Geriatric and psychiatric hospitals are less critical relatively speaking, except when their installations are damaged or when there is a great psychological impact on individuals in the population affected by the disaster.

The fundamental role of health centers is surveillance. Historical evidence has demonstrated that an uncontrolled spread of communicable diseases after a natural disaster has been the exception and not the rule.

Some health centers are equipped to treat people with minor injuries, which is extremely useful in order to reduce congestion and referral to hospitals or other more sophisticated medical facilities.

Hospitals require special consideration with regard to risk mitigation due to the following factors:

- Their complexity and occupancy characteristics;
- Their role during disaster situations, with regard to the preservation of life and good health, especially in the diagnosis and treatment of injuries and illness.

Complexity and occupancy characteristics

Hospitals can be described as systems, composed in turn of subsystems: inpatient care units, outpatient consultation, diagnosis and support services, and administrative offices. The inpatient and outpatient subsystems have functions similar to those of a hotel, since they require patient rooms, operating rooms, food services, laundry, etc. The diagnosis and support subsystem is made up of small high-cost units, great technological complexity and various functional characteristics. The administrative subsystem provides, through complicated processes, the necessary backup for the provision of medical and support services.

It is thus clear that such a complex installation requires a permanent supply of electricity, drinking water, liquid and solid waste disposal services, and communication services. It needs pharmaceutical products, medical-surgical supplies, gases, chemicals, and vital fuels if it is to function properly.

However, all of these also constitute hazards if they are stored, handled, used, or, in the case of equipment, maintained incorrectly, or if there are seismic movements, fires, explosions or other events that could at some point affect the personnel, provisions, and equipment, as well as the building itself.

Hospitals may at any time find themselves full of resident patients, transient patients, staff members, employees and visitors. Hence, there are three principal reasons for having a disaster preparedness plan:

- Patients must continue to be treated during the occurrence of a hazardous event: provision must be made for the personnel and support services to be readily available at all times.
- Safety and security for all the occupants must be guaranteed. A vulnerability analysis of the installations must be carried out and, if necessary, the installations must be retrofitted in accordance with current requirements of design and construction. There are cost-effective ways to do this; the documents in this series contain a description of appropriate techniques for this type of analysis and alteration.

- It may be necessary, at some point during the disaster, to evacuate outpatients and resident patients. This problem can be exacerbated if the event occurs suddenly and while the hospital is full of visitors who, in most cases, are not familiar with evacuation procedures.

Visitors in this case aggravate the problem, since visiting the patients is a popular practice. In all of Latin America the number of visitors at peak periods, such as weekends, may be twice the number of resident patients. Most hospitals have companion beds which means that a high percentage of the resident patients may be accompanied at night. Evacuation plans should take into account such situations.

The hospital in disaster situations

No one questions the importance that medical treatment centers have under normal conditions. If to this we add an emergency situation or disaster where the demand for services calls for a greater response in a short period of time, it is evident that there is a need for an in-depth analysis of those factors that give rise to special conditions in the case of health institutions: complexity, occupancy, and dependency on public services and on critical supplies. Such conditions call for alterations to be made to reduce vulnerability, as a matter of priority.

In the event of disaster, a hospital must continue with the treatment of resident patients and serve the people injured in the disaster. To do this the personnel must be in place and know how to respond to the situation. The building and its equipment must also remain serviceable. Most hospital authorities recognize these facts, and for that reason have prepared formal plans for the mitigation of disasters. However, all these plans suffer from a lack of organizational alternatives in the event of severe damage to, or paralysis of, the facility. Little attention has been paid to this, which is worrisome since in many places medical care depends on only one hospital and its damage could cause an enormous crisis due to the lack of alternatives in the area.

Good systems for organizing and mobilizing personnel, equipment and supplies within a safe environment are fundamental for an effective response to the disaster. This need for systematic arrangements underscores the critical nature and interdependence of processes, buildings and equipment. Deficiencies in any of these elements of the functional system of a hospital could induce a crisis in the institution.

Processes

These mainly have to do with the mobilization of people, equipment and supplies. Organizing them includes setting up a committee to formulate measures for the mitigation of disasters. The terms of reference of the committee in charge of disaster preparedness include drawing up a formal preparedness plan for the provision of medical care, its dissemination among the personnel for the purpose of creating awareness and familiarity with the plan, training in its execution, and tests and exercises to evaluate the effectiveness of the plan in the face of different types of hazards. The plans should be reviewed and updated frequently.

Buildings

The plans should include organizational alternatives in the event of serious damage to the hospital installations. Previous disasters have clearly demonstrated that this is a defect in existing plans. Experience indicates that factors have to be incorporated into the design and construction of buildings that will not only insure safety but will also preserve certain critical areas of the hospital, such as the emergency department, the facilities needed for diagnosis, operating rooms, the pharmacy, food and medicine storage areas, and registry services.

In the past, the emphasis in hospital design was on the optimum allocation of space and the arrangement of services in such a way as to ensure the best possible interrelationship between the functions and activities of the different departments. New hospitals with modern design and construction techniques have also proved to be vulnerable due to defects in the functional distribution of sectors in the event of the need for massive treatment of injured people, as well as to defects in their non-structural components. Many installations fail due to simple omissions in their design, which could have been corrected at a marginal cost during the construction or alteration of their existing structures.

Equipment

The contents of buildings cause more problems when earthquakes occur than when hurricanes occur. Much damage can be prevented by applying simple and inexpensive measures, such as securing shelves to the walls and placing plant and equipment in strategic and safe positions. Regular inspections and appropriate maintenance of such elements could also ensure that they will always be operational and in good condition.

It would suffice to bear these things in mind when carrying out normal, periodic maintenance of the building, its installations and components.

ECONOMIC AND SOCIAL COSTS

Health is usually understood as an individual right and a right pertaining to the entire community. For this reason, in many countries health installations are owned by the State and run by the government. In most cases health is financed by revenue generated mainly from taxes, which is why public health services are provided at low cost or free of charge and depend on the economic capacity of the governments. In other words, since health institutions are the result of government investment, their survival depends on the state of the economy of the government.

Any adverse impact on the economy of a country will affect its ability to provide health services. Moreover, due to the importance and high cost of hospital facilities, severe damage to them will not only affect the productive capacity of a country but will also erode public finances due to the cost of rehabilitation and reconstruction.

In recent years, much capital has been invested in expansion of hospitals and in alterations designed to reduce vulnerability despite the fact that this capital generates no income and can become an added burden to the government in meeting the recurrent expenditures to keep the facilities running properly. This makes it all the more important to ensure that all investment in social programs, particularly in times of economic difficulty, is properly safeguarded and not at the mercy of natural disasters.

RESPONSIBILITY OF THE HEALTH ADMINISTRATOR

Health administration in general in Latin America and the Caribbean has been concerned about promoting and orienting a process of institutional change which could lead to an improvement in the allocation and utilization of resources, and has thereby had a positive impact on the state of health of the population. Its role in hospital management has been directed towards achieving comprehensive development of infrastructure based on the needs of communities. Some aspects of this have had to do with the reduction of vulnerability to natural disasters. The most relevant are:

Analysis of hospital demand

The growth in the demand for medical care and the limitations in the supply of services have generated a process of rationalization of resources, expressed in such concepts of planning, organization and structure as:

The hospital network, understood as a system made up of medical treatment centers of differing degrees of complexity with regard to the services provided, and with fixed mechanisms of interaction in which relations are governed by the principle of complementarity.

Classification according to levels of care, which constitutes a fundamental tool for the formation of the hospital network. It uses criteria such as the characteristics of the user population, areas of coverage, morbidity, type of services and available human resources.

Categorization or qualification, within the hospital network concept, and that of classification according to levels of care, where the need arises to evaluate institutional resources individually with regard to physical plant, instruments and equipment, type and level of qualifications of the personnel involved, use of technology and other parameters that help characterize a medical facility.

The referral and counter-referral systems understood as the set of standards, protocols and procedures designed to orient the care and referral of patients from the lower levels of the health services toward the higher levels and from the higher levels to the lower, respectively. This aspect aims to rationalize available resources to the utmost by seeking efficiency, effectiveness and timeliness in the delivery of health care.

The potential demand due to disasters of natural or man-made origin can frequently cause modifications in the way health systems operate. These changes should be specific for each disaster (type, magnitude, intensity and duration), place, population and exposed infrastructure; aspects that undoubtedly should be related to epidemiological information, mortality, and, in general, with the health situation in the region. This set of data should be compared with the capacity to deliver health services in order to obtain a potential demand/supply ratio in the event of a disaster. This analysis is of great importance in detecting and rectifying variables that have a negative impact.

Vulnerability analysis

Considering the importance of hospital infrastructure after a disaster and the need for an efficient response to the emergency by the health

sector, it is necessary for the administration to carry out or promote an analysis of the structural, non-structural and functional vulnerability of health services.

Structural vulnerability

The term "structural" refers to those parts of a building that keep it upright. This includes the foundations, columns, load-bearing walls, beams, and diaphragms (meaning the floors and ceilings designed to transmit horizontal forces, like earthquake tremors, through the beams and columns toward the foundations).

Planned or already existing health service installations located in areas exposed to seismic activity should apply seismic resistance norms designed to ensure the safety of the people on the premises and, secondly, to protect hospitals' vital equipment. To construct a completely "earthquake-proof" building would be too expensive. However, seismic resistance is a construction criterion that aims to prevent a building from collapsing, so that in the event of a low intensity quake the structure and its contents would not suffer damage, and, in the case of a very intense earthquake, its structure would suffer permanent damage without actually collapsing. In other words, the structure would manage to support the weight of the building and its contents without causing casualties, even if eventually it had to be demolished and then repaired or rebuilt.

Non-structural vulnerability

The term non-structural refers to those components of a building that are incorporated into the structural parts (windows, ceilings, doors, etc.), that fulfill essential functions in the building (plumbing, heating, air conditioning, electric connections, etc.), or the contents of a building (equipment). They can be subdivided into three categories: architectural, electro-mechanical and contents.

In the case of medical facilities, the non-structural components cost more than the building itself. Studies have shown that the average value of the structural component is less than 15% of the total cost of the hospital.

Situations can arise where non-structural components may have a bearing on structural failures. Heavy equipment such as central air conditioning systems, X-ray equipment, electric generators, boilers, hydrotherapy pools, and other equipment can significantly modify the dynamic response built into the design and construction of a building by

moving or overturning due to a lack of anchorage and finally causing a partial or total collapse of the building. Architectural elements such as unreinforced masonry fill-in walls and heavy veneers can cause dynamic alterations to the rigidity of a building while it is in movement. In addition the partial loss of this heavy masonry causes eccentric shifts and twisting of the building possibly leading to a partial collapse. Were such elements to fall on a sector of the structure itself the impact could be considerable. On the other hand, changes, remodeling and adaptation within hospitals in an attempt to create new spaces is done without the effects on the structural elements should a seismic event occur being taken into account. Mechanical installations, ventilation, drainage, and other systems located in sites that modify the structural characteristics of the building are also common. These situations arise when there are variations between the design of a building and its actual construction and they can cause failures or partial collapses during an earthquake, even though the initial design might have been seismic-resistant.

Functional vulnerability

In order to keep the critical services of a hospital running so that it can respond to the demands of the local community at a time when they are most needed, it is necessary to protect people, furnishings, and medical services themselves.

The first aspect of functional vulnerability refers to the distribution of architectural spaces and services inside hospitals and the relation between them. Proper zoning and relationships between the areas that make up the facility can guarantee an adequate level of operation not only under normal conditions but also when large numbers of patients must be cared for. Well-arranged and well-placed areas for outpatient consultations, external services and emergencies, together with a well-conceived area for general services with special operational and safety characteristics can guarantee adequate care and avoid an interruption of services, which may occur even when the building has not suffered severe damage.

Among the furnishings, there may be equipment and other elements that, although they do not affect the operation of a hospital's essential services, could constitute important economic losses. This category includes, for instance, office equipment (photocopiers, typewriters, etc.).

Another example might be that of a monitor located above a patient's bed, which could fall causing him or her harm; an analysis of functional vulnerability would have detected this factor and preempted the risk

through adequate anchorage thus reducing the likelihood of that object harming the patient.

Damage to, or the loss of, certain elements could result in a serious disruption in the delivery of medical services. Even though there may not be any direct risk to people, they could be indirectly affected by equipment or system failures. An example might be damage to an electric generator needed for basic life-support systems such as respirators in an intensive care unit.

It is the responsibility of the health administrator to consider the above-mentioned aspects in order to reduce potential breakdowns in services and the social impact of disasters in which hospitals fail to deliver the kind of services that the population needs most.

CHAPTER 4

VULNERABILITY OF HOSPITALS

VULNERABLE ASPECTS OF HOSPITALS

Hospitals are essential for dealing with a disaster, but they are also highly vulnerable installations. Perhaps there are other buildings and installations of equal size and construction in a city, but not as complex from the functional, technological and administrative point of view. The factors that make hospitals especially vulnerable include:

Complexity. Hospitals are very complex buildings that combine the functions of a hotel, offices, laboratory and warehouse.

The hotel aspect alone is highly complex since it involves not only lodging, but food services for a large number of people, including patients, employees and visitors. These centers usually contain numerous small rooms and many long corridors. After a disaster, the patients and visitors will be very confused. There may be a power outage. The corridors and doorways of the rooms may be blocked by fallen furniture or rubble. The elevators will not work and staircases may have collapsed or be difficult to use.

Occupancy. Hospitals are densely occupied buildings. They lodge patients, employees, medical personnel, and visitors 24 hours a day. Many patients require constant assistance and specialized care and may

be surrounded by special equipment and perhaps utilize potentially dangerous gases such as oxygen. Patients might be connected to life-support equipment which requires electric current at all times.

Critical supplies. Most of the supplies that hospital installations require (medicine, splints, bandages, etc.) are essential for the survival of the patient and they are crucial for the treatment of earthquake victims. Patients' case-history files are vital if they are to get proper treatment, especially if they are evacuated to other centers. Damage to storage and file areas will make it impossible to obtain these documents at the time they are most needed.

Public services. No institution depends more on public services than hospitals. Without electricity, water, fuels, refuse collection, communications, and free access to and from them, hospitals could not function. X-ray equipment, monitoring equipment, life-support services, sterilization, and other equipment all require electricity.

The complex organization of health care installations means that internal and external communication systems are crucial.

Larger health facilities depend on elevators for moving both people and supplies. Even in a moderate earthquake, for example, elevators will remain out of service until they can be inspected for possible damage.

Dangerous materials. Several products used in a hospital are dangerous if they are spilled or leak. Shelves full of medicine or chemicals that are overturned can release poisonous liquids or gases. Fires may be started by spilt chemicals and overturned gas cylinders or ruptured oxygen supply lines can pose serious threats. In addition, some drugs may fall into the wrong hands once safety controls break down.

Heavy articles. Many hospitals have equipment or televisions on high shelves above or near the beds of the patients; these can fall and cause serious accidents. Other pieces of specialized equipment, such as X-ray machines or emergency generators, are heavy and capable of being overturned or thrown across a room during an earthquake.

External problems. In addition to these internal problems caused by damage to the hospital itself, the damage suffered by the local community may delay the arrival of firemen, the police, and, perhaps, disrupt the telephone service, at the same time that an unprecedented number of injured are arriving. There will also be crowds seeking information about patients in the hospital. Just when it is most needed, the building may cease to be functional, and medical personnel may be killed or injured.

FUNCTIONAL VULNERABILITY

From the functional point of view, we should mention a hospital's external characteristics such as the selection of the land, its size, the public services available, environmental restrictions, adjacent roads and their connection to the urban street network. It is also necessary to deal with general physical layout, that is, with the interrelationships between areas, with the primary and secondary, private and public corridors within the hospital, and with public and private access to the basic areas which make up the hospital. Finally, one should take into account physical layout in areas not open to the public, that is, the internal functioning of each of the five sectors that make up the hospital.

A hospital building is composed of five basic areas, each of which has very specific functions, but which in turn must interact with other areas in ways which are vital if a hospital is to operate properly. The relations between such areas or sectors—Administration, Ambulatory Care Units, General Services, Outpatient Consultation and Emergency Services, and Inpatient Care Units—can be critical if the original design failed to consider their function and distribution in the case of a sudden influx of patients. A hospital can suffer a "functional collapse" as a result of this situation, which is only detected at the time an emergency occurs. In addition to the above-mentioned areas, it is important to have an external services area, which plays a particularly important role in dealing with disasters.

NON-STRUCTURAL VULNERABILITY

A building can remain standing after a disaster but still be unserviceable due to non-structural damage. The cost of the non-structural elements in most hospital buildings is considerably higher than that of the structural elements. This is especially true of hospitals where 85% to 90% of the value of the installation is not in the support columns, floors and beams, but in the architectural design, mechanical and electric systems and in the equipment contained in the building. A relatively minor seismic movement may cause more non-structural damage than damage to structural components. As a result, the most vital aspects of a hospital, those that are most directly related to its purpose and function, are those most easily affected or destroyed by earthquakes. Conversely, it is easier and less expensive to adapt them and prevent them from being damaged or destroyed.

It does not suffice to ensure that a hospital simply does not collapse after an earthquake; it must continue to function as a hospital. It may continue to look like a hospital, but if it is critically affected internally,

it cannot provide proper medical care. This section focuses on the need to prevent an "internal disaster" or what is technically known as "non-structural failure". It also refers to the non-structural failures that may affect the integrity of the structure itself.

Architectural elements

With regard to architecture, the specific points to be looked into are unreinforced masonry fill-in and heavy veneers. Although unreinforced masonry fill-in is not usually considered to be a structural element, it does give rigidity to a building until it begins to fall. If these segments of internal partitions fail irregularly, they may cause stress on the columns and beams that was not foreseen in the design.

If one side of the building loses a large part of its heavy veneer exterior while another side does not during an earthquake, the imbalance may cause the building to twist. This torsion may not have been foreseen in the structural calculations and could result in partial collapses.

In buildings with platforms, account should be taken of the impact on the lower diaphragms if the architectural components of the upper floors come loose and fall.

Another architectural problem that may affect the structure of a building is known as "the short column effect." Sometimes buildings are designed with a ground floor that includes a great quantity of open space between support columns. Their engineering should be adapted in order to enable them to resist earthquakes by ensuring that ground level columns are strong and flexible enough. Sometimes these buildings are remodeled later on in order to close those open areas with filler masonry up to a certain level, just leaving space for windows in the upper part. This confines the lower part of the columns and, essentially, shortens their effective length. It is known that such "short columns" give way in earthquakes because the flexibility and resistance with which they were originally constructed have been altered.

Installations and equipment

Incidents observed in previous earthquakes can illustrate the type of problems that may arise:

- Overturned oxygen or inflammable gas cylinders, with highly dangerous leaks.
- Overturning of the emergency generator due to the corrosion and weakness of the fixtures anchoring it, causing a power outage and creating a fire hazard.

- Total or partial overturning of high-voltage transformers and spilling of oil, also causing power outages in the emergency power supply system and a potential fire hazard.
- Displacement of the telephone communications control panel, causing a temporary interruption in a hospital's communications.
- Overturned storage shelving and breakage of flasks in cupboards causing the loss of their content and consequently the loss of badly needed medicine.
- Falling laboratory equipment and breakage of such instruments as microscopes and computers.
- Broken cables and falling of elevator counterweights.

As regards mechanical installations, there have been cases in which the structural walls that were part of an earthquake-resistant design were opened up in order to install air-conditioning units. This may not have happened during the original construction of the building, but later when the original design engineers were no longer associated with the construction. These openings weaken the structural walls, which could result in failures or a partial collapse during an earthquake, even though the initial design was earthquake-resistant.

STRUCTURAL VULNERABILITY

It is easy to conclude that hospitals have more problems being prepared for a disaster than any other service. Many of the problems mentioned previously stem from deficiencies in the structural and non-structural safety of the building. In the case of a new building, the structural component should be considered during the design and construction stage, or in the case of an existing building, during repair, remodeling or maintenance. A good structural design is crucial if the building is to withstand a severe earthquake. The building may be damaged, but it is unlikely to collapse. If a hospital collapses even partially, it will be a liability for the community after the disaster and not the asset that it should be.

Moreover, in the planning of a hospital it is necessary to take into account that one of the most common causes of damage in buildings is a hazardous architectural-structural configuration. Departure from simple structural schemes can turn out to be a costly decision when it comes to earthquakes. In addition, unfortunately, the usual methods of seismic analysis fail to quantify most of these problems correctly. Given the erratic nature of earthquakes, as well as the possibility that their

magnitude will exceed that envisaged in a building's design, it is advisable to avoid proposing hazardous configurations, regardless of the degree of sophistication that it may be possible to achieve in the analysis of each particular case.

Unfortunately, in many countries of Latin America seismic-resistant construction standards have not been effectively applied and in others such standards have not taken into account specifications unique to hospitals. Thus, it is hardly surprising that every time that an earthquake occurs in the region the buildings worst hit are precisely the hospitals, which should be the last to be affected. Because the structural vulnerability of hospitals is in general high, this situation should be corrected totally or partially if enormous economic and social losses are to be avoided, especially in developing countries.

EVALUATION OF VULNERABILITY

In the case of health facilities it is necessary to evaluate their vulnerability to natural hazards at the local level in order to obtain precise estimates of the degree of risk that they face. Once this type of analysis has been completed, the information obtained allows a decision to be taken on an acceptable level of risk.

A vulnerability analysis could begin with a visual inspection of the facilities and with the preparation of a preliminary evaluation report. Such an inspection makes it possible to identify areas that require attention. The report can be discussed with the consultants and the authorities in charge of the facility with a view to defining priorities and timetables for the work to be carried out. Once the retrofitting program has been designed, other reviews and studies should be carried out in specific areas identified as being in need of modification.

Functional aspects

The first aspects that should be confirmed when evaluating functional vulnerability are those related to infrastructure. This includes the external physical resources on which the hospital depends, such as communications, water supply, sewage systems, energy, and the information network of the facility.

Telephone lines may be seriously damaged by natural disasters. This can occur even though underground lines are not susceptible to hurricanes and they are, normally, sufficiently insulated and flexible enough to resist damage caused by floods and earthquakes.

The main water supply system, which normally consists of pumping stations, water treatment plants and underground pipes, may be interrupted because of damage to the pumping mechanisms or, more frequently, because of broken pipes. For this reason, hospitals should have water storage tanks that are incorporated into the daily supply system in order to guarantee that the water is in good condition at the moment the emergency occurs.

The power supply system, which consists of electricity generators, high tension wires, underground plants, and equipment located on the ground, are the most vulnerable parts of this system. The transformers and porcelain insulators are the weakest points, because damage to them can start fires. Poles supporting power lines and cables are particularly vulnerable to strong winds. It is therefore advisable for health facilities to have emergency generators ready to operate at any time.

During earthquakes, the vulnerability of water, sewage, gas and fuel pipelines depends on their resistance and flexibility. A high degree of flexibility of the pipes can avoid breakage during a moderate earthquake; settling may be compensated for and the displacement of the soil will not necessarily lead to breakage. Special attention should be given to connections inside buildings, which need to meet special design requirements.

Other special measures to mitigate the effects of disasters in hospitals are of great importance. Signs and orientation maps on each floor should be clear and easily recognizable by visitors; the fact that electric current may be cut off must be taken into account; elevators should not be used even if they remain operational; the stairs should be used to get downstairs even though, in the case of an earthquake, some rubble may fall since the rigid elements between floors are subjected to heavy loads and are likely to suffer damage; the doors can get stuck due to the movement of the building and may make it difficult to get out of the facility. It should be emphasized that even when no non-structural damage occurs and the hospital can continue operating it is necessary to have a structural inspection done immediately by professionals specially trained for this purpose.

A detailed analysis of the outlying areas, of hospital access routes and of the interrelationship between the sectors that together make up the services provided by a hospital can lead to recommendations for functional redistribution and for the layout of certain areas that would prove particularly useful in emergency situations involving large numbers of patients.

Non-structural aspects

Non-structural elements include non-load bearing exterior walls, dividing walls, interior partitions, windows, ceilings, elevators, mechanical and electrical equipment, lighting systems, and other internal components. Non-structural damage frequently causes enormous losses, particularly as a result of earthquakes. Damage to non-structural components can be severe and can paralyze a hospital, even when the structure of the building remains intact.

The cost implications of such damage can be high, given that the structure of the building only represents between 15% and 20% of the total cost of the facility. As a result, the more vulnerable non-structural elements are to earthquakes and to other natural hazards the greater the risk for the occupants and the probable losses.

A breakdown in hospital services can be aggravated because design codes do not normally take into account specific requirements for the design of mechanical and electrical systems. Experience has demonstrated that secondary effects of non-structural damage can significantly aggravate the situation. For example, ceilings and wall finishings that fall into corridors or stairwells can interrupt the flow of people. Fires, explosions, and chemical leaks can endanger people's lives.

Much of what is to be found in health facilities is essential for their operation. Expensive equipment for patient registration is crucial immediately after an earthquake or a hurricane. Construction codes do not cover this type of equipment, which is why preventive measures should be taken by health administrators and managers.

In many cases, people without specialized training can carry out a preliminary evaluation of the level of risk by bearing in mind two basic questions for each non-structural element under consideration:

- Could this element be damaged in an earthquake?
- If it were damaged would it cause a serious problem?

This will produce a preliminary list of elements for more detailed consideration. At this stage it is preferable to be conservative and to overestimate vulnerabilities (see Table 3).

Structural aspects

Since many hospital buildings are old and others were neither designed nor constructed to resist earthquakes, there are doubts as to whether they are safe enough to perform properly in the event of an earthquake. Such doubts are particularly worrisome in the case of those hospitals that are needed in a seismic emergency and have nevertheless

been designed only in order to support their own weight. In those cases what is urgently needed is as detailed a review as possible of the capacity of the structure to withstand moderate and strong earthquakes. One should bear in mind that the difficulty of constructing new hospitals in seismic areas, due to their high cost, makes strengthening existing health facilities all the more important. Before any action is taken, there should be an analysis of the existing capacity to resist and absorb earthquakes, as well as of the functional, organizational, and administrative vulnerability of the hospital.

Buildings essential for post-seismic recovery call for especially careful analysis. There are analytical and experimental methods available for this purpose. The latter determine the dynamic behavior of the structure by direct measurement of environmental vibrations but have the disadvantage of only providing information about the dynamic characteristics of the construction under minor vibrations. These measurements are insufficient when it comes to answering queries about resistance, dissipation of energy, etc., and should be complemented with purely analytical methods.

In Latin America, the buildings are usually made of reinforced concrete, brick masonry or wood with light roofs. The assessment of the structural vulnerability of these types of buildings should be carried out by specialized engineers.

The evaluation of the condition of an existing construction can give rise to serious doubts about its capacity to withstand seismic events. Some countries of the Region have launched campaigns to retrofit existing buildings in order to reduce their vulnerability before a disaster occurs. In principle, where hospitals are evaluated and determined to be inadequate to resist seismic and other natural hazards, one would conclude that reducing vulnerability should be compulsory since these facilities are essential for handling emergencies.

REDUCTION OF EXISTING VULNERABILITY

The level of risk can be reduced if it is understood as a combination of the hazard or probability of occurrence of disaster and the vulnerability to it of the elements exposed, or as an estimate of the severity of the possible impact on those elements. Structural measures such as the construction of protective works or alterations designed to diminish the vulnerability of the elements at risk, and non-structural measures, such as regulating soil use, incorporating preventive aspects into investment budgets, and making preparations for providing medical

care during emergencies can all reduce the impact of a disaster on a region or a population.

All this should be done before a disaster occurs. Everything that is done to reduce or prevent the damages that a disaster may cause is called "mitigation of risks." Everything done afterwards is known as "response." This section focuses only on mitigation in the case of health facilities, and, in particular, hospitals.

Mitigation of the impact of disasters by the adoption of preventive measures is a highly cost-effective activity in areas where disasters are frequent. For every dollar well spent on mitigation before a disaster occurs, much more will be saved in terms of losses prevented. Mitigation is not, in fact, a cost. In the long run it pays for itself. And it does so in real money, and in lives saved.

Functional alterations

Traditionally, functional distribution of areas within hospitals does not include as one of its design criteria the treatment of large numbers of injured persons. If this aspect is taken into account, certain adjustments can be made in the relationship between areas and, in some cases, it will be necessary to make some design changes that could help mitigate disasters in the building.

Not only for purposes of mitigation and prevention, but also for administrative reasons, the possibility of separating the general services sector from the main hospital building should be explored, for the following reasons:

- The general services sector usually houses boilers, which can become dangerous time bombs capable of doing untold damage should they explode.
- Similar considerations apply to a hospital's gas plant. Although it is true that this modification would be costly, when compared with the costs of the damage that could be avoided the costs involved should be considered minor.
- Another service commonly located in this sector is the emergency generator. This is a service that could also be housed in a separate building, not so much because of the risks associated with it but in order to ensure that it can be used at critical moments.
- For the same reasons, it may also be advisable to put telephone, radiocommunication, and other facilities in this separate area. As with the electric generator, this would enhance the possibility of such services being available after a disaster.

- It also is desirable to locate a hospital's water storage tanks in this area, whenever possible. In most cases they are located on the upper floors of buildings, increasing the load on the structure, and thereby constituting one more risk.
- It follows that it also would be desirable to put kitchen services in the same area, given that they require water, light and gas.
- If the same thing were done with the laundry service that would complete the package of services available and in operation, capable of serving either all or some areas of the hospital affected by a disaster or in the case of the need for an open-air hospital.

Such modifications are possible if there is a multidisciplinary team made up of engineers, architects, planners, etc., as well as medical and paramedical personnel, striving to work out a set of actions, responsibilities, movements and physical solutions. Obviously this is more feasible in the case of new designs, but it can also be implemented in certain types of existing installations.

One of the most important aspects from the functional point of view is proper posting of signs inside the hospital. This is important not only to guide people during normal use of hospital services, but for also the evacuation of the building when a disaster occurs. The signs should point to evacuation routes leading to stairs or emergency exits not normally used but designed especially for emergencies. In addition, there should be signs pointing to fire extinguishers, hoses and other fire equipment, fire doors wherever they exist, emergency telephones, etc. Signs should be posted not only inside the building, but outside and in the surrounding urban area.

Non-structural alterations

After identifying a non-structural element that can suffer or cause damage, and its priority either functionally or in terms of loss of human lives or of property, appropriate steps should be taken to reduce or eliminate the danger. We list below 12 applicable mitigation measures which, in many cases, has been shown to be effective:

1. Removal
2. Relocation
3. Restricted mobilization
4. Anchorage
5. Flexible couplings
6. Supports
7. Substitution
8. Modification
9. Isolation
10. Reinforcements
11. Redundancy
12. Rapid response and repair

1. Removal is probably the best mitigation option in many cases. For example, a dangerous material that could be spilled could be stored off the premises. Another example would be the use of heavy stone or concrete veneer on the outside of the building or along some balconies, which could easily come loose during an earthquake endangering everything beneath it. One solution would be to use better anchorage or stronger supports, but the most effective solution would be removal and substitution.

2. Relocation would reduce danger in many cases. For example, a very heavy object on a shelf could fall and cause serious injury, or it could become damaged, causing economic losses. If the object were to be relocated to a floor level shelf, it would not endanger human lives or property. It is also advisable to keep bottles containing dangerous liquids on the floor, if possible.

3. Restricting movement of certain objects, such as gas cylinders and electricity generators, is a good measure. It does not matter if cylinders shift so long as they do not fall and break their valves, releasing their contents at high pressures. Sometimes it seems desirable to install emergency generators on springs in order to reduce the noise and vibrations when they are operating, but the springs would amplify seismic tremors. Restrictive supports or chains should be placed around such springs in order to keep the generator from shifting or being knocked off its stand.

4. Anchorage is the most widely used precaution. It is a good idea to fasten objects with bolts or to tie them down using cables or other materials to keep objects of value or of considerable size from falling or sliding. The heavier an object is, the more likely it is to move owing to forces of inertia. A good example would be a water heater, of which there may be several in a hospital. Since they are heavy and if they fall could break a water main, an electric wire or a pipe carrying fuel, they constitute a fire or flood hazard. A simple solution is to utilize metal strips to fasten the lower and upper parts of the heater against a wall or other support.

5. Flexible couplings are sometimes used between buildings and exterior tanks, between separate parts of the same building and between buildings. These are utilized because separate objects each move independently in response to an earthquake, some move rapidly or at high frequencies, others slowly at low frequencies. If a tank is connected to a building by a rigid pipe, the tank will vibrate at frequencies and in directions and amplitudes different from those of the building, causing

the rigid pipe to break. A flexible pipe would prevent ruptures of this kind.

6. Supports are appropriate in many cases. For example, ceilings are usually hung from cables that withstand only the force of gravity. When submitted to the multitude of horizontal and distorting forces that result from an earthquake, they fall easily. Although electrical boxes are not heavy, sometimes they may have heavy lights fixtures attached to them. If they fall, they can seriously injure the people underneath. The electric connections may also be torn out of the ceiling and constitute a fire hazard.

7. Substitution by something that does not represent a seismic danger is the correct solution in some situations. For example, a heavy tile roof not only makes a building heavy, but also more susceptible to the movement of the earth in an earthquake. The individual tiles tend to detach themselves creating a danger for the people and objects below. A solution would be to switch to a lighter and safer roof.

8. Modification of an object that represents a seismic hazard is feasible. For example, the movements of the earth twist and distort a building, possibly causing the rigid glass of its windows to shatter, throwing sharp glass splinters at the occupants. Clear plastic can be used to cover the internal surfaces; it is invisible and reduces the likelihood of a glass window causing injuries.

9. Isolation is useful for small loose objects. For example, if lateral panels are placed on open shelves or latches on cabinet doors, their contents will remain isolated and will probably not be thrown about in the event of an earthquake.

10. Reinforcements are feasible in many cases. For example, an unreinforced fill-in wall or an unreinforced chimney can be strengthened at no great cost by covering the surface with wire mesh and by filling it in with cement or some other mixture. Not only will these non-structural objects be protected against failures; in the case of the fill-in walls the structural elements will also be strengthened.

11. Redundancy of supplies is advisable for emergencies. It is possible to store additional quantities of certain products in boxes in places that will be accessible after an earthquake.

12. Rapid response and repair is a mitigation tactic often used for long pipelines. Sometimes it is not possible to do anything to prevent a pipe breaking in a given site, so parts are stored nearby and the necessary arrangements are made to ensure rapid access to the area in case of rupture of the pipeline during an earthquake. In a hospital, spare

parts for plumbing, electricity, and other repairs, together with the appropriate tools should be kept on hand, so that if something is damaged, it can easily be repaired. For example, during an earthquake water pipes may burst; it may be impossible to couple each of the tubes and take each one of the measures necessary to eliminate this risk altogether, but it should be possible to ensure that everything necessary for a quick repair is at hand. By planning before an emergency it is possible to save the enormous cost of damage caused by water with a minimum investment in a few articles and by thinking in advance about what could occur.

The general measures discussed above are applicable to almost all situations. However, in many cases, one simply has to be creative and think up one's own way to mitigate the effects of disasters.

Structural alterations

In most countries there already exists some awareness of the importance of health facilities being properly equipped to meet future needs. Many of these facilities are probably vulnerable in variable degrees to damage from earthquakes, hurricane winds, or other natural hazards. However, it is possible to reduce that vulnerability. Experience shows that applying relatively inexpensive measures has increased safety and improved existing structures. To be really efficient and beneficial, the adaptation or alteration of existing installations should be carried out systematically and consistently.

Many existing buildings do not meet the current technical requirements. Their vulnerability to certain natural hazards can be so great that associated risks may far exceed currently accepted levels. Remedial action based on scientific knowledge should, therefore, be taken in order to reduce the risk and guarantee that buildings behave as they should. Likewise, this adaptation or strengthening of existing buildings should be consistent with current engineering requirements and in accordance with the requirements established by the design codes of each country.

The usual methods for retrofitting existing structures generally include the insertion of the following elements:

Walls on the outside of the building. This solution is usually used when space limitations and continuity in the use of the building make it preferable to do construction work around the building. In order to ensure the transmission of seismic forces from the old structure to the new structural walls, beams are used at the edge of each slab.

Buttresses. Unlike the previously mentioned walls, they are placed perpendicular to the face of the building. Apart from stiffening the building, they are useful in order to keep tall buildings from tipping over. Due to space limitations, however, they are not always feasible.

Walls in the interior of the building. If conditions permit construction work inside the building, these are an alternative that must be considered in the case of long buildings, in which the structural flexibility of the floors is to be reduced. These walls are usually inserted by means of perforations in the plates of the floors through which the reinforcement bars of the new structural elements are passed.

Frame walls. Both on the inside and the outside of buildings, a practical solution to the problem of rigidity and resistance is to fill frame openings with concrete or strengthened masonry walls. Because they are joined to columns, the stresses borne by the latter will change substantially. If the reinforcement steel in the columns is strong enough to support the new loads, the connection to the wall may be made using soldered braces only. If not, the columns will have to be sealed monolithically within the wall.

Specially anchored frames. Another frequent solution consists of including several steel frames with diagonals firmly anchored to the floors, as a substitute for the rigid walls. Also, diagonals only, joined to existing frames, can be constructed when the frames prove capable of withstanding the stress placed on them by the new system.

Covering of columns and beams. Used for frame systems, this technique is usually applied to most of the columns and beams of a building, in order to increase their rigidity, resistance and ductility. These systems are mostly differentiated basically by the way in which the new covering is connected to the existing column.

Construction of a new frame system. Sometimes it is possible to carry out a total restructuring by attaching the old structure to new external parametric frames. Usually this is combined with the incorporation of internal structural walls perpendicular to the longitudinal direction of the frames.

There are several reasons why altering the seismic vulnerability of the structure of a hospital building is usually more complex than a similar operation in another type of building:

- Normally the building cannot be vacated in order to carry out retrofitting.
- The scheduling of the construction work must take into account the need to keep different medical services operating, and to

avoid seriously disrupting hospital activities or unjustifiably interrupting certain types of services.

- The need to perform a large number of unforeseen tasks due to the difficulty of identifying in advance precise details of the construction process.
- The complexity of the non-structural elements and the difficulty of identifying changes or effects on architectural elements prior to the beginning of the structural alteration.

It follows from the above that should be based on a very detailed work plan that includes keeping medical services going at each stage of the process. In the same way there must be coordination between administrative personnel, the medical staff, and the maintenance department of the hospital.

It is not possible to know the cost of reducing the vulnerability of a hospital unless there is a detailed design of the structural solution and of its implications with regard to non-structural elements. However, this does not preclude drawing up a plan in advance with enough precision to ensure that it will only require minimal adjustments as the work proceeds.

Usually reinforcement costs are relatively high if they are carried out all at once. However, if the work is carried out by stages, it makes it possible for funds to be assigned more gradually and more in line with a hospital's maintenance budget.

Cost-benefit ratio

In general, it is possible to divide mitigation recommendations into two categories:

- Those that are easy to implement in the short term, for example providing windows with shutters and extra locks for doors; installing additional fasteners to roof tiles; fixing external plants; or relocating storage systems to safe buildings if the building where they are is vulnerable. These tasks should be carried out by the maintenance staff of the health center or by small contractors.
- Those that require the advice of specialists or major capital investment, such as expensive modifications or new constructions to be built in the medium and long term.

In many cases, it is up to the maintenance staff to take such steps, which can be an advantage given their knowledge of the site and their ability to carry out periodic reviews of the measures adopted. Indeed, the

improvement of existing buildings and structures can be carried out through routine repairs and maintenance.

The additional costs involved in making a building resistant to hurricanes, earthquakes, and floods can be considered a form of insurance. Comparative studies show that the difference in costs between a building constructed according to anti-seismic specifications and a similar building where the code has been ignored may vary by between 1% and 4% of the total cost of the building. If the cost of the provision of the hospital's equipment is considered, the percentage could be much lower, because equipment costs may represent around half the total cost of the building.

If one analyzes the problem in terms of the cost of protecting a specific piece of equipment, the difference could also be surprising. For example, a power outage in a hospital as a consequence of severe damage to an emergency generator which could cost US\$50,000 to repair, can be avoided by installing seismic insulators and other fixtures to keep the generator from overturning, the cost of which may be as little as US\$250.

The high economic and social returns of improving the structural behavior of vulnerable hospital buildings have been demonstrated. The cost of retrofitting, although it may seem high, will always be significantly less than the services budget or the alternative cost of repairs or physical replacement. Some good figurative questions to ask might be, how many scanners could be bought for an amount equivalent to the cost of retrofitting? And how many scanners does the hospital have? The replies could yield surprising results, without taking into account all the other elements, equipment and goods that the building normally contains, not to mention the human lives involved directly or indirectly and, in general, the social cost of a loss of hospital services.

Planning and financing

As mentioned earlier, health administrators should spot opportunities to include disaster mitigation and preparedness as part of the hospital infrastructure and operation. Coordination with the governmental and private entities that are responsible for the study of geological, seismological, and hydrometeorological conditions will make it possible for them to be familiar with the different hazards to which existing or projected health facilities will be subjected. This will enable them to take the pertinent mitigation measures to diminish the general vulnerability of hospital infrastructure. For this purpose it is necessary to define an

acceptable level of risk, which establishes a balance between the cost of the investment involved and the benefit expected in terms of economic and social losses avoided within a framework of feasibility.

Planning is a permanent activity, fed by the knowledge described above and carried out explicitly as an expression of institutional policy, which should formulate the objectives, the strategies and the activities to achieve them. There is a need, also, to plan aspects related to risk mitigation and later to prepare for providing care in emergency situations, although of course these are not independent activities but are rather closely related, each complementing the other.

Promotion and financing strategies

One of the great difficulties is demonstrating the need for an investment and its merits in terms of cost-benefit analysis. Factors that weigh against making an investment at a given time include: the limited extent to which certain types of natural disasters can be predicted, the relatively prolonged periods between recurrences, and the almost permanent economic crises of many medical facilities and of the health sector as a whole in most developing countries. This latter situation has limited the resources available for investment. However, despite everything said so far, it can be argued conclusively that a decision to reduce the vulnerability of the health services in order to guarantee the safety of people and equipment and the continuity of service at times when it is most needed, is amply justified in terms of economic and social returns.

There are various ways to promote and finance this investment. While those cited below are relatively simple, they obviously call for a well-coordinated program of mitigation and preparation for disasters for health installations, that includes human resources education, technological development, standardization and advisory services.

Approval of licenses to operate

Approval or renewal of a health center's license constitutes an excellent opportunity to require that every center consider earthquake resistant construction techniques and measures in preparation for both external and internal emergencies.

Approval of investment budgets

It is common knowledge that budget allocations are one of the principal instruments for promoting processes of investment and

development with specific emphases, which in this case would be the inclusion of disaster mitigation and emergency preparedness in institutional development plans. Thus, consideration of a request for financing maintenance or construction works (remodeling, expansions, etc.), can be made dependent on the inclusion of the above mentioned factors in the design.

It is considerably more economical to construct a health facility using earthquake-resistant techniques or to carry out retrofitting of a building constructed without such techniques than to face the economic loss resulting from the collapse of the hospital building with all the morbidity and mortality, loss of equipment, and the interruption of services that such a disaster would entail.

Approval of support allocations

Another way to encourage and promote the adoption of disaster mitigation measures and emergency preparedness in hospitals is to offer economic support through allocations that specifically encourage and facilitate their adoption, either by cofinancing relevant studies, consultancies, and designs, or by carrying out some of the works.

NEW DESIGNS FOR HOSPITALS

Health centers have special characteristics as regards occupation, complexity, critical supplies, dangerous substances, dependency on public services and continuous interaction with the external environment. Since natural disasters are infrequent, very often they are ignored in the planning and design of hospitals and of other related installations, even in regions where the risks are well known. It is possible to predict with accuracy what may happen in an installation as a consequence of earthquakes or other types of disaster, but given the great variety of activities that may be underway in a hospital, it is necessary to carry out a careful analysis of possible scenarios in order to avoid a chaotic interruption in hospital services.

An unsafe building may suffer structural damage or even collapse. If such a collapse occurs the disaster is greater, since the hospital becomes a problem requiring a great deal of attention rather than an institution providing support for the affected community. Serious damage may lead to a complete evacuation of the hospital and, as a result, to loss of hospital services for a prolonged period of uncertain duration.

Mitigation of the effects of natural disasters is, as mentioned earlier, a highly cost-effective activity. Earthquakes provide, perhaps, one of the clearest and most representative examples of this.

The design stage constitutes, without doubt, an excellent opportunity to implement effectively and efficiently mitigation criteria and emergency preparedness in the health systems. The five stages traditionally described in the planning of health units are:

- Diagnosis
- Preparation of the medical-architectural program
- Formulation and presentation of the draft plans
- Design of specialized areas
- Definition of equipment

Diagnosis

This is based on identification of the population group that will be served by the health facility, its composition and dynamics (foreseeable changes), the factors that determine it; quantification and qualification of health problems; health resources available in the area and accessibility and utilization of those services by the community; the existing levels of coordination and communication between these centers; and conditions affecting the operation, construction and maintenance of health facilities. Specifically, it is necessary to identify:

- ***Demographic and socioeconomic factors*** relevant to the population such as growth rates, age distribution, economic level, social and cultural characteristics.
- ***Epidemiological factors*** which could prompt the creation of specific services for diseases prevalent in the region.
- ***Mortality and morbidity***, which reflect the state of the population's health, and in turn determine the potential demand for outpatient and hospitalization services.
- ***Communications and accessibility***, which determine the relations that should exist between different health care units in a region, and in some cases the need for more or less funds, depending on relative isolation from or nearby availability of resources.
- ***Topography and type of soils***, understood not only as the morphology and formation of soils, also including the seismological features of the region that will determine the selection of the building site and the type of structure.
- ***Climatology***, including data on temperature, moisture, prevailing winds and rainfall, which will determine the selection of the site, as

well as serving as a guide for building the structure, type of ventilation, natural illumination, etc.

- **Hazards and risks.** Coordination with the governmental and private entities that are responsible for the study of geological, seismological and hydrometeorological conditions will make it possible to know the different hazards to which a particular population group will be exposed. That will determine a probable demand for medical services in the event of disaster as well as the need to take the mitigation measures required to diminish the general vulnerability of hospital infrastructure.
- **Area of influence.** Based on the considerations described under communications and accessibility, a certain geographical area will be defined within the jurisdiction of the institution with its respective referral and counter-referral system for patients.
- **Resources and services.** This means those installations, furniture and equipment; professional, technical and auxiliary personnel; and financial resources available for health expenditures that form part of the health organization where the new health center will function and that are likely to be utilized within the institution.

Preparation of the medical-architectural program

This takes as its point of departure the justification and the diagnosis mentioned in the previous section, and with the help of a multidisciplinary team initiates the detailed description of the services and areas required. These are then translated into construction plans that result in a preliminary architectural model that specifies the type of construction, function, height, orientation, distribution of spaces or services, capacity, connections and circuits, and so on.

Formulation and presentation of the draft plans

This consists of a detailed elaboration of the medical-architectural program in the form of plans. It will include the required specifications concerning capacity to resist earthquakes in accordance with the established diagnosis.

Design of specialized areas

This is based on specialist advice in defining such aspects as: water installations, wastewater, illumination, ventilation, waste disposal, gas systems (oxygen, compressed air, anesthetics, suction), and the electric system with built-in installations for radiology, radiation therapy, etc.

The designers will take into account the observations made in the section on non-structural and functional vulnerability.

Architectural design

The conceptual design involves making a series of decisions, including:

- Location of the building;
- Functional relations between hospital sectors;
- Geometry, shape or composition of the building;
- Structural system;
- Building materials.

These are decisions that should be taken jointly in the early stages of the execution of the project by the owners, health administrators, physicians and other medical personnel, architects, engineers, builders, and all those professionals who for some reason are involved with its conception and execution.

One should emphasize that, due to the complexity and close relationship to the spatial and formal layout of the construction, the problems of configuration should be tackled at the stage of preliminary definition of the spatial layout of the building, and throughout the formal and structural design stage. Thus, configuration is a subject that should be grasped in all its breadth by the designers and architects.

The seismic design of hospitals is a responsibility shared by the architects and the engineers. In particular, it is necessary to emphasize that it is shared with regard to the physical relationships between architectural forms and resistant structural systems, and it would be ideal if every designer working in disaster-prone areas understood those relationships. Unfortunately, international educational methods and practice have tended to reduce incentives for promoting this broad approach in a designer's way of thinking since training for new architects is separate from that given to new engineers and, in many cases, they remain distinct in practice. As it happens, some architects, by intuition or because of their intellectual background, have an excellent sense of structure, but this understanding on their part tends to occur despite their education and practice.

The costs involved are determined by construction techniques, the availability of materials, the nature of the equipment used, labor, and the time taken in construction, which is the reason why in some countries the responsibility for monitoring costs is entrusted to people trained in other disciplines, such as field supervisors. However, ideally, designers should

from the beginning be able to count on a professional or a group of professionals who can integrate all aspects that have to be taken into account, among which are the requirements for dealing with natural disasters. In other words, the ideal would be to have a conceptual designer with sufficient experience in architecture, engineering, costing and construction, to enable him or her to consider aspects with which to achieve maximum efficiency in design.

Design requirements in engineering

Although this document does not attempt to be a manual on design for engineers, it is important to indicate that many problems in the design of health installations can be recognized by the owner of the services, the administrator, the planner, the architect or the engineer. They can also recognize the factors that may substantially increase the seismic risk of existing buildings or of the new ones to be constructed. These factors are:

- An appropriate evaluation of the seismic hazard, including the local conditions of the soil. The harm done to a building depends both on its resistance and the type of soil it is built on and the intensity and the characteristics of the seismic movement itself.
- The design of new health installations in accordance with the requirements of the seismic building codes of each country attempts to guarantee an acceptable level of safety from the economic and social point of view.
- The administrators of health facilities should consider how to implement additional performance requirements for earthquakes in order to protect the occupants and the internal components of the building.

It is suggested that seismic performance should be guided by the following objectives, in the case of health facilities:

- The damage caused by strong earthquakes should be repairable and should not be a threat to life.
- Patients, personnel and visitors should be protected during an earthquake.
- The emergency services of the health center should remain operational after the earthquake.
- The occupants and rescue and emergency personnel must be able to move about safely inside the installations.

These objectives attempt to guarantee that the hospital is able to fulfill its role by putting into effect its emergency plan following a disaster.

The loss of life and property caused by earthquakes can be avoided by applying existing technologies and without going to enormous expense. The only thing that is required is the will to do it. Since around two generations are required before the current inventory of buildings in most communities gets replaced, as much attention must be paid to the structural improvement of existing buildings as to the design and construction of new buildings. At this time there exist very few technical limitations on the design and construction of most buildings to enable them to resist hurricanes, earthquakes, or other natural hazards which means that it is possible to minimize risks and damage if preventive measures are incorporated into the design, construction and maintenance of new health installations.

Definition of equipment

This refers to thorough specification of the individual characteristics of each of the pieces of furniture, equipment, sets of instruments and material required for the operation of the institution. It encompasses everything needed in operating rooms, hospitalization and consultation rooms, laboratories and diagnostic aids, kitchen, laundry, maintenance, etc. Each of these descriptions should include aspects regarding damage mitigation, the location of the equipment, how it is secured, and considerations regarding functional vulnerability.

CHAPTER 5

EMERGENCY PREPAREDNESS

HOSPITAL EMERGENCY PLAN

Owing to their geological, topographical, and hydrometereological characteristics, as well as their level of industrial and social development, the countries of Latin America and the Caribbean are exposed to the occurrence of natural disasters, such as seismic movements, volcanic eruptions, floods, hurricanes, landslides, etc. and to man-made disasters or accidents, such as fires, explosions, spills of hazardous substances, toxic gas leaks, etc. Apart from causing, in most cases, huge economic and social disruptions, such events also have a sudden and massive impact on the health status and health conditions of the exposed population, due to the occurrence of deaths and injuries, and of environmental and epidemiological changes.

If one adds to this the structural, non-structural and functional vulnerability of health facilities, the need to draw up emergency plans for hospitals is evident. These plans make it possible to protect first the hospitalized patients, the staff, and visitors, and, secondly the equipment and installations, while maintaining the ability to provide services on a larger scale than before as a consequence of the disasters. This plan should be operational, functional, and flexible so that it can adapt to

circumstances. It should be familiar to the entire staff of the hospital and be reviewed and updated at least once a year.

EMERGENCIES OUTSIDE OF THE HOSPITAL

The hazards that can trigger an emergency situation or a disaster can be classified in two groups: foreseeable and unpredictable. The first permit the health sector to take a series of steps, starting from a state of alert, through three levels of readiness, up to the very moment that the emergency begins. In contrast, with the second type of hazard there is no time for such preparations.

Alert stages may be of various degrees of intensity, according to the severity of the foreseen disaster and the capacity of the health center to respond. Typically, these different stages are known by their colors.

- **Green alert.** The staff who at that point are working routinely in the hospital are organized to deal with a possible emergency, but the rest of staff who are not present in the hospital remain on call in order to be able to provide reinforcement.
- **Yellow alert.** Preparedness with physical presence in the hospital. The organization is ready with all its resources, but has not yet begun to attend the victims of the disaster.
- **Red alert.** This goes out as soon as the scale of the demand for medical attention as a result of the disaster is apparent; it may be preceded by the previous stages or it may be declared from the outset.

Depending on the magnitude of the disaster, the levels of preparation range from self-sufficiency to the request of external assistance. Thus:

- **LEVEL I.** The human and physical resources available are sufficient to handle the situation.
- **LEVEL II.** It is necessary to summon up all the resources of the hospital in order to deal effectively with the situation.
- **LEVEL III.** The hospital's capacity is exceeded, and it is necessary to request external support.

Once the red alert is declared, the formal organization of the hospital disappears and is replaced by a functional scheme. A model scheme of this kind is to be found in the appropriate section below.

Components of the emergency plan

Identification

It is necessary to have basic information on the health facility that can be used at a given time by hospital staff who do not always know such obvious data as: address of the hospital; type of institution (private, official, mixed); level of complexity; hospital capacity in terms of the total number of beds, beds available in the case of an emergency and occupancy rate. A brief description of the communications systems of the hospital, the number of telephones, fax and/or telexes, radio communication frequencies and the type of transportation that it owns such as in-service ambulances and other vehicles.

Internal and external hospital maps

Every emergency plan should have a diagram showing access routes to the hospital and the flow of patients in accordance with medical treatment priorities. This map would also locate admissions, emergency, inpatient care units, surgery, laboratory, x-ray, morgue and information areas, etc.

Alarm

This is the signal or warning by siren, bell, whistle or message to the staff of the hospital which activates the hospital's emergency plan in case of an external emergency. For this purpose it is indispensable to define how emergency calls are to be taken and the type of information that should be requested. They can be received through telephone systems available 24 hours a day or by radiocommunication. Operators working in shifts must be assigned to both the telephones and radios.

It is also necessary to specify who sounds the alarm and how it is to be transmitted: by siren, bell, whistle, message over the loudspeaker or by word of mouth; and how the chain of communications or calls is to be activated, a process that should be initiated as soon as the alarm is sounded. For example, the chief of emergencies communicates to the director of the hospital or to the person in charge. In their absence, he or she establishes contact with some member of the Hospital Emergency Committee who in turn contacts other members of the committee, who call the heads of different services, in the following order:

Chief of Emergency Services
 Director of the Hospital
 Head of Medical Treatment
 Head of Operating Rooms
 Head of Outpatient Consultation

Head Nurse
 Nurse-in-charge of Operating Room
 Nurse-in-charge of Inpatient Care Units

Administrator
 Maintenance Chief
 Head of Statistics

Functional organization

During an emergency, the formal organic structure of the institution is temporarily suspended and replaced by a functional organization, made up of medical, diagnostic, support service, and administration teams.

HOSPITAL EMERGENCY COMMITTEE		
MEDICAL TREATMENT	DIAGNOSIS AND SUPPORT	ADMINISTRATION
Emergencies	Clinical laboratory	Maintenance
Operating Rooms	Blood bank	Communications
Inpatient care	Radiology	Transportation
Outpatient Consultation	Pathology-morgue	Food service
Special medical care or intensive care unit	Pharmacy	Statistics
	Social work	Supplies
	Volunteers	Security
		Laundry

Hospital Emergency Committee (HEC)

The Hospital Emergency Committee is made up of 4 or 5 members of the hospital staff, in charge of performing a series of activities before, during, and after a disaster. They should be formally appointed and all should have deputies who could stand in for them and guarantee that the hospital continues to operate in their absence.

HEC - Actions PRIOR to the disaster

The Committee will have activities of a permanent nature, including, for instance:

- Structural, non-structural and functional vulnerability analysis, as well as carrying out alterations to remove the causes of such vulnerability.
- Inventories of human and physical resources.
- Determining how long the hospital can support itself in the event of a disaster (estimated duration of reserve stocks of drugs, supplies, food, water, gas, fuel, electricity).
- Determining operating capacity, that is, the maximum number of patients who can be attended to simultaneously, based on the number of patients handled by the emergency service, by the surgical services, and by the intensive care unit, both under normal conditions and given a certain amount of reinforcement.
- Identification of the functional areas and those that could be expanded to increase hospitalization capacity.
- Establishment of the circulation of patients within the health center.
- Internal posting of signs (pointing to stairs, exits, fire extinguishers, services, etc.).
- Establishment of an organizational chart for emergencies.
- Adoption of a triage card or instrument for identifying and classifying patients.
- Drawing up a Hospital Emergency Plan (HEP) in accordance with the hospital's level of complexity, capacity, and the demand that may be generated as a result of an emergency or a disaster.
- Coordination of this HEP with other existing plans at the municipal level (for instance, with those of rescue teams, firemen, military units, other hospitals, etc.).
- Testing existing plans, through simulations and fire or other emergency drills that make it possible to update them periodically, at least twice a year.

HEC - Actions DURING a disaster

- Confirming the resources for which they are responsible.
- Determining the extent to which the hospital can respond to the emergency or disaster.
- Assigning the necessary resources.
- Checking the number of staff and amount of equipment.
 1. Existing

2. Available
 - Number of beds
 1. Available at the time
 2. Total existing
 3. Possibility of increasing
 - Checking medical supplies.
 - Cancellation of optional surgical cases.
 - Information to referral and support hospitals on the occurrence and characteristics of the emergency.
 - Determining the need and the desirability of sending medical equipment to the place of the disaster.
 - Organizing shifts for hospital staff, taking into account the need for efficiency, sufficient time for rest, and the likely duration of the emergency.
 - Preparing press releases with information concerning hospitalized patients, referred and day patients, and determining the physical and human resources to be requested, since the HEC is the only entity authorized to do this.

HEC - Actions AFTER the disaster

- Reviewing the guidelines indicated in the previous section above, evaluating performance, implementing the necessary corrective actions, and reporting on them to the hospital staff.
- With regard to the provision of medical care, the HEC will make sure that the following tasks continue:
 - Physical therapy
 - Mental therapy
 - Social therapy
 - Occupational therapy
 - Basic primary health care programs, including maternal and child services, mental health outpatient consulting services, and emergencies, as well as environmental sanitation.

The health center should, at the same time, extend its field of action beyond its own installations, intervening in measures involving medical care, environmental sanitation, and epidemiological surveillance in shelters and refugee areas.

Treatment of patients

The way to handle a large number of patients is to use the triage method. Triage is the diagnosis process that ensures that the largest

possible number of patients are treated, while setting priorities and arranging transport for them. Its parameters are based on severity of the injuries, prognosis and the chances that the action taken may contribute to the recovery of the patient.

The degrees of priority can be represented through the utilization of colors, as indicated below:

COLOR	TYPE OF PATIENT	PRIORITY
Red	Critical. Recoverable	First
Yellow	Deferrable	Second
Black	Critical. Recovery unlikely	Third
Green	Mildly injured	Fourth

For corpses no color is issued and they are not a priority for health personnel.

Assuming that the number of patients to be treated following a disaster will be significantly higher than the average number usually handled by the treatment center, the allocation of staff should initially concentrate on four fundamental areas, in accordance with the priorities established in the triage.

Thus there will be an assigned level of priority and a medical team and area chosen for any particular course of action. An example of this organization is shown below.

TYPE OF PATIENT	RESPONSIBLE TEAM	AREA OF INITIAL DESTINATION
RED Card	Stabilization team	Emergency Service
BLACK Card	Black team	Observation of Emergencies
YELLOW Card	Yellow team	Area of Outpatient Consultation
GREEN Card	Green team	Area of Vaccination
Corpses	Pathology	Morgue

This organization is meant to rationalize the existing human resources in the hospital and those that could be called upon as reinforcements in the event of an emergency. For this purpose it takes into account the

three areas mentioned: emergency medical treatment, support services and administration.

A list should be drawn up containing all the functions assigned to each of the teams. This list should be copied or photocopied in order to form a functions notice board. This should be located in a strategic place in the hospital so that it can be consulted both in normal times and in an emergency.

Triage team

In accordance with current thinking, triage involves not only establishing medical care priorities and transportation needs, but also includes deciding which cases to refer. That makes it possible to rationalize existing resources in the hospital where the emergency is being handled and also to make use of neighboring hospitals, bearing in mind their level of complexity and the number of patients they can cope with.

The triage team is made up of personnel with experience in the field of emergencies, surgery or traumatology. It directs the patients to the areas where they should receive initial treatment. The location should be as close as possible to, but outside of, the emergency service, and close to the ambulance entrance.

As many triage teams as are needed and feasible, given existing capacity, should be formed. Each one should be made up of a trained doctor, a nurse, an auxiliary in charge of keeping statistics, and two orderlies and volunteers to replace some of the last two categories mentioned, if need be.

It should be pointed out that the triage team is temporary and that once it finishes its task, it will be incorporated into the other hospital teams as needed.

Functions:

- Classification of the patient according to priority of treatment.
- Remission or referral of the patient to the right place within the hospital in order to initiate his/her stabilization and/or treatment, or outside the hospital, in the case of outpatients.
- Patient referral to other treatment centers, following stabilization and coordination in accordance with the parameters of the medical care manual.
- To inform the Hospital Emergency Committee.

Stabilization and emergency treatment team:

Response levels I and II (treatment with normal hospital resources). The area to be utilized should be predetermined, using, if necessary, areas near the emergency service. Teams should be formed consisting of a doctor, a nurse, an orderly and a volunteer, and there should be as many such teams as are needed, depending on available capacity.

Response level III (the magnitude of the disaster requires external support). At this level it is necessary to appoint a coordinator for the external support teams to make sure they perform well and in harmony with the other teams.

Functions:

- Care of patients in accordance with assigned priorities.
- Establishment of standardized procedures and treatment.
- Determination of patient destination:
 - Diagnosis areas
 - Inpatient rooms
 - Operating rooms
 - Special care unit
 - Morgue
 - Discharges
- To report needs to the Hospital Emergency Committee.

Surgical team:

This team is made up of staff for operating and sterilization rooms. A doctor should be appointed to be in charge of the operating rooms, together with a head nurse in that area, if possible with replacements in case one of them is absent. It is important to designate a meeting place next to the operating rooms, changing rooms or recovery rooms.

Level I: The kind of organization set up depends on the level of response that is considered necessary to deal with the emergency. The teams are made up of a surgeon, an aide, an anesthetist, an instruments nurse, another nurse, an orderly and a volunteer.

Levels II and III: Additional teams should be available in accordance with the availability of rooms at a given time, and with the availability of qualified human resources capable of performing the functions needed.

Functions:

- Suspending all optional surgery.

- Organizing surgical equipment (surgical boxes, gowns, instruments, supplies).
- Checking the presence of medical personnel (surgeons, aides, anesthetists) and of paramedical staff (instrument staff, nurses, auxiliaries, orderlies, volunteers) assigned to this area.
- Providing surgery in accordance with established priorities.
- Remaining constantly in contact with the chief of emergencies.
- Checking out areas other than the operating rooms that could be used for surgery.
- Reporting needs to the Hospital Emergency Committee.

Special care team

Considering that hospitals of first and second levels of complexity do not have intensive care units, but that it is necessary to find a place for patients that require special medical care, the most suitable areas should be chosen beforehand, assigning to them the personnel and the basic resources needed in order to serve that type of patient.

Yellow team

This team should serve patients that were described as deferrable and that are usually taken care of initially in the outpatient consultation area. This area is recommended since in normal times it has stretchers and other elements that allow the area to be adapted into whatever is needed.

Such teams should be made up of a doctor, a nurse, nursing auxiliaries and voluntary personnel.

Green team

This team looks after mildly injured patients on an outpatient basis, and it consists of a nurse and a nursing auxiliary. If existing resources allow it, a doctor could be added to the team. Since it is an outpatient activity, the area chosen should be away from the emergency service and set aside from other areas of treatment.

Hospital team

This team is in charge of helping and supervising patients already in or admitted to wards, rooms, or floors for hospitalization. A meeting point should be established. It could be at a nurse's desk or a classroom or meeting room.

The team consists of doctors, nurses, auxiliaries and volunteers. More teams can be set up, if needed. Members of the new teams may

come from the triage teams that have been reincorporated into the hospital or are the product of reorganization after the emergency stage.

Functions:

- To evaluate and to discharge patients who can be released.
- To ensure that reserve beds are available at all times.
- To determine the possibility and need for adapting areas of expansion.
- To ensure the provision of the elements and supplies needed to provide adequate attention in wards.
- To inform the Hospital Emergency Committee of changes made, and what is currently needed.

Support services

Support services are made up of each of the following services:

- Clinical laboratory
- Radiology
- Pathology - morgue
- Pharmacy
- Social work
- Coordinator of volunteers (Civil Defense, Red Cross, others)

They will be staffed with the normally assigned personnel, working at most a 12-hour shift, but they can be reinforced if needed, and if sufficient personnel are available.

The functions of each service should be described in the emergency plan's appendix on functions, in the section corresponding to the staff members of each service mentioned.

Administration

The areas described below are of vital importance and for that reason have been incorporated in the emergency plan.

- Maintenance
- Communications (telephone operator, radio operator)
- Transport (Head of Transport, the most senior driver)
- Food service
- Statistics
- Supplies
- Security
- Laundry

These should be composed of the personnel normally assigned in each area. If they are short-staffed, auxiliary personnel should be trained in this type of work, so that each team can fulfill the functions assigned to it.

Public Information Center

Given the importance of establishing a place where the general public can go to request information concerning family members, a site should be considered that is independent of the internal hospital teams but which is closely in contact with them. It should be coordinated by the social worker of the hospital and staffed by hospital personnel or by volunteers. Its location should be on the perimeter of the hospital, where it does not interfere with triage and other medical activities. Its functions are as follows:

- To give information about patients admitted and discharged to family members and others concerned for the victims.
- To find out the address and whereabouts of family members of patients admitted to the hospital.
- To coordinate with the transportation team and with institutions and individuals outside the hospital for the transfer of patients.
- To collaborate in the identification of the victims.
- To help family members to locate victims.

Areas that can be converted for emergencies

Described below are the three most important settings within the hospital that should be predetermined so as to allow the different teams to act quickly and in an orderly fashion.

Triage area. An area next to the emergency service but not inside it, with easy access to the ambulances. It should be indicated on the first map in the front of the emergency plan manual.

Areas to accommodate extra beds. Areas other than corridors and passageways should be used, since these could block the normal flow of patients and hospital staff. Ideal areas are medical staff lounges, conference rooms, chapels, solariums waiting rooms, etc. Their description should include where they are located, their size in square meters and the number of extra beds that could be placed there. If these areas are to be used, one should take into account their proximity to the operating theaters and also the resources available in those rooms

(electric outlets, oxygen connections, suction tubes fixed to the walls, etc.) Such places can be predetermined for use as observation, hospitalization, post-surgical recovery or intensive care units. To remember which is which, it suffices to use the letters O, H, PS, or ICU respectively.

Parking lots. Likewise it is essential to define the areas where both ambulances and private cars are to be parked. The helicopter landing pad should be considered a fundamental part of the hospital. Advice on its use should be requested from experts (commercial aviation, the armed forces, etc.)

Referral and support hospitals

It is important to identify all the referral and support hospitals noting their characteristics and distances (understood as the time usually spent for the transportation of patients, whether by air, river, sea or land). The initials A = air, R = river, S = sea or L = land are used, depending on which type of transport is employed. Also to be noted are level of complexity, number of total beds in the hospital, the number of beds available in the event of an emergency, the type of patients who can be handled (in terms of surgical and medical pathology), together with aspects such as the availability of ambulances to help out in an emergency and the possibility of sending human or physical reinforcements, if needed. This information will help rationalize referrals.

Hospital support group

This is made up of professionals, technicians and others who can contribute their knowledge and experience and thereby help the hospital perform well. They should be registered with their name, profession, address and the telephone number or other medium through which they can be reached.

Sources of supply

Water. One should note the principal source of water, specifying the nature of the water, (treated, partially treated or untreated). Details should include aspects related to non-structural and functional vulnerability analysis (condition of the tanks, networks) as well as the procedures for a prompt response in case repairs are required.

In the same way, note should be taken of alternative sources such as wells, rural water supply systems, firemen or others that could provide the service to the hospital if the principal source is cut off.

Electricity. Note the type of power provided, whether it is mono- or three-phase, the power plant it comes from and the characteristics of the current provided (volts, amperes, watts, cycles). Details should be included on aspects related to non-structural and functional vulnerability analysis (condition of the internal transformers, fuse boxes, wiring) as well as the procedures for a prompt response in case repairs are required.

Similarly, note should be made of alternative electricity supplies such as electricity generators, either belonging to the hospital or not, that would be utilized in an emergency situation.

Fuel. Note how much fuel the hospital uses, including that needed for vehicles, electricity generators, and boilers. Details should include aspects related to non-structural and functional vulnerability analysis (condition of the storage tanks). It is important to identify an alternative source of fuel, if needed.

Gas and oxygen. Details should include aspects related to non-structural and functional vulnerability analysis (condition of the tanks, distribution networks), as well as the procedures and equipment, such as alarms and safety valves, needed for a prompt response in case of disaster. Record the name of the company that normally distributes the gas and oxygen, as well as possible alternative sources.

Food. Note the name of the stores where food is bought under normal circumstances, as well as others where food and other supplies needed in an emergency could be acquired.

Medicine and supplies. Record the names of companies where drugs and supplies are normally obtained, as well as other warehouses, depositories and institutions where they could be acquired if necessary.

EMERGENCIES INSIDE THE HOSPITAL

There are a great variety of events that, as we said earlier, may endanger hospital installations, the people in them (patients, employees, visitors) and the provisions and equipment to be found there. Among the major natural disasters, we have taken earthquakes as a point of reference for emergency planning since it is the event that causes most damage to the physical plant, in addition to serious damage in terms of morbidity and mortality. Among acts induced or caused by man, fires, explosions and attacks are the events which most frequently and seriously

affect hospital infrastructure. In such situations it will be necessary to evacuate the buildings, depending on the physical state of the structures; on the functionality of the equipment and services; on the condition (without injury) of the staff and their capacity to react, which will be determined to a great extent by the training they have received, the degree of organization, and by the equipment necessary for handling the emergency.

Evacuation is defined as the set of activities and procedures aimed at conserving the life and physical integrity of people, should they be threatened, by moving them to less risky areas.

With regard to the scope of the evacuation, it may be

- Partial: specifically defined areas.
- Total: the entire hospital.

The decision to evacuate, and to what extent, should be taken by the director of the hospital, head of medical services, the administrator, the head nurse, or the doctor on duty. Officials not related to the hospital, such as firemen, may, given their knowledge of the layout of the hospital, of its structure and formation, lead the evacuation when the time comes to carry it out.

Likewise the advice of an engineer with knowledge of structural engineering and earthquake resistance can help determine the need for either partial or total evacuation after an earthquake.

With regard to this last point, it is worth emphasizing the importance of establishing contact prior to the emergency between the health sector and national associations of civil, structural and seismic engineers, since they have highly developed techniques for detecting problems in the physical plant. In the case of hospitals, certain evaluations should be carried out prior to any disaster. After a seismic event, groups of the qualified personnel mentioned above should evaluate the state of the building immediately and take the pertinent measures. It is important to determine the evacuation routes for each sector of the hospital (i.e. rooms, wards, wings or services, such as pediatrics, surgery, maternity, internal medicine, etc.). These routes should lead from any point in the hospital to less risky open-air spaces outside. With these considerations in mind, next there should be a list of the established routes, described in a way that would be recognized by the entire staff, for example: outpatients consultation corridor, the staircase in the emergency department, main corridor, etc.

As for where these routes lead to, the destinations should be located in safe areas of easy access, preferably in the open air and with the capacity to hold the number of people expected to evacuate by that route. Finally, priorities should be established in the following order:

- Children
- Disabled (physical or mental)
- Women
- Men

The plan should mention the section or service to evacuate, the route, point of exit and final destination. For example:

- Service: pediatrics; route: main corridor; exit: main door; destination: park.
- Service: surgery; route: ramp leading to operating theaters; exit: door to the parking lot; destination: parking lot.

The system of evacuation should be tested to check whether the order and routes are appropriate and that they permit rapid and safe evacuation. Once this test has been carried out, the routes, exits, fire-fighting materials, internal services, etc., should be marked using clear, highly legible signs. These topics can be used to design leaflets or other materials that facilitate the permanent dissemination of the plan among the staff of the hospital, patients and visitors.

Diagram of the hospital for internal emergencies

Maps of the hospital should be drawn up identifying evacuation routes, stairs, emergency exits, safe areas for evacuation, location of fire-fighting equipment, boilers, fuel tanks, oxygen tanks, as well as the safety areas for evacuation.

Sequence in evacuations

Alarm

Sounded initially by the head of emergencies on duty, who immediately will contact the director of the hospital or the highest ranking professional available at that moment. Risk classification will make it possible for him to decide whether the evacuation should be partial or total. The necessary external support will then be requested: Firemen, Civil Defense, Red Cross, professional associations (for example, engineers in the case of earthquakes), and others that are considered of importance at the time.

The order to evacuate

This will be issued by the director or highest-ranking professional available at the time of the emergency, although they might be assisted by non-hospital staff, for example, by the fire chief.

Priorities:

- People (children, disabled persons, women, men).
- Materials, divided into three large groups:
 - Dangerous - Those which can cause risk of greater destruction (oxygen cylinders, fuels, anesthetic gases, etc.).
 - Material useful in emergencies such as sets of instruments, resuscitation equipment, respirators and portable ventilators, etc.
 - Documents and previously classified material that cannot be replaced.

Execution

Once an evacuation has been ordered, all the staff should obey the order, with the sole exception of personnel assigned to bringing the risk itself under control (maintenance staff and others designated by the director or available administrator). It is important to recall that after a seismic event, there can be further tremors, usually of less intensity than the initial quake but which can aggravate its destructive effects, which is the reason why it is advisable to use interior and exterior safety areas as well as established routes of escape.

The most experienced person available will take charge of the evacuation. Hospital staff will transport the disabled patients who cannot move themselves. Some people will be put in charge of moving materials useful in emergencies and documents, in accordance with the priorities described previously.

Attending to those evacuated

Those evacuated should be told to remain calm and to rest in safety areas and those who require it should receive medical care. An area to look after emergencies and patients with preexisting pathologies should be set up in the same area. A triage system will have to be resorted to, if necessary, in order to ensure rapid and timely attention to patients, following the criteria established in this document.

Safety and administration

Once an evacuation has been ordered, visitors should be evacuated and staff not needed to deal with the emergency should not be allowed in. A practical measure consists in evacuating the parking lot area, thus freeing up an extensive area for mobilization as required.

General recommendations during an evacuation:

- Once the alarm has sounded, the evacuation should be carried out in an orderly fashion without running, avoiding any shouting or exclamations that could induce panic.
- The same procedure should be followed for an earthquake, with the difference that whoever feels it will immediately notify the personnel on duty in order to organize the evacuation.
- Don't shout. Obey the orders of whoever is in charge of the evacuation.
- Neither the patients nor hospital staff should carry cumbersome objects that could hinder a proper evacuation.
- Don't wear shoes with high heels.
- Don't use the elevators.
- If someone falls, he or she should be taken out of the evacuation route and then helped to get up, otherwise he could cause others to fall and create a pile-up. Whoever is nearest should help the person who fell to stand up as quickly as possible.
- If someone loses something during the evacuation, he should not attempt to recover it, but continue.
- Try to help others during the evacuation.
- Collaborate with the organizer of the evacuation in order to help him or her determine the number and state of health of the persons evacuated.
- In the event of seismic movements, tremors can be expected to follow an earthquake, so it is important to remain calm if they do occur.
- Remain in the evacuation area until otherwise advised, without hindering the task of the personnel performing specific tasks.
- **THE ENTIRE STAFF SHOULD FEEL RESPONSIBLE FOR THE EVACUATION OF THE HOSPITAL.**

CHAPTER 6

UNIVERSITY AND PROFESSIONAL TRAINING

ADAPTING CURRICULA

The health sector is one of the sectors with the most experience in preparation for and dealing with disasters and that is why, since the beginning of the 1980s, there have been moves to include the subject in undergraduate and graduate curricula for the medical professions. Although this educational strategy may have had no major results in the short term, it has contributed to a change in the way future professionals in this sector think and feel.

It is common to observe a certain resistance in medical schools, nursing schools and the public health sector in general to including new subjects in the curriculum. To do so, the importance and relevance of the subject in professional practice must be demonstrated.

Previous experience indicates that the process is usually initiated as a result of the private interest of some educator or as a result of the realization of conferences or seminars that spark interest. In this, particular circumstances play a fundamental role. For instance, the recent occurrence of an earthquake can be a catalyst for this type of activity within the university.

Institutionalizing those teaching practices is a difficult and slow process. Two studies of the PAHO/WHO Collaborating Center in

Disaster Preparedness, which functions in the National School of Public Health of the University of Antioquia in Colombia, point to important achievements but also to limitations. The first study was carried out in connection with the teaching of Emergency Health Administration in Situations of Disaster in the Medical Schools and Nursing Schools of Colombia and the other one was on the same subject but at the graduate level for schools of public health in Latin America. Both studies show that progress has been made but also that there are gaps that have impeded the generalized treatment of the subject in universities.

Among other aspects, the studies demonstrated that there are external and internal factors that influence this phase in the academic centers. The task of promoting the incorporation of the subject of disasters in the curricula of the institutions in charge of training human resources for health was initiated in 1983, beginning with public health institutions, and then medical and nursing schools. A sizable number of teaching and reference documents have been produced and continue to be produced in order to help students learn and keep up to date on this topic.

The work done by PAHO/WHO has been developed in each country by the Ministries of Health and some of the major national universities. However, there are still some obstacles due to lack of commitment on the part of educators and of the administration of academic centers, and also due to restrictions in the number of trained educators available and in support material on the subject. This situation requires maintaining and promoting an information network or the integration and utilization of already existing resources in order to rationalize the available capacity throughout Latin America and the Caribbean.

On the other hand, the above-mentioned studies also indicate that the subject fails to receive the treatment it deserves because of time restrictions within curriculum plans, because it is not recognized as a subject for curricula, and for other reasons. A comprehensive strategy to ensure that this subject gets dealt with properly at the undergraduate and graduate level is the following:

- Presentation of a well-structured proposal addressed to directors and teachers at academic centers on how to teach the subject, explaining both the importance of the subject and the proposed contents;
- Availability of up-to-date information concerning training policies related to this subject;
- Preparation of a cross-curricular project. All this should be accompanied by efforts to motivate students and to keep them up to

date through training activities such as seminars, workshops, conferences and short courses.

The curriculum could take on three forms:

- A specific unit devoted to health administration in disasters distributed over different stages of a university (or equivalent) career;
- Incorporation and coherent assimilation of the material on disasters into traditional academic divisions (epidemiology, environmental sanitation, medical and surgical faculties, hospital administration, sociology, etc.);
- A combination of the two previous alternatives, which would guarantee more homogenous knowledge of the subject linked to the basic subjects studied, and a more comprehensive and multidisciplinary vision of the subject.

The formal education and the experience of the health administrator regarding disasters can be enriched by the individual contribution of professionals in the health sector, whose training has already included aspects related to disasters, as well as other matters related to specific disciplines that contribute to "safety in the exercise of the profession", and, taken together, contribute to disaster preparedness and the ability to mitigate the damage disasters cause.

There is no doubt that once the subject is included within the academic curriculum of the health professions, it will take on a dynamic of its own. The losses caused by disasters will be less severe and capacity to supply health services following a disaster will match the demand and be based on criteria ensuring timeliness and efficiency.

CONTINUING EDUCATION

Since the current formal education strategy does not offer tangible results in the short term, it is necessary to formulate a strategy for informing those already practicing their profession, be they staff members of the health sector, consultants or educators.

Bearing in mind that the most effective strategy for getting the subject incorporated in the curricula of the health faculties is promoting training and ongoing educational activities, it is essential—before promoting the curriculum changes—to set the scene for such changes inside professional and union associations and among undergraduate and graduate-level students.

Short courses in continuing education programs and lectures on the performance of hospitals hit by earthquakes or other natural hazards in

congresses, symposia, seminars and workshops can awaken the interest of professionals involved in hospital administration and in many cases give them the foundation for beginning risk mitigation in existing health facilities and in the design of new buildings. These subjects can be presented by interested educators on their own initiative, or by a group of professionals who are knowledgeable about the subject, with a view to offering to organize for institutions of the health sector seminars and congresses that focus on the subject of risk mitigation, thereby creating concern and increasing the number of interested parties.

Professional and union associations, and the universities, can collaborate effectively to ensure that this process of professional training is developed seriously and with a sense of relevance, thereby expanding the coverage that can be achieved within institutions. This educational technique is an excellent means for comparing experience and proposing alternatives for formal education.

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