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HEALTH ASPECTS OF THE MEXICO EARTHQUAKE

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HEALTH ASPECTS OF THE MEXICO EARTHQUAKE

1. Background

On 19 September, at 7:19 a.m. (local time), a strong earthquake with an intensity of 8.1 on the Richter scale shook Mexico. The epicenter was located near the Pacific Coast at 17.8°N, 102.3°W, approximately 250 miles (400 km) southwest of Mexico City, near the coast of the state of Michoacán. In terms of intensity, this earthquake is considered to have been the strongest one of this century. The overall area affected by the seismic wave is estimated at 800,000 km,^{2} extending from coast to coast.[1]

The states most affected by the telluric movement were: Colima, Guerrero, Oaxaca, Jalisco, Michoacán, Morelos, parts of Veracruz, and the Federal District (Fig. 1). The Federal District was the most seriously affected with a large loss of lives and severe damage to buildings and the infrastructure of basic services.

On 20 September, at 7:40 p.m. (local time), a second earthquake registering 7.5 on the Richter scale, with its epicenter located at the same place as the first, aggravated the situation, causing panic in the population although damage to dwellings and the loss of lives were insignificant compared to the magnitude of the first quake.[2] During the first ten days, more than 50 secondary tremors were registered; one had an intensity of 5 on the Richter scale and occurred on 27 September at 9:53 p.m. (local time).

2. Effects of the earthquake on the Federal District

The metropolitan area of Mexico City has an approximate population of 18,400,000 inhabitants, based on UNFPA's census projection for 1985, and a land surface of 779 square miles (1,246.4 km^2). It is the most rapidly growing city in the Western Hemisphere and is undergoing accelerated industrial development. In the 1960-1980 period, the city's population tripled from 5,186,000 to 15,100,000 (Figs. 2 and 3).

Mexico City, founded by Hernando Cortez in 1522 on the ruins of the Aztec city of Tenochtitlan, is located in what used to be the Lake of Texcoco. Its geological constitution is alluvial and the ground is relatively unstable; the area has considerable telluric activity, making this city vulnerable to seismological phenomena.

The Federal District is divided into 16 wards (Delegaciones). The wards that were most strongly affected were, in order of importance for the level of damage caused: Cuauhtemoc, Benito Juárez, V. Carranza, Coyoacán, part of Gustavo Madero, and part of Miguel Hidalgo. The disaster area covered approximately 40 km^2 (25 miles^2), representing 3.2% of the area of the Federal District (Fig. 4). The most severe effects were produced in Cuauhtemoc, located in the central region of the Federal District.

Approximately 80% of the estimated total of 800 buildings destroyed in the earthquake are located in this ward, which has an area of 32 km^2 (20 $miles^2$) and an approximate population of 814,983 inhabitants. It is the commercial, hotel, and touristic center of the city; many government offices are located there as well.

The damages caused by the earthquake in the Federal District are considerably high, not only in terms of the lives that were lost in buildings that collapsed and the entrapment of victims, but in terms of the loss of multifamily dwellings, government offices that are vital for the operation of public administration, severe damage to the telecommunication system, and damage to the infrastructure of basic services, particularly the water supply network. Although an accurate evaluation has not yet been made of the losses, it is thought that they could total several million dollars in the Federal District alone, without taking into account the damages that the earthquake caused in the cities of Lázaro Cárdenas (state of Michoacán), Guzmán (state of Jalisco), and Ixtapa and Zihuatanejo (state of Guerrero)[4].

3. Damage to buildings in the Federal District and effects on health institutions

The Metropolitan Emergency Commission reported on 3 October that 2,831 buildings had been damaged in the Federal District; 880 (31%) of these are uninhabitable due to the damage, 370 (13%) will be potentially inhabitable after major repairs, and 1,581 (56%) could be recovered with minor repairs.[3] Table 1 shows the categories of buildings that were damaged.

In the health sector, three major third-level hospitals were critically affected by the earthquake. The National Medical Center of the Mexican Social Security Institute (IMSS), which has a capacity of 3,265 beds, was completely evacuated; according to reports, approximately 40% of this complex's facilities were damaged.[5]

The General Hospital under the Ministry of Health, with a capacity of 1,966 beds, lost its entire gynecology and obstetrics ward along with the student residence section in a collapse; approximately 1,000 patients were evacuated. As of 30 September, 107 persons and 245 corpses had been rescued from the rubble.[6]

At the Juárez Hospital, which is also under the Ministry of Health and has a capacity of 566 beds, the central, 12-floor tower which housed various areas of specialty collapsed. As of 30 September, 191 persons and 106 corpses had been rescued from the rubble.[6]

In all, at these three hospitals alone the health sector lost the use of 5,829 beds (beds destroyed or not used due to evacuation) during the critical stage that followed the earthquake. Partial operation of the potentially usable units is being carefully studied.

4. Response of medical care during the emergency phase

Although the disaster area was basically limited to the Federal District, the buildings that collapsed were not concentrated in a single place, rather they were scattered over a geographical area of approximately 25 miles^2 (40 km^2). This dispersion of the area of the disaster made it impossible to provide an exact idea of the magnitude of the problem and of the spatial distribution or exact sectorization of the disaster area. The dispersion of the "disaster points" (Fig. 5) made it necessary to mobilize hundreds of rescue and medical aid brigades to be sent to the disaster sites. In all, approximately 50,000 persons, including civilians and military staff, worked during the first days of the emergency; they worked, in shifts, around the clock to rescue victims and provide first aid, transportation, and hospitalization for the seriously injured as well as to locate, identify, and dispose of corpses.

Given the magnitude and unique characteristics of the disaster, it was impossible to hope for optimization in organization, unity of command levels, and coordination of actions. However, special note should be taken of the efforts made by institutions and the voluntary support of thousands of young people, of both sexes, between the ages of 14 and 20, who under the guidance of their natural leaders constituted a formidable and indefatigable work force in the relief tasks. Later, specialized relief groups arrived from abroad with equipment and trained dogs, contributing significantly to the difficult task of rescuing victims trapped in the rubble. Six days after the disaster, survivors were still being rescued: children born right before the disaster and adults who stoically withstood the lack of food, light, oxygen, and the total lack of water. These aspects will surely merit the attention of medical and scientific groups to explain the physiological aspects of adaptation and survival under such adverse conditions.

Due to the dispersion of the "disaster points", a mass response was needed from the health sector's institutions to care for the large number of injured. Naturally, there was much confusion at first. However, once the impact had passed, more than 500 ambulances were mobilized and nearly 100 hospitals in the Federal District entered into action, especially those that were closest to the disaster area. The resources available to the health sector after the earthquake are indicated in Table 2. This data gives an idea of the tremendous concentration of resources in the metropolitan area of the Federal District and explains the capacity to handle approximately 4,000 patients; this estimate was reached by adding the number of patients evacuated from the IMMS Medical Center, the General Hospital, and the patients evacuated from ISSTE hospitals after the second earthquake.

On 22 September, three days after the earthquake, it was reported that 2,609 beds were available at sector institutions.[7] This explains

why it was not necessary to set up "field hospitals" or "mobile hospitals." The increase in hospital capacity during the disaster was made possible by discharging patients on a volunteer basis and by discharging non-critical surgical patients and chronic patients. These actions provided a large number of available beds; as a result, it was not necessary to place extra beds in corridors or other usable spaces.

In accordance with the report of the Medical Chief of the Department of the Federal District, nearly 90% of the persons injured by the earthquake were attended during the first day; hospital demand dropped abruptly in the days that followed.

The exact total number of victims of the disaster has not yet been established. Provisional official figures as of 1 October showed between 5,000 and 10,000 dead, 2,000 missing, 10,000 seriously injured, 30,000 with minor injuries, and around 30,000 who suffered major material losses. Figures for hospital medical care throughout the entire health sector are presented in Table 3, which shows that health sector institutions hospitalized a total of 3,285 patients, of whom 2,741 (83%) were discharged before 1 October. The Mexican Association of Hospitals reported that it attended, at its private hospitals, to 226 patients with emergency services and hospitalization. As of 1 October, the total number of patients still hospitalized at health sector institutions was 141.[6]

With reference to the handling of corpses, minimum criteria were established for identification: indication of where the corpse was found, taking of photographs, indication of apparent size, thumbprint, sex, and distinguishing features of the garments. In general, the handling of corpses was properly performed from the moment of discovery through final disposal. Polyethylene bags and ice were used so as to slow down the process of organic decomposition. To the extent possible, time was allowed for relatives to identify the victims; it should be pointed out that this task was painful in many cases owing to the disfiguration of corpses that were crushed or owing to the initiation of decomposition. After 72 hours, the corpses that had been discovered at the disaster site, after registration of basic identification indicators, were transferred to wooden coffins for final disposal in common graves.

Taking into account the magnitude of the problem, the lack of communications, the temporary cut in electricity, gas leaks with sporadic fires, and other difficulties that adversely affected the possibility of any kind of more organized and coherent action, the response of the health sector in providing medical care during the emergency was appropriate and in keeping with the general guidelines for care in disaster situations.

5. Response of the health sector during the rehabilitation phase

The Interinstitutional Commission for the Health Sector, under the Ministry of Health, approved measures to strengthen epidemiological

surveillance measures and the actions to be taken for the recovery of basic services. These decisions were implemented through the Department of the Federal District, which was the operational agency in charge of actions for emergency medical care and public health measures.

As of the third day of the disaster, a wave of rumors began to spread on the possibility of epidemic outbreaks, such as the plague, typhoid fever, typhus, and other diseases. This fear was also wrongly spread to a certain extent by the mass media. At the same time, mass vaccination campaigns were launched against tetanus and typhoid fever. Fear also spread with respect to the possibility that the thousands of corpses that were still under the rubble could cause epidemics; this fear spread rapidly among the general public and even caused doubts in some circles of medical professionals and nonofficial institutions, who began to vaccinate indiscriminately against tetanus and typhoid on their own. Timely and decisive action by the health authorities made it possible to calm the public's fear by disseminating properly oriented and documented information and by holding an orientation seminar for the press in the Federal District focusing on the topic of "Health Problems in Disaster Situations" with emphasis on the epidemiological aspects of communicable diseases. The press apparently grasped the technical bases, because it made no further comments on the possibility of epidemics from the earthquake. The press turned to the social concerns of the injured persons, focusing on the political and social problems created by the disaster.

With respect to the demand for vaccinations, tetanus vaccinations alone were distributed selectively and on a voluntary basis to the brigades involved in rescue operations. Sodium hypochlorite was used to fumigate areas where rescue efforts had been completed and the only action left was to remove rubble, although this measure was not entirely backed up by the health sector. Reasons, which were more psychological than technical, were presented for carrying out this task in order to calm the public regarding the supposed health risk produced by the process of decomposition of corpses in the rubble, considering that the clean-up process would be an arduous and painful task, carried out by special groups from Mexico's army and navy.

The initial evaluations of damage to basic services, water supply, and excretae disposal reported considerable damages in the primary and secondary water service networks (1,100 breaks in secondary pipes and 70 in primary networks) as of 30 September. Concerning drainage and wastewater treatment, an inspection of major facilities and structures, pumping plants, deep drainage intakes and differential wells showed that the system was apparently in good condition, except for the La Piedad viaduct which was damaged at 17 joints in its structure; these were rapidly repaired[8] (Fig. 8).

A system of epidemiological surveillance was set up on a daily basis for water quality, diarrheal diseases, acute respiratory diseases, and vaccine-preventable diseases. Special emphasis was placed on surveillance at shelters and open camps where measles vaccinations were given to children of vaccination age and packages of oral rehydration salts were widely distributed. The authorities also ordered that primary care services be provided to persons who suffered major material losses, whose number was estimated at 30,000.

In an effort to provide shelter to the adversely affected people, 131 shelters were set up, with a potential capacity for 37,000 persons, along with 72 open air camps, where 13,176 persons were settled.[9]

Table 5 shows the distribution of shelters and camps by ward (Delegación), their capacities, and the percentage of occupation as of 28 September. It should be noted that only 53% of all the shelters were occupied. The total number of refugees in shelters and camps reached 33,224 persons.

In conjunction with the measures for epidemiological surveillance, an intense public information and education campaign was launched to stress the importance of boiling water for consumption, hygiene in the handling of food, and personal hygiene, especially the washing of hands. Starting in the second week, a mental health program was established with participation from the main psychiatry, psychology, and sociology institutions, including the UNAM, in order to provide attention, support, and consultation to persons in need. A rapid survey of the mental health demand indicated that the most frequent reasons for consultation were states of depression, anxiety, insomnia, and high blood pressure associated with emotional crises.

The availability of food was not a problem during the emergency phase nor during the early rehabilitation phase (the first and second weeks). There was an abundant supply of traditional foods as well as hot and cold food offered by government agencies, private and voluntary institutions, and individuals. There was some fear regarding the mass handling of food without proper hygiene.

6. Problem of water supply

One of the more critical problems that had to be faced after the earthquake was that of water supply. The earthquake had seriously damaged the primary and secondary networks of the drinking water system. Inspections were carried out rapidly in order to identify visible leaks and work crews worked in shifts around the clock to repair the visible leaks. On 23 September, the Bureau of Waterworks of the Federal District reported that 70 ruptures had been detected in primary networks, of which 35 (50%) had been repaired, and 1,100 ruptures had been detected in

secondary pipes, of which 450 (41%) had been repaired. The normal supply of water in the Federal District under normal conditions is $30m^3$ per second. During the first two days after the earthquake, this flow dropped $7.8m^3$ per second to $22.2m^3$ per second.[8, 10]

This situation seriously affected the population located in the southeastern region of the Federal District and resulted in the emergency mobilization of all available resources so as to find contingency solutions while leaks were repaired and services returned to normal. Meanwhile, the affected populations went to other wards to obtain water in household containers. In the more marginal areas of the southeastern region, some users broke meter boxes and valves in their anxiety to obtain water.

In the period between 19 and 23 September, the water supply situation was as follows:

	Problem	Ward		Estimated Population
1.	Without water	Tlahuac		200,000
		Ixtapalapa		1,300,000
			TOTAL	1,500,000
2.	Limited water supply	Milpa Alta		60,000
		Ixtacalco		700,000
		Xochimilco		250,000
			TOTAL	1,010,000
3.	With supply problems	Juárez		700,000
		Cuauhtemoc		900,000
		Madero		2,000,000
		V. Carranza		800,000
			TOTAL	4,400,000

In all, for the period indicated, 6,910,000 persons were affected to some degree (38% of the total population of the metropolitan area of the Federal District); 1,500,000 persons had no water services at all (8.3% of the population of the Federal District), while the rest of the population of the Federal District, 11,090,000 persons, had a normal supply (62% of the total population). The geographical distribution of the problem is shown in Figs. 6 and 7.

Work continued without interruption in an effort to recover water services. As an alternate measure, government and private tank trucks

were used along with existing stationary tanks, including those sent from other countries in response to the emergency situation. During the first week, 405 government and private tank trucks were in operation; 169 of these were sent from other states of Mexico.[8]

A comparison of the recovery of water services in the period from 20 to 30 September is presented in Table 6. In regard to water quality, the National Bureau of Epidemiology of the Ministry of Health, in coordination with the institutions that operated in the Federal District, established a surveillance system for bacteriological quality and residual chlorine in water in the system networks, tank trucks, and stationary tanks. Each day an average of 800 samples were taken for analysis.[11] It was thought that the ruptures caused by the earthquake and the variations in pressure would constitute a potential risk of water pollution due to negative pressure. It appears that this did occur, although to a very limited extent, as can be seen from the analysis of the reports presented by the central laboratory of the Federal District and by the bacteriology laboratory of the Children's Hospital, carried out on 23, 24, and 28 September (Table 7). Preliminary reports indicate that the normal quality of drinking water under normal conditions for the area affected by the earthquake was in general acceptable; this suggests the possibility of some form of contamination after the earthquake. In any event, it is necessary to sequentially verify the method that was used, the techniques for sample-taking, and other details related to the bacteriological analysis of the water.

With respect to residual chlorine, data indicates a broad range between 0.0 ppm to 4.0 ppm. Health authorities agreed to the hyperchlorination of water in order to raise the residual chlorine level to 2 ppm in networks, tanks, and tank trucks. This entailed a mass mobilization of resources and the widespread use of calcium hypochlorite.

Notwithstanding the fact that water quality apparently did not meet the parameters for potableness, there were no outbreaks of diarrheal diseases that could be attributed to water quality. The increase in the incidence of diarrhea at some of the shelters was attributed to dietary causes and not to water.[6, 11] In addition to the measures for water chlorination, it is necessary to point out that the public responded positively and cooperated widely in observing the measures recommended by the health authorities. There is proof that even in the most marginal populations the community itself used flyers and posters to recommend that all drinking water be boiled. Without a doubt, this public attitude greatly contributed to checking the potential risks related to water quality.

7. International cooperation

International solidarity manifested itself from the first hours of the disaster in the form of shipments of drugs and medical supplies and

the cooperation of volunteers. Without wishing to underrate the noble purposes of the donors and their very humanitarian spirit and solidarity, it should be pointed out that much of the assistance provided was in the form of supplies, drugs, and clothes--articles which were not requested by the country's authorities. Large quantities of plasma, blood, intravenous solutions, and drugs were also sent. The difficulty for Mexico was its limited storage capacity, even at the internal level. As of the second day of the disaster, bulletins were issued to inform the population that blood was no longer needed in view of the fact that volunteers were still donating at the city's laboratories. Due to the large quantity of plasma the decision was made to lyophilise it in order to create an albumin bank.

It should be pointed out that there was no shortage of emergency drugs and medical supplies. The priorities in this disaster were different: specialized teams were required for the task of rescuing persons trapped in the rubble using heavy machinery, cranes, and other equipment for the removal of rubble. Priority was also given to cooperation activities in order to guarantee the normal water supply; these were in the form of stationary tanks, purification plants, tank trucks, and chlorine.

The General Accounting Office (Secretaría de la Contraloría) reported that in the period between 20 and 30 September, 117 flights arrived from 31 countries at Mexico's international airport, bringing a total volume of 1,088 tons. Drugs accounted for one third of this volume (Table 8).[12]

UNDRO, the United Nations Disaster Relief Office, reported on 1 October that contributions from U.N. agencies, government organizations, voluntary agencies, the International Red Cross, and intergovernmental organizations totaled an estimated US$10,750,000.

8. Lessons learned

The unique nature of this disaster, which affected one of the most populated cities in the world, along with its scattered nature and complexity provided valuable lessons and highlighted concerns such as the need to:

- Strengthen the health sector plans for disaster situations.
- Establish operational contingency and prompt response plans, by geographical area and clearly sectorized in advance.
- Develop hospital plans for internal and external disasters, and provide continuous training to personnel in the area of mass medical care to victims.

- Develop techniques and methodologies for the rescue of trapped persons and surgical medical care at the site of the disaster.

- Establish continuous programs for public motivation and education regarding what to do when an earthquake occurs, first aid, and organized volunteer work.

- Establish information programs for the mass media on the health aspects of natural disasters.

- Develop information and motivation activities for donor countries and agencies regarding the importance of not shipping nonrequested supplies and how to channel international assistance in a positive and efficient form.