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EMERGENCY MEDICAL CARE FOLLOWING THE GREAT HANSHIN-AWAJI EARTHQUAKE: PRACTICES AND PROPOSALS (A REPORT FROM A UNIVERSITY HOSPITAL LOCATED IN THE DAMAGED REGION)

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INDEXING WORDS

Hanshin-Awaji earthquake; major disaster; emergency medical care; crush syndrome

SYNOPSIS

The major earthquake, which hit the southern portion of Hyogo Prefecture, Japan, just before dawn on January 17, 1995, caused a tremendous amount of damage in a very short time. It killed 6,348 individuals, injured more than 33,000, destroyed about 170,000 houses, and left more than 300,000 people homeless. The central area of Kobe City was almost completely destroyed. Communication and transportation networks as well as other life lines were severed in many places. As a result, Kobe city was almost completely cut off from the outside world.[1,2]

This paper will outline how the emergency care unit in the Kobe University Hospital, located in the center of Kobe City, provided emergency care after the great Hanshin-Awaji earthquake, in the face of the many unfavorable conditions encountered in a major disaster. Based on our experience, we will also propose modifications for future emergency care systems coping with large-scale disasters.

INTRODUCTION

The major earthquake, which hit the southern portion of Hyogo Prefecture, Japan, just before dawn on January 17,1995, caused a treme-

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ndous amount of damage in the area in a very short time. It killed 6,308 individuals, injured more than 33,000 people, destroyed about 170,000 houses, and created more than 300,000 homeless people. The central area of Kobe City was almost completely destroyed. Communication and transportation networks and other life lines were severed in many places. As a result, Kobe city was almost completely cut off from the outside world. [1,2] Now, 14 months after the earthquake, the disaster-stricken area has only begun to take gradual steps towards restoration. A number of countermeasures and reforms for the medical care system response to large scale disaster, have been proposed and are being implemented.[3] This paper reports on the emergency care services provided after the earthquake at the Emergency Care Unit of the Kobe University Hospital, located in the center of the disaster-stricken area(Fig.1). At the same time, this recommendations for future emergency care systems faced with disasters are also proposed from a university hospital's perspective.

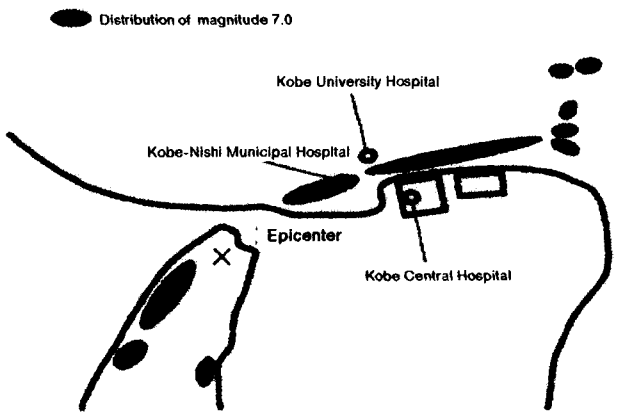

Fig. 1. Geographic distribution of greatest seismic forces (force 7) in relation to location of main hospitals surrounding the epicenter of the Great Hanshin-Awaji Earthquake.

MATERIALS AND METHODS

This study examines how the Emergency Care Unit at Kobe University Hospital handled the large numbers of emergency patients during the first week following the earthquake.

RESULTS

1. State of preparation to provide emergency care at our hospital immediately after the earthquake and documentation of the care provided

When the earthquake hit the Hanshin region at 5:46 A.M. on January 17, 1995, two experienced physicians (an internist and a surgeon, with 5-6 years of experience in medicine) and 4 interns (who had completed the course of medicine in the previous spring) were on holiday duty. The first patient was brought to the emergency care unit at about 6:05 A.M. that day. From approximately 6:30 A.M. on, private automobiles and police cars carrying a steady stream of patients filled the parking lot in front of the entry to our emergency care unit. Very quickly, however, the overwhelming number of injured as well as DOA patients brought into the emergency care unit caused confusion and panic around the reception window (This paper will use the term DOA although the Emergency Care Committee of the Japanese Association of Acute Medicine recently proposed the term CPAOA, cardiopulmonary arrest on arrival, to indicate patients whose cardiopulmonary functions are nonexisting on arrival, irrespective of whether or not cardiopulmonary resuscitation is performed on them after arrival.[4]) The panic soon subsided due to the cooperation of ward physicians on duty and the assistance of physicians and nurses living near by who came to provide help. Rooms which were normally used for outpatient care were allotted to emergency care, to allow smooth triage and treatment. Initially CPR was performed on every apparently DOA patient. After a number of injured patients had been brought in, we adopted the basic principle that CPR was not to be performed on evidently DOA patients, for whom it would be meaningless. In this way, we were able to avoid being seriously overwhelmed by the arrival of many dead and injured patients.

2. Damage to the hospital facilities and establishment of an emergency care system to meet extraordinary circumstances

(1)The hospital's life lines and instruments

Immediately following the earthquake, the commercial power

supply to the hospital was interrupted. An independent generator at the hospital worked smoothly, preventing a larger problem. The commercial electric power supply was reestablished 5 hours after the earthquake. Since the hospital was not located in the epicenter where seismic intensity was at its greatest (degree 7 on the Japanese scale), the water pool tank (800m3) and water pipes of the hospital were spared damage. The water supply lasted until the evening, when water was no longer available. The gas supply was completely cut soon after the earthquake. Fortunately, the hospital building itself was not seriously damaged. After the commercial power supply came back on, plain roentogenography and computed tomography were available. Our hematological and biochemical testing devices and blood gas analyzers were also available for urgent use. Since we had a stock of medical drugs sufficient to cover about 1 or 2 weeks, we faced no shortage of drugs. The stock of intravenous solutions was rapidly consumed and ran very low, but it was smoothly replenished by measures taken in the drug purchasing department. Three operating rooms were available for use soon after the earthquake. Thus, we could cope smoothly with cases requiring urgent operations. Based on these assessments, we concluded that the hospital was sufficiently prepared and was able to serve as a regional core hospital in the disaster area.

(2)Establishment of an emergency care headquarters and a computerized system for patient registration and management

Due to the vast number of emergency patients, patient reception and medical records preparation did not work smoothly. Later, an emergency care headquarters was organized by placing long tables and chairs in front of the emergency care unit reception window, so that triage could be performed. Because the computer system throughout the hospital was out of operation for some time, a portable computer was installed in the headquarters and used for computerized registration of emergency patients until the original computer system came back on line. In addition to the injured patients themselves, family members and friends began to arrive at the hospital. Because registration procedures for all admissions (DOA and living patients) had been streamlined by the evening, the uninjured visitors caused little confusion.

(3)Establishment of a system for facilitating support of the emergency care unit by all other departments

The earthquake also injured or disrupted the lives of many employees at the hospital. It was therefore necessary to determine the number of employees who could participate in emergency care services and the extent to which the departmental infrastructure and support systems at the hospital were functional. It was also necessary to provide accurate information to all the hospital staff members themselves, so they would be better informed regarding the disaster and the frequent aftershocks. The first emergency meeting was held at 9:00 A.M. on January 18, with representatives from all departments including the central medicare unit, the pharmacy, the nursing division and the clerical division. During this meeting, the condition of each member of each department or division (safe, injured or dead) was confirmed, and reports were made concerning instrument damage, level of function, drug stocks, number of vacant beds, and status of various life lines (power, water and gas supplies) and their expected schedules of recovery. After this meeting, it was decided to discontinue non-emergency outpatient care temporarily. Each department then sent some physicians to the emergency care unit to help with as many emergency patients as possible. With the cooperation and consent of each department and the nursing division, the emergency care headquarters monitored the number of vacant beds and allocated emergency patients requiring hospitalization to these beds, even if the ward where these beds were located was not directly related to the patient's problem. To avoid confusion on the part of support staff, who were now providing care for patients with unfamiliar conditions, teams of internists, general surgeons and orthopedic surgeons were organized to take care of the array of patients accepted on the various wards. Furthermore, a special team was organized to deal with renal failure and multiple organ failure (MOF) in patients with crush syndrome,which is described later. These teams were coordinated by the emergency care headquarters (Fig. 2).

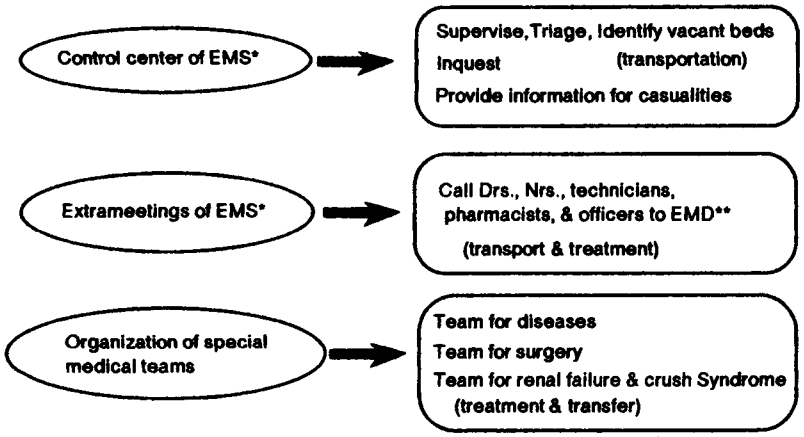

Fig.2 Configulation and task assignments of the emergency medical care system during the earthquake.

(EMS* : Emergency medical system , EMD** : Emergency medical division)

(4) Management of inpatients hospitalized before the earthquake

Because the first half of January 1995 included many holidays in Japan (the New Year holidays and several days around the Day of Adulthood, January 15th), the number of patients staying in the hospital on the day before the earthquake was relatively small (680people;77%), and there were many vacant beds(198). This made it easier for the hospital to accept earthquake-injured emergency patients. However, it was not possible to estimate how many injured patients would arrive at the hospital. Inpatients were anxious about their families and the state of their homes. We recommended that those patients who were not seriously ill or hospitalized only for intensive examinations be discharged from the hospital or transferred to other hospitals. The beds vacated by these patients were utilized for emergency patients. On the day of earthquake, the patients' food needs were satisfied with crackers from storage and rice balls as relief food and food from other sources. A hospital aftershock committee was organized. This committee provided information to reduce the fear and anxiety of inpatients and staff concerning any further threat of earthquake damage to the hospital building because of the continuing aftershocks.

3. Emergency patients accepted during the first week after the earthquake

(1) On the day of the earthquake, approximately 400 emergency patients were examined (there were probably dozens of patients who were not recorded due to the initial panic prior to computerized registration). Approximately 1,200 emergency patients were managed during the first week after the earthquake. Of these patients, 191 were hospitalized, 41 were DOA, 10 underwent emergency surgery, and 11 died after hospitalization (Table I,II). The emergency patients, evaluated during the first week, were divided into two groups; the injury group and the disease group. 487 (46%) were allocated to the injury group and 576 (54%) to the disease group. Some patients were unclassified. Of 191 patients hospitalized during this period, 131 (69%) were allocated to the trauma group and 60 (31%) to the disease group. Thus injury rather than disease was more often responsible for the hospitalization of these patients(Fig. 3). Among all patients who presented to our unit for emergency care, the percentage treated for trauma was very high (83%) on the first day of the earthquake and decreased gradually with time: 43% on the second day, 37% on the third day, 34% on the fourth day, and about 18% on the fifth day (Fig. 4).

Table I. Volume and distribution of patients presenting for emergency medial care of earthquake related complaints at Kobe University Hospital as a result.

Dates / Distribution	'95 1/17	1/18	1/19	1/20	1/21	1/22	1/23	Total
No. of patients	363+α	167	168	166	106	82	116	1168+α
No. of inpatients	113	26	10	13	10	13	6	191
DOA*	29	2	0	4	0	1	5	41
No. of operation	3	1	2	0	3	0	1	10
Dead inpatients	1	3	1	3	2	1	0	11
No. of outpatients	0	63	169	271	76	37	446	1062

*DOA : Dead on arrival

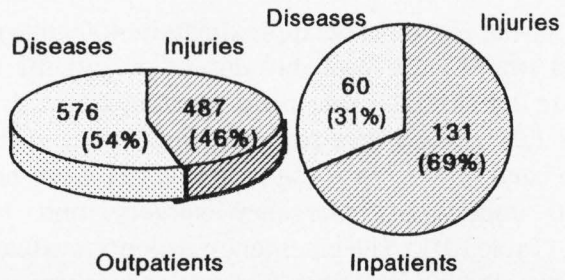

Fig.3 Percentage of patients with injury versus disease prompting hospital evaluation for outpatient and inpatient care after the earthquake.

TableII. Precipitating injury for emergency operations performed following the earthquake.

Dates	No of Cases	Diagnosis
'95 Jan. 17	3	Rupture of urinary bladder Traumatic occlusion of bil. femoral artery Traumatic occlusion of left femoral artery
Jan.18	1	Laceration of Eyeball
Jan. 19	2	Rupture & necrosis of small intestine Acute subdural hematoma
Jan. 21	3	Rupture of eyeball Injuries of Inf. mesenteric vessels Posterior dislocation of the hip
Jan. 23	1	Penetrating leg wound
Total	10	

(Excluding Minor surgeries)

Fifty percent of trauma injuries were confined to the pelvis, lumbar area and spine (sites primarily handled by the field of orthopedic surgery), injuries to the head (including the face) accounted for 26% of all cases, chest 9%, and abdominal region 1%. Multiple injuries were sustained in 15% of patients. Thus, the incidence of thoracic and abdominal trauma was lower than one might expect, probably because many people were sleeping and those of severe thoracic and abdominal injuries were killed immediately when the earthquake hit (Fig.5).

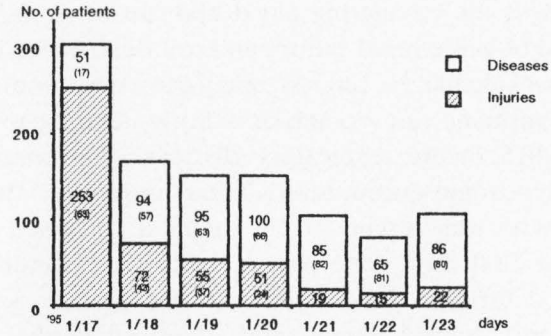

Fig.4 Distribution of injury versus disease related complaints in the first 7 days following the earthquake. (Numbers in parenthesis represent percentage of total patients seen that day)

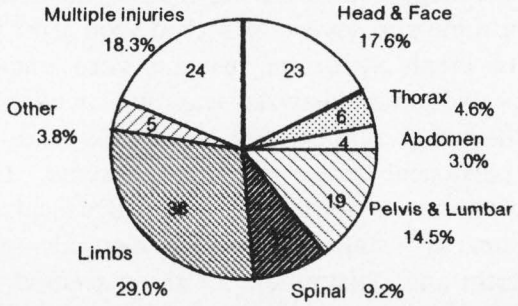

Fig.5 Body distribution of injuries in patients requiring hospitalization after earthquake related trauma.

(2)Management and referral of patients with crush syndrome

Crush syndrome came to public attention as a significant form of injury caused by this major earthquake. This syndrome develops when the extremities sustain a blunt form of crush due to compression by furniture, pillars, debris, etc., following the destruction or falling of houses and furniture caused by earthquakes and similar catastrophes. Although the term " crush syndrome" gives the impression that this condition refers to pressure-induced crushing of muscles, etc., the syndrome, in fact, primarily involves disturbance of circulation through the crushed area and its periphery. In cases when muscles crushed or undergone necrosis, there is ofen accompanying neurovascular damage and fracture. Removal of the cause of compression can lead to swelling in these areas, due to bleeding or edema after reperfusion. Reno toxic substances then flow out of the crushed muscles. The outflow of these

substances reduces the circulating blood and causes acute renal failure. The combination of acute renal failure and cell destruction causes rapidly advancing hyperkalemia. Unless adequate treatment is provided immediately, symptoms can worsen drastically, leading to complications such as fatal ARDS (acute respiratory distress syndrome).[4,5] The first case of crush syndrome encountered in our unit after this earthquake was a patient who was rescued from under a collapsed house on the afternoon of the first day. The patient had myoglobinuria and severe MOF. Oligurlia deteriorated into anuria, as the patient developed acute renal failure and hyperkalemia and then suddenly died. After recognizing this syndrome, we immediately organized a team to cope with patients exhibiting renal failure and MOF. Muscle crush was suspected in 70 patients. Thirty-two patients (24.4% of the 131 patients hospitalized due to injury) were diagnosed as having crush syndrome. Two patients who had this syndrome and severe MOF died soon after hospitalization. Thirteen cases of crush syndrome were severe enough to require hemodialysis, however hemodialysis was not available due to the interruption of the water supply after the earthquake. Hemofiltration (CHDF, etc.) and peritoneal lavage were used instead. In seven milder cases of crush syndrome, respiratory and cardiovascular complications were treated, primarily using conservative methods (e.g., intravenous solutions, urinastatin and dopamine). Of those treated, 3 died and 12 improved. Fifteen patients were referred to other hospitals located outside the earthquake-damaged area during January 19-22 (Table III).

Table III. Summary of volume, care, and outcome of patients with suspecte crush syndrome following earthquake related injury.

No. of patients with suspected crush injuries 70			
No. of patients with crush syndrome (Cr > 2.0mg/dl, CPK > 1000IU/L)	32		
Treatment regimens:		Disposition:	
Hemofiltration, etc.	13 pts.	Dead	3 pts.
Conservative therapy	17 pts.	→ Transported	5 pts.
		Improved	12 pts.
Early death	2 pts.		

DISCUSSION

The first problem we encountered with the provision of emergency care following the earthquake was the delay in governmental assessment and dissemination of information related to the nature and extent of damage to people and property. An additional area of difficulty concerns the inadequate implementation of emergency response programs by various government agencies. Under these circumstances and due to the interrupted life lines, it was impossible for many medical facilities to provide satisfactory emergency care services. Although our hospital had relatively adequate manpower, drug stocks and functional instruments, ours was the exception. Some hospitals were obliged to cope with a deluge of more than 1,000 emergency patients on the first day of the earthquake.[2,3]

The incidence of natural disasters, including earthquakes, is high in the Japanese islands. To facilitate rapid and smooth emergency medical care following natural calamities, it is essential that assessment the disaster-stricken area and collection of information, and transmission of information be performed smoothly to update medical facilities. Pre-established networks, including alternative networks which can be utilized in the event the major network is out of order can be of great help. It is also necessary to review the patient transportation system, so that patients requiring emergency care can be transported to appropriate medical facilities using a system tailored to individual districts, making use not only of the land route but also of air or sea routes. The following also seem to be essential: (1) development of specialists versed in emergency care following extensive disasters, (2) development of medical care coordinators who cover a number of districts or small regions following the onset of disasters, and (3) large-scale training and drills of emergency personnel to prepare for the delivery of emergency care following extensive natural calamities.

Although triage tags were not used, the entrance to our emergency care unit from the outside was limited to one site, where 3 or 4 experienced surgeons triaged emergency patients. Since we had space within university hospital, we were able to prepare special rooms for dealing separately with severely injured and sick patients soon after the earthquake. Patients whose condition was stable on arrival received intravenous infusions and other therapies on the sofas and lounge chairs

in the outpatient waiting rooms. The condition of these less serious patients was later re-evaluated, and those showing deterioration were immediately hospitalized. In this way, serious confusion was avoided. Our university hospital has 12 divisions and 18 treatment departments, with a total of 878 beds, and serves as a place for education, research and practice on the most advanced frontiers of medicine. Usually, outpatient care, inpatient care and ward management are the responsibility of individual departments. Following this major earthquake, emergency care headquarters have been designated with the responsibility of monitoring vacant beds and inpatient management. We believe that this will allow emergency care to flow more smoothly. In view of the social responsibilities of university hospitals, it is a matter of course that patient-oriented medical services must be provided without limitations of sectionalism or competition among different departments at all times, not just during extraordinary circumstances. We feel strongly that our experiences following the Hanshin earthquake will facilitate smoother inter-departmental cooperation in daily practice.

The latest earthquake took place only 1.5 months after I assumed the office of Directer of the Emergency Care Unit. Facing the need to provide emergency care to earthquake-traumatized people, I immediately organized an emergency care command headquarters and ordered information to be collected and status assessments to be made. Arrangements were made rapidly and adequate steps taken to cope with anticipated situations. Fortunately, adequate medical staff support was obtained and the hospital's infrastructure functioned relatively well. Because of these factors, I believe the hospitals served well as a core regional care site following the earthquake. I recognize that a university hospital such as ours, where personnel and medical necessities are sufficient, could have taken more rapid action by sending teams of physicians to the earthquake-damaged areas, refugee camps and other hospitals, instead of merely confining staff activity to the hospital.

I emphasize the importance of identifying in advance those hospitals which are expected to serve as core facilities for the management of individuals injured by disasters. These hospitals can be selected from among critical care centers, university hospitals or other facilities which are expected to continue functioning even when a major earthquake hits. Once such core hospitals are appointed, a regional network of medical care should be established around this core facility and emergency

personnel should be trained and utilized during ordinary times, so that all of the ambulance crews, physicians, nurses and citizens become well acquainted with the emergency care network system. If this is done, patient care after disasters can be conducted appropriately on the basis of severity assessments, and only-moderately-injured citizens can be advised to visit appropriate facilities, rather than rushing to just any facility and causing confusion, as was seen after the Hanshin-Awaji earthquake. Such a network system will also allow for medical aid teams (composed of physicians and nurses of the core facility and neighboring facilities) to move smoothly into the damaged area and staff medical facilities short of personnel. Transfer of rescued patients to medical facilities outside the damaged area, when needed, will also proceed more smoothly under a network system. It is essential that people in administrative agencies become well acquainted with the concept : "pro-active" (which means to take necessary actions in advance) to prepare for disasters. If the principle of taking immediate countermeasures (the principle that actions are to be taken immediately after a disaster, if damage seems to have been caused, even if no definite information about damage has yet been obtained) is established, I believe that earlier rescue of injured people and higher levels of life saving can be achieved.

CONCLUSION

This paper has presented how the emergency care unit in the Kobe University Hospital, located in the center of Kobe City, provided emergency care with the cooperation of physicians, nurses, technologists and other people from various departments or divisions, after the great Hanshin-Awaji earthquake, while facing such unfavorable conditions as interrupted life lines. Based on our experience, we have presented a proposal for an emergency care network designed to facilitate access to and level of medical care in the face of a large-scale natural disaster.

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