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Brief Report

Lessons Learned in Helicopter Operations During a Large Multiagency Disaster Prevention Drill in Japan

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A B S T R A C T

Objective: In 2018, the Cabinet Office executed a disaster prevention drill based on the scenario that Nankai had a megathrust earthquake and a large tsunami hit Tokushima Prefecture. The purpose of this study was to summarize the key lessons learned in the review of the Department of Aviation Operation for Tokushima Prefecture in this drill.
Methods: This report was based on a review using data from the Japan emergency medical information sharing system that can be accessed via the Internet.
Results: In the disaster drill, the doctor helicopter (DH) headquarters of Tokushima Prefecture at Takamatsu Airport was able to procure 2 actual DHs and 2 mock DHs. The Department of Aviation Operation within the Tokushima Prefectural Government was able to procure 1 actual helicopter belonging to the Coast Guard and 8 mock helicopters (4 belonging to the military and 4 to the fire department). There were 29 flights, including actual and mock flights, and 44 victims were medically transported.
Conclusion: By making flight plans with each organization concerned, we were able to share the basic rules, concepts, and management approaches of flights among the responding organizations. Disaster planners should have at least a passing familiarity with the aviation capabilities of the local helicopter emergency medical service and other helicopter operations.

The 1995 Great Hanshin and Awaji earthquake resulted in a large number of casualties, creating a massive demand for medical care. In response to this demand, the Japanese government decided to establish disaster medical assistance teams (DMATs) to function as "mobile, trained medical teams that can be rapidly deployed during the acute phase of a sudden-onset disaster."[1] DMATs are dispatched from outside the stricken area to stabilize patients and transport the seriously injured by air to disaster base hospitals located outside of the stricken area in order to offer definitive medical care.[1] To achieve expedient air medical evacuation, the DMAT also establishes and manages a staging care unit at an airport to receive seriously injured or ill patients from disaster base hospitals. This staging care unit functions as a temporary medical intensive care unit.

In Japan, general mass casualty incidents are usually managed by the fire department. Mass casualty incidents that cannot be managed by the fire department are managed by the local government, which can control every agency within the local prefecture or request military assistance.[2] Huge mass casualty incidents that cannot be managed by a local government, such as the Kumamoto earthquake, or huge disasters that affect multiple prefectures at one time, such as the Great East Japan earthquake, are managed by the Japan Cabinet.[3,4]

Emergency medical services that use helicopters are known as air ambulances or helicopter emergency medical services (HEMS). In Japan, physician-staffed helicopters are called "doctor

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helicopters" (DHs).[5,6] The first DHs came into operation in April 2001 in response to concerns over air medical evacuations not being performed in the acute phase of the 1995 Great Hanshin and Awaji earthquake. As of March 2018, 52 DHs are stationed at hospitals located in 42 of the 47 prefectures in Japan (http://www.hemnet.jp/english/where/index.html). The indications for DHs are decided on at the receipt of the 119 (emergency) calls based on the judgment of the dispatcher who receives the 119 call and before the emergency medical technician's arrival at the patient(s) side, or it is based on the patient's medical condition when the emergency medical technician makes contact with the patient(s).[7] The indications for DH transportation include both trauma and endogenous diseases.[8-11] In addition, the DHs are used to evacuate patients from the scene before a definitive diagnosis has been made in a medical facility. When the DH is dispatched to a scene, the helicopter lands at a rendezvous point where permission for use has been granted in advance; the patient is transported there by ambulance. In some cases, when the DH lands before the ambulance arrives, the physician and nurse are transported to the scene by another ambulance. In addition to rapid transportation, the DH staff attempts to perform early medical interventions to save the life of the patient. After being examined by the physician, the patient undergoes emergency treatment and triage for transportation to an appropriate hospital. An analysis of the DH services in Japan revealed that they were associated with an increased survival rate among severe cases and showed the cost-effectiveness of the program.

Japan is deemed to be at risk to experience a Nankai megathrust earthquake in the near future. Nankai megathrust earthquakes occur along the Nankai megathrust, which forms the plate interface between the subducting Philippine Sea Plate and the overriding Amurian Plate. Nankai megathrust earthquakes are huge disasters due to not only the earthquake itself but also the resulting tsunamis exceeding 10 m in height (Fig. 1).

On August 4, 2018, the Cabinet Office executed a disaster prevention drill based on predictions of a Nankai megathrust earthquake. The main scenario depicted a Nankai megathrust earthquake and a large tsunami hitting Tokushima, Kagawa, Kochi, Oita, and Miyazaki Prefectures on August 3, 2018. The organizations participating in this drill were the Cabinet Office and relevant organizations.

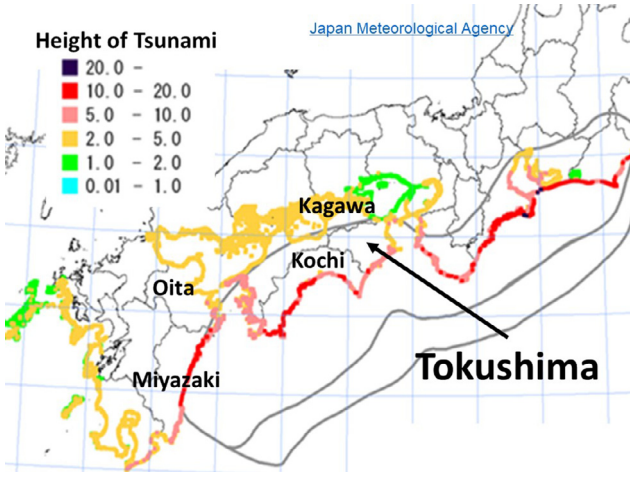

Figure 1. The estimated height of a tsunami created by a Nankai megathrust earthquake. Nankai megathrust earthquakes are huge disasters due to not only the earthquake itself but also the resulting tsunamis. (Modified with permission from the Japan Meteorological Agency https://www.data.jma.go.jp/svd/eqev/data/nteq/assumption.html.)

Figure 2. The initial plan concerning the evacuation of victims in Tokushima Prefecture. The victims are transported to a staging care unit at Takamatsu Airport in Kagawa Prefecture or Mazenooka staging care unit under escort by DMATs in order to evacuate victims to safe areas by air.

In Tokushima Prefecture, the medical disaster drill included the establishment and management of a headquarters for disaster control, the coordination of local medical transportation, and the staging of a care unit at Takamatsu Airport and Mazenooka Auto area (Fig. 2). Within the Tokushima Prefectural Government, the governor and members of the Crisis Management Division, DMATs, Coast Guard, Ministry of Defense, and relevant organizations established a headquarters for disaster control. The Department of Controls for Aviation Management was also established at this headquarters. In a huge disaster, many people will be injured; these patients tend to crowd damaged medical facilities within the disaster area. The collapse of the medical supply and demand balance results in the occurrence of avoidable disaster-related death. To prevent this potential issue, it is necessary to evacuate the wounded patients from the stricken area using dispersion transportation or "spreading out" methods. The spreading out method has the advantage of distributing patients to various receiving centers, allowing for a larger medical facility catchment area to be used while maintaining short prehospital times.[12] This property is particularly important in multiple-casualty disasters in which the number of people requiring hospitalization frequently exceeds the number of available beds at nearby hospitals.[12] Helicopters can play an important role in spreading out the patient loads in both the primary (ie, on the scene) and secondary transport of injured patients to hospitals further removed from the disaster location without the costs in transport time incurred by ground emergency medical services.[12-16] In addition to performing this mission, air evacuations are very useful because roads will be damaged by the disaster or jammed by large numbers of vehicles used by victims attempting to escape and by rescuers attempting to enter the area. However, the disadvantages of helicopter use is the financial cost and its limited ability to transport a large number of people. The Department of Controls for Aviation Management in Tokushima Prefecture coordinated multiple helicopters belonging to different agencies that worked together.

Because there are no studies in the English language medical reports concerning controls to aviation management during huge-scale disasters, we describe the activity of this Department of Controls in the present report.

Methods

This review was approved by the review board of Juntendo Shizuoka Hospital, and the examinations were conducted according to the standards of good clinical practice and the Declaration of Helsinki.

This report was based on the lessons learned in the aftermath of the review. This disaster drill included controllers and players, who were DMAT members, as well as members of the local government and other agencies. The controllers observed and evaluated the player's activities in the disaster drill. The first author of this article worked as a controller in Tokushima Prefecture. Data of the activity in the disaster drill were recorded by DMAT members using the emergency medical information system (EMIS) in actual disasters and disaster drills (http://www.wds.emis.go.jp/). The EMIS is a medical information sharing system that can be accessed via the Internet.[1] The EMIS can work using satellite phones, which DMATs should have in the event of a major disaster. The purpose of an EMIS is to share information regarding such factors as hospitals, patients, disaster medical assistance teams, medical evacuation, medical supplies and medications, and shelters with all of the personnel involved in the disaster-related medical activities. The EMIS is able to integrate this information in order to effectively deal with needs and demands and to adjust the distribution of patients, medical supplies, medications, DMATs, and means of transportation. The EMIS also includes a medical air transport tracking system (MATTS). All flight plans are reported to the MATTS to share information among DMAT members and members of the Ministry of Health, Labor and Welfare who report to the Cabinet. This system is also used when a huge disaster occurs. We collected the flight plans from the MATTS after a disaster drill was performed in the Tokushima Prefecture.

We selected the narrative method to describe the role of the Department of Aviation Operation within the Tokushima Prefectural Government in the 2018 disaster prevention drill conducted by the Cabinet Office.

Results

Based on the scenario in which a great tsunami had destroyed hospitals and airports located near the shore, the headquarters of DHs for Tokushima Prefecture was set at Takamatsu Airport in Kagawa Prefecture, where the staging care unit of Tokushima Prefecture was also established. Generally, medical transportation is executed by DHs. However, during major disasters, there are many overlapping requests for DHs; therefore, helicopters belonging to other organizations are also used for medical transportation. The Department of Aviation Operation within Tokushima Prefectural Government mainly managed medical transportation using helicopters belonging to the fire department, Coast Guard, police, and military (Fig. 3) when the headquarters of DHs for Tokushima Prefecture could not handle requests for medical transportation because of the high volume of transport requests received.

In the disaster drill, the headquarters of DHs for Tokushima Prefecture at Takamatsu Airport was able to procure 2 actual DHs (Tokushima and Tottori Prefecture, Fig. 4) and 2 mock DHs (Western Shizuoka and Osaka). However, the Department of Aviation Operation within the Tokushima Prefectural Government was able to procure only 1 actual helicopter belonging to the Coast Guard (Fig. 5) and 8 mock helicopters (4 belonging to the military and 4 to the fire department). One police helicopter

Figure 3. The Department of Aviation Operation within the Tokushima Prefectural Government. The department mainly manages medical transportation using helicopters belonging to the fire department, Coast Guard, police, and military.

Figure 4. DHs at Takamatsu Airport. Two DHs (upper: Tokushima, lower: Tottori) for Tokushima Prefecture assembled at the Takamatsu Airport.

Figure 5. A Coast Guard helicopter at the Takamatsu Airport. One Coast Guard helicopter for Tokushima Prefecture assembled at the Takamatsu Airport.

Table 1
The Flight Plan Using Actual and Mock Helicopters After Adjustments by Each Organization Concerned

Flight No.	Patient No.	Kind of Helicopter	Actual/ Mock	Lading Time at Departure/Plan Lading Time at Departure/Actual	Departure Point Landing Point	Planned Departure Time Actual Departure Time	Planned Landing Time Actual Landing Time	Destination Landing Point	Planned Departure Time at Destination Actual Departure Time at Destination	Fuel Time
1	1	Tokushima DH EC135	Actual		Tokushima Prefectural Central Hospital	1000	1015	Takamatsu Staging Care Unit	1045	
					Ditto	1001	1018	Takamatsu Airport	1046	
2	2	Tokushima DH EC135	Actual	1105	Tokushima Red Cross Hospital	1125	1145	Takamatsu Staging Care Unit	1215	1230
				1105	Ditto	1125	1145	Takamatsu Airport	1215	1230
3	3	Tottori DH EC135	Actual	1150	Kaifu Hospital	1210	1230	Takamatsu Staging Care Unit		
				1149	Ditto	1209	1230	Takamatsu Airport		
4	4	Tottori DH EC135	Actual	1310	Kaifu Hospital	1330	1350	Takamatsu Staging Care Unit		
				1310	Ditto	1329	1350	Takamatsu Airport		
5	5	Western Shizuoka DH BELL429	Mock	1120	Tokushima Red Cross Hospital	1140	1210	Takamatsu Staging Care Unit		
				1120	Ditto	1140	1210	Takamatsu Airport		
6	6	Hyogo FH BK117C-2	Mock	1130	Tokushima Red Cross Hospital	1150	1205	Mazenooka Staging Care Unit		
					Ditto			Ditto		
7	7	Kobe FH BK117C-2	Mock		Tokushima Red Cross Hospital	1325	1345	Kagawa Prefectural Central Hospital	1405	1415
					Ditto			Ditto		
8	8	Ishikawa FH BELL417EP	Mock	1510	Tokushima Red Cross Hospital	1530	1550	Kagawa Prefectural Central Hospital	1610	1630
					Ditto			Ditto		
9	9	GSDF UH-1 907	Mock		Tokushima Red Cross Hospital	1540	1600	Kagawa Prefectural Central Hospital	1620	1630
					Komatsushima baseball field			Ditto		
10	10	GSDF UH-1 906	Mock	1255	Kainan Hospital	1315	1330	Tokushima Prefectural Central Hospital	1350	1405
					Mazenooka Staging Care Unit			Komatsushima baseball ground		
11	11	GSDF UH-1 906	Mock		Kainan Hospital	1545	1600	Tokushima Prefectural Central Hospital		
					Mazenooka Staging Care Unit			Komatsushima baseball field		
12	12	GSDF UH-1 907	Mock	1325	Kainan Hospital	1345	1400	Tokushima Central Hospital	1420	1435
					Mazenooka Staging Care Unit			Komatsushima baseball field		
13	13	GSDF UH-1 906	Mock		Kainan Hospital	1425	1440	Tokushima Prefectural Central Hospital	1510	1525
					Mazenooka Staging Care Unit			Komatsushima baseball field		
14	14	GSDF UH-1 907	Mock		Kainan Hospital	1455	1510	Tokushima Prefectural Central Hospital		
					Mazenooka Staging Care Unit			Komatsushima baseball field		
15	15	Western Shizuoka DH BELL429	Mock	1250	Houetsu Hospital	1305	1320	Shikoku Medical Center for Children and Adult	1335	1345
				1250	Ditto	1305	1320	Ditto	1335	1345
16	16	Tokushima FH BK117C-1	Mock	1315	Handa Hospital	1335	1345	Shikoku Medical Center for Children and Adult	1405	1430
					Ditto			Ditto		
17	17	Osaka DH EC135	Mock	1520	Kaifu Hospital	1535	1550	Tokushima Prefectural Central Hospital	1600	1615
				1520	Ditto	1535		Ditto		
18	18	Western Shizuoka DH BELL429	Mock	1435	Kaifu Hospital	1445	1500	Tokushima Prefectural Central Hospital	1510	1525
				1435	Ditto	1439	1500	Ditto		
19	19	Tottori DH EC135	Mock	1505	Kaifu Hospital	1515	1530	Tokushima Prefectural Central Hospital		
				1505	Ditto	1505	1530	Ditto		
20	20	Tokushima DH EC135	Mock	1550	Kaifu Hospital	1555	1610	Tokushima Prefectural Central Hospital		
					Ditto			Ditto		
21	21	Western Shizuoka DH BELL429	Mock	1555	Kaifu Hospital	1610	1625	Tokushima Prefectural Central Hospital		
					Ditto			Ditto		
22	22	Tokushima DH EC135	Mock	1450	Kaifu Hospital	1500	1515	Tokushima Prefectural Central Hospital	1535	
				1450	Ditto	1500	1515	Ditto	1535	
23	23	Tokushima FH BK117C-1	Mock	1540	Tokushima Prefectural Central Hospital	1600	1625	Shikoku Medical Center for Children and Adult	1645	1710
					Ditto			Ditto		
24	24	Tokushima FH BK117C-1	Mock		Tokushima Prefectural Central Hospital	1730	1800	Hyogo Emergency Medical Center	1820	1850
					Ditto			Ditto		
25	25	Kobe FH BK117C-2	Mock	1605	Tokushima Prefectural Central Hospital	1625	1655	Hyogo Emergency Medical Center	1715	1745
					Ditto			Ditto		

Table 1 (*Continued*)

Flight No.	Patient No.	Kind of Helicopter	Actual/ Mock	Lading Time at Departure/Plan Lading Time at Departure/Actual	Departure Point Landing Point	Planned Departure Time Actual Departure Time	Planned Landing Time Actual Landing Time	Destination Landing Point	Planned Departure Time at Destination Actual Departure Time at Destination	Fuel Time
26	26	Kobe FH BK117C-2	Mock		Tokushima Prefectural Central Hospital Ditto	1805	1835	Hyogo Emergency Medical Center Ditto	1855	1905
27	27	MSDF SH—60J 99	Mock	1635	Tokushima Prefectural Central Hospital Komatsushima baseball field	1655	1725	Kobe Airport Ditto	1755	1825
28	28	MSDF SH—60J 70	Mock	1700	Tokushima Prefectural Central Hospital Komatsushima baseball field	1720	1750	Kobe Airport Ditto	1810	1840
29	29	Coast Guard MH-689	Mock	1645	MIMA Rehabiliation Hospital Shikoku Saburo no Sato	1725	1805	Miki Disaster Prevention Park Ditto	1845	1900
	30	Ditto								
	31	Ditto								
	32	Ditto								
	33	Ditto								
	34	Ditto								
	35	Ditto								
	36	Ditto								
	37	Ditto								
	38	Ditto								
	39	Ditto								
	40	Ditto								
	41	Ditto								
	42	Ditto								
	43	Ditto								
	44	Ditto								

DH = doctor helicopter, GSDF = ground self-defense force; FH = fire department helicopter; MSDF = maritime self-defense force

was only used for reconnaissance and was not available for medical transportation. The flight plan using actual and mock helicopters is shown in Table 1. There were 29 flights, including actual and mock flights, and 44 victims were transported medically. The last flight was performed for the total evacuation of MIMA Rehabilitation Hospital, which was deemed at risk of collapsing because of the earthquake. Among the admitted patients, 16 were evacuated altogether by a single helicopter provided by the Coast Guard.

Discussion

This article is the first English language report concerning controls for managing multiple aircraft during huge-scale disasters. One of the most important aspects of managing any large-scale incident is effective communication during control.[17,18] Without such communication, the organization and control of the incident are severely compromised because information and instructions cannot be delivered in a timely manner.[18] During this drill, communication using mobile phones was easily accomplished without time loss. However, in a disaster setting, many communication tools are compromised and cannot be used. In addition, the participants in this drill were able to use mock helicopters without communicating with the pilot, crew, or ground controllers at either the airport or the rendezvous zone. Accordingly, the flight plan was able to be established without difficulty or time loss. In addition, on day 2 after a Nankai megathrust earthquake, the helicopters of the fire department, Coast Guard, or military would likely still be performing search and rescue missions or transporting materials; therefore, medical transportation using such helicopters would be impossible. Accordingly, the flight plan established during this drill might be difficult to actually enact. In addition, the fact that this drill predominantly uses mock helicopters limits the sensitivity of this drill in identifying issues and learning real-life lessons that are applicable to actual disasters.

Effective evaluation assesses performance against disaster drills and identifies and documents strengths and areas for improvement. However, because there are no standard methods to evaluate disaster drills, we did not use a specified scoring system to evaluate the activity of the players in the disaster drill.[18,19] As such, the external validity of what was done and what was learned is limited. However, by making flight plans with each organization concerned, we were able to share the basic rules, concepts, and management approaches of flights among the responding organizations. For instance, the Coast Guard and military helicopters generally do not perform medical transportation during times of peace. Therefore, through this drill, the staff involved were able to understand that medical transportation required the inclusion of medical staff on board, as well as monitoring tools, oxygen supply, mechanical ventilation, aspirators, hooks for hanging infusion bags, or stretchers to carry patients. Medical transportation requires more space than the transportation of healthy people. In addition, by making flight plans with each organization concerned, we underscored the importance of mutual understanding and establishing good relationships.

Johnsen et al[16] reported the results of a systematic literature review that was performed using phrases that combined HEMS and “major incidents” to identify when and how HEMS were used. This approach revealed that HEMS were mainly used for patient treatment and for the transportation of patients, personnel, and equipment in the early medical management of major incidents; however, the optimal use of this specialized resource remains unclear. This review identified operational areas with improvement potential. In addition, these researchers noted the need for systematic reporting because a lack of systematic indexing, heterogeneous data reporting, and weak methodological design complicated the identification and comparison of incidents. Because this report also lacked a systematic indexing system, there is need for further investigations concerning the use of helicopters in mass casualty training.

In a catastrophic large-scale disaster, all resources—both material and human—are needed in order to ensure an early favorable outcome. Disaster planning must take into account the fact that the types of aircraft available will be determined by the helicopter types that are used by both the area helicopter emergency medical services and other sources (eg, military or corporate).[12] Thus, disaster planners should have at least a passing familiarity with the aviation capabilities of the local HEMS and other helicopter operations.[12] The coordinated and combined use of each organization’s resources in response to a large-scale natural disaster will be beneficial and help to significantly reduce human suffering.[17,20]

Conclusions

We described the role of the Department of Aviation Operation for Tokushima Prefecture in the 2018 disaster prevention drill conducted by the Cabinet Office. Using the observations made in this drill, we hope to reduce human suffering during large-scale natural disasters.

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