Articles

A Study on Medical Support System in Multiple Hospitals for a Large Tsunami Disaster

Jun Sasaki and Yuko Murayama*

Summary

In 2011, the Great East Japan Earthquake and Tsunami destroyed three prefectural hospitals of Iwate Prefecture in Japan. Iwate Prefecture has 25 public hospitals in the area of Iwate prefecture. The authors interviewed two medical doctors. One is a doctor in a seacoast-area hospital and another is a doctor of an inland-area hospital. The doctor in the inland-area hospital has been helped by the medical service in a coastal area hospital in the large disaster. And the authors also interviewed an officer who works in Iwate Medical Central Office. He accumulated the hospital information and contributed to arrange much support in the disaster. Based on the interviews and obtained several documents, this paper describes some issues and problems on the current medical support system in the emergency and long-term medical service. Then, a new idea of Medical Support System is proposed for applying a large-scale disaster. This concept obtained from the precious experience can be adopted in other areas to prevent from medical and healthcare damages in the future large tsunami disaster.

Key words: Disaster information, emergency management, medical information, network system, information system

JEL Classification: C6, C 63, C8, C81, D 8 1.

Introduction

On March 11 in 2011, the Great East Japan Earthquake and Tsunami occurred. It destroyed many buildings and killed many people living in Tohoku area of Japan [1]. The nuclear power plant crisis occurred in Fukushima Prefecture and many problems caused by it are still remained.

There is research on the influence of the large disaster, for example, some issues in disaster communications [2] [3] and information systems [4]. And, there are several reports on influence of medical disease caused by the large disaster. But, we cannot find a useful report on the issues and solutions in emergency medical activity from early to stable stage. This paper studied Iwate Prefectural hospitals' condition in the disease by interviewing three people and analyzing obtained document. Based on the survey, some problems are discussed in each stage of medical activity. Finally, the paper proposes a new high-resilience hospital network to reduce the complexity in patient transport in a large scale disaster.

2. Damage condition of Iwate Prefectural hospitals

Iwate Prefecture is the largest prefecture in Honshu (a main island) of Japan, the area is about 15,280km^2. The distances of north-

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south and east-west are 200km and 150km, respectively. It takes over 2 hours by car from the center city (Morioka city) to an end town of the prefecture. Moreover, it is surrounded by mountains and it has less public transport. As the land vast and the traffic way is inconvenient, the Iwate Prefecture has 25 public (prefectural) hospitals. The number of prefectural hospitals is the largest in Japan. All prefectural hospitals are managed by Iwate Prefectural Medical Office.

The conditions of Iwate Prefectural hospitals on March 14 in 2011 are shown in Table 1, which the authors edited to the document provided by Iwate Prefectural Medical Office.

The authors defined a hospital with beds for patients as "Main hospital" in Table 1. "Triage" is a tag used in emergency medical care, which is attached to the victims, and the color has a meaning in a standard that death is black (B), critical

Table 1. Conditions of Iwate Prefectural hospitals on March 14 in 2011.
(The authors edited to the obtained document provided by Iwate Prefectural Medical Office.)

Hospital ID	Number of beds	Number of triage tags	Acceptable patients	DMAT teams	Condition	Information
1	685	Not used	157	0	Main hospital	
2	0	Not used	5	0		
3	0	Not used	0	0		
4	434	Y:18	78	1	Main hospital	Interviewed
5	68	R:2,Y:4,G:1	0	0	Main hospital	
6	199	Not used	12	1	Main hospital	
7	0	Not used	0	0		
8	351	R:8, Y:1, G:42	80	0	Main hospital	
9	145	Not used	3	0	Main hospital	
10	315	Not used	64	0	Main hospital	
11	393	Not used	?	0	Main hospital	
12	114	R:4, Y:22, G:26, ?: 20	59	0	Main hospital	Collaboration
13	81	Not used	0	0	Functional damaged	
14	489	R:33, Y: 83, G:177, B:9	20	8	Functional damaged	Interviewed
15	70	?	?	?	Completely damaged	
16	0	Not used	0	0		
17	272	R:4, Y:22, G:97	30	7	Functional damaged	
18	60	?	?	?	Completely damaged	
19	387	?	?	?	Functional damaged	
20	60	?	?	?	Completely damaged	
21	342	R:9, Y:16, G:10, B:2	41	2	Seacoast area	
22	289	Not used	40	1	Main hospital	
23	325	Not used	36	0	Main hospital	
24	105	0	5	0	Main hospital	
25	0	0	0	0		

condition is red (R), semi-serious condition is yellow (Y), and mild injured condition is green (G). In Table 1, "?" represents no information. There were four hospitals with no information and it indicates that those hospitals were completely destroyed by the large tsunami. The "Functional damaged hospital" means a hospital in seacoast area in Iwate Prefecture, which has accepted and supported a lot of patients of the affected area with a completely damaged hospital. The Functional damaged hospital was unusual condition for a long time. The authors interviewed two medical doctors, one is a doctor in a Functional damaged hospital (ID = 14) and another is a doctor in a typical supporting hospital (ID = 4). Those interviewed doctors had played a significant role at the time of the disaster. In Table 1, "Collaboration" means that a Functional damaged hospital (ID = 13) was full supported by a Main hospital (ID=12).

From a document of Iwate Prefectural Medical Office, Functional damaged hospitals had some problems on telecommunication, electricity (including fuel for a temporal power generator), water, chemical and medical materials and food. Yet, those problems were solved within three days. In a completely damaged hospital area, there were strongly requested clothing, gasoline, portable heating goods, food, toilets, blankets, medicines, diapers and oxygen tanks. Those requested items had been provided sequentially by government, volunteer and other support groups and the problem was almost resolved.

Figure 1 shows the conditions of Iwate Prefectural hospitals in the Great East Japan Disaster in 2011. The number in a small circle indicates each hospital ID as the same ID shown in Table 1. The circles of 15, 18 and 20 are completely damaged hospitals and the circles of 14, 17 and 19 are Functional damaged hospitals. Iwate Prefectural hospitals can be classified into two groups. One is an inland-area hospital and another is a seacoast-area hospital. A large mountains area exists called Kitakami Sanch between the two hospital groups. There is a significant problem of communication gap.

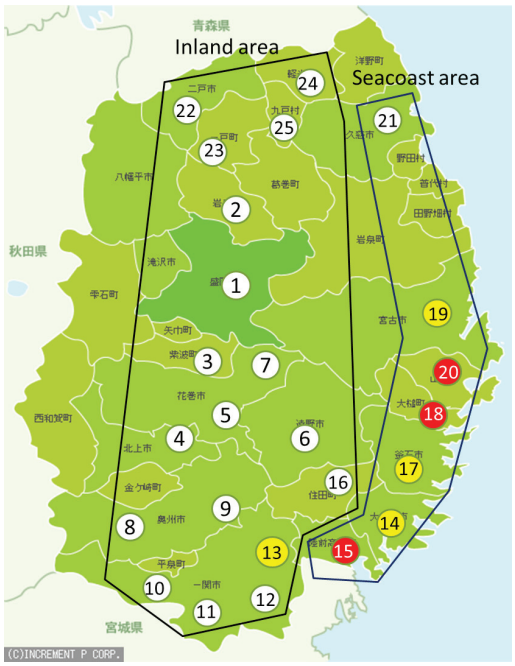

Fig.1. Conditions of Iwate Prefectural hospitals in Great East Japan Disaster in 2011.

3. Issues on Iwate Prefectural hospitals in the disaster

3.1. Communication

For few minutes after the earthquake on May 11, 2011, all communication was unavailable in the seacoast-area hospital (ID = 14). Then, the hospital became to be able to use emergency wireless phone for disaster provided by Iwate Prefecture and satellite phone provided by NTT (Nippon Telephone and Telegram Corporation). They connected those telephone line with private wireless phone system in the hospital. The medical doctor said in our interview that the temporally constructed telephone system was useful in the case of the disaster.

In emergency meeting after the large disaster, the medical doctor's team wrote many things (characters, tables, figures and maps) on whiteboards to arrange the supporting. When the whiteboards were filled with written characters, they took the photos of the whiteboards and erased them and rewrote. By repeating the act, they could leave the precious records of the emergent works in the disaster. Another medical doctor in the inland-area hospital (ID =4) said that they wrote many things on building doors and wall as well as whiteboard in the emergency meeting and it was important to ensure a wide space and tools for writing.

3.2. Patient transport

After the disaster, many DMAT (Disaster Medical Assistance Team) came to the affected areas immediately from all over the world as well as all Japan. In Japan, most of all hospitals can know the disaster information by using EMIS (Emergency Medical Information Systems) [5]. From all of the area in Japan, we can recognize if the area in disaster, vigilance, disaster assistance, training and support a training by seeing the color of each area in the map of EMIS. In the case of emergency in a large disaster, DMAT is immediately arranged and goes to the affected area by helicopters or cars.

However, the inland-area hospitals could not grasp how many teams of DMAT came to the seacoast-area hospitals. In fact, the Iwate Prefectural Medical Office did not know at that time that 19 teams (totally 83 people) of DMAT came to the interviewed hospital (ID = 14) during the disaster period.

In the Japan disaster on March 11 in 2011, many patients in seacoast-area were transported to inland-area hospitals for providing better medical care by using ambience cars and helicopters. Table 2 shows the number of patient transport between Iwate Prefectural hospitals from March 11 to March 31, 2011. We can see that the number of patient transport from sea-coast area hospitals of ID = 14, 17 and 19, and the number of received patients in inland-area hospitals of ID = 1, 2, 4, 6, 8 and 12 was large (over 10). We can find the number of patient transport was distributed. The interviewed medical doctor in a seacoast-area hospital (ID = 14) said that the complex arrangement of patient transport was carried out one by one by using a telephone and a facsimile.

Table 2. Number of transport patients between Iwate Prefectural hospitals (from a seacoast-area hospital to an inland-area hospital) from 11 to 31 March 2011. (The authors created from the obtained document provided by the interviewed doctor in the hospital, ID =4)

		Inland-area hospital ID								
		1	2	4	5	6	8	9	12	23
Seacoast-area hospital ID	14	3				15	6	3	29	
	15	2		4	4					
	17	16		68	1	56	17	6		
	18									
	19	33	11	5						
	20									6
Total		54	11	77	5	71	23	9	29	6

Figure 2 shows the number of inbound patient transport from seacoast-area hospitals to an inland-area hospital (interviewed hospital, ID = 4) per month. The

number of patient transport was reduced rapidly after the disaster. In the early time, helicopter transport was comparably many.

Figure 2 shows the number of outbound patient transport from a seacoast-area hospital (interviewed hospital, ID = 14) to inland-area hospitals. We can find that most of patient transport from the hospital was carried out in March, 2011 by ambient car.

From those results, it is said that a large number of patient transport should be carried out immediately and intensively after a disaster by using a lot of ambience cars and helicopters.

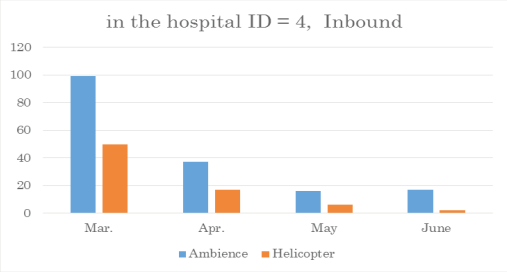

Fig. 2. Number of inbound patient transport from sea-coast-area hospitals to an inland-area hospital (ID = 4). (The authors created the figure from obtained documents provided by the interviewed doctor in the hospital, ID =4)

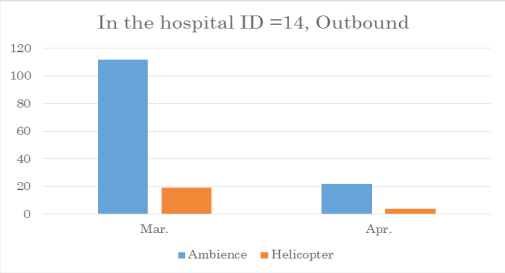

Fig. 3. Number of outbound patient transport from a seacoast-area hospital (ID = 14) to inland-area hospitals. (The authors created the figure from obtained documents provided by the interviewed doctor in the hospital, ID = 14)

3.3. Medical and healthcare support

The feature of the Japan disaster in March 11, 2011 was low ratio of injured to missing or dead of 0.31 (the number injured people was 6,121 and the number of missing or dead was 19,824) [6]. Incidentally, the ratio in Great Hanshin-Awaji Earthquake in 1995 was 6.8 (the number injured people was 43,792 and the number of missing or dead was 6,437) and the ratio in Indian Ocean Tsunami in Thailand in 2004 was 1.01 (the number injured people was 8,457 and the number of missing or dead was 8,393). It means that long-term medical and health care support were more needed than short-term medical support for physical injured people.

For example, Figure 4 shows the number of outer support teams for an area in a seacoast-area city which has the hospital (ID = 14) in 2011. This figure was created from documents provided by the interviewed medical doctor in the hospital. Medical support team was disappeared from July 2011 in the hospital. Instead, healthcare and psychological care team was working comparatively long-term.

There are many reports on lifestyle related diseases increase after the Japan disaster March 11, 2011. For example, cardiovascular disease was rapidly increased in Miyagi Prefecture [7]. Respiratory disease such as pneumonia of elderly people was rapidly increased in Ishinomaki city in Miyagi Prefecture after the 2011 Great East Japan Earthquake [8]. The number of high blood pressure patients and diabetes patients was increased in a seacoast-area hospital (ID =15) caused by the effects of the Great East Japan Earthquake [9]. Further, in shelters or temporary house in Fukushima Prefecture, tsunami-related aspiration pneumonia, influenza, food poisoning and other illness occurred more frequently than usual condition areas [10]. There is an experimental report in England that sudden death has a relationship with earthquake [11].

In the early stage of a large tsunami disease, DMAT is required to patient transport to inland hospital immediately. After that, a lot of healthcare teams will

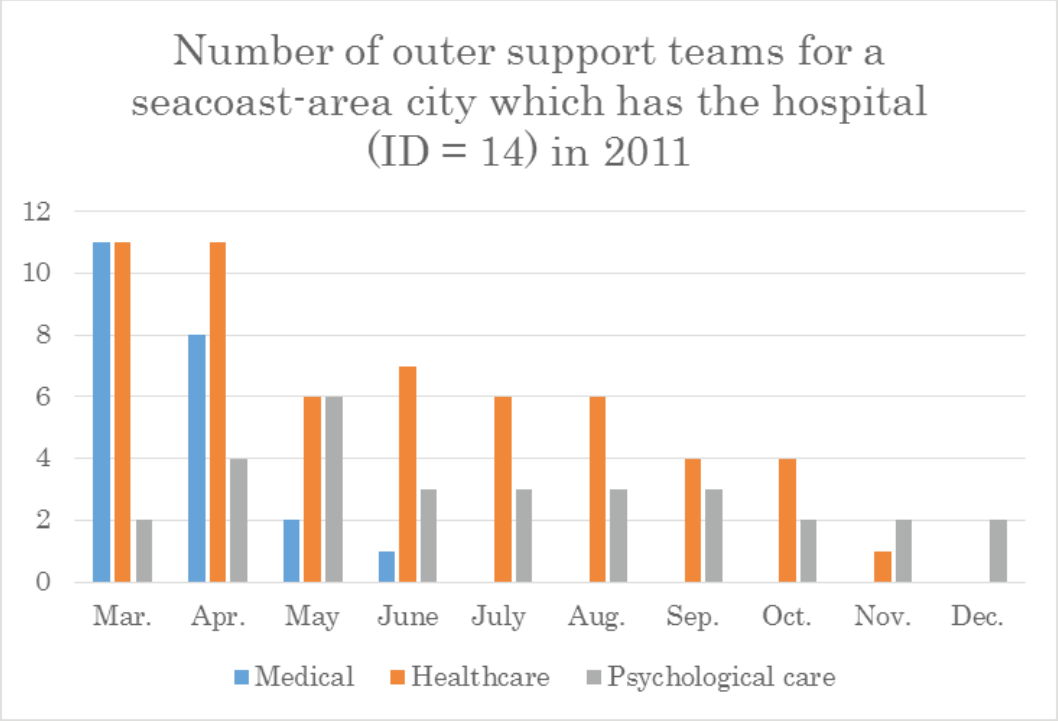

Fig. 4. Number of outer support teams for a seacoast-area city which has the hospital (ID = 14) in 2011 (The authors created the figure from obtained documents provided by the interviewed doctor in the hospital, ID = 14)

be needed for maintaining the health of many people living in shelters and temporary houses. The health care teams should act for the victim to prevent from the disaster related illness such as hypertension, deep vein thrombosis (DVT), respiratory problems, mental and psychosocial health and infectious diseases [12].

Because of the mass-scale tsunami, the whole medical record was lost in the completely damaged hospitals (ID= 15, 18 and 20). As those medical records were written on paper, the medical staff had to recover them after the tsunami. The conventional clinical data was unavailable. It was a big problem that medical doctors had to obtain the information from the patient and to perform re-inspection one by one.

Ministry of Health, Labor and Welfare of Japanese government recommends to use SS-MIX (Standardized Structured Medical record Information eXchange) [13] for patient information share and collaboration among related hospitals or medical and healthcare organizations in a local area. Iwate Prefectural Medical Office is planning to introduce it as a medical data backup system to prevent from the data lost problem in the case of a large disaster. But, the completely destroyed hospitals are not yet rebuilt. Before the introduction of SS-MIX, the construction of hospital buildings, facilities and electrical medical record systems has to be done.

4. Proposal

From the experience of the Great East Japan Earthquake and Tsunami disaster in

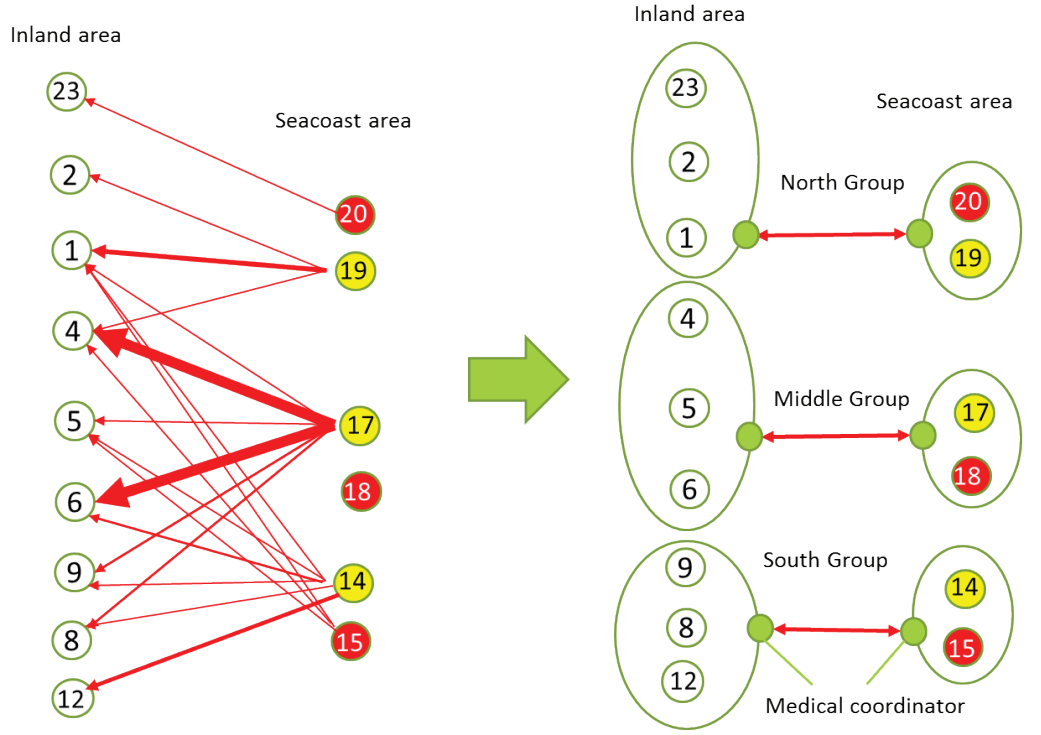

Fig. 5. Number of outer support teams for a seacoast-area hospital (ID = 14) in 2011 (The authors created the figure from obtained documents provided by the interviewed doctor in the hospital, ID = 14)

2011, there are mainly three problems on current medical support system in Iwate Prefectural hospitals.

(1) Communication: There was a communication gap between inland-area hospitals and sea-coast area hospitals.

(2) Patient transport: Medical doctors in the disaster site had to make a negotiation with an inland-area hospital on patient transports one by one.

(3) Medical and healthcare support: Long-term healthcare teams were needed to maintain the healthy life of people living in shelters and temporal houses.

In order to solve above problems, the authors proposes a new medical support system.

Figure 5 (a) shows the current condition of patient transport negotiation in the case of the large tsunami. This figure is illustrated based on the experience shown in Table 2. Arrows indicate the destination of the patient transports, and its thickness indicates the number of transport patients. The hospitals of ID = 17 and 14 are comparably big hospitals. The doctors in the big hospitals had to make a negotiation on the patient transports one by one. The action was very complex and hard work.

Figure 5 (b) is a proposal of new Medical Support System. The feature of the idea is to make hospital groups and medical coordinators. In the case of Iwate Prefecture, two near seacoast-area hospitals make a group. From the experience of the large disaster in 2011, three coastal area hospital groups (north, middle and south) will be reasonable. Each seacoast-area group is supported by each inland-area hospital group. So, inland-area hospitals (only main hospitals) should be divided into three groups (north, middle and south). For each hospital group, a coordinator is set up. In the case of emergency, the coordinator has to grasp all information of hospitals in its group and make a communication the coordinator of the corresponding group. The information includes the number of DMAT and medical and health care supporters, needs and seeds of medical resources and the medical condition of patients living in shelters and temporal houses. In reference [14], Emergency Medical Services (EMS) is proposed. It is an organized and collaborative effort between several organizations providing different levels or tiers of care designed to transport sick or injured patients to the hospital. The concept is similar to DMAT in Japan. The Medical Support System proposed in this paper is different from the EMS. In order to provide continuously long-term medical and health care service in a disaster area, a Disaster Care Assistant Team (DCAT) is expected to be more active in Japan. In the proposed system, DCAT is also considered to be arranged by the medical coordinator.

If the proposed Medical Support System will be realized, the main three problems of (1), (2) and (3) mentioned above will be solved simultaneously. As the concept was obtained from the precious experience of the Great East Japan Earthquake and Tsunami, the proposal system can be adopted in other areas with a risk of tsunami.

5. Conclusions

This paper described the medical conditions and issues on Iwate Prefectural hospitals in the Great East Japan Earthquake and Tsunami disaster based on interview and documents provided by two medical doctors and an officer of Iwate Medical Central Office. Next, the paper offers a new idea of Medical Support System for applying to emergency medical support and long-term healthcare. This concept based on invaluable experience will be adopted in other regions to avert possible medical and healthcare damage in the event of a large-scale tsunami disaster in future. In further research, an attempt will be made to assess the effect of the proposed model by simulation.

Acknowledgement

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