Lessons from Hanshin Awaji Earthquake
—Experience of a medical association—

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Abstract
An earthquake of unanticipated scale occurred just beneath an urban area that included the cities of Kobe (prefectural capital with 1.5 million inhabitants), Ashiya (90,000 inhabitants), and Nishinomiya (420,000 inhabitants). It was a terrible disaster that struck the narrow strip of land containing important east-west transportation routes squeezed between mountains to the north and the sea to the south. Interruption of information severely impeded cooperation among local governments and that between them and private organizations, and local entities had to act independently for a time. Medical institutions were also isolated due to the interruption of information, experiencing difficulty in communication with other hospitals for patient transportation. At the time, the concept of triage was understood and practiced by emergency personnel, but we were still uncertain about the general public’s understanding of the concept. However, triage was accepted well at the hospitals performing it and no problems were encountered. In the extreme difficulties caused by the unexpected disaster, medical association members did their best with a firm sense of mission to help victims from the initial to the subacute and chronic phases, overcoming the lack of experience and bewilderment. However, it is also a fact that our response was not sufficient. This article provides some proposals based on this experience.

Key words Lifeline facilities, Acute care, Subacute care, Chronic care, Disaster medicine, Medical association

Introduction

At 5:46 a.m., January 17, 1995, there was a great rumbling of the earth followed by strong vertical shakes and then violent horizontal shakes. I could not stand up fully, and it was all I could do to prevent myself from falling over. After the shock subsided, I moved out of my house to see most of the houses in the neighborhood completely destroyed or half-collapsed. It was a miracle that my house stood apparently intact. The 2-storied apartment in front of my house had collapsed burying 2 children, who were soon rescued alive. An old woman died of compression in another collapsed house. Fortunately, the JR Shinkansen Line and other railways had not started the day’s operation at the time of the earthquake, and there were no casualties from derailment or other railway accidents. However, fire in some areas killed people confined in collapsed houses, and the collapse of the expressway killed drivers in their cars. Tremendous losses resulted from the damage to medical institutions, impacts on medical workers, interruption of telecommunications, interruption of lifelines (electricity, gas, and water), disruption of road networks including expressways, and destruction of railway facilities.

Damage to Medical Institutions

January 15 and 16 were holidays. When the earthquake hit at 5:46 a.m. of January 17, only the personnel on night duty were in hospitals other than emergency hospitals. It was a time when hospitals were at their most understaffed. The situation was similar in smaller clinics. These also sustained

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total and half collapse of buildings, destruction of medical equipment, and personal damage. The earthquake killed 9 members of the medical association, and very regrettably, there were also deaths among the families of members, employees, and the families of employees. These personal losses aggravated the impairment of clinical functions.

According to the survey of disaster medicine in Hyogo Prefecture (June 1995), the damage to medical institutions affiliated with the medical association was as follows. Of the 1,436 medical institutions in Kobe City, 40.6% sustained total or half collapse. The damage was particularly severe in the hardest-hit strip of land (seismic intensity 7) passing through the central part of Kobe from west to east and reaching Nishinomiya City. The percentage was 33.4% in Suma Ward, 62.3% in Nagata Ward, 53.8% in Hyogo Ward, 50.4% in Chuo Ward, 61.8% in Nada Ward, 46.7% in Higashinada Ward, 36.6% in Ashiya City, and 23.6% in Nishinomiya City. When adjacent areas are combined, 747 of the total 2,983 medical institutions sustained total or half collapse and lost the ability to perform medical functions. Other medical institutions that remained without major destruction also suffered from damage to some extent and their clinical functions were impaired.

**Interruption of Electricity, City Gas, Water Supply, and Other Lifelines**

Disruption of lifelines, including the stoppage of the water supply, breakdown of electric power supply, stoppage of city gas, and interruption and disturbance of telephone lines drastically affected not only medical care services, but also citizens’ livelihood. The failure of electricity made it impossible to operate medical equipment and laboratory apparatuses using electric power, in addition to lighting. The stoppage of city gas hindered tasks involving boiling water and caused difficulties in preparing meals for in-patients. The lack of water supply caused a shortage of drinking water and water for general use, the latter required for hand washing and for flushing toilets. While the supply of drinking water was barely secured by the use of bottled mineral water, the shortage of water for general use caused difficulties beyond expectations. Because hemodialysis was impossible due to the disruption of the electricity and water supply, patients requiring hemodialysis had to be moved to hospitals that could perform this procedure.

As the then president of the Nishinomiya Medical Association, I asked the municipal government of Nishinomiya for a prioritized supply of drinking water to hospitals and hemodialysis
centers. According to the announcement of the Nishinomiya City Disaster Response Headquarters, the restoration of lifelines in Nishinomiya City progressed as follows. Electricity was restored in the areas where transmission was possible on January 21, and restoration in other areas would be later depending on damage to electrical facilities. A fire was reported to have been caused by a short-circuit in a collapsed house when the power returned. While the telephone lines were restored completely by January 31, problems due to line congestions continued for an extended period of time. Cellular phones were sufficiently serviceable, as the total number of subscribers was small at the time.

Currently, cellular phones now suffer from problems due to line congestions, similar to fixed telephones. Priority telephones designated for use in a disaster were useful for making calls, but they had the same difficulty as ordinary fixed telephones when receiving calls, and this resulted in the impediment of telephone communication. Internet communications did not work with sufficient performance due to damage to equipment and interruption of electricity, as reported later at the Hyogo Prefecture study meeting on the information network. This disruption of communications had considerable impact on medical care in the initial phases. Recovery of the water supply took more than a month, and temporary restoration was completed on February 28. City gas was not supplied for a long period until restoration was completed around April 11 after 3 months of interruption. Households got through this period using portable propane gas grills.

### Impairment of Clinical Functions

According to the survey of disaster medicine conducted by Hyogo Prefecture (June 1995), major factors that caused impairment of clinical functions were as shown in Table 1. (Unless otherwise specified, descriptions in the following are based on this survey.)

The disruption of lifelines (water, city gas, and electricity) had considerable impact on the clini-
A shortage of medical workers was also reported by more than 40% of medical institutions. The survey also examined the workers’ attendance at work on the day of the disaster (Table 2).

As mentioned above, many medical workers were prevented from going to work as a result of the damage suffered by them and their families, as well as the interruption of commuting routes. The data shown here are for the whole day, as opposed to the moment of the earthquake. Except for emergency hospitals, hospitals were very understaffed at the time of the earthquake. The rate of attendance at work was high among physicians working at clinics, probably reflecting the fact that many of them lived in the same places as the clinics. Other physicians, as well as most nurses and staff, lived in separate places, and many of them had difficulty in reaching the workplaces due to the damage from the disaster and interruption of transportation. Although the number is not known, there were casualties among employees and families. In such a situation we had to try our best to provide medical care during the initial phases of disaster.

Medical Care in the Acute Phase

We had to provide acute phase care in the situation outlined above. As the president of the Nishinomiya Medical Association, I rushed to the office of the Association with no means of obtaining a full picture of the situation. While the building of the Medical Association was unharmed, city gas was not supplied and air conditioning was not working. Electricity was available, but the water supply had stopped. We only had a limited amount of water remaining in the outdoor aboveground tank.

While trying to confirm the situation of medical institutions with no avail, due to the interruption of telephone services, I set up the Nishinomiya Medical Association’s headquarters in a small building located near where the Medical Association’s building was located. A total of 221 persons were treated at the Association’s headquarters. The number of those treated varied each day, and on the 7th day, there had been only 44 patients treated (Table 4)
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miya Medical Association Disaster Response Headquarters. I instructed the small number of personnel appearing in the office to confirm the damage and casualties at medical institutions, and made contact with the Hyogo Prefectural Medical Association, Nishinomiya Health Center of Hyogo Prefecture, and Nishinomiya City Office. We had to cope with the situation without sufficient emergency management systems. The president of Hyogo Prefectural Medical Association instructed me to concentrate on the response in Nishinomiya City. To avoid telephone line congestions, we arranged to make subsequent contacts at fixed times late at night.

Casualties seeking medical care in this situation mostly visited medical institutions in their neighborhoods using their own means of transport, they had no information and patient transportation routes were disrupted. Calling an ambulance was impossible due to the interruption of telephone services. Ambulances were used mostly for relief activities rather than the transportation of emergency cases, and the Fire Department later identified this fact as a problem to be solved in the future. To handle the large number of patients, triage was practiced at some hospitals, while confusion developed at hospitals where triage was not performed. Victims seeking a sense of security stayed in some hospitals treating them as if they were refuge camps, and in some cases, they had to be removed by the police. Requests for medicines in short supply mainly included antibiotic injections, infusions, and local anesthetics. The breakdown of treatment was as shown in Tables 3 and 4.

The transportation of patients to hospitals outside the disaster area was almost impossible because of the interruption of telephone services and the destruction of roads. Only one patient was transported using a helicopter on the first day. In this case, the Nishinomiya Municipal Fire Department requested the transport of drugs, and the helicopter of the Osaka Municipal Fire Department that arrived in response to this request was used for carrying a patient with crush syndrome to a medical institution in Osaka. At that time, the procedure for requesting helicopter transport was complicated and not widely known. Hyogo Prefecture announced the procedure regarding the operation of helicopters on January 22. It was demanded that a physician should attend the patient in a helicopter, and this resulted in additional impairment of clinical functions at the front line of medical care.

Disaster relief teams from various organizations began to arrive on the 2nd day following the earthquake.

The total death toll from this earthquake was 6,433, including earthquake-related deaths. The police asked us to participate in post-mortem examinations of the deceased. While a medical examiner system was in place in the older parts of Kobe City, other areas did not have this system, and the police in such areas made the request to the local medical association. The number of post-mortem cases examined by medical association members totaled 2,654, as compared with 2,340 cases examined by medical examiners and 486 cases by volunteer physicians. This was also a duty of physicians, and was conducted with the participation of 388 medical association members (Survey by Hyogo Prefectural Police, June 9, 1995). The causes of death among the victims of earthquake were death from traumatic asphyxia in 4,224 cases, death due to fire and thermal injury in 504 cases, head and neck injury in 282 cases, visceral injury in 93 cases, traumatic shock in 63 cases, whole body contusion in 45 cases, crush syndrome in 15 cases, other in 123 cases, and unknown in 124 cases.

Refuge sites were opened on and after the day of the disaster and became the homes of a great many victims. Medical association members were sent to refuge sites as follows:

- From hospitals: 71 persons on day 1 and 87 persons on day 2.
- From clinics: 281 persons on day 1 and 293 persons on day 2.

People at various risk, such as the sick, injured, babies, the elderly, and those suffering from psychological shock, were forced to live in confined spaces with little privacy.

**Medical Care in the Subacute Phase**

Two days after the disaster, people were still being rescued from collapsed houses and patients with injury were being treated (Tables 3 and 4).

It is regrettable that these patients with serious and severe conditions could not be transported efficiently to the hospitals outside the disaster area, as a result of the disruption of communications and transportation routes. Although Osaka Medical Association provided about 500
beds to accept patients from the disaster area, only a part of these beds were used.

First-aid stations were opened in succession. Responding to the call of the Japan Medical Association, relief teams from prefectural medical associations, university medical schools, NPOs, the Japanese Red Cross Society, and many other organizations cooperated in providing care at first-aid stations and making rounds at refuge sites. I worked with Nishinomiya City authorities and the Nishinomiya Health Center of Hyogo Prefecture to facilitate cooperation among these teams. I also instructed medical association members to ensure early setup of clinical capabilities and to make rounds at refuge sites. While most of the relief teams were self-supported, we were perplexed by some teams that requested lodgings and meals.

**Medical Care in the Chronic Phase**

There were 984 refuge sites in the prefecture on January 23, and the number peaked at 1,153 with 316,678 refugees on January 23. As mentioned above, the group living with little privacy and no choice of meals was the worst situation for patients with chronic diseases, who also suffered from significant psychological shock and were in extremely insecure conditions. Starting from the subacute phase, the Nishinomiya Medical Association announced the list of local medical institutions that could provide medical care. Some of the patients with chronic diseases suffered from a shortage of drugs, because their physicians had stopped practicing or they could not visit hospitals due to the interruption of transport services. Some showed worsening of symptoms resulting from the interruption of medical treatment, change in diets, change in living environment, psychological shock, etc. Exacerbation of symptoms of mental illness, acute stress reaction due to mental stress from the disaster, alcohol dependence, and other problems were treated at first-aid stations and medical institutions that were operating.

With respect to psychological care, the director of the Nishinomiya Health Center was a psychiatrist. Psychiatrists and clinical psychologists supported by the help from neighboring prefectures performed visiting care at refuge sites from the subacute phase. In addition to medical care, public health is also an important problem at refuge sites. With mutual communication and cooperation with related organizations, we addressed the issues of privacy, post-traumatic stress syndrome, alcohol dependency, and other psychological problems, as well as health problems caused by maladaptation to the living environment and prevention of infectious diseases. It was a praiseworthy fact that there were no outbreaks of oral infectious diseases despite the continued presence of many refuge sites over a long period including the rainy season.

**Proposals for Future Disaster Response**

Based on this experience of an unexpected major disaster, I would like to make the following proposals:

1. We strongly felt that physicians in general need to learn triage techniques. After the disaster, we visited various localities in response to lecture requests from local medical associations, and found to our delight that training using triage models was being performed in various departments regardless of their specialties. Training should be provided so that all physicians can perform triage. The difference between emergency medicine and disaster medicine and the purpose and meaning of triage should be announced to the general public in ordinary times to improve the people’s understanding and recognition of triage.

2. After triage, patients should be transported to medical institutions outside the disaster area according to the severity of conditions. At the time of this disaster, there were relatively few emergency helicopters in the country, helicopter transportation of patients was not widely recognized, and the procedure was complicated and time-consuming. While operation of emergency helicopters in Hyogo Prefecture was entrusted to the police before the earthquake, the organization was reformed with the establishment of the Air Rescue Team and streamlining of the procedure.

3. Once a disaster takes place, the land transportation of patients will be impeded by the destruction of roads and other damage, and patients will concentrate at the nearest medical institutions. For this reason, first-aid stations should be established at as many loca-
tions as possible near the places suitable for the landing of a helicopter. The physicians attending first-aid stations should be assigned in ordinary times, and other physicians in the vicinity should attend to help out as long as possible in the event of a disaster.

(4) The earthquake resistance of houses must be ensured. Earthquake resistance diagnosis and reinforcement based on it are required. Furniture and equipment should be fixed to prevent from falling.

(5) Accurate information and the means of communication must be secured. Public announcement from governmental bodies via the TV, radio, etc. must be provided, and police information must be secured. While securing of the means of communication (wire, wireless, satellite telephone, the Internet, etc.) is one of the most important requirements, both fixed telephones and cellular phones are expected to suffer from inability of communication due to line congestions. Vehicle-installed satellite telephones would be the best option. The connection with the Disaster and Emergency Medical Information System must also be ensured.

(6) Lifelines must be secured and provided in redundant systems. The disruption of lifelines seriously affects clinical functions, as mentioned above. While the waterworks bureaus of some cities have recently begun replacing water supply pipes with earthquake-resistant pipes, the use of such pipes is still limited. The water required for drinking, cooking, and medical care should be stored. Use of well water should be considered with respect to water for general use, which is needed in large quantities. In this earthquake, most of the elevated water tanks installed on rooftops were damaged. In some cases, the water that spilled from the tank damaged the interior of the building. In particular, medical institutions performing hemodialysis must ensure the storage of dialysis fluid and the supply of water. While emergency generators are already used to backup the supply of electric power, the quantity of fuel in storage is limited by the Fire Services Law. In this earthquake, some generators ran out of fuel and were unable to supply power. We need to consider a means to ensure the fuel supply for power generation. As demonstrated in the experience of this earthquake, the stoppage of city gas affects a wide area and restoration takes much time. When city gas is used for cooking in hospitals, additional use of other fuels such as propane gas should be considered.

(7) Disaster response manuals must be developed and the ability to use such manuals must be ensured through repeated practice. In ordinary times, it is necessary to confirm what should be included in the emergency kit and what the roles of each staff member are. Manuals are of no use without repeated practice. A disaster like this earthquake generates a large number of deceased persons at one time, and general physicians also have to participate in post-mortem examination. Based on this experience, the Hyogo Prefectural Medical Association established the Hyogo Prefectural Medical Association Society of Police and Clinical Forensic Medicine, and is conducting training in cooperation with university departments of forensic medicine, medical examiners, and criminal identification sections of the police.

Conclusion

In this article, the lessons learned from the experience of the Hanshin Awaji Earthquake, which occurred more than 10 years ago has been described. I hope that these may be relevant today, although drastic changes in social situations have taken place during the last decade. Disasters strike when you least expect them, and the development of a situation may not go as planned in the manuals. Manuals are important, but what is more important is to take proper steps flexibly to meet the actual situation.