The Medical and Public Health Response to the Great Hanshin-Awaji Earthquake in Japan: A Case Study in Disaster Planning

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The Great Hanshin-Awaji (Kobe) earthquake, which struck Japan on January 17, 1995, caused 5,488 deaths and tens of thousands of other casualties. The health impacts immediately after the quake are assessed, as are the changing health needs of the injured and evacuees over time. The impact on the social and health care infrastructures, including regional strengths and shortcomings, is described. The organization and implementation of search and rescue operations, medical relief, coordination with outside agencies, and volunteer assistance are evaluated and critiqued. Lessons from the Kobe quake and previous earthquakes worldwide must be applied to the development of a new disaster response plan for Japan. [M&GS 1995:214-226]

This paper presents an overview of the health consequences and the response to the Great Hanshin-Awaji (Kobe) earthquake, which struck on January 17,1995, at 5:46 a.m., at an epicenter about 15 km to the south west of Kobe city in western Japan (Figure 1). Since Japan lies on the intersection of four tectonic plates, it has been hit by a number of earthquakes throughout its history (Table 1). The Great Hanshin-Awaji earthquake -- of magnitude 7.2 on the Richter scale -- was the most devastating disaster in postwar Japan, causing 5,488 deaths and more than 36,000 injuries, and leaving 320,000 people homeless. The earth quake revealed the wretched fragility of highly

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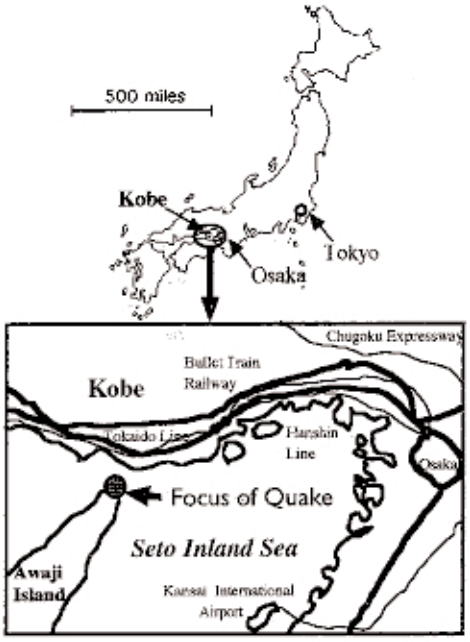

Figure 1. Region affected by the quake

advanced urban infrastructure and the insufficiency of Japan's disaster response when faced with enormous calamities. The authors examine the health impacts of the Kobe earthquake and the appropriateness and effectiveness of the organized disaster response. By comparing the impact of the Kobe quake with reported effects of other earth quakes, they attempt to extract lessons from this experience. Three questions are especially important in this regard:

* What was responsible for the failure of Japanese disaster planners to anticipate and prepare for an earthquake of this magnitude, given the vulnerability of the region to such incidents?
* How could a more effective set of response plans have reduced mortality from the Kobe quake?
* What more appropriate medical and public health interventions could have been provided for the injured and for evacuees?

Although its Richter scale magnitude might not indicate tremendous severity, the ground motions of the Kobe earthquake were the high est recorded in Japan's history. It is difficult to explain precisely why disaster planners had not envisioned something on this scale or, if they had, why they did not conduct serious drills in advance. As the details of disaster response are dependent on each prefectural government, the level and quality of disaster preparedness differs from prefecture to prefecture. Some prefectures, such as Shizuoka, which has had frequent tremors just above the tectonic plates, have prepared disaster plans for the most severe scenarios. The central government and most of the prefectural and municipal governments, however, lack comprehensive plans for crisis management.

The Impacts on Health and Society

Immediate Health Consequences of the Quake

For several days following the quake, the number of deaths accumulated rapidly (Figure 2). A review of death certificates of 3,651 persons[1] showed that 59% of the dead were women and that more than half were

Table 1. Major earthquakes in 20th century Japan

Year	Area	Magnitude	Deaths
1909	Anegawa, central Japan	6 8	41
1914	Senpoku, northern Japan	7 1	94
1923	Kanto Plain, central Japan	7 9	140,000
1925	Kita Tajima, western Japan	6 8	428
1927	Kita Tango, western Japan	7 3	2,935
1930	Kita Izu, west of Tokyo	7 3	272
1933	Miyagi, northern Japan	8 1	3,064
1943	Tottori, western Japan	7 2	1,083
1944	Higashi Nankai, central Japan	7 9	998
1945	Mikawa, central Japan	6 8	1,961
1946	Nankai, off central Japan	8 0	1,330
1948	Fukui, central Japan	7 1	3,769
1968	Tokachi, northern Japan	7 9	52
1974	Izu, west of Tokyo	6 9	38
1983	Akita, northern Japan	7 7	104
1993	Okushiri Island, northern Japan	7 8	200
1994	Hachinohe, northern Japan	7 9	233
1995	Kobe, western Japan	7 2	5,488

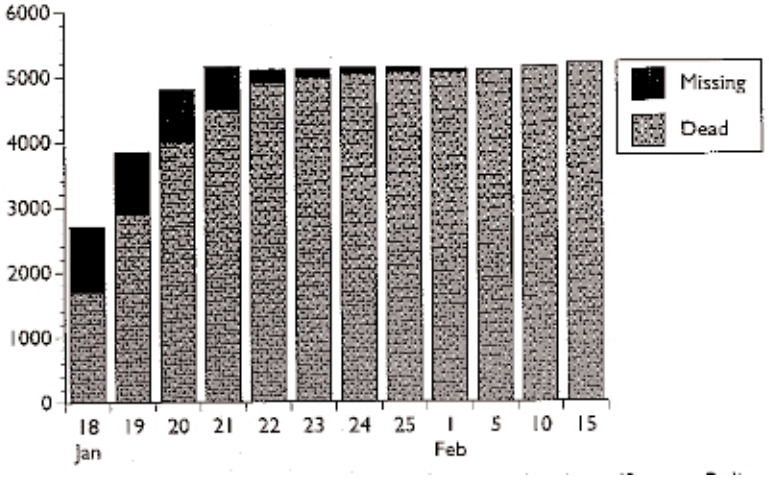

Figure 2. Reported number of dead and missing by date (Source: Police Department, Hyogo Prefecture, Japan, 1995)

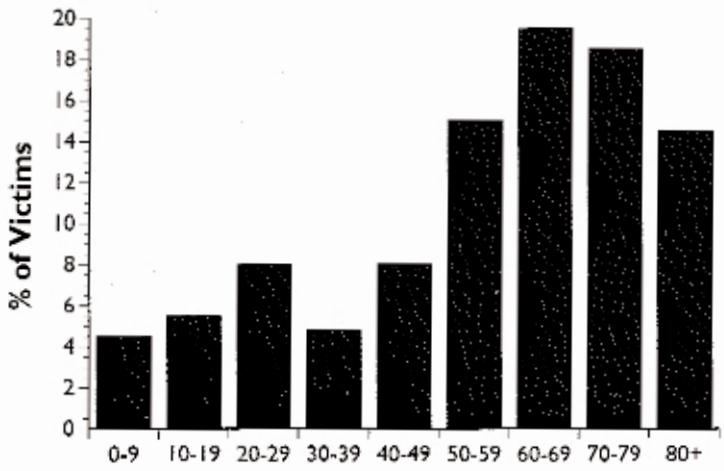

Figure 3. Age distribution of the quake victims. (Source: Police Department, Hyogo Prefecture, Japan, 1995)

1. All death certificates were presented to the Hyogo Prefecture as victims of the Great Hanshin-Awaji Earthquake as of March, 1995. Of the total number of certificates, 2,416 were examined by the medical examiners of Hyogo Prefecture and by physician members of the National Association of Legal Medicine in Japan; 1,235 were examined by physicians who served temporarily as medical examiners at the request of the Hyogo Prefecture police department.

Table 2. General population of Hyogo Prefecture by sex and age.

Age (years)	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80+
Male %	5.8	7.7	6.5	6.4	8.1	6.3	4.4	2.2	0.8
Female %	5.6	7.5	6.9	6.7	8.2	6.6	5.1	3.3	1.6
Total %	11.4	15.2	13.5	13.1	16.3	12.9	9.5	5.4	2.4

Source: Population Census, Management and Coordination Agency, Japan, 1992

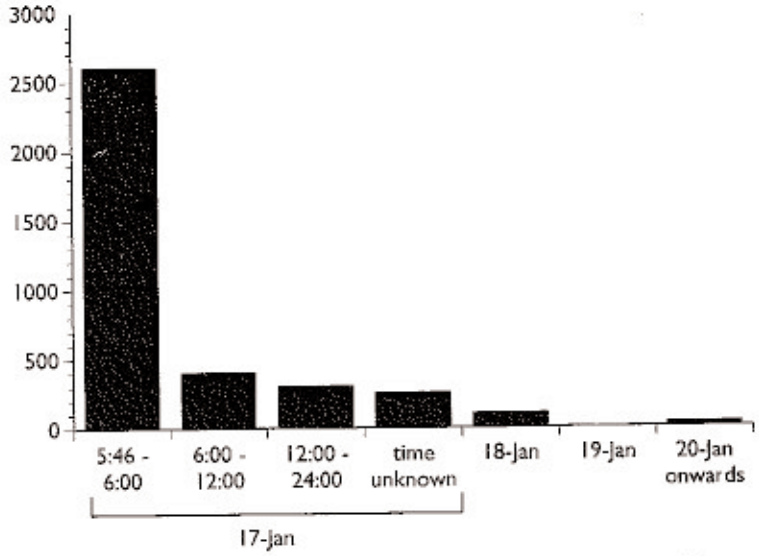

Figure 4. Number of victims by estimated time and date of death. (Source: Public Health and Environment Department, Hyogo Prefecture, Japan, 1995)

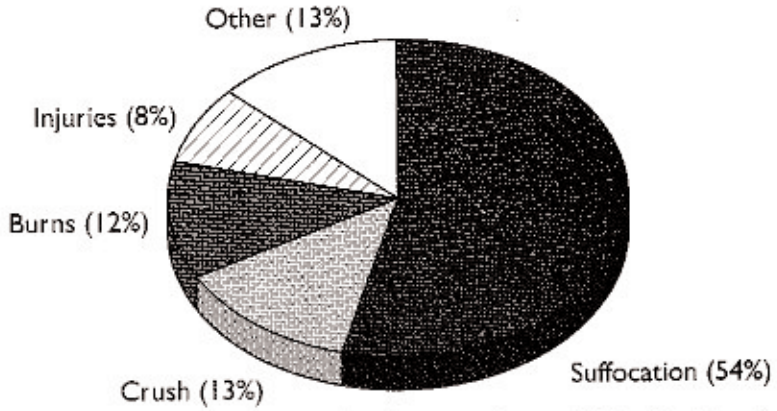

Figure 5. Direct cause of death of victims. (Source: Public Health and Environment Department, Hyogo Prefecture, Japan, 1995)

more than 60 years old [1](Figure 3). By comparison, 51.5% of the entire population of Hyogo Prefecture was female at the time of the quake and only 17.3% of the total population was 60 years of age or older (Table 2). The proportion of elderly female victims was extremely high.

More than 70% of the victims are thought to have died immediately after the impact and more than 90% within the first day of the quake (Figure 4). Like many other earthquakes [2,3,4], entrapment within collapsed houses caused most of the deaths 86.6% of the victims died at home (Figure 5) [5]. A study of the 1977 Guatemala earthquake, for example, showed that deaths and injuries are critically dependent on the damage to housing and on the type of construction materials used [2]. In the Japan earthquake, most of the victims were found on the first floor of the so-called "bunka jutaku"(civilized apartment) -- the two-story, wooden houses with heavy tiled roofs and thin walls that had been rashly built in the years just after World War II. The fact that there were many elderly people living alone in these houses and that they customarily slept on the first floor may have increased morbidity significantly. As there are still many wooden houses in Japan, fires tend to occur following a earth quake. In the 1923 Great Kanto earthquake in Japan, which struck just before noon, subsequent fires were responsible for most of the 143,000 deaths. Only a relatively limited number of fires — 136 — occurred on the day of the Great Hanshin-Awaji earthquake, causing 12% burn deaths [5]. The affected areas, however, could have been hit even more heavily by more and larger fires due to the preponderance and high density of wooden houses and poor firefighting conditions, such as narrow or obstructed roads and blocked supplies of water. In fact, there were fires that could not be extinguished despite the efforts of firefighters and those ravaged survivors who were trapped under collapsed houses. An even more tragic situation may have been prevented because of the time of day the earthquake occurred -- 5:46 in the morning. If the earthquake had happened during rush hour, a large number of people might have been caught in the collapse of elevated expressways, railways, and subways. In addition, the search for the missing and the identification of the dead might have been more difficult if the earthquake had occurred after people had already started moving about the city.

Figure 6 shows the causes of death, as deter mined by post-mortem examinations, of 47 victims whose deaths occurred during the three months following the earthquake and were suspected to be related indirectly to the earthquake.[2] Although disaster-related morbidity and mortality are difficult to define, physical and mental stress caused by the Kobe quake and adverse situations in its aftermath may have increased the incidence of particular diseases and worsened conditions related to chronic diseases. Relative to the association of quake impact and cardiovascular diseases observed in past disasters [6,7,8], the incidence of temporary hyperten-

2. All cases reported to Hyogo Prefecture from January 17 February 10, 1995.

sion [9], and morbidity [10,11] and mortality [12] from acute myocardial infarction increased during the first month following the Kobe quake.

The health problems and needs of evacuees changed over the course of time after the impact. For a few days following the earth quake, many cases of moderate and severe injuries and some cases of crush syndrome requiring dialysis were reported and referred to functioning hospitals. Figure 7 shows the changes in the health problems of the outpatients in evacuation centers one week and one month after the earthquake. As evacuees stayed in subfreezing environments without heat or sufficient blankets, acute respiratory infections, especially influenza, became epidemic. These conditions accounted for 53% of the total of all the outpatients in evacuation center clinics one week after the impact, but decreased to 34% after one month [13]. Many pneumonia cases, especially among elderly evacuees, were admit ted to hospitals. After a few weeks, worsening cases of poorly controlled chronic diseases such as hypertension and diabetes mellitus were increasingly reported.

Various emotional disturbances, especially post-traumatic stress disorder (PTSD) and depressive disorder were also increasingly reported. The Japanese Red Cross Society reported that a review of medical records turned up serious PTSD cases in 3.4% of 440 outpatients in a evacuation center clinic about three weeks after the earthquake [14]. A psychological care team reported that young people with PTSD had a history of receiving psychiatric care before the quake while older people did not [15]. The team also reported that many elderly people in evacuation centers fell into a neurotic or depressive state, or showed behavioral disorders and dementia. Another report suggested that life in crowded evacuation centers might have left many elderly people bed-ridden and may have increased the incidence of dementia [16].

Further studies are needed to understand in more detail the psychological impact of the Hanshin-Awaji earthquake and to compare it with the findings of other earthquakes [17,18,19]. As many studies have indicated [20,21,22], in addition to the immediate severity of a trauma itself, later adversities such as harsh living conditions with few normal amenities, a lack of privacy, loss of fortune, the breakup and displacement of families, and lack of jobs may increase psychiatric morbidity.

The Impact on Social Infrastructure

Although the magnitude of this earthquake was only slightly stronger than the magnitude 6.7 Northridge California quake one year earlier, the Japan quake had a far larger economic impact: damage was estimated at $150-200 billion [23], or about five times the economic loss from the Northridge earthquake or the 1994 Hurricane Andrew in the U.S. [24]. One reason is that the epicenter of the Japan quake was very close to the surface -- enough to record one of the strongest ground motions in seismography and the highest seismic intensity -- 7 -- on the Japan Meteorological Agency JMA) scale, corresponding to Intensity 11 and 12 on the Modified Mercalli Scale. Moreover, the quake directly hit the highly populated Hanshin Industrial Area, including Japan's sixth

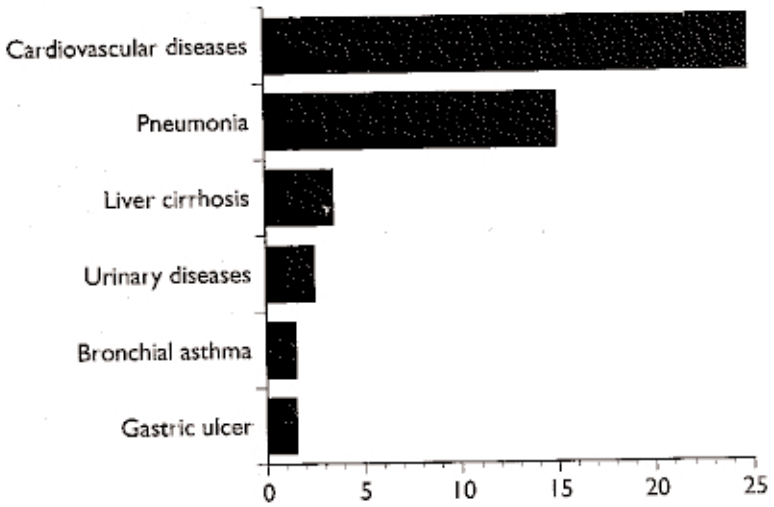

Figure 6. Suspected cause of death in post-mortem examination of deaths related to earthquake during the three weeks after the quake. (Source: Public Health and Environment Department, Hyogo Prefecture, Japan, 1995)

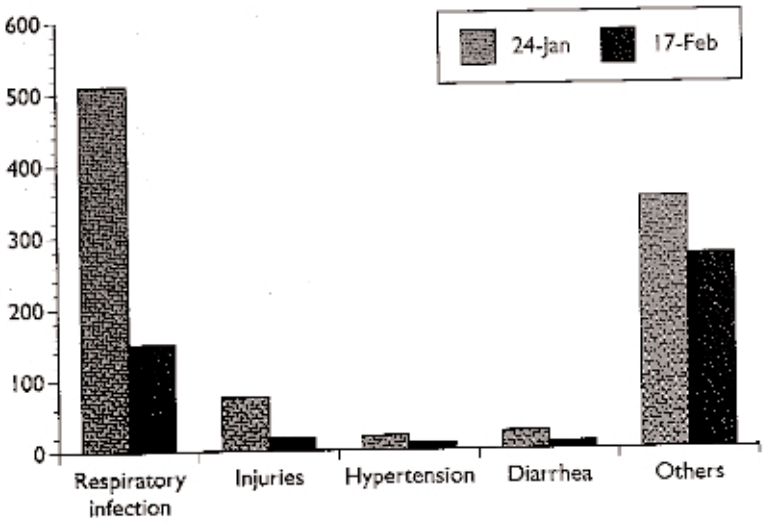

Figure 7. Health problems at evacuation centers one week and one month after the quake (Source: Public Health and Environment Department, Hyogo Prefecture, Japan, 1995)

largest city, Kobe, with a population density of 2,697/km2 and about 9,000 manufacturing industries employing 120,000 workers [5]. By comparison, 80% of the kinetic energy of the Northridge quake slammed into a sparsely populated mountain area, rather than down town Los Angeles.

Although modern Japanese structures were believed to be quake-resistant or quake-proof, the Kobe earthquake caused heavy damage to a huge number of buildings and great swathes of recent infrastructure. In particular, roads and railways, including the Shinkansen bullet train line and the Hanshin Expressway, were cut off in many places, which led to the disruption of main ground transportation routes that handle 20% of the distribution of domes tic goods between western and eastern Japan.

Since Kobe is a typical linear city, stretching 35 km from east to west and facing the mountains to the north and the sea to the south, ground access to the affected areas was very limited. As a result, traffic was extraordinarily congested in and around the affected areas, hampering prompt large scale rescue and evacuation during the early stages of disaster response. Although 222 airplanes and helicopters and 48 ships contributed to the transport of relief materials [26], aviation and marine transportation could not be effectively mobilized for search, rescue, and medical relief during the first few days after the quake due to the scarcity of landing places and heavy damage to berths.

Moreover, about 223,000 houses collapsed partly or totally during the tremor. Lifelines were blocked in most of the area and 1,200,000 households were left with no water supply, 850,000 with no natural gas, and 1,000,000 with no electricity [24]. As a result, one-fifth of Kobe's population were forced to live in 1,150 temporary shelters at schools, community centers, parks, and other public facilities in 15 cities and towns [24]. Although the Hyogo Prefectural Government has planned to pro vide 70,000 makeshift houses, only half of them had been completed and 24,500 evacuees were still staying in 400 temporary shelters as of mid-June 1995 [24]. As of November 30, 1995 all the evacuation centers had officially closed, but 1,201 people -- most of them elderly and without family -- were still living in 65 temporary facilities, while 47,500 families continued to live in makeshift houses.

Table 3. Impacts on health facilities

	Hospitals (n=173)	Clinics (n=1,106)
Affected	96%	81%
Building totally collapsed	2.3	4.6
Building partially collapsed	6.9	4.6
Inpatients killed	1.7	0.1
Inpatients injured	3.5	0
Damaged equipment (top 3)	water pipe (56) MRI (47) dialysis (45)	roentgen (25) water pipe (12) computer (9.2)
Factor influenced on clinical practice		
no water supply	67	58
disconnection of telephone	56	38
no gas supply	49	43
Fully restored on two months after	61	56

Source: Public Health and Environment Department, Hyogo Prefecture, Japan, 1995

Impact on Health Services

According to a survey of 1,185 medical facilities in Kobe city, the earthquake had an impact on most of the hospitals and clinics, including patients, equipment, and/or buildings [1] (Table 3). Some inpatients at medical facilities were killed or injured, but evacuation and care of patients were quite well managed in most hospitals. Disaster plans established by most of the hospitals, however, could not work well in this case because such a large-scale disaster had not been anticipated. Most of the medical facilities acted independently to evacuate inpatients, to procure medical supplies, and to obtain blankets to protect inpatients from cold temperatures. Patients requiring special care or treatment, such as those in the intensive care unit and those on dialysis, were promptly referred to hospitals in unaffected areas. There was, however, no systematic referral network in place to deal with emergency situations.

Since most of the medical facilities lacked separate independent sources of water, gas, or electric power, the blockage of lifelines impeded the delivery of inpatient and outpatient care3 (Table 4). Due to the poor function of the medical facilities, external medical volunteers could not be accepted or utilized in most of the medical facilities in affected areas.

Public health centers played an important role in the overall coordination of the medical and public health response despite structural or interior damage. Their quick initial actions, however, were hampered by the loss or lack of manpower, the absence of information and communication systems, and the unavailability of detailed manuals for managing such a large scale disaster.

The Disaster Response

Search and Rescue

Although the Self Defense Forces (SDF),

3. In Japan, most large hospitaLs have electrical generators, but few are equipped with water tanks.

the National Police Agency, the Fire Defense Agency, and the Maritime Safety Agency had contributed more than 340,000 person-days to search and rescue work by the conclusion of the relief effort, initial action was considerably delayed. The SDF was not dispatched to the disaster site for four hours following the earth quake and the first SDF team included only 170 people.

A survivor of the Kobe quake was rescued more than five days after his entrapment just as several people "miraculously" survived extended periods of entrapment in Mexico City (1985), Armenia (1988), Turkey (1992), and Egypt (1992). Although the timing of extrication decisions (i.e. when to stop searching for survivors) is difficult, Japanese authorities made their judgment based on whether there remained places where missing people might be trapped. About one week after the earth quake the Emergency Countermeasure Center of one affected city held a meeting on the search and rescue work at the last possible site. Even after official completion of the search of all possible sites, a small number of search teams continued to find missing people in the affected areas.

Medical Relief

With local governments in a state of panic, systematic coordination of medical assistance could not be initiated during the days immediately after the earthquake. At the beginning, many medical teams rushed into evacuation centers that lacked proper health care delivery systems and started temporary daytime or 2 hour clinics. Later, the local health department, the health center, and the medical association in each ward and city of the affected areas took the initiative to coordinate meetings with external medical teams once every few days. These meetings acted as the place to exchange information about evacuees' health needs, about the progress of relief work, and about various other problems.

As health needs altered, medical and public health responses also changed. Although medical teams initially put their focus on the treatment of injuries and acute diseases, they came to recognize the importance of controlling chronic diseases. For several weeks, volunteer medical teams prescribed medicine to patients with chronic diseases, but gradually sent patients to restored local medical facilities. Intensive discussions, however, were held between local and outside medical specialists in order to determine the time when outside medical teams would close temporary clinics and leave the affected areas. This departure had to be effected in a way that would not cause unnecessary anxiety to those victims, especially the elderly, who had found easy access to medicine and consultation in the evacuation centers.

Table 4. Disaster preparedness of health facilities

	Hospitals (n=173)	Clinics (n=1,106)
Disaster plan	93%	33%
Drill	97	72
Water tank equipped	46	10
Natural gas stored	98	52
Generator equipped	72	25
Medicine stored	34	15
Food stored	27	40

Source: Public Health and Environment Department, Hyogo Prefecture, Japan, 1995

Certain kinds of public health work were also conducted in the evacuation centers. To prevent possible influenza and pneumonia epidemics, medical teams started to distribute masks to those with coughs and to vulnerable individuals and also placed gargles and anti septic solutions at the entrances of wash rooms. Flu and pneumonia cases, especially among the elderly and infants, were actively detected at an early stage in some evacuation centers for treatment or referral to hospitals. Influenza vaccines were also provided to those who requested them, mainly those age 65 or older.

In some wards of Kobe city, health centers conducted "the roller operation,"[4] through which public health nurses and other health experts screened health care needs of the evacuees, especially the elderly and bedridden per sons. Those who needed special care were transferred to hospitals or nursing homes in unaffected areas. Mental health care was provided by psychiatrists and psychotherapists in evacuation centers and health centers for those who needed it. Volunteers also contributed to the mental health care of evacuees by performing concerts and plays, playing with children, and listening to the quake victims recount their own stories of personal tragedy.

The Problem of Outside Assistance

Although nine countries, including England, Korea, and Bangladesh, offered to send medical teams to areas affected by the earthquake, Japan did not accept them on the grounds that these teams were unlicensed to practice medicine in Japan, that there would be language barriers, and that the outside relief workers would have difficulty finding

4. A term used by public health nurses and other health staff to describe the comprehensive series of visits to all the evacuation centers to find those needing special health care.

room and board. Ultimately, Japan accepted various kinds of aid from 38 out of 72 nations that offered assistance [25], but some of the emergency aid, including rescue dogs, arrived late due to slow bureaucratic procedures. Moreover, some of the relief materials could not be used effectively, because they did not correspond with actual needs or they had already been provided from other parts of Japan.

The Role of Volunteers

It should be noted that a great number of volunteers -- reaching approximately 20,000 persons at the peak of the disaster response effort [24] -- gathered at the quake-struck region to offer help. Although the Japanese had been criticized for lacking a spirit of volunteerism, medical volunteers grew to 339 teams involving 1,700 doctors, nurses, and other staff, who participated individually or who were sent by private and public clinics, hospitals, medical schools, or prefectural governments [13]. Private volunteer organizations, such as the Japan Overseas Christian Medical Cooperative Service (JOCS), which had general international experience providing medical and public health assistance in austere circum stances, made the most of their knowledge and skills during this domestic tragedy.

In principle, a temporary headquarters for disaster relief in each municipality or ward of Kobe city was supposed to supervise and organize all the relief workers and volunteers. Volunteers were requested to register in these offices, but many volunteers complained that they received no response from the office after registration. Therefore, many unregistered volunteers started working individually or in groups in evacuation centers and elsewhere in affected areas without guidance from the headquarters. Eventually many of these volunteer activities came under headquarters control and, generally speaking, contributed significantly to the overall effort.

The modes of supervision and coordination of public health and medical volunteer work were different from those required for other volunteers, because of the special knowledge and skills involved. The types of supervision varied in different municipalities and wards. In one ward, the public health center supervised all the volunteers. In another ward, the task fell to the local medical association, and, in a third, physicians from a general hospital assumed leader ship. In one ward the local government had no capacity to organize external volunteers in an early stage of the quake, so volunteers held their own coordination meetings.

Volunteer workers, especially health workers, seemed quite effective and did not hinder relief efforts to any serious extent. Rather, most local governments expressed heartfelt gratitude to the volunteers. Since most of the volunteers had no experience in previous relief work, however, there were some inefficiencies and failures of coordination, such as an excess number of health volunteers in some affected areas and mismatched allocations of volunteers and medicine in some evacuation centers.

A great deal was learned from this experience. Although in the disaster plan governing the crisis volunteers were not counted as important relief resources, the response to the Kobe quake demonstrated the necessity of obtaining external aid and volunteers in large scale calamities. The disaster contingency plan should clearly describe how to supervise and utilize volunteers in relief work. Moreover, the headquarters for disaster relief must improve human resource management to use relief workers and volunteers more efficiently. The amended disaster plan will emphasize the importance, role, and supervision of volunteer workers.

Lessons from the Quake

The Great Hanshin-Awaji earthquake has taught many lessons to Japan and to other nations. The damage from the earthquake has forced disaster planners worldwide to question the safety of urban structures, the practicality of disaster plans, and levels of preparedness in populated areas. The impact of both natural and technological disasters hitting urban areas has been magnified by:

1. greater population density,
2. taller buildings,
3. more widespread utilization of underground facilities,
4. a greater number of passengers using public transportation at any given time and travelling at higher speeds,
5. the increasing proximity of industrial plants and residences. In fact, the number of victims per disaster has been increasing and the economic damage from disasters worldwide has tripled in the last thirty years -- estimated at $40 billion in the 1960s and $120 billion in the 1980s [24].

There are similarities and differences in the impacts of disasters on developed and developing countries and in the ways these countries respond. Although the needs of the injured and of evacuees are much the same all over the world, countries differ in their ability

to provide resources and in the infrastructure available to support disaster response. In the emergency response to the Kobe earthquake, one of the most critical issues was how to mobilize resources, which were abundant in unaffected areas, in order to get them to the affected areas quickly and efficiently. Information, materials, and human resources are key to implementing emergency response. The Kobe quake taught many lessons about the use of these resources, coordination, and overall disaster management.

Disaster Preparedness

As shown in Figure 8, the study of structural damage caused by the Japanese earthquake supports the finding that improvements in building engineering will be critical to lessening structural damage and mitigating the sub sequent health impacts of future earthquakes [26]. To reduce earthquake deaths and injuries, both civil engineers and public health specialists should work together to explore in more detail the associations between structural dam age and health impacts and to improve building design and construction practices.

A number of studies have shown that occupant behavior during the emergency was also a crucial factor determining quake-related mortality and morbidity [3,27]. A study of the Guatemala earthquake revealed significant differences between injured and uninjured per sons in relation to their behavior immediately after the impact [2]. A study of injuries in the 1988 Armenia earthquake suggested that leaving buildings after the first shock of the earth quake was a protective behavior [28]. It is often assumed that intense earth tremors are too violent and the time too short for people to pursue any actions to ensure their own survival or that of others. Some studies suggest, however, that occupants of buildings often have both the time and ability to take several actions (e.g., running out of doors, hiding under a table or desk, covering one's head with a futon or blanket, etc.) to prevent injury [3,27]. Protective behaviors will vary according to the location and situation of people at the time of an earth quake (e.g., whether they are in a city or a village, in a high building or a wooden house, in a car or a train, in sleeping quarters or in the kitchen).

Additional studies are needed to determine appropriate individual behaviors in different situations to prevent death or injury. The existing disaster prevention plan for Japan was approved in June 1963 and was built upon the Basic Law of Disaster Response in the wake of the 1959 Isewan Typhoon, which left more than 5,000 people dead or missing. The plan has not been reviewed, how ever, since May 1971, when it was partially amended. The plan included policies on how to prevent disasters, how to reduce damage, and how to secure gas, water services, and other "lifeline" necessities.

The Kobe earthquake has demonstrated that this current plan is no longer suitable to meet the needs of the present society, which have changed with rapid urbanization and modernization. Moreover, the impracticality of the plan, which provides a basic framework for an emergency response but no detailed procedures or manuals for specific disaster scenarios, was revealed. In fact, only five prefectural governments out of 47 had local disaster prevention plans envisioning the most serious scenarios of a Level 7 earthquake on the JMA scale, which would collapse 30% or more houses and cause landslides, ground cracks, or faults. Most of the prefectures had not prepared disaster plans for earthquakes that would affect the seat of the prefectural office [29].

The decision-making and command systems incorporated as part of the disaster plan are also crucial. In this disaster, as has been point ed out in retrospect, the decision-making process of the present disaster plan posed obstacles to prompt relief actions.

Coordination

Not until this earthquake did public and private agencies in Japan, SDF and civilians, specialists and lay people, Japanese and foreigners, work together for a sole purpose -- responding to the disaster. Because information, materials, and people converged on the affected areas so abruptly, local authorities

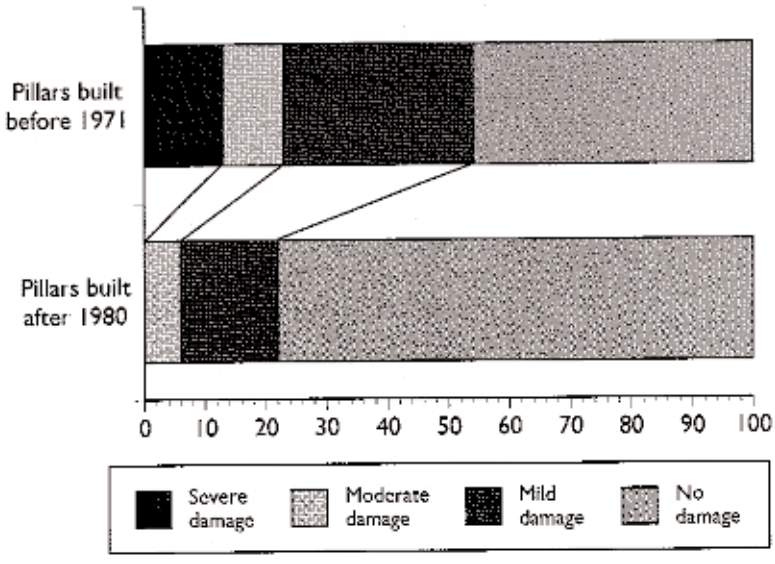

Figure 8. Severity of damage to the pillars of the expressway constructed on the building code enacted before 1971 and after 1980 (Source: [26])

had difficulty organizing and coordinating all those resources. External medical volunteers were at a loss as to where and how to start medical relief work and were without proper guidance or command during a period of several days following the earthquake. Public health centers or local health departments were supposed to coordinate health-related activities in each region, but they had little capacity in the absence of clear instructions based on appropriate emergency manuals for such a huge calamity. Experiences after previous earthquakes have shown that coordinated work in the aftermath of an impact would be quite difficult due to the paralysis of key local organizations, the different rules and limitations of different relief teams, the existence among some relief workers of counterproductive individualism, and occasional irresponsibility [30,31,32].

This disaster taught the important role of coordination in order to identify priorities for relief and to match them effectively with avail able supplies. To implement effective relief coordination, emergency coordination structures should be clarified in the disaster plans at all levels (Figure 9). Moreover, both the public and the private sectors should make an effort to nurture skilled coordinators and to conduct drills of cooperative emergency relief work.

Information and Communication

Tardy and obstructed flows of information to decision makers delayed the initial response in ways inappropriate to earthquake relief. Two hours passed before the Prime Minister even obtained the first report of the earthquake, while the U.S. President was alerted 15 minutes after the Northridge earthquake. This happened possibly as a result of technical and organizational problems. The former include the lack of proper human resources and effective communications media in the affected local governments. Staff members of the local authorities were them selves affected by the earthquake and could not gather reliable information in the field for release to the prefectural or central governments. Other than telephone communications, radios and cellular phones were not sufficiently prevalent to set up a communication net work covering such vast areas. The organizational problems involved an inflexible, vertical flow of report and command in the government and the steady-but-slow character of Japan's bureaucracy. The fact that the initial report of confirmed deaths -- 22 in the first four hours after the quake -- was relied upon by the decision makers to assess the severity of the disaster might also have been responsible for the delay in the response.

After the earthquake, the mass media played an important role by providing rapid and constant information. In some cases, however, they broadcast incorrect images or biased information about the disaster, which led to a disjunction between internal needs and the external response. For instance, after seeing casualties and seriously ill patients on TV, some clinical experts visited the affected areas with emergency resuscitation kits a week after the earthquake, even though few serious cases remained in the area by that time. Some evacuation center clinics overflowed with medical volunteers, who sometimes outnumbered patients. Although medical experts from different teams independently started to investigate the health needs of evacuees within sever al days, there was no coordinated effort to collect and share information among these experts for several weeks.

To identify urgent health needs and to deter mine relief priorities properly and promptly, rapid assessment should be conducted at an early stage by an interdisciplinary team with skills in health care, logistics, sociology, and other fields. A lack of appropriate information may result in ineffective and wasteful relief action [33]. Even in a later stage of relief, systematic information gathering and analysis would help effective relief response. To help develop the short term and long term medical and pubic health response measures for future disasters, more studies of disaster epidemiology should be conducted in Japan and in other countries.

A management information system also should be established to evaluate health situations rapidly and correctly. Such a system would involve collecting, reporting, and storing data and information about disaster-related morbidity and mortality. Since the large scale disruption of telephone services can hinder the collection of information and can result in tardy responses to casualties, public health organizations should work out scenarios for a range of information dissemination contingencies in pre-disaster periods.

In addition, medical facilities should set up a communications network comprising computers, radios, cellular phones, and related technologies at the regional, prefectural, and national levels to facilitate the exchange of information on infrastructure damage, stocks of medical supplies, patient loads, and other issues. Since information is essential to all decision making, systems should be set up that include practical guidance for standard scenarios, unified reporting formats, and communi cations drills for various scenarios to ensure that the flow of information and command decisions will be quick and smooth.

Logistics

The lack of experienced logisticians may have contributed to delayed and ineffective resource allocation. Although large quantities of food, water, medicine, and other emergency supplies were provided from all over Japan, they were sent to the affected areas directly and independently by individuals, companies, hospitals, and others using their own cars and trucks. Since local authorities failed to cordon off the roads for official use at the beginning, prolonged serious traffic congestion hampered quick and systematic emergency operation in the affected areas.

Many of the evacuees were located far from municipal offices or were sheltered in areas with difficult access and, therefore, they suffered from inequitable distribution of aid materials in the early stages due to the scarcity of transportation and the blockage of roads. The lesson here is that those who are to man age the logistics of procurement, storage, and distribution of emergency supplies should be trained at the local, prefectural, and national levels.

In particular, preparing logistical support for the procurement of drugs and medical supplies in an emergency is essential for medical facilities. Together with the individual efforts to equip the main hospitals with independent supplies of gas, power, and water and to stock pile drugs and medical supplies, medical facilities should establish a mutual aid system to provide medical personnel, supplies, and blood from unaffected hospitals. Such a system contributed greatly to the emergency medical response to the 1989 Loma Prieta earthquake [34]. The success of logistics in crisis situations depends on continuous preparation and planning in a pre-disaster time.

Human Resources

Immediately after the Kobe earthquake, the most essential human resources were search, rescue, and medical teams. Studies of earth quakes in Peru 1351, Italy [3], Mexico [36], Armenia [4], and California [37], show that quick provision of life support proved crucial in reducing mortality. It has been suggested that first aid applied to victims immediately following an earthquake, followed by advanced trauma life support within a few hours, could have saved 25% to 50% of those who survived the immediate impact but who died subsequently [38]. Search and rescue work -- the prerequisite for initiating medical care -- must also be carried out promptly and successfully for mortality to be reduced. A number of studies have shown that mortality rates of people trapped during disasters is a function of the duration of their entrapment

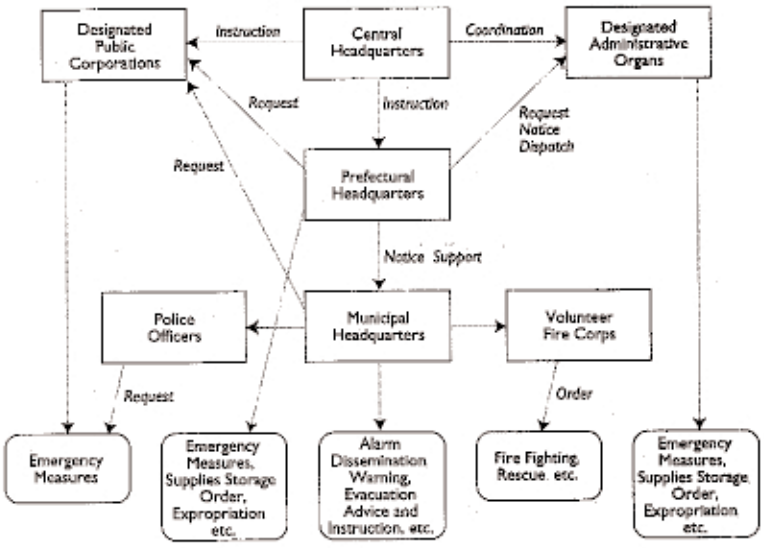

Figure 9. Organizational Chart for Disaster Response: January 1995
The disaster plan that was used in Japan following the Kobe quake indicated that the municipality of the affected area is the responsible first responder in the event of a major disaster and must establish a headquarters for disaster countermeasures that precede emergency relief from outside. The prefectural and central governments, if required by the scale of the disaster, establish the headquarters for major disaster countermeasures and promote comprehensive emergency countermeasures appropriate to the extent of the disaster. Depending on the circumstances, the Disaster Relief Law or the Law for the Payment of Solatia for Disaster may be applied. The Kobe earthquake showed the need to amend the disaster plan, revealing especially the impractical organizational structure and awkward chain of command for disaster response. An amendment to the Disaster Relief Law will be taken up in the Diet. Source: Disaster Prevention Bureau, National Land Agency, Japan, 1995

[4,39,40,41,42]. Moreover, it is reported that duration of entrapment may also be an important determinant of injury severity [43]. To initiate effective life-saving relief work quickly and effectively, collaborative drills should be conducted among search, rescue, and medical experts in pre-disaster periods.

The dispersion of casualties across a large disaster area, however, can make it impossible for a limited number of experts to deal with all the search-and-rescue work promptly. In the Kobe earthquake, many survivors were res cued by family members and neighbors. In the 1980 earthquake in southern Italy, 76% of the survivors were extricated by people in the same house and another 14% by neighbors [3]. In the 1964 earthquake in Japan, 75% of the survivors were engaged in rescue activities one-half hour after the quake [44]. Other studies show that people in the community, who knew where the trapped people were when the earthquake struck, have played a key role in search and rescue work [43]. In this respect, training in search-and-rescue procedures and in basic medical care should be given to the general

public. Local communities should set up their own detailed disaster response for search, rescue, and medical care and for evacuation. There are about one million volunteers in community fire brigades in Japan, which have been mainly organized to protect their own communities from fire. Retraining and reorganizing such resources for a variety of disaster scenarios would contribute to effective disaster response at the community level.

In Japan, there are many experts in emergency medicine, but few in disaster medicine or disaster epidemiology who can deal with mass casualties and evacuees. Proper knowledge about the factors associated with death and injuries in disasters is crucial to determining the needs for relief and an appropriate medical and public health response [3,4,45]. Health experts who can manage disaster response from a broader standpoint are required for future challenges.

Preparing for the Future

The Japanese government, having learned many lessons from the Kobe experience, approved the revision of the country's disaster prevention plan on July 18, 1995. The new basic plan will allow the SDF to be dispatched without an official request. Local governments and public organizations are advised to improve communications facilities in order to report more accurately the extent of damage and to coordinate rescue and relief efforts from inside and outside the country. The revised plan also describes joint drills and action of SDF personnel and local governments in search and rescue operations, food preparation, and removal of rubble. The plan calls for the central and local governments, as well as concerned private and public organizations, to work out ways of accepting volunteers and providing them with support centers. Similar measures for promptly accepting international aid and support will also be mapped out.

The plan also encourages the public to stock pile food and drinking water in quantities that would enable them to survive two or three days, to keep on hand emergency equipment such as a radio, a flashlight, and dry cell batteries, and to put aside bank notes and other financial documents relating to land and home ownership. The plan also urges citizens to cooperate during an emergency in helping the elderly, the disabled, and young children and to try to extinguish fires before firefighters arrive. To raise awareness about disaster preparedness, the plan suggests that local officials compile maps indicating routes to evacuation shelters and booklets that give advice on what to do in case of a natural disaster and to distribute them to all residents in the community.

Although the new disaster plan seems well revised, it would not be possible for it to cover every detail of disaster response. In terms of the medical and public health response, leading groups of medical and public health specialists, such as public health centers, the Japan Medical Association, the Association of Private Hospitals, and the Japanese Red Cross Society should take the initiative to establish systematic disaster management capacities with integrated short term and long term countermeasures for internal and external disasters. Serious drills are critical to realizing an effective emergency response to future disasters.

The Great Hanshin-Awaji earthquake brought unprecedented immense impacts far beyond the imaginations of most Japanese, who had been accustomed to living in a considerably secure and peaceful society. This disaster, however, taught Japan and all the world that catastrophe can strike at any time, in any place, without warning. The only way to prevent or mitigate tragedy is to make a strenuous effort to improve prediction techniques, to establish more appropriate disaster prevention and response plans, to enhance levels of preparedness, and to conduct repeated drills for the most serious scenarios during pre-disaster periods. ❧

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