Original Research

Profile and Outcome of Victims of an Earthquake in an Aging Society: A Population-Based Descriptive Study of the Earthquake in Osaka, Japan, on June 18, 2018

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Abstract

Objective: The aim of this study is to reveal the characteristics and outcomes of patients injured in a major earthquake and who were transported to a hospital by ambulance.

Methods: This study was a retrospective descriptive epidemiological study including all patients who were injured after a major earthquake struck Osaka Prefecture on June 18, 2018, and were transported to a hospital by ambulance. The main outcome was the prognosis at each hospital's emergency department.

Results: In total, 214 patients were included in the analysis. Their median age was 74 years (IQR, 54-82); 53 (24.8%) were men and 161 (75.2%) were women. The median time from ambulance call to arrival at the scene was 10 min (IQR, 7-15), and the median time from ambulance call to the hospital arrival was 37 min (IQR, 30-51). Ninety-seven patients (45.3%) were admitted to a hospital, 114 patients (53.3%) were discharged home to and from the emergency department, and 3 patients (1.4%) died. Among the patients discharged to home from the emergency department, the most common pathological condition was head bruising in 16 patients.

Conclusions: This study revealed the profile of injured patients transported by ambulances after an earthquake that struck an aging society.

Introduction

A major earthquake not only destroys infrastructure such as railways and water supplies but also kills and injures people due to collapsed housing. From 2000 to 2018, 2634 earthquakes of magnitude 6 or greater occurred worldwide,[1] of which 123 occurred in Japan, one of the most earthquake-prone areas in the world. Among these 123 earthquakes, people were killed in 14 (Figure 1). In the Great East Japan Earthquake occurring in 2011, the number of fatalities including missing persons was 18 429, and the number injured was 6157. Such statistics are often based on autopsy results performed by police departments in Japan. However, the activity of emergency medical services (EMS) and the profile or outcome of the injured in a disaster situation has not been fully revealed. It is important to reveal the profile of the patients injured by an earthquake to develop medical policies for response, treatment, and recovery following earthquakes.

At 7:58 AM, Tokyo time, on June 18, 2018, a 6.1-magnitude earthquake struck Takatsuki City in Osaka Prefecture. Twenty houses were completely destroyed, and 58 027 other houses and 725 public facilities were damaged.[2] The Osaka Prefecture Government developed and introduced an information system for emergency patients (the Osaka emergency information Research Intelligent Operation Network [ORION] system) that uses a cell phone application (app) for hospital selection by on-scene EMS personnel and has been accumulating all ambulance records since January 2013.[3,4] Furthermore, medical institutions have input all data on diagnosis, treatments, and outcome of emergency patients transported to medical institutions by ambulances into the ORION system since January 2015. The ORION system has merged these data with ambulance records and cell phone app data. The purpose of this study was to reveal the activity of EMS and the profile and outcomes of injured patients who were transported to a hospital by EMS after the earthquake occurring in Osaka Prefecture on June 18, 2018.

SDMPH
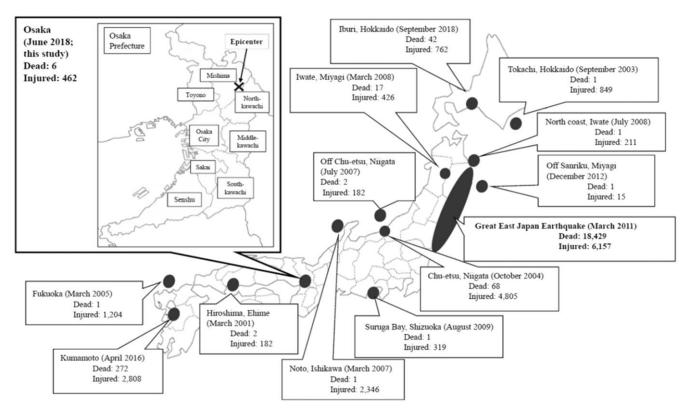SOCIETY FOR DISASTER MEDICINE & PUBLIC HEALTH

Figure 1. The great earthquakes over magnitude 6 occurring in Japan from 2000 to 2018.

Methods

Study Design, Population, and Settings

This study was a retrospective descriptive epidemiological study. The epicenter of the 6.1-magnitude earthquake was Takatsuki City in Osaka Prefecture (34° 50.6′ N [north latitude], 135° 37.3′ E [east longitude]) at a depth of 13 kilometers (km). Although Osaka Prefecture was the most affected area, the earthquake was felt as far away as the Kanto area to Kyushu area.

According to the ORION system, the reasons for ambulance calls are divided into "fire accident," "natural disaster," "water accident," "traffic accident," "injury, poisoning, and disease due to industrial accident," "disease and injury due to sports," "other injury," "trauma due to assault," "self-induced injury," "acute disease," "inter-hospital transport," and "other." This study included the patients who were transported by EMS due to the natural disaster on June 18, 2018, and excluded those who were not transported to the hospital and those with missing data.

This study was approved by the ethics committee of Osaka University Graduate School of Medicine, Osaka, Japan (approval number [No.] 15003). Because the ORION data are anonymized without specific personal data such as the patient's name, date of birth, and address recorded, the requirement of obtaining patient informed consent was waived. This manuscript was written based on the strengthening the reporting of observational studies in epidemiology (STROBE) statement to assess the reporting of cohort and cross-sectional studies.[5]

Emergency Medical Service and Hospitals in Osaka, Japan

The EMS in Japan is a public service, and patients are transported to a hospital by this system. Osaka Prefecture, the largest metropolitan community in western Japan, has a population of 8.8 million people spread over 1900 km[2]. There are 519 hospitals (106 273 beds) in Osaka Prefecture, 288 of which are emergency hospitals, including 16 critical care centers that are designated to accept patients with life-threatening diseases such as severe trauma and sepsis. In disaster situations such as a major earthquake, these emergency hospitals and critical care centers must accept the patients injured by the disaster.

The ORION System

EMS personnel at the scene use the ORION smartphone app for each emergency patient. All of the data input into the smartphone app, such as vital signs and the time of the call to the hospital to enquire about acceptance, are also recorded. The smartphone app data are accumulated in the ORION cloud server, and in cooperation with the dispatched EMS personnel, a data manager at each fire department directly inputs or uploads the ambulance record of each emergency patient so that it can be connected with the app data. Furthermore, the operators of each hospital also directly input or upload the patient's data, such as diagnoses and outcomes, after hospital acceptance. The results of the data aggregated in the ORION system are fed back to every fire department and emergency hospital. The Department of Public Health of Osaka Prefecture can also analyze the effects of health policy on the emergency medical system using these collected data. It was previously reported that the data on 97.9% of all emergency patients transported by ambulance were captured, and the data were collected with the ORION system.[3]

Statistical Analysis

Descriptive statistics for all numerical variables, including the median, interquartile range (IQR), and percentages of all
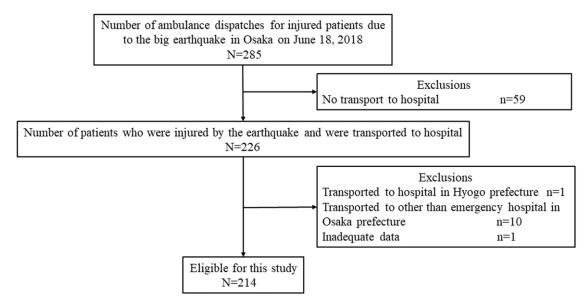
Figure 2. Patient overview in this study.

categorical variables, were calculated. Based on the administrative divisions, the data were categorized by area into the Mishima, the Toyono, Osaka city, and the North and Middle Kawachi areas, and tabulated. The patients were classified into age groups: children (0-19 years old), adults (20-64 years old), and the elderly (65 years old and over). To assess the impact of the earthquake on transport to the hospital by ambulance, we used a t-test to evaluate the mean response time from ambulance call to arrival at the hospital for these patients and other ones in 2018. In addition, we compared the characteristics of patients who were admitted to the hospital and those who went home post-emergency department. A *P* value of < 0.05 was considered to indicate statistical significance. Statistical analyses were carried out using SPSS version 23.0J (IBM, Armonk, NY).

Results

On June 18, 2018, 285 patients were injured by the earthquake and called for an ambulance. Of these patients, 59 patients were not transported to medical institutions, 1 patient was transported to a hospital in Hyogo Prefecture, 10 patients were transported to non-emergency hospitals in Osaka Prefecture, and 1 patient had inadequate data. Thus, 214 patients were included in this study (Figure 2). The mean response time from the ambulance call to arrival at the hospital of these patients was longer than that of non-disaster-related patients in 2018 (42.9 vs 33.9 minutes [min], $P < 0.001$).

Table 1 shows the characteristics of the patients injured by the earthquake. The median age was 74 years old (IQR, 54–82), and there were 53 men (24.8%) and 161 women (75.2%). By area, 86 patients (40.2%) were in the Mishima area, 63 patients (29.4%) in the Toyono area, 51 patients (23.8%) in the Osaka city area, and 14 patients (6.5%) were in the North and Middle Kawachi areas. Among these patients, 20 (9.3%) were children, 66 (30.8%) were adults, and 128 (59.8%) were elderly. The injuries most commonly occurred inside the house (159 patients, 72.9%) followed by a public space (30 patients, 14.0%). The most common time that patients were transported to the hospital was 10:00 AM (41 patients, 19.2%), followed by 8:00 AM (39 patients, 18.2%). The median time from ambulance call to arrival at the scene

was 10 min (IQR, 7–15); the shortest time was 8 min (IQR, 6–10) in the North and Middle Kawachi areas, and the longest time was 11 min (IQR, 7–19) in the Osaka city area. The median time from ambulance call to hospital arrival was 37 min (IQR, 30–51); the shortest time was 35 min (IQR, 28–45) in the Mishima area, and the longest time was 39 min (IQR, 32–53) in the Toyono area. After they were treated in the emergency department of each receiving hospital, 97 patients (45.3%) were admitted to the hospital, 114 patients (53.3%) were discharged to home from the emergency department, and 3 patients (1.4%) died.

Table 2 shows the clinical characteristics of the 114 patients who were discharged to home from the emergency department. The median age was 64 years (IQR, 26–77), and there were 33 men (28.9%) and 81 women (71.1%). Among the 3 age groups, there were 19 children (16.7%), 48 adults (42.1%), and 47 elderly patients (41.2%). The median Glasgow Coma Scale score was 15 (IQR, 15–15), and the median respiratory rate was 18/min (IQR, 18–20). The median systolic blood pressure was 141 mmHg (IQR, 121–164), that of pulse rate was 86 beats per minutes (bpm) (IQR, 71–98), and that of saturation of percutaneous oxygen (SpO_2) was 98% (IQR, 97–98). Figure 3 shows the diagnoses of the injured patients who were discharged to home from each hospital emergency department. The most common pathological condition was head bruising in 16 patients, followed by psychogenic physical disorders in 11 patients, and forearm lacerations and lower extremity lacerations in 6 patients each. One patient underwent orthopedic treatment, 7 patients underwent surgery including wound suturing, and 106 underwent other treatments.

Table 3 shows the clinical characteristics of the 97 patients who were admitted to hospitals. Their median age was 78 years (IQR, 71–84), and they comprised 18 men (18.6%) and 79 women (81.4%). Among them were 18 adults (17.6%) and 79 elderly patients (81.4%). The median Glasgow Coma Scale score was 15 (IQR, 15–15), and the median respiratory rate was 20/min (IQR, 18–20). The median systolic blood pressure was 150 mmHg (IQR, 132–170), that of pulse rate was 87 bpm (IQR, 76–100), and that of SpO_2 was 97% (IQR, 96–98). Figure 4 shows the diagnoses of the hospitalized patients. The most common pathological condition was femoral fracture in 27 patients, followed by lumbar fracture in 13 patients, thoracic

Table 1. Characteristics of the patients injured by the large earthquake in Osaka Prefecture on June 18, 2018

	Total	Mishima area	Toyono area	Osaka city area	North & Middle Kawachi areas
	(n = 214)	(n = 87)	(n = 63)	(n = 50)	(n = 14)
Population		747 084	1 041 743	2 702 033	1 998 042
Surface area (km^2)		213	276	225	306
Population density (/km^2)		3507	3774	12 009	6530
Number of ambulance dispatch centers		4	5	1	7
Number of ambulances		28	36	65	68
Number of hospitals		33	43	179	91
Gender, n (%)					
Male	53 (24.8)	16 (18.6)	16 (25.4)	18 (35.3)	3 (21.4)
Female	161 (75.2)	70 (81.4)	47 (74.6)	33 (64.7)	11 (78.6)
Age, median (IQR)	74 (54-82)	75 (61-81)	75 (62-83)	67 (26-80)	70 (51-76)
Age group, n (%)					
Children (0-19 years old)	20 (9.3)	8 (9.2)	4 (6.3)	8 (16.0)	0 (0.0)
Adult (20-64 years old)	53 (24.8)	16 (20.6)	15 (20.6)	16 (32.0)	6 (23.8)
Elderly (65 years old or older)	141 (65.9)	63 (72.4)	44 (73.0)	26 (52.0)	8 (57.1)
Location					
Home	156 (72.9)	67 (76.7)	53 (84.1)	26 (52.9)	10 (71.4)
Public space	30 (14.0)	8 (9.3)	6 (9.5)	16 (31.4)	0 (0.0)
Working space	9 (4.2)	2 (2.3)	2 (3.2)	4 (7.8)	1 (7.1)
Road	20 (8.9)	10 (11.6)	2 (3.2)	4 (7.8)	3 (21.4)
Hospital arrival time					
8:00-8:59 AM	39 (18.2)	12 (14.0)	10 (15.9)	12 (23.5)	5 (35.7)
9:00-9:59	31 (14.5)	11 (12.8)	7 (11.1)	8 (15.7)	5 (35.7)
10:00-10:59	41 (19.2)	14 (15.1)	11 (17.5)	14 (29.4)	2 (14.3)
11:00-11:59	27 (12.6)	12 (14.0)	9 (14.3)	6 (11.8)	0 (0.0)
12:00-12:59 PM	24 (11.2)	12 (14.0)	6 (9.5)	5 (9.8)	1 (7.1)
1:00-1:59	15 (7.0)	6 (7.0)	6 (9.5)	3 (5.9)	0 (0.0)
2:00-2:59	9 (4.2)	5 (5.8)	4 (6.3)	0 (0.0)	0 (0.0)
3:00-3:59	10 (4.7)	6 (7.0)	4 (6.3)	0 (0.0)	0 (0.0)
4:00-4:59	5 (2.3)	2 (2.3)	2 (3.2)	1 (2.0)	0 (0.0)
5:00-5:59	6 (2.8)	3 (3.5)	3 (3.5)	0 (0.0)	0 (0.0)
6:00-6:59	3 (1.4)	3 (3.5)	0 (0.0)	0 (0.0)	0 (0.0)
7:00-7:59	1 (0.5)	1 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)
8:00-8:59	1 (0.5)	0 (0.0)	0 (0.0)	1 (1.5)	0 (0.0)
9:00-9:59	1 (0.5)	0 (0.0)	1 (1.6)	0 (0.0)	0 (0.0)
10:00-10:59	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
11:00-11:59	1 (0.5)	0 (0.0)	0 (0.0)	0 (0.0)	1 (7.1)
Time interval from ambulance call to arrival on scene, median (IQR)	10 (7-15)	11 (7-15)	8 (7-15)	11 (7-19)	8 (6-10)
Time interval from ambulance call to hospital arrival, median (IQR)	37 (30-51)	35 (28-45)	39 (32-53)	38 (30-51)	36 (26-49)
Outcome in emergency department					
Hospitalization	97 (45.3)	44 (51.2)	37 (58.7)	13 (26.0)	3 (21.4)
Home	114 (53.3)	41 (46.5)	26 (41.3)	36 (72.0)	11 (78.6)
Dead	3 (1.4)	2 (2.3)	0 (0.0)	1 (2.0)	0 (0.0)

IQR, interquartile range.

vertebrae fracture in 8 patients, and pelvic fracture in 4 patients. Among the treatments performed, 18 patients (18.6%) underwent orthopedic surgery, 1 patient was placed on dialysis, and 64 patients underwent other treatments. The outcomes at 21 days after admission were 47 patients (48.5%) were discharged to home, 41 patients (42.3%) were still hospitalized, 9 patients (9.3%) were transferred to other hospitals, and no patients had died. In the analysis of patients admitted to the hospital and those who went home from the emergency department, pat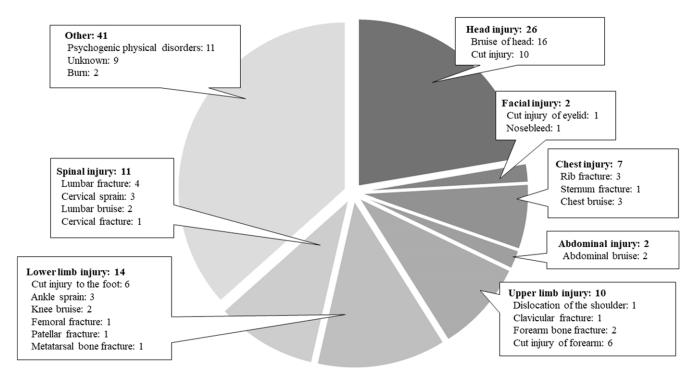ients admitted to the hospital were older than those who returned home (64 vs 78, $P < 0.001$), and there was no significant difference in the time interval from ambulance call to hospital arrival (40.0 vs 45.0, $P = 0.127$).

Table 4 shows the clinical characteristics and outcomes by age group. One pediatric patient and 2 elderly patients died. The time interval from ambulance call to hospital arrival was longer for the children (median, 62 min [IQR, 34-68] than that for the adults (median, 34 min [IQR, 30-45] and the elderly (median, 37 min [IQR, 30-51]).

Table 2. Clinical characteristics of the injured patients who returned home on the day of the large earthquake

	Total	Children 0-19 y.o.	Adults 20-64 y.o.	Elderly ≥ 65 y.o.
	(n = 114)	(n = 19)	(n = 38)	(n = 57)
Age, median (IQR)	64 (26-77)			
Gender, n (%)				
Male	33 (28.9)	4 (21.1)	10 (26.3)	19 (33.3)
Female	81 (71.1)	15 (78.9)	28 (73.7)	38 (66.6)
Vital signs on scene				
Glasgow Coma Scale, median (IQR)	15 (15-15)	15 (15-15)	15 (15-15)	15 (15-15)
Respiratory rate (breaths/min), median (IQR)	18 (18-20)	20 (18-24)	20 (18-20)	18 (18-20)
Systolic blood pressure (mmHg), median (IQR)	141 (121-164)	110 (105-122)	140 (122-159)	160 (144-180)
Pulse rate (beats/min), median (IQR)	86 (71-98)	87 (71-97)	85 (72-98)	87 (70-96)
SpO₂ (%), median (IQR)	98 (97-99)	99 (98-100)	98 (98-99)	97 (96-99)
Treatment, n (%)				
Orthopedic treatment	1 (0.9)	0 (0.0)	1 (2.6)	0 (0.0)
Other surgery, including wound suturing	7 (6.1)	1 (5.3)	2 (5.3)	4 (7.1)
Dialysis	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Other treatment	101 (88.6)	17 (89.5)	33 (86.8)	51 (91.1)
Unknown	5 (4.4)	1 (5.3)	2 (5.3)	1 (1.8)

IQR, interquartile range; SpO$_2$, saturation of percutaneous oxygen; y.o., years old.

Figure 3. Diagnoses of the patients who were discharged to home from each hospital emergency department.

Discussion

Until now, there has been no comprehensive study on the injured patients caused by earthquake in urban areas of developed countries. In order to plan in advance for the care of patients injured by earthquake and evacuation outside the disaster area, it is necessary to understand how many patients with what severity of injuries actually occur. Whil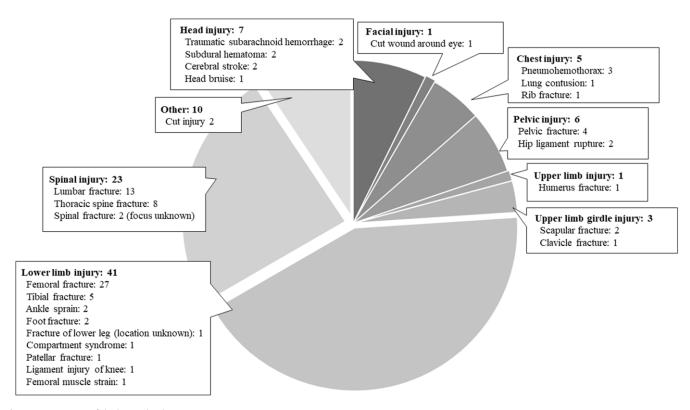e it may be possible to calculate the number of patients through simulation, clarification of the patients generated by an actual earthquake is important to consider for medical countermeasures in an earthquake disaster—and then building a foundation for collecting data on transported patients by ambulance on a daily basis and becoming familiar with the handling of ORION led to its usefulness for data collection in a disaster situation.

Table 3. Clinical characteristics of the hospitalized patients injured by the large earthquake in Osaka on June 18, 2018

	Total	Adults 20-64 y.o.	Elderly ≥ 65 y.o.
	(n = 97)	(n = 13)	(n = 84)
Age, median (IQR)	78 (71-84)		
Gender, n (%)			
Male	18 (18.6)	4 (30.8)	14 (16.7)
Female	79 (81.4)	9 (69.2)	70 (83.3)
Vital signs on scene			
Glasgow Coma Scale, median (IQR)	15 (15-15)	15 (15-15)	15 (15-15)
Respiratory rate (breaths/min), median (IQR)	20 (18-20)	20 (18-20)	20 (18-20)
Systolic blood pressure (mmHg), median (IQR)	150 (132-170)	145 (128-155)	152 (136-172)
Pulse rate (beats/min), median (IQR)	87 (76-100)	90 (75-105)	85 (76-97)
SpO_2 (%), median (IQR)	97 (96-98)	98 (97-99)	97 (96-98)
Treatment			
Orthopedic treatment	18 (18.6)	3 (23.1)	15 (17.9)
Other surgery, including wound suturing	2 (0.0)	0	2 (2.4)
Dialysis	1 (1.0)	0	1 (1.2)
Other treatment	63 (66.0)	9 (69.2)	54 (64.3)
Unknown	14 (14.4)	1 (7.7)	13 (15.5)
Prognosis at 21 days after hospitalization			
Home	47 (48.5)	5 (38.5)	42 (50.0)
Hospitalization	41 (42.3)	8 (61.5)	33 (39.3)
Inter-hospital transfer	9 (9.3)	0 (0.0)	9 (10.7)
Dead	0 (0.0)	0 (0.0)	0 (0.0)

IQR, interquartile range; SpO_2, saturation of percutaneous oxygen; y.o., years old.

Figure 4. Diagnoses of the hospitalized patients.

Table 4. Clinical Characteristics of the Injured Patients due to the Big Earthquake by age groups

	Total	Children, 0-19 y.o.	Adults, 20-64 y.o.	Elderly, ≥ 65 y.o.
	(n = 214)	(n = 20)	(n = 51)	(n = 143)
Age, median (IQR)	75 (55-82)			
Gender, n (%)				
Male	53 (24.8)	4 (20.0)	14 (27.5)	35 (24.5)
Female	161 (75.2)	16 (80.0)	37 (72.5)	108 (75.5)
Vital signs on scene				
Glasgow Coma Scale, median (IQR)	15 (15-15)	15 (15-15)	15 (15-15)	15 (15-15)
Respiratory rate (breaths/min), median (IQR)	20 (18-20)	20 (18-24)	20 (18-20)	18 (18-20)
Systolic blood pressure (mmHg), median (IQR)	145 (125-166)	110 (105-119)	140 (122-151)	154 (137-174)
Pulse rate (beats/min), median (IQR)	86 (75-98)	84 (71-97)	90 (80-104)	85 (73-94)
SpO$_2$ (%), median (IQR)	98 (96-99)	99 (98-100)	99 (98-100)	97 (96-98)
Outcome in emergency department, n (%)				
Hospitalization	97	0	13	84
Home	114	19	38	57
Dead	3	1	0	2
Time interval from ambulance call to arrival on scene, median (IQR)	10 (7-15)	15 (12-26)	9 (7-12)	10 (7-14)
Time interval from ambulance call to hospital arrival, median (IQR)	37 (30-51)	62 (34-68)	34 (30-45)	37 (30-51)

IQR, interquartile range; y.o., years old.

Because EMS in Japan is a free public service,[6] calls for ambulances may have been concentrated immediately after the earthquake occurred. In a previous study, 58% of patients transported to hospitals by ambulance were discharged to their home after treatment at an emergency department of a hospital in Osaka Prefecture.[3] When comparing the results of the present study with this previous study, the severity of patients transported to hospitals in the present disaster situation was almost same. Perhaps, patients may have called for an ambulance even when they suffered only minor injuries in the earthquake. Although earthquakes can cause a large number of injuries all at once, the number of available ambulances is limited. In addition, anyone can call for an ambulance free of charge in Japan. It is difficult to decide on the dispatch of an ambulance based on the severity and urgency of the patient over telephone alone, even if the determination is based on a protocol, when many injured patients request an ambulance in a disaster situation. Calling an ambulance even for minor trauma may make it impossible to dispatch an ambulance selectively to a severely injured patient. The patients injured by the 2018 earthquake in Osaka were older than the usual patients transported by ambulance.[3] Elderly people tend to depend on ambulances to access hospitals,[7] and those injured in the earthquake may have called for an ambulance first. To use ambulances to transport more severe trauma patients to hospitals, it would be necessary to transport elderly patients who suffer minor trauma due to a disaster by means other than ambulance such as transport by neighbors before agencies such as the military and the Red Cross come to rescue. While there are education programs for first responders and medical personnel in response to disasters, few are aimed at the general public.[8] It may be necessary to educate the public about the appropriate use of ambulances and other means of transportation in a disaster situation.

In this study, the proportion of females was higher than that of males. Although the reason for this was not clear, it may be due to the fact that many elderly women are at high risk of fracture or that women called for an ambulance due to anxiety caused by the earthquake. Among the numbers of patients transported by area, the proportion of elderly patients was large in the Mishima and Toyono areas, whereas that of adults was large in the Osaka city area. In addition, the proportion of transports from home was large in the Mishima and the Toyono areas, whereas that from public spaces was large in the Osaka city area. The Osaka city area is the most metropolitan area in Osaka Prefecture, and many workers and students were on the way to the office and school, respectively, at 7:58 AM when the earthquake struck. There is a lower proportion of homes in the Osaka city, whereas that of public spaces is greater. In the Hanshin-Awaji earthquake occurring at 5:47 AM, January 17, 1995, that struck Kobe and Osaka, a previous study revealed that 79% of the patients were injured indoors.[9] In urban areas, the movements of people vary depending on the time of day, so medical measures for earthquakes in urban areas will always need to consider chronological factors.

In Japan, the usual time interval from ambulance call to arrival at the scene is about 8 min.[10] In the present study, the time interval from ambulance call to arrival at the scene was 8 min in the Toyono and the North and Middle Kawachi areas but 11 min in the Mishima and the Osaka city areas. The epicenter of this earthquake was located in the Mishima area, and that may have affected the time from ambulance call to arrival at the scene due to traffic congestion caused by road deformation and loss of traffic lights in that area. Also, in the Osaka city area, as this earthquake occurred during commuting and school hours, the time interval from ambulance call to arrival at the scene may have been extended due to traffic congestion. From the previous study,[10] the usual time from ambulance call to hospital arrival is about 34 min in Japan, whereas in the present study, the time interval was 35 min in the area with the shortest time and 39 min in the area with the longest time. Thus, the time interval from ambulance call to hospital arrival during this earthquake was similar to that of normal ambulance transport time, and hospital acceptance for emergency patients appeared to have worked well. However, the mean response time from ambulance call to arrival at the hospital among these patients was longer than that among the other ones in 2018, which may suggest the fact that some

patients transported to hospitals due to the earthquake had long response times.

The time interval from ambulance call to hospital arrival was longer for children than for the adults and the elderly. In trauma care, prehospital time is an important factor that influences patient prognosis.[11] Especially, it is important to transport severe trauma patients to a hospital that can provide definitive care within 60 min.[12,13] In a study comparing adult and pediatric trauma patients in North Carolina, the arrival on-scene time and transport time were shorter in children with both blunt and penetrating trauma than in adults.[14] In addition, we previously revealed that emergency pediatric patients transported by ambulance were accepted smoothly by emergency hospitals.[6] In this study, the time interval from ambulance call to hospital arrival was prolonged for the pediatric patients, which indicates that the earthquake affected the emergency medical system's ability to accept pediatric patients.

Limitations

There are some limitations in this study. First, it was planned that all patients who were injured in the earthquake were included in this study. However, all patients affected by the earthquake were not able to be surveyed because the hospital record did not record whether or not they were affected by the earthquake. Therefore, in the registry of patients who were transported by ambulance, the reason recorded for the ambulance call was "natural disaster." Also, this study included only patients who were injured by this earthquake and transported by ambulance. Second, the 3 patients who died due to this earthquake were not assessed. The ages and names of these 3 persons were already reported by the press, and local law on the protection of personal information in Osaka Prefecture prohibits disclosing these victims' data for the protection of personal information. Third, there are no data on the patients who were injured and transported to hospitals other than emergency medical institutions in Osaka Prefecture. By building a common data format across regions, it will be possible to collect comprehensive data on the victims of disasters that cause damage over multiple jurisdictions of local governments. Finally, detailed mechanisms of injury and the situations were unknown because these data are not collected in the ORION system.

Conclusion

This study revealed the profile of injured patients who were transported to the hospital by ambulances after a big earthquake struck Osaka, Japan, on June 18, 2018. Medical resource allocation and EMS systems for earthquakes may need to be updated based on the evidence from this disaster. This study, which revealed the profile of injured patients due to an earthquake in a metropolitan area of Japan, could be useful when considering countermeasures for earthquakes in many cities around the world.

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