Paper:

A Study on Disaster Medical Response During the Great East Japan Earthquake Disaster Based on the Emergency Support Function – Nine Days at Iwate Prefecture from Hyperacute to Subacute Phase –

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During the Great East Japan Earthquake Disaster, the medical team's responses in the Iwate Prefecture Emergency Operation Center (EOC) experienced many difficulties, especially in the first nine days after disaster occurrence. In this paper we proposed to objectively reveal problems of response activities at the viewpoint of information processing by the After Action Review (AAR), focusing on the activity logs in the time series (chronologies). By using the Emergency Support Function (ESF) as a framework of our analysis, we clarified the gap between the task that should be performed and actual conditions in the operation of the Japan Disaster Medical Assistance Team (DMAT) from the hyperacute phase to the subacute phase of medical responses.

Keywords: Disaster Medical Assistance Team (DMAT), Incident Command System (ICS), Emergency Support Function (ESF)

1. Introduction

1.1. Background

On March 11, 2011, the Tohoku Earthquake occurred off the Pacific coast of Japan. This was the largest earthquake ever recorded in Japan – measuring Mw 9.0 – and caused a tsunami with a maximum height reaching 40.1 m. The total number of deaths and missing persons after the earthquake and tsunami reached 18,440 [1]. At the Fukushima Daiichi Nuclear Power Plant, the earthquake and tsunami caused the core to melt due to a power loss and resulted in successive hydrogen explosions until March 15. A large amount of radioactive materials was released and diffused; this caused wide-ranging contamination. As a result of the unprecedented scale of the disaster, it was called the Great East Japan Earthquake Disaster.

In Iwate Prefecture, the total number of dead and missing was as many as 5,794. The prefecture has an area equivalent to the four prefectures in Shikoku District; its coastal area is about half the size of Washington state's in the U.S. Therefore, the Iwate Prefectural Government had to cover an extremely large area. The governmental office itself was disabled by the seismic activity and force of the tsunami, and the staff in charge of recovery and restoration were debilitated by the tsunami disaster to a massive degree. Confusion also occurred about support from the central Japanese Government. For example, the Disaster Information System (DIS) [2] installed at the Cabinet Office estimated immediately after disaster occurrence that the intensity on the Japanese seven-stage seismic scale was lower than 6, or stronger in the total area of about 9,300 km^2, and that the number of the dead was 1,000 and the number of evacuees was 200,000 [3]. This damage estimate was based only on the tremor of the earthquake and does not include damage caused by the tsunami. The estimated number of deaths was less than 100 in Iwate Prefecture, where there were not many areas of intensity (Report on Coordination between Medical Teams and the Japan DMAT Secretariat from reference materials concerning the medical team of the Iwate Prefecture Emergency Operations Center [EOC]). This resultant figure was taken out of context and the damage in Iwate Prefecture was considered not as severe due to

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the incorrect interpretation of information.

Although various chaotic situations occurred in and outside Iwate Prefecture simultaneously, it did not have enough staff and materials to cover the numerous devastated areas – this was also the case for medical teams. Due to the misinterpretation of the damage estimate by the DIS, the national and prefectural governments advised medical teams throughout the nation of the low necessity of support needed in Iwate Prefecture. Therefore, the medical teams mainly responded to Fukushima Prefecture and Miyagi Prefecture first. Since Aomori Prefecture also supported the coastal municipalities of the prefecture, including Hachinohe City, Iwate Prefecture could only receive substantial support from Akita Prefecture. The prefectural government issued an advisory to prepare inland core disaster medical hospitals not stricken by the tsunami as disaster bases. However, some core disaster medical hospitals could not accept the seriously injured because of disabled transformers and converters. In the first place, Akita Prefecture does not have enough core disaster medical hospitals capable of accepting critically ill patients because its area is large. In addition, two of the three hospitals with rescue and relief centers in the prefecture were located on the coast. Therefore, it was even more difficult to accept critical patients from devastated areas.

As mentioned previously, medical management was severe from first the acute phase of life rescue to then the subacute phase of the evacuation center support. The Japan Disaster Medical Assistance Team (DMAT) dispatched in the case of a disaster is defined as a "trained medical team having mobility capable of working at the acute phase of a disaster" [4]. Partly because of this definition, the Japan DMAT activity period was prescribed as 72 hours at the acute phase in those initial days. The Japan DMAT Secretariat issued a withdrawal instruction as early as on the second day of dispatch when the 72-hour period assumed by the Japan DMAT ended. This was because Fukushima Prefecture and Miyagi Prefecture did not make an additional Japan DMAT dispatch request and information about devastated areas was not available. Additional reasoning for this is that the governments of the devastated areas could not grasp the damage early and their crisis management became delayed. Therefore, there was a necessity of continuous Japan DMAT dispatch not only to Iwate Prefecture but also to Miyagi Prefecture and Fukushima Prefecture. As a result, the Japan DMAT Secretariat detracted the withdrawal instruction and determined continuous dispatch to the three prefectures. Consequently, Japan DMAT could operate on a 9-day rotation in Iwate Prefecture. This triggered a shift from conventional support of the acute phase finishing activities after 72 hours to the relief team support capable of continuing local activities for at least one week. To construct a seamless medical system, the medical support was allocated sequentially to the Japan Medical Association Team (JMAT), composed of the Japan Medical Association and the Japanese Red Cross team, which took three days from the sixth day after disaster occurrence. To build up a continuous medical system, the adjustment of medical team dispatch was planned continuously. However, communication network interruptions and road blockages caused various problems. In devastated areas where communication is difficult, teams may disassemble by their own judgment if the situation becomes even slightly stable. This issue of activities under information network interruptions and information in disarray needs to be resolved.

1.2. Purposes of Research

As described above, there were many difficulties during the Great East Japan Earthquake Disaster in keeping the medical system from the hyperacute phase to the subacute phase, in which the work shifted to evacuation center support. In the background, there seems to have been issues about information processing and work processes of responses – such as information network interruptions and information in disarray – in an environment vastly different from the usual environment. It will be useful for improving responses at disasters to review not only the results of responses but also such processes (After Action Review [AAR]). Research on the Great East Japan Earthquake Disaster and many other cases have reported on the Emergency Operation Center (EOC) on the pivot of governmental organizations and medical teams in devastated areas. However, most of the cases are subjective studies focused on the results of responses. Only a small number of them allow different interpretations of activity judgments depending on the perspective of judging response results. For example, there is a report about the activities of Japan DMAT saying that command and control functioned as planned from the perspective of a dispatcher [5]. From the perspective of a support receiver, however, the activities hardly functioned because of restrictions [6]. Successful cases tend to be over-evaluated as heroic stories. In unsuccessful cases, people tend to finger-point and consider evaluations as unexpected. Were the activities rational those days? Did the information affect the activities, if available? Research conducted from the perspective of evaluating response processes and not response results is scarce. For this kind of evaluation, it is necessary to track technology in a time series by considering what kind of information was obtained and what actions were taken. However, since most of such chronological information is handled on paper or whiteboard, it is not documented in chorological logs in many cases. Even if some information remained, it is not shared but likely buried without any standardization in an organization's facility or in warehouses.

This research examined an enormous volume of reference materials about the Great East Japan Earthquake Disaster remaining at the EOC of Iwate Prefectural Office as hard copies or electronic media. The authors converted these reference materials into electronic data, extracted chronological portions, and analyzed them from the perspective of medical team chronology. The purpose of this AAR was to clarify on the basis of facts what were potentially quick responses that were not taken quickly and what information was collected.

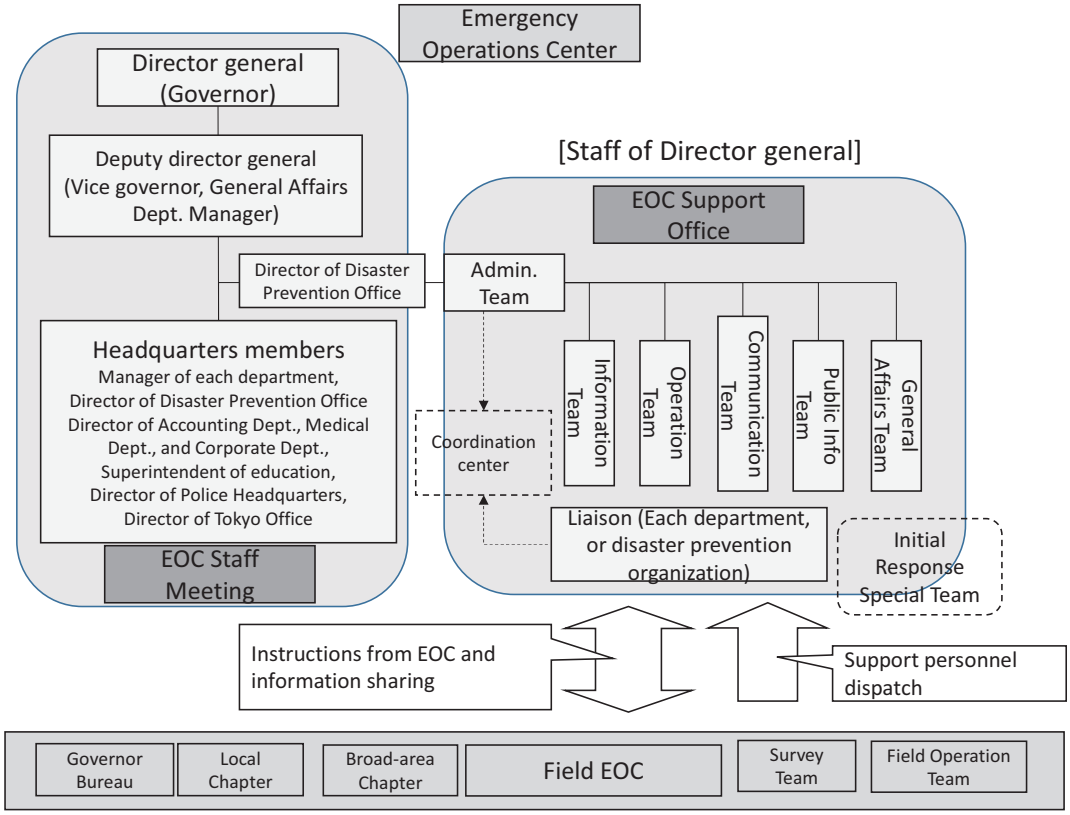

Fig. 1. System of Iwate Prefecture Emergency Operations Center (Source: Page 7 of [7]).

2. Preparation and Operation of the Medical Team in Iwate Prefecture

2.1. Preparation Before the Earthquake and the Situation Immediately After Disaster Occurrence

The General Disaster Prevention Office, Department of General Affairs, and Iwate Prefectural Government started building up a simplified management system (**Fig. 1**) in reference to the U.S. Incident Command System (ICS) [8] to deliver responses even for unexpected situations by referring to the lessons learned from the Iwate-Miyagi Nairiku Earthquake in 2008. In October 2010, a blind-type exercise was held on the Staging Care Unit (SCU), in which temporary medical facilities were to be installed at Iwate Hanamaki Airport to extract issues about the response procedure. A blind-type exercise is an exercise performed without prior transfer. Many organizations including governments, self-defense forces, fire stations, and police hold a collaborative training on accepting the injured or sick from the coastal areas not only to build up common recognition, but also to extract issues about the response procedure.

During the progress of this preparation, the Great East Japan Earthquake Disaster occurred. Hereinafter, the experiences of the authors as members of the Iwate Prefecture EOC and activities during those days are described on the basis of reference materials including the time-series progress of the medical team.

Immediately after disaster occurrence, Iwate Prefecture EOC started activities with the top priority to rescue lives by predicting immense damage. Before the disaster, collaboration between medical teams and EOC organizations was not under particular consideration. Since the use of helicopters and DMAT was expected to account for a great percentage of activities due to the degree of damage, Iwate Prefecture EOC changed the layout to assign the space reserved for the administration group to a medical team and arranged an aircraft group operating helicopters between the countermeasures group and the information group [7]. Thus, the EOC prepared for information sharing and collaboration with all organizations relating to people's lives. When TV screens started to show tsunami videos, a new response approach had to be configured. One of the causes of the chaos was a damage estimate calculated by the Cabinet Office immediately after the disaster. As mentioned before, DIS under-estimated the number of the dead and missing in Iwate Prefecture as less than 100 (figure was out of context where the exclusion of damage by the tsunami was ignored). Since the rescue priority of Iwate Prefecture was lowered at first, Japan DMAT came to Iwate Prefecture on the day of disaster occurrence from only two prefectures: Akita and Aomori. Therefore, a core disaster medical hospital support plan based on a small number of medical teams had to be created. The Iwate-Miyagi Nairiku Earthquake in 2008 caused great damage to Iwate Prefecture, but ex-

ternal medical teams only gathered in Miyagi Prefecture. It was predicted from past lessons that support was more concentrated on Miyagi Prefecture and to a lesser degree on Iwate Prefecture as the disaster scale was larger. The Sanriku Coastal Tsunami Earthquake in 1896 killed a total of 22,000 people, including 18,000 in Iwate Prefecture. Considering this historical fact, the nationwide possibility of support disproportional to damage was discussed. Medical team arrangements in Iwate Prefecture were also planned in the case that only a small number of Japan DMAT teams should be dispatched to Iwate Prefecture, despite serious damage. However, the situation became much worse than assumed because even inland core disaster medical hospitals became unable to accept critically ill patients from the devastated coastal areas due to transformer faults and other problems.

2.2. Operations After the Occurrence of the Great East Japan Earthquake Disaster

Rescue and transport activities narrowed down to five points below were set as the first goal in the initial three-day period after disaster occurrence, with the top priority to rescue lives and prevent chaos wherever possible.

(1) Search, rescue, and transport of people mainly at core disaster medical hospitals who may die within three days without medical intervention (e.g., seriously injured people, patients requiring intensive care, patients receiving dialysis, patients receiving oxygenation (including oxygen therapy at home), and patients requiring continuous medication).
(2) Post-rescue transport of the injured or sick found in a devastated area
(3) Firefighting activities around where a fire is approaching an evacuation center
(4) Other emergency cases
(5) Unconditional distribution of milk powder to all evacuation centers

Main activities from the fourth day to the ninth day were to expand support to devastated area hospitals other than core disaster medical hospitals and to assist evacuation centers. Until the system allowing first-aid stations was established, activities had been only Japan DMAT's traveling clinic and emergency transport as is if the transport criteria are satisfied.

In Iwate Prefecture, Japan DMAT operated for nine continuous days. A total of 243 injured or sick people were transported by helicopter to SCUs at Iwate Hanamaki Airport and Iwate Prefecture Fire Academy. The number of transported patients and the injured or sick totaled 1,422. The number of patients transported from the coast to inland areas was 507. The number of people transported from Miyagi Prefecture, Fukushima Prefecture, and other prefectures into Iwate Prefecture was 103. This reduced the medical care burden on the coastal area of Iwate Prefecture and saved many lives. Iwate Prefecture also provided support to other prefectures and saved many lives. By the first broad-area medical transport of patients across prefectural borders in Japan, a total of 16 critically ill patients were transported to Tokyo Metropolis, Akita Prefecture, and Hokkaido and their lives were saved.

Table 1. Chronology of Iwate Prefecture EOC (Excerpt).

Date	Time	Activity Log
2011/03/11	17:05	(1) The Akita DMAT started for Iwate (cancelled by Miyagi). (2) The Iwate Medical University team started for Ninohe Hospital.
2011/03/11	17:10	8 teams of Akita DMAT were requested to prepare for dispatch to the Iwate coastal area (by Prefecture EOC)
2011/03/11	17:18	Preparation started for DMAT dispatch request throughout the nation (consideration of installing EOC). ↓ Completed at 17:21
2011/03/11	17:20	Hospitals in Iwate Prefecture started investigating the situations of hospitals throughout the area (Prefecture EOC).
2011/03/11	17:22	Iwate Medical University was specified as the DMAT team gathering place (phone call from Hanamaki Fire Stations). (Allocation depending on the situations of hospitals in the prefecture)
2011/03/11	17:28	The functioning of Ofunato Hospital was confirmed (beyond the capacity and unable to transport). Even the JR Sakari Station is flooded.

Although not under the command of Japan DMAT, medical teams from the Japanese Red Cross, Tokushukai Hospitals, Toda Medical Group, and others – excluding Japan DMAT – gathered in Iwate Prefecture and actively supported devastated areas. They included many medical teams who relocated to Iwate Prefecture because they found no locations to work from in Fukushima Prefecture and Miyagi Prefecture at the hyperacute phase.

On the 10th day from disaster occurrence, Japan DMAT withdrew by handing over their tasks to the relief teams of JMAT, the Japanese Red Cross, and others. Since field communication networks were interrupted, it was recommended for efficient information integration that at least one member of Japan DMAT remain as a member of the relief teams. The purpose of this recommendation was to maintain command and control by minimizing chaos.

3. Research Method

3.1. Details of Chronology Analysis and Determination of Timeline

Iwate Prefecture EOC has been logging and storing any possible information as chronology about specific activities in a time series in paper form or electronic media to add to various reference materials created and distributed (**Table 1**). The purpose of this chronology is to help response members correctly grasp what happened and when and where it happened – including the current status – to prevent response losses. The chronology has various types of information, including several statements concerning activities occurring at the same time. However,

Table 2. Timeline.

Timeline	Time elapsed	Date and time of arrival
Disaster occurrence	–	Mar. 11, 2011 14:46
∼1 hour (Disorientation phase)	0.04 days	Mar. 11, 2011 15:46
∼24 hours (Hyperacute phase)	1 day	Mar. 12, 2011 14:46
∼72 hours (Acute phase)	3 days	Mar. 14, 2011 14:46
∼216 hours (Subacute phase)	9 days	Mar. 20, 2011 14:46

since one log is basically created when one instruction or report is made, the authors decided to handle logs of the same time as a single log of activity chronology. As the targets of analysis, the authors set minimum necessary support information for field command and adjustment and information to be collected and shared. Analysis in this paper is focused on the contents of support.

A medical response cycle at a disaster can generally be divided into hyperacute phase (immediately after disaster occurrence), acute phase (about 2 days after disaster occurrence), subacute phase (about 2 weeks after disaster occurrence), and chronic phase (years after disaster occurrence). To discuss details of support and transition of information from the perspective of a timeline, the timeline from disaster occurrence was as follows (**Table 2**).

1 hour: Prepare for system startup while checking not only yourself but also your family and the organization you belong to.

24 hours (1 day): Prepare for rescue and relief and move while building up an information network, collecting information, and analyzing the situation. Start firefighting and life-saving activities appropriately at disaster-stricken sites.

72 hours (3 days): While continuing life-saving activities [9, 10] to reach the goal of life rescue, provide public support [11] to victims living in devastated areas where lifelines are interrupted.

216 hours (9 days): Build up a medical care administration system and a medical team changeover system for shifting from DMAT and other teams at the acute phase to JMAT of the Japan Medical Association and relief teams led by the Japanese Red Cross to enable efficient medical support.

Regarding the above, the hyperacute phase is within 24 hours, the acute phase is from 24 hours to 72 hours, and the subacute phase is from 72 hours to 216 hours. One hour from disaster occurrence is the disorientation phase when you cannot do anything but secure the safety of yourself and your family without knowing what is happening.

3.2. Emergency Support Function (ESF)

The U.S. crisis management standard "National Incident Management System (NIMS)" [12] prescribes details of work to be supported at crisis responses and role sharing to determine which organization should supervise the work as the Emergency Support Function (ESF) [13, 14]. In Japan, the Disaster Management Basic Plan [15] provided by the Central Disaster Management Council of the Cabinet Office specifies 11 activities in Part 2, Chapter 2 as emergency measures. These activities can be considered as the ESF of Japan. However, the Plan does not specify primary and support drivers of each activity – unlike the ESF.

Federal Emergency Management Agency (FEMA) specifies 15 items for ESF. However, some states or applicable organizations expand or replace the items. In this research, the authors decided to handle the 18 items below as ESF based on the case of application at Vashon Island (Washington state) where volunteer support and animal care activities are included [16]. More specifically, the authors checked the chronological contents of 216 hours (9 days) after the occurrence of the Great East Japan Earthquake Disaster when Japan DMAT operated in Iwate Prefecture. Then the contents were classified into 18 items of ESF.

ESF1 Transportation
ESF2 Communications
ESF3 Public Works and Engineering
ESF4 Firefighting
ESF5 Emergency Management
ESF6 Mass Care, Housing, and Human Services
ESF7 Resources Support
ESF8 Public Health and Medical Services
ESF9 Urban Search and Rescue
ESF10 Oil and Hazardous Materials Response
ESF11 Agriculture and Natural Resources
ESF12 Energy
ESF13 Public Safety and Security
ESF14 Long-term Community Recovery and Mitigation
ESF15 External Affairs
ESF16 Volunteers and Donations
ESF17 Animal Care
ESF18 Administration and Finance

3.3. Transition of Information Volume in the 9-Day Period After Disaster Occurrence

In the chronology of the Iwate Prefecture EOC medical team, 1,309 information items had been entered about support managed by the team in the period from immediately after disaster occurrence until May 1 of 2011. For evaluation using ESF, the authors set timelines to the 689 chronological items entered in the period of 216 hours (9 days) when Japan DMAT operated. More specifically, the author classified information entered into the chronology in each period of 1 hour, 24 hours (1 day), 72 hours (3 days), and 216 hours (9 days) based on ESF, then conducted correspondence analysis and cluster analysis, R's MASS package and "corresp" function were used as analysis software. Activities logged in the chronology were classified manually to identify the corresponding ESF. Several people not affiliated with the EOC

Table 3. Volumes of ESF.

	1h	24h	72h	216h	Subtotal	Rate
ESF1	0	23	26	26	75	10.9%
ESF2	0	2	2	2	6	0.9%
ESF3	0	0	0	0	0	0.0%
ESF4	0	2	0	0	2	0.3%
ESF5	0	5	6	8	19	2.8%
ESF6	0	0	0	0	0	0.0%
ESF7	0	17	8	8	31	4.5%
ESF8	0	72	72	176	320	46.4%
ESF9	0	58	71	45	174	25.3%
ESF10	0	0	0	0	0	0.0%
ESF11	0	0	0	0	0	0.0%
ESF12	0	1	2	0	3	0.4%
ESF13	0	0	0	0	0	0.0%
ESF14	0	0	0	0	0	0.0%
ESF15	0	0	0	0	0	0.0%
ESF16	0	0	0	0	0	0.0%
ESF17	0	0	0	0	0	0.0%
ESF18	0	0	0	0	0	0.0%
Other	0	3	9	15	27	3.9%
–	0	14	5	13	32	4.6%
Subtotal	0	195	201	293	689	100.0%

during the Great East Japan Earthquake Disaster made the first classification. Then a member of the EOC confirmed the classification.

4. Research Results and Discussion

4.1. Details of ESF

Table 3 shows the results of aggregating information entered into medical team chronology in the periods of 1 hour, 24 hours, 72 hours, and 216 hours from disaster occurrence.

Of support managed by the medical team, ESF8: Public Health and Medical Services accounted for the greatest percentage of 46.4%. As a matter of course, support relating to medical care accounted for a large percentage. The percentage was 25.3% for ESF9: Urban Search and Rescue, 10.9% for ESF1: Transportation, and 4.5% for ESF7: Resources Support. The tasks of medical teams were found to include extensive support such as for Urban Search and Rescue, and Material Transport and Supply, which were originally not considered as tasks of medical teams. This indicates the possibility that medical teams dispatched to assist disaster-stricken hospitals were requested to assist medical teams supporting those facilities. Teams gathered for support may have increased burden on the devastated areas.

Teams not only had to consider medical care, they also had to make important decisions and provide support even for crisis management. One of the causes was considered as radioactive contamination caused by the Fukushima Daiichi Nuclear Power Plant accident. More specifically, medical teams had to treat victims of a natural disaster and an emergent disaster – radioactive contamination. They were also requested by other departments to give medical opinions. These were new tasks not prepared for or considered in advance. To cope with even new issues quickly in the future, we need a management system that adjusts relationships between many organizations in advance.

The maximum number of ESF items in the chronology of within 216 hours was 320 for ESF8: Public Health and Medical Services that was reached at the subacute phase (between 72 hours and 216 hours). At the Great Hanshin-Awaji Earthquake, deaths that could have been prevented were concentrated at the hyperacute phase (24 hours) [17]. At the tsunami disaster sites, however, priority was given to the support of hospitals in catastrophically damaged areas rather than to the possible prevention of deaths. Support for the acute phase and subsequent phases seem to have increased with the passage of time.

Considering this, if a large-scale earthquake like the Great East Japan Earthquake Disaster interrupts information networks and causes chaos, a new disaster situation may appear or new support may become necessary, even when information has been gathered to some extent and the current situation seems to have settled. Then necessary support increases again (**Fig. 2**). In the future, medical teams should not withdraw in a hurry even when a situation seems to have settled without enough information. It is necessary to keep collecting information while preparing for further support.

4.2. ESF Correspondence Analysis

The authors conducted correspondence analysis to investigate inter-ESF relationships by timeline. **Fig. 3** shows the result.

The relationships were very close to ESF7: Resources Support at the hyperacute phase (within 24 hours), to ESF1: Transportation, ESF2: Communications, ESF5: Emergency Management, and ESF9: Urban Search and Rescue at the acute phase (24 hours to 72 hours), and to ESF8: Public Health and Medical Services at the subacute phase (72 hours to 216 hours).

Considering the intended purpose of Japan DMAT, ESF8: Public Health and Medical Services should have become the main activities immediately after disaster occurrence. At the hyperacute phase, however, information collection about resources support was found to play an important role. The acute phase was related to Transportation, Urban Search, and Rescue, and other activities requiring considerable coordination with other organizations. At the subacute phase, the intended public health and medical support became main activities. Public health and medical support activities are the key to life rescue. If the activities are stagnant from immediately after disaster occurrence to the hyperacute phase, compared with other activities, extensive labor may be spent on other adjustment activities. This requires due care.

Table 4 shows the result of canonical correlation analysis conducted at the same time to validate the axes of

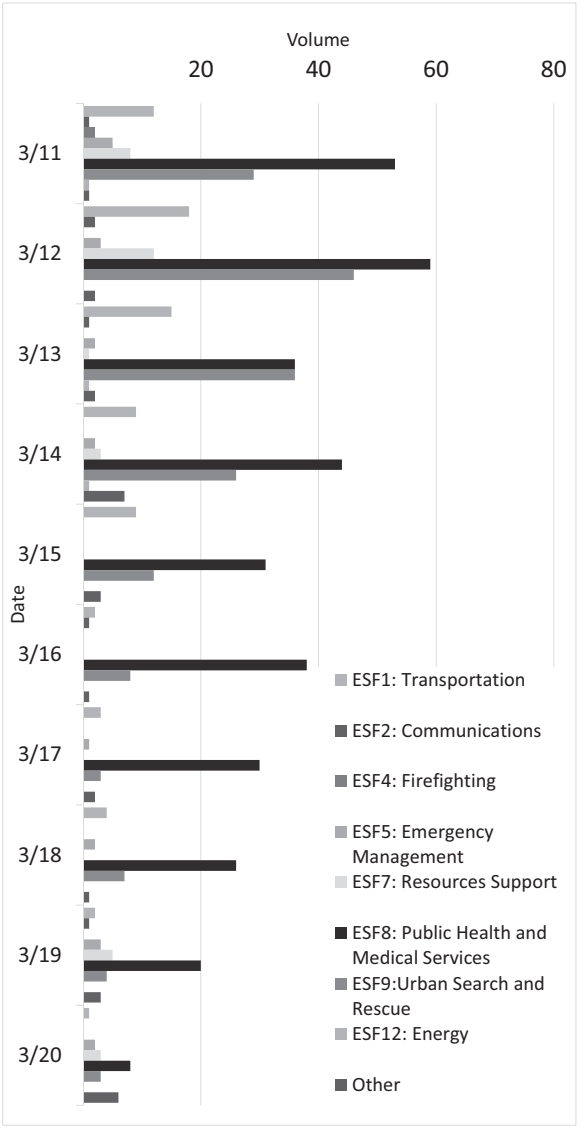

Fig. 2. ESF transition with the passage of time.

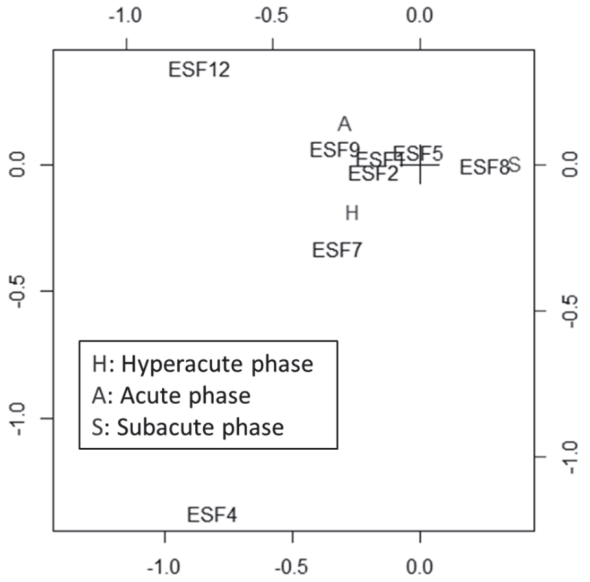

Fig. 3. Correspondence analysis regarding ESF.

Table 4. ESF canonical correlation.

Canonical correlation	0.2806394	0.1156229
Row scores	[,1]	[,2]
ESF1: Transportation	−0.53707	0.231944
ESF2: Communications	−0.629514	−0.23334
ESF4: Firefighting	−2.888626	−11.86543
ESF5: Emergency Management	−0.002457	0.4359811
ESF7: Resources Support	−1.138088	−2.85994
ESF8: Public Health and Medical Services	0.9349186	−0.057027
ESF9: Urban Search and Rescue	−1.17694	0.5546611
ESF12: Energy	−3.0788	3.2823558
Columns scores	[,1]	[,2]
H: Hyperacute phase	−0.810662	−1.371916
A: Acute phase	−0.890718	1.2552312
S: Subacute phase	1.1730647	0.0357462
Percent contribution:	[,1]	
	85.4889	14.5111

analysis. On this table, the percent contribution on the first axis is 85.5%. This indicates a very high contribution to data changes. In other words, classification using ESF was validated for evaluating support management by medical teams.

4.3. ESF Cluster Analysis

Cluster analysis was conducted to confirm the independence of each ESF. **Fig. 4** shows the result.

At a height of 50 or less, information was classified into three clusters: ESF8: Public Health and Medical Services, which has high independence; ESF1: Transportation; and ESF9: Urban Search and Rescue – the latter two were closely related to each other.

Main activities by medical teams of EOC are ESF8: Public Health and Medical Services, as a matter of course. Therefore, high independence of this item indicates that functions are assigned correctly for the intended activities.

ESF1: Transportation and ESF9: Urban Search and Rescue were classified into different sectors but are slightly close to each other. This may be attributable to the fact that devastated area hospitals, transportation of patients, and transportation of the injured or sick found by search rescue were under the same chain of command at that time.

4.4. Restrictions on ESF Classification

By ESF classification of chronology, 27 chronological items (3.9%) were classified into "other" because their classification was not clear. However, this paper does not discuss it in detail. For AAR including these items, it seems necessary to improve the classification accuracy

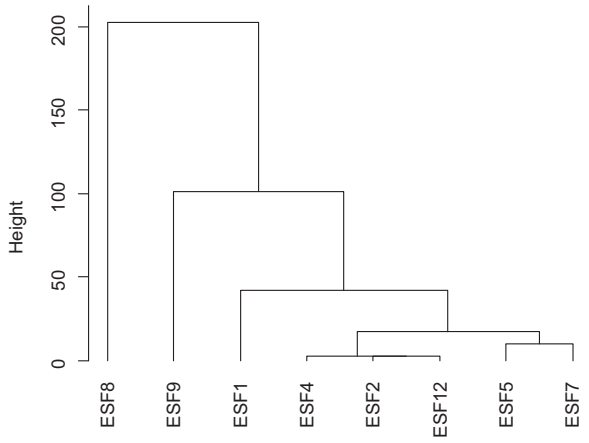

Fig. 4. Cluster analysis regarding ESF.

and review classification items in the future.

4.5. Comprehensive Discussion

Various assumptions had been made to prepare for large-scale disasters. Since the actual contents of support had not been clarified, however, various unexpected problems occurred. In the future, other disaster chronologies will also be organized and analyzed by ESF classification. Accumulating knowledge by hearings will enable practical field responses.

The chronologies did not have information at one hour after disaster occurrence. This indicates that early information collection and sharing is very difficult, particularly with large-scale disasters. In the future, systems and trainings will be necessary for collecting and sharing information early as data for judgments at disasters. Even when various information begins to be gathered after information interruptions, it is still difficult to have necessary information gathered by decision makers according to the corresponding stage. Solving this issue will be the key to optimum medical care. For analysis, the authors organized actual disaster chronologies by bottom-up integration. Therefore, the information does not satisfy all requirements for disaster responses. For example, there was not sufficient information about ESF2: Communications. This indicates that the information networks were almost entirely interrupted and there was not a system capable of collecting information as expected. In addition, other departments requested medical knowledge about responses to radioactive contamination at the Fukushima Daiichi Nuclear Power Plant. If there was a system capable of meeting the requests as part of ESF10: Oil and Hazardous Materials Response and collected information, medical knowledge could have been provided effectively without a burden on medical team activities.

Considering this, it is important to establish a system of collecting necessary top-down information and to organize information necessary for disaster responses, including the necessity of system installation and prior coordination and collaboration with related organizations.

5. Conclusion

This is unprecedented research of analyzing support provided by medical teams of prefectural EOC in devastated areas from the perspective of information processing on the supporting side. The activity logs (chronologies) of command and adjustment by Iwate Prefecture were analyzed for this research. In this research, the authors reviewed the contents and tasks of support by the AAR using the ESF framework and clarified gaps between the intended task and the actual task. More specifically, Japan DMAT's intended support (ESF8: Public Health and Medical Services) was greatly needed even at the subacute phase and could not help doing unintended work – such as supply and transportation support – at the hyperacute phase. This fact was clarified by chronological analysis. It is also necessary to investigate from the perspective of processing the kind of information that was collected and or should have been collected for tasks. A separate report will be made about this evaluation.

The authors proceeded with research and analysis first to acquire detailed information by hearing surveys from 20 specialists in various fields who were involved in the Great East Japan Earthquake Disaster. When issues mentioned by the specialists were classified by using ESF, they were found very imbalanced. Therefore, the authors surveyed ESF items not pointed out by the specialists and found other issues. As for animal care activities (ESF17), power outages disabled cow milking machines, causing heavy labor of manually milking thousands of liters of milk from cows, and then facing difficulties in disposing of thousands of liters of milk; however, no ESF17 activities were shown in the chronology. Since livestock transport was stopped, livestock were exposed to danger – even under the policy of giving high support priority to people over livestock. If power outages last long during summer nights, fans at poultry farms may be stopped for many hours. Consequently, tens of thousands of chickens are predicted to die due to heat. A great deal of labor is required in order to dispose of animal carcasses. In case of massive livestock deaths, measures against impending infectious diseases may pose a serious problem in the chaos after an earthquake. Handling of pets at evacuation centers was covered by the mass media on several occasions. Some victims were found to become sick after returning home with pets because they could not take care of their pets at evacuation centers. This study showed the potential problems of "zero activity ESFs," which were expected to not be aware of the situation.

This research was about activities on the supporting side. In the future, the authors will discuss not only the supporting side but also the supported side and make proposals to deepen mutual understandings on activities. Then we will consider the disaster ethnography technique proposed by Hayashi and Shigekawa [18], and Komatsubara et al. [19]. This is a technique of systemization by repeating hypothesis, verification, and correction processes. To the technique, the authors will add evaluations based on ICS and Standard Operating Procedure

for more complete research and verification to realize efficient feedback and evaluation not only to governments but also to activity organizations.

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