

# Investigation of final destination hospitals for patients in helicopter emergency medical services (doctor–helicopter) in Fukushima Prefecture

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## Abstract

**Purpose** In using an emergency medical service helicopter with an emergency medicine doctor on board (doctor–helicopter), transporting all patients to the University Hospital (base hospital for the helicopter) could cause a chronic bed shortage at the University Hospital. It is also disadvantageous for patients from distant areas. We investigated whether appropriate hospital selections are being carried out in Fukushima Prefecture.

**Methods** The subjects of the study were patients who were transported by doctor–helicopter since the services started. We investigated the medical conditions of patients at emergency scenes, whether they were transported to a hospital inside or outside the region, the means of transportation, and the final destination hospital.

**Results** There were 450 flights, of which 295 were to emergency scenes, involving 307 patients. The majority were trauma patients (191 patients, 62.2%). The final destination hospital was the University Hospital for 104 patients (33.9%); 99 patients (30.3%) were transported to three emergency and critical care medical centers (ECCMCs) in other regions. Most patients were transported to appropriate hospitals in the respective regions. The means of transportation from the emergency scene was by doctor–helicopter in the largest number of cases (223 patients, 72.6%), and the final destination hospital was ECCMCs in 81.6% of cases.

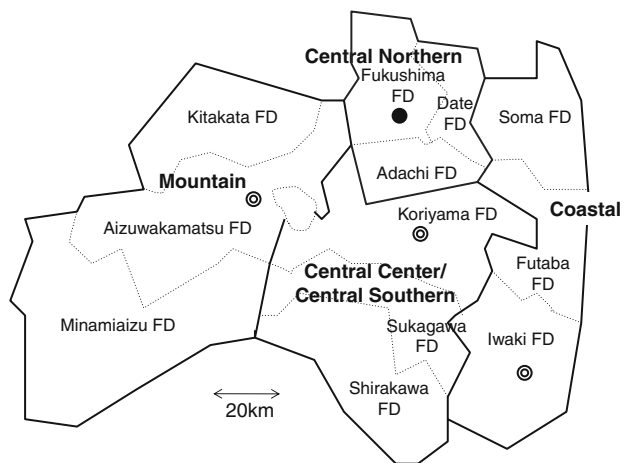
**Conclusion** Patients from emergency scenes are transported by doctor–helicopter to appropriate hospitals in the region, and hospitals in each region are cooperating with the doctor–helicopter operations.

**Keywords** Helicopter emergency medical services · Trauma · Final destination hospital · Rural areas · Emergency scene

## Introduction

Fukushima Prefecture, located in the northern part of Japan, lies within 200 km of Japan's capital, Tokyo. The prefecture stretches 166 km from east to west and 133 km from north to south. It is the third largest prefecture in Japan in land area, with many rural and isolated areas (Fig. 1). It has a land area of 13,782 km<sup>2</sup> and a population of 2,079,808. The population density is 151 people/km<sup>2</sup>, and the percentage of young people (<15 years old/entire population) is 14.5%. Thus, Fukushima Prefecture is a sparsely populated prefecture with many elderly people. The prefecture is divided into four regions based on geography, culture, and living sphere: Central Northern (Kenpoku) Region (area of region, 1,753 km<sup>2</sup>; main city, Fukushima City), Central Center/Central Southern (Kenchu/Kennan) Region (area of region, 3,639 km<sup>2</sup>; main city, Koriyama City), Mountain (Aizu) Region (area of region, 5,421 km<sup>2</sup>; main city, Aizuwakamatsu City), and Coastal (Hamadori) Region (area of region, 2,969 km<sup>2</sup>; main city, Iwaki City). In each core city, there is an emergency and critical care medical center (ECCMC). Each of these regions has three fire departments (FDs) that conduct pre-hospital care in the regions. These ECCMCs must cover such a wide area that in the case of patients with serious

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**Fig. 1** Fukushima Prefecture stretches 166 km from east to west and 133 km from north to south. It is divided into four regions: Central Northern Region, Central Center/Central Southern Region, Mountain Region, and Coastal Region. Each region has three fire departments (FD) that provide prehospital care. Each region has one Emergency and Critical Care Medical Center (ECCMC) (double circles). The base hospital for the doctor–helicopter is Fukushima Medical University Hospital (solid circle)

conditions in distant areas from the cities, much time is needed to transport the patient to the ECCMC, and the possibility that the patient’s condition may worsen is anticipated in some cases.

An emergency medical service (EMS) helicopter with an emergency medicine-trained doctor on board (doctor–helicopter) operates in Fukushima Prefecture; however, depending on the area to which the doctor–helicopter is dispatched, it can actually take a longer time to transport a patient to the base hospital (Fukushima Medical University Hospital, University Hospital) that operates the helicopter than to an appropriate regional facility. Moreover, if most patients were brought to the University Hospital, the ECCMC at the University Hospital would have a chronic bed shortage. From this perspective, it is advantageous to have serious cases hospitalized at regional ECCMCs. Hospitalization in a regional hospital also has advantages for the patient. In addition, for patients with cardiopulmonary arrest (CPA) with no prospect of recovery, transport to a nearby hospital rather than to a regional ECCMC is theoretically preferred. Taking these factors into consideration, critically ill patients should be transported to an ECCMC in each region, and moderately ill patients to an appropriate regional hospital according to his or her condition. Fukushima Medical University Hospital (base hospital) is the ECCMC in the Central Northern region and accepts all patients who cannot be treated in other hospitals in this program.

In Fukushima Prefecture, however, patients are accepted without delay from ambulance to hospital at the first inquiry in only 84.5% of cases [1], and even with the doctor–

helicopter, not all patients can be accepted without delay. Therefore, we investigated whether appropriate regional hospitals are selected as final destination hospitals for patients, and whether patients are admitted without delay.

## Materials and methods

This study investigated the number of flights and patients transported by the doctor–helicopter in Fukushima Prefecture. The study covered 450 flights since doctor–helicopter services were initiated on January 28, 2008. Flights were divided into those of emergency scenes, hospital transfers, and cancellations. Of these flights, we focused on flights to emergency scenes and investigated the condition of patients at these scenes, whether the transport of patients was within or outside of the region, the selection of the means of transport, and the final destination hospital.

## Results

### Operation status

There were a total of 450 flights during 523 days from January 28, 2008 to August 31, 2009. Of the 450 flights, 295 were dispatched to an emergency scene, 75 were hospital transfers, 79 were canceled, and, in 1 case, doctors were brought in from outside the prefecture during an earthquake disaster. “Cancellation” was defined as abandonment of the flight after the engine was started after receiving a request. All cancellations were made following requests for a helicopter dispatch to an emergency scene. Reasons for the cancellations included the condition of the patient at the scene was not severe enough to warrant the use of helicopter; the life of the patient could not be saved as a consequence of CPA; and poor visibility made it impossible to fly to the site.

There were many requests for the doctor–helicopter from Koriyama FD, Sukagawa FD, and Shirakawa FD, in the Central Center/Central Southern regions (Table 1). There were also many requests from Soma FD and Futaba FD in the Coastal region, which have no nearby ECCMCs. There were few requests from Fukushima FD and Date FD in the Central Northern region, the Mountain region, and Iwaki FD in the Coastal region.

### Condition of patients at the emergency scenes and the hospitals to which they were transported

A total of 307 patients were involved in 295 calls to emergency scenes. The most common condition was trauma from traffic accidents, occupational accidents, and

**Table 1** Fire department making requests for helicopter dispatch and number of requests

Fire department	No of dispatches (%) ( <i>n</i> = 295)
<b>Northern region</b>	
Fukushima FD	20 (6.8)
Adachi FD	27 (9.2)
Date FD	18 (6.1)
<b>Center/Southern region</b>	
Koriyama FD	65 (22.0)
Sukagawa FD	42 (14.2)
Shirakawa FD	42 (14.2)
<b>Mountain region</b>	
Aizuwakamatsu FD	7 (2.4)
Kitakata FD	6 (2.0)
Minamiaizu FD	13 (4.4)
<b>Coastal region</b>	
Iwaki FD	3 (1.0)
Soma FD	24 (8.1)
Futaba FD	26 (8.8)

FD, fire department; Northern, Central Northern; Center/Southern, Central Center/Central Southern

other reasons (191 patients, 62.2%) (Table 2). CPA was the next most common condition, at 9.1% (28 patients), followed by stroke (8.5%), intoxication (6.2%), and acute coronary syndrome (ACS) (5.2%). The hospitals to which the patients were taken were the Fukushima Medical University Hospital in 104 cases (33.9%) and the other three ECCMCs (Ohta General Hospital, Iwaki Kyouritsu Hospital, and Aizu Chuo Hospital) in 99 cases (30.3%) (Table 3). In other cases, the patients were transported to appropriate local specialty hospitals. There were no cases in which an appropriate hospital could not be found or transport was delayed. Fukushima Medical University Hospital and Aizu Chuo Hospital have their own heliports, but other ECCMCs use other heliports or nearby parking lots as a heliport.

Whether the transport of patients was within or outside the region and the selection of the means of transport

The transport areas from which requests are received are shown in Table 4. In most cases, the patients were transported to a hospital in the same region. In the regions of Central Northern, Central Center/Central Southern, and Mountain, in particular, nearly all patients (94.3, 84.4, and 86.2%, respectively) were transported to hospitals within their region. In contrast, many patients who were transported from outside the region were transported to the University Hospital, as there was little difference in transport time with a helicopter, or for reasons such as

difficulty in accepting patients by the regional ECCMC with high bed occupancy. In some parts of the Coastal Region, the transport time to the University Hospital was shorter than to the regional ECCMC, so many patients in these areas were transported to the University Hospital.

The means of transportation from the emergency scene was the doctor–helicopter in the largest number of cases (223 patients, 72.6%), and the final destination hospitals were four ECCMCs in 81.6% of cases (Table 5). In contrast, a doctor rode with the patient in a ground ambulance in 48 cases (15.6%) and did not ride with the patient in 36 cases (11.7%). These cases included many patients with CPA or mild conditions, and in either case, few of these patients were transported to an ECCMC or the main regional hospital.

## Discussion

There are many reports on the utility of helicopters, particularly in cases of trauma, ACS, stroke, and pediatric patients [2–9], but there are also studies that did not find helicopters to be more useful [10–12]. Diaz et al. [12] studied cases in which ground ambulances and medical helicopters were dispatched at the same time, and reported that ground ambulance transport provided the shortest emergency room arrival time within distances <16 km from the hospital. However, at distances 16 km or more from the hospital, air transport was faster [13]. However, the medical staff members in their helicopter emergency services consist of paramedics only. In comparison, because our doctor–helicopter system can start emergency medical treatment by the doctor at the emergency scene, the usefulness of medical helicopters may be greater even within distances under 16 km. Moreover, because medical specialists perform triage at the emergency scene, it is considered that there are fewer cases of under-triage in potentially severe trauma patients. Again for this reason, a system of objective evaluation may be necessary [14].

In response to requests from the FD within Fukushima Prefecture, patient placement was decided in an average of 84.5% cases on the first inquiry and 96.2% by the third inquiry in the entire prefecture in 2006 [1]. However, in some regions, the placement was between 60 and 70% on the first inquiry. According to the 2009 Annual Report issued by the Fire and Disaster Management Agency in Japan, severe patients are accepted without delay from the ambulance to hospital on the first call in only 84.3% of cases in the nation [15]. This finding indicates that even when a doctor–helicopter is sent to an emergency scene and a request is made for placement at an appropriate hospital within the region, the patient is not always accepted without delay.

**Table 2** Breakdown of patient condition at time of helicopter dispatch

Patient condition	No. of patients (%)	Means of transportation		
		Heli (%)	Amb D (%)	Amb P (%)
Trauma				
Traffic accident	93 (30.3)	69 (74.2)	10 (10.8)	14 (15.1)
Occupational accident	54 (17.6)	42 (77.8)	8 (14.8)	4 (7.4)
Other trauma	44 (14/3)	34 (77.3)	6 (13.6)	4 (9.1)
CPA	28 (9.1)	5 (17.9)	12 (42.9)	11 (39.3)
Stroke	26 (8.5)	24 (92.3)	2 (7.7)	0
Intoxication	19 (6.2)	15 (78.9)	1 (5.3)	3 (15.8)
ACS	16 (5.2)	14 (87.5)	2 (12.5)	0
Burn	7 (2.3)	4 (57.1)	3 (42.9)	0
Great artery disease	4 (1.3)	4 (100)	0	0
Others	16 (5.2)	11 (68.8)	4 (25)	1 (6.3)

Heli, doctor–helicopter; Amb D, ambulance with doctor; Amb P, ambulance with paramedic; CPA, cardiopulmonary arrest; ACS, acute coronary syndrome

**Table 3** Final destination hospital and number of patients transported at times of helicopter dispatch

Destination hospital	No. of patients (%) ( <i>n</i> = 307)
University Hospital <sup>a</sup>	104 (33.9)
Ohta General Hospital	56 (18.2)
Iwaki Kyouritsu Hospital	22 (7.2)
Aizu Chuo Hospital	21 (6.8)
Others	104 (33.9)

<sup>a</sup> Fukushima Medical University Hospital (base hospital)

Because Fukushima Prefecture is large in land area, when the doctor–helicopter service was started, the travel time was long in cases where the helicopter was sent to a remote scene and the patient was transported to an ECCMC in a distant region or back to the University Hospital. Therefore, when the doctor–helicopter is sent to an emergency scene, the first choice as the final destination hospital for patients is an appropriate hospital in the same region as the emergency scene that is suitable for the patient’s condition. Hospitalization within the region is also thought to have many benefits for the patient, such as lowering the financial and psychological burdens. To improve the understanding of these factors, briefings, lectures, and flight simulations are actively held for FDs, hospitals, and government agencies.

The number of flights in the prefecture (450) was fewer than predicted. One reason may be that, in the early months after the start of the service, there was insufficient awareness of the effectiveness of the doctor–helicopter. It has also been suggested that the doctor–helicopter is not used as often because a doctor–car service is operated in Mountain Region; however, the largest number of requests

in the prefecture is from Koriyama FD, which also operates a doctor–car service. The dispatcher at Fukushima FD is thinking only of transportation time, and not of emergency treatment that the doctor–helicopter can provide at the scene, and as a result the dispatchers are not fully aware of the usefulness of medical helicopters because Fukushima FD is located close to the University Hospital. However, it is reported that the mortality rate within 6 h in seriously ill patients who received initial medical treatment by doctors on site is significantly decreased when initial treatment by a doctor is done directly on site [16]. In Fukushima FD, there might be many cases in which the doctor–helicopter could have been more effective than the ambulance. A thorough understanding of the doctor–helicopter service and education are needed.

An investigation of conditions at doctor–helicopter emergency scenes revealed that approximately two-thirds of patients were trauma victims, and, in briefings, the usefulness of the doctor–helicopter for cases of trauma has also been emphasized [2, 3]. However, there were few requests for endogenous diseases, such as ACS [6] and stroke [7, 8], that require treatment soon after occurrence; establishment of a system to identify these conditions at an early stage in telephone calls to emergency services and quick request for a helicopter is an issue for future study.

In transporting patients from emergency scenes by doctor–helicopter, there are “U-turn” flights, in which patients are transported back to the base hospital, and “J-turn” flights, in which patients are transported to other appropriate hospitals within the region of the emergency scene. In general, it is thought that, after the doctor–helicopter arrives at a scene, the patient is given initial treatment and then transported to the base hospital, where further fundamental treatment is provided [17]. In the

**Table 4** Transport areas for each dispatch area

Dispatch area	No. of patients (%) ( <i>n</i> = 307)	Transport area	No. of patients (%) ( <i>n</i> = 307)
Northern Region	70 (22.8)	Northern	66 (94.3)
		Center/Southern	3 (4.3)
		Coastal	1 (1.4)
Center/Southern region	154 (50.2)	Center/Southern	130 (84.4)
		Northern	20 (13.0)
		Mountain	2 (1.3)
		Coastal	2 (1.3)
Mountain region	29 (9.4)	Mountain	25 (86.2)
		Northern	3 (10.3)
Coastal region	54 (17.6)	Center/Southern	1 (3.4)
		Coastal	27 (50)
		Northern	27 (50)

Northern, Central Northern; Center/Southern, Central Center/Central Southern

**Table 5** Means of transport from emergency scene and destination hospital

Means of transport	No. of patients (%) ( <i>n</i> = 307)	Destination hospital	No. of patients (%) ( <i>n</i> = 307)
Helicopter	223 (72.6)	ECCMCs (%)	182 (81.6)
		Regional center hospitals (%)	9 (4.0)
		Others (%)	32 (14.3)
Ground ambulance (doctor)	48 (15.6)	ECCMCs (%)	12 (25)
		Regional center hospitals (%)	8 (16.7)
		Others (%)	28 (58.3)
Ground ambulance (no doctor)	36 (11.7)	ECCMCs (%)	9 (25)
		Regional center hospitals (%)	4 (11.1)
		Others (%)	23 (63.9)

ECCMCs, emergency and critical care medical centers

present study, most of the patients were taken to hospitals within the region. When patients were transported outside the region, the reason was convenience related to the geographical area. In other cases of transport outside the region, an appropriate hospital was selected considering such things as the severity of the patient's medical condition, living area, and distance. "U-turn" cases in which emergency scene patients were brought back to the University Hospital accounted for 33.9% of cases. This figure is thought to indicate that medical organizations in all regions of the prefecture are cooperating smoothly.

When the helicopter was sent to emergency scenes, the means of patient transport was by the doctor-helicopter for 223 (72.6%) of 307 patients. Most of these patients were transported to ECCMCs, and they were thought to be serious cases. Other than ECCMCs, some patients were often taken to central hospitals or hospitals specializing in cardiovascular medicine or neurosurgery. Conversely, in 27.4% of transport cases, the patient was transported to a

regional hospital by ambulance. CPA patients and mild cases were basically transported by ambulance and taken to neighbor hospitals near the scene, as well as clinics. It is possible that helicopter transport also includes many patients with mild conditions who could be transported in ambulances [18, 19], and further investigation is needed to clarify this.

In conclusion, when the doctor-helicopter was dispatched, there were cases in which appropriate regional hospitals were selected as the destination hospital for patients, while patients were also transported to the University Hospital in about one-third of all cases.

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