—Short Communication—

Lessons Learned from the Japan Earthquake and Tsunami, 2011

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Abstract

On March 11, 2011, an earthquake occurred off the coast of Honshu, Japan. The quake was followed by a powerful tsunami that caused extensive damage to the east coast of the Tohoku and Kanto regions. This disaster destroyed the medical system in place and thus drastically reduced the ability of the healthcare system to handle the large number of casualties. During the initial response to this disaster, we participated in several types of outreach medical relief teams dispatched to the affected area from the day of the earthquake onwards. The ratio of persons injured to persons missing or dead for the 2011 Japan disaster (0.31: 5,994 to 19,371) was much lower than for the Indian Ocean Tsunami of 2004 in Thailand (1.01; 8,457 to 8,393) and for the Great Hanshin-Awaji Earthquake of 1995 in Japan (6.80; 43,792 to 6,437). The different ratios for the different types of disasters indicate that medical relief efforts in response to natural disasters should be tailored to the type of disaster to optimize the effectiveness of the response and prevent further deaths. From a medical viewpoint, unnecessary deaths must be prevented following natural disasters. Doing so requires appropriate information transmission and an understanding of the mission's overall and specific objectives: 1) rapid search and rescue; 2) early care in the field, evacuation centers, and primary clinics; 3) definitive evaluation at disaster base hospitals; and 4) proper evacuation to unaffected areas. We propose a descriptive device that can guide headquarters in dealing with the commonalities of a disaster.

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Key words: tsunami, earthquake, medical informatics, disaster planning

On March 11, 2011, at 14 : 46, an earthquake of magnitude 9.0 on the Richter scale occurred off the coast of Honshu, Japan. The quake was followed by a powerful tsunami that caused extensive damage to the east coast of the Tohoku and Kanto regions. The exact extent of damage is still being assessed, but as of January 13, 2012, the death toll had reached 16,131 with 3,240 missing and 5,994 injured[1]. This disaster—one of the worst that medical systems have faced to date—destroyed the medical system in place and thus drastically reduced the ability of the healthcare system to handle the large number of casualties. During the initial response to this large-scale disaster, we participated in several types of outreach medical relief teams dispatched to the affected area from the day of the earthquake onwards, providing prehospital and disaster management.

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Table 1 Characteristics of 3 natural disasters

	Great Hanshin-Awaji Earthquake, 1995	Great East Japan Earthquake and Tsunami, 2011	Indian Ocean Tsunami 2004 in Thailand
Date of onset	January 17, 1995	March 11, 2011	December 26, 2004
Lifeline systems	Severely damaged	Severely damaged, including fuel	Intact
Hospitals	Damaged	Damaged	Largely preserved
Patient overflow surge	Weeks	Delayed, weeks	Days
Number of injured	43,792	6,121	8,457
Number of missing or dead	6,437	19,824	8,393
Ratio of injured to missing or dead	6.80	0.31	1.01
Characteristic injuries/diseases	Trauma, crush syndrome	Worsening of co-existing diseases	Aspiration, trauma

Authors' Experience

We mobilized quickly as a disaster medical assistance team and reached the city of Sendai in Miyagi prefecture at midnight on the day of the disaster, just 9 hours after the earthquake struck, but we were unable to reach the tsunami-affected areas by road because of the huge amounts of debris left by the tsunami. Moreover, our relief efforts were hampered by absences or shortages of electricity, water, and gas in the affected areas (the shortage of gasoline continued for 4 weeks due to disruption of the physical distribution network by the tsunami and the temporary shutdown of some oil refineries). Telephone services were also overloaded in the first 2 to 3 days, so we could communicate only with satellite mobile phones. This communications problem seriously hampered the medical relief activities and meant that, despite our rapid mobilization, we could not provide any effective medical care during the first 24 hours due to a lack of information. We were also impeded by a lack of medical supplies available in the disaster area: at the hospital in the city of Kesennuma, where we provided medical relief activities, there was a severe shortage of supplies, including medications, during the first week after the earthquake.

Ratio of Injured to Missing or Dead

The ratio of persons injured to persons missing or dead for the 2011 Japan disaster (0.31: 5,994 to 19,371) was much lower than for the Indian Ocean Tsunami of 2004 in Thailand[2] (1.01; 8,457 to 8,393) and for the Great Hanshin-Awaji Earthquake of 1995 in Japan[3] (6.80; 43,792 to 6,437) (**Table 1**). The ratio for previous earthquakes has been estimated to be 3, although the ratio of injury to death varies markedly for each event due to region-specific factors[4].

The different ratios for the different types of disasters indicate that medical relief efforts should be tailored to the type of disaster. One lesson learned from the Great Hanshin-Awaji earthquake is that wide-area transportation is necessary for treating persons with severe injuries, such as crush syndrome. However, the Tohoku disaster had a low ratio of injured to missing or dead of 0.31, and wide-area transportation was not needed on a large scale, although it was available via the doctor-helicopter system (the "Doctor-Heli" system) that was mobilized. Because the number of casualties presenting with multiple trauma, burns, and crush syndrome was smaller than expected, medical relief teams were needed to provide medical support at evacuation shelters in the disaster area, even in the acute phase. In fact, in the days following the tsunami and up to 8 weeks afterwards, rather than having medical problems related specifically to the tsunami (such as tsunami lung), most patients complained of a worsening of pre-existing chronic conditions, such as hypertension and diabetes, and the inability to obtain their usual medications[5]. Clearly, tailored medical relief efforts will optimize the effectiveness of any medical response and prevent consequent deaths; therefore, such efforts

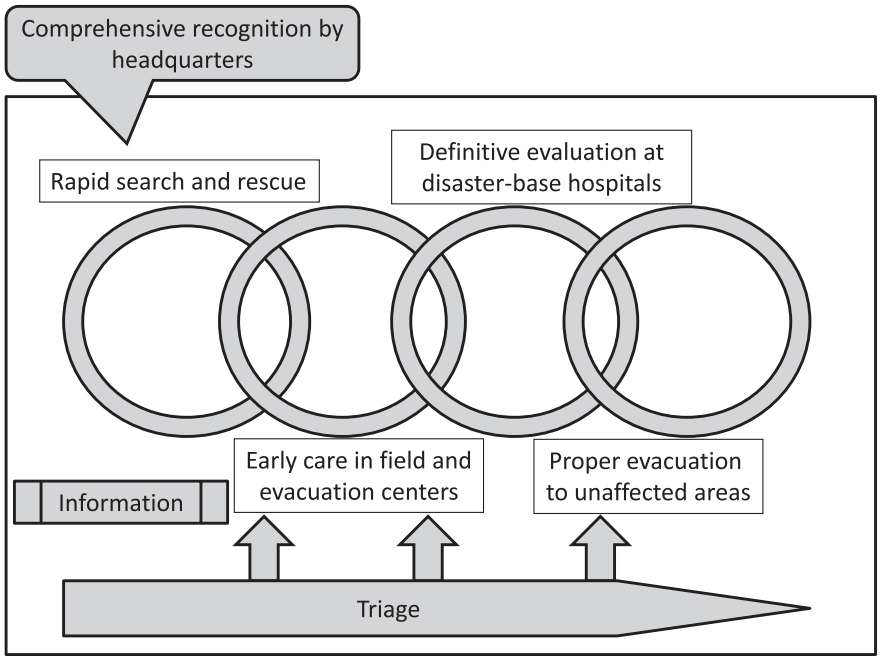

Fig. 1 Chain of Survival for Disasters

The proposed chain of survival for disasters covers each response activity that should be undertaken: 1) rapid search and rescue; 2) early care in the field, evacuation centers, and primary clinics; 3) definitive evaluation at disaster-base hospitals; and 4) proper evacuation to unaffected areas. Headquarters should be guided by this sequence, in which the "lifeline" system of communicating up-to-date information is vital. In Japan, headquarters is run by the local government and comprises a government officer and local fire and police departments. Medical personnel join headquarters as advisors. The chain covers the universal basic concept of disaster medical relief response in the acute phase of a disaster and can be applied to smaller scale relief efforts, such as onsite relief.

should be planned and carried out according to the type and severity of the event—which determine the characteristic injuries and diseases seen—and according to the capabilities of the local medical facilities and lifeline systems still in place.

A New Model

From a medical viewpoint, unnecessary deaths following large-scale natural disasters must be prevented. To prevent such deaths, appropriate information transmission and an understanding of the mission's overall and specific objectives are required. We propose that an illustrated descriptive device, which we have named the "chain of survival for disasters" (**Fig. 1**), be used to guide headquarters in dealing with the commonalities of a disaster.

The chain covers each response activity that should be undertaken in a natural disaster and aims to save more lives by moving through the following sequence of appropriate responses as rapidly as possible: 1) rapid search and rescue; 2) early care in the field, evacuation centers, and primary clinics; 3) definitive evaluation at disaster base hospitals; and 4) proper evacuation to unaffected areas. Headquarters coordinating the overall response should be guided by this sequence, in which the "lifeline" system of communicating up-to-date information plays a vital role. The Internet infrastructure in the affected areas in Tohoku was not operational in the acute phase of the aftermath, so network data links in the future need to be more resistant to infrastructure damage, and redundant or reach-back systems must be implemented.

The proposed "chain of survival for disasters" illustrates the concept of medical relief activities in affected areas and helps medical staff to understand their position in a disaster-support situation at any

given time while remaining connected to other aspects of the relief effort.

Acknowledgements: Finally, I offer my heartfelt condolences to the families and friends of the many victims of the Great East Japan Earthquake and Tsunami disaster.

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