Need for Emergency Medical Functioning of Hospitals in Post-Nuclear Evacuation Areas

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Understanding needs for emergency medical care is important to promote restoration work in areas affected by nuclear disasters. Most of the 72 000 residents in the Futaba District (Figure 1) were forced to evacuate after the Fukushima Daiichi Nuclear Power Plant accident. Six hospitals existed in the district predisaster, but 5 hospitals were pushed into closure post-disaster, and Takano Hospital (Hirono Town) was the only hospital (see Figure 1) that continuously operated after the disaster, despite governmental evacuation orders.[1] On March 31, 2012, the evacuation order was lifted in Hirono Town, and a restoration process progressed around the hospital thereafter. However, it took more than 8 years before another hospital started its operation in Futaba District, and little is known about extents and types of emergency medical care needs that the hospital was required to handle in the long-term aftermath of the disaster. The objectives of this study were to elucidate temporal trends and characteristics of the patients transferred by the local emergency medical services (EMS) to a remaining hospital in the district in the long-term aftermath of the nuclear disaster.

We considered the patients who were transferred to Takano Hospital with the local EMS. We did not consider the walk-in patients and those transferred from other health care facilities because we presumed that they do not necessarily reflect the local emergency medical needs after the disaster. We retrospectively reviewed EMS records of the included patients from January 1, 2010, to October 31, 2015. We handled the predisaster patients as a reference for the post-disaster patients. We evaluated the annual trends of EMS transfers and their characteristics from 2010 to 2015. We classified patients' symptoms based on a previous study[2] and classified dispatched location according to whether they were located in evacuation-designated zones[3] (Table 1).

Table 1 summarizes the number of EMS transfers during the study period and characteristics of the transferred patients. After the disaster, the number of EMS transfers decreased in 2011 and then consistently increased after the disaster during the study period. In that period, while the number of patients ages 15 and above increased, that of those ages 14 and below did not change at all. Other notable increases in EMS transfers were observed in male, dispatched locations of residences and workplaces and symptoms of trauma, abdominal symptoms, and disturbances of consciousness. In terms of severity, an increase was observed in the conditions that do not require hospitalizations.

The most plausible explanation of an increased EMS transfer after the disaster was a progress of restoration process and closure of other hospitals in the area. Because this study did not consider those transferred to outside of the district, we may have underestimated the number of EMS calls in the district. An inflow of reconstruction workers may have particularly contributed to this phenomenon, considering demographics and symptoms of the transferred patients. Indeed, it is estimated that approximately 5000 reconstruction workers reside in the district as of March 2017. Also, there may have been only a small number of children and female who returned to the area, as shown in Table 1.

A surge capacity of Takano Hospital was speculated to be quite low after the disaster, given that an elderly director operated the hospital as a sole full-time physician, and the hospital experienced a substantial outflow of health workers after the disaster.[1] While some hospitals successfully recruited young health workers and rebuilt a health care workforce, mainly as a result of a rigorous research program and media activities,[4] the sudden death of the director at Takano Hospital in 2016 led to an interruption of EMS transfer acceptance.[5] In this respect, it is important for both affected hospitals and other stakeholders to continue endeavors to sustain and increase health workers in the long-term aftermath of nuclear disasters. Although we failed to elucidate the number and characteristics of the patients transferred to other facilities, we believe that our study provides valuable data on the EMS transfers in the long-term aftermath of the disaster.

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TABLE 1

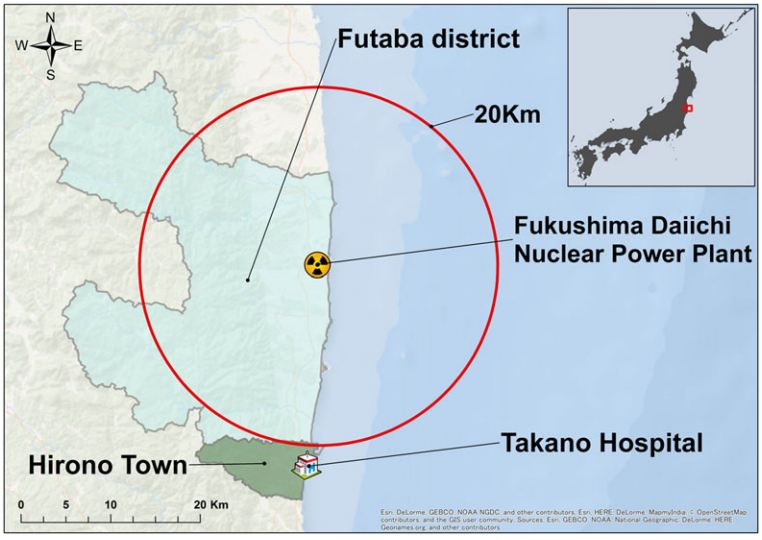
Patients' Characteristics

Characteristics	2010[a] (N = 13)	2011[b] (N = 1)	2012 (N = 8)	2013 (N = 10)	2014 (N = 31)	2015[c] (N = 53)
Age (N, %)						
14 or below	1 (6.7)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (1.8)
15-64	4 (26.7)	1 (100.0)	5 (72.5)	6 (60.0)	14 (45.2)	34 (64.2)
65-	10 (66.7)	0 (0.0)	3 (37.5)	4 (40.0)	17 (54.8)	18 (34.0)
Sex (N, %)						
Male	5 (33.3)	0 (0.0)	4 (50.0)	8 (80.0)	19 (61.3)	41 (77.4)
Female	10 (66.7)	1 (100.0)	4 (50.0)	2 (20.0)	12 (38.7)	12 (22.6)
Dispatched Location Status						
Residence	12 (80.0)	1 (100.0)	6 (75.0)	6 (60.0)	21 (67.7)	27 (24.5)
Workplace	0 (0.0)	0 (0.0)	0 (0.0)	2 (20.0)	3 (9.7)	13 (50.9)
Public space	3 (20.0)	0 (0.0)	2 (25.0)	1 (10.0)	2 (6.5)	8 (15.1)
Road	0 (0.0)	0 (0.0)	0 (0.0)	1 (10.0)	3 (9.7)	5 (9.4)
Other	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (6.5)	0 (0.0)
Transfer From Evacuation Zone						
Yes	NA	0 (0.0)	1 (12.5)	3 (30.0)	8 (25.8)	21 (41.2)
No	NA	1 (100.0)	7 (87.5)	7 (70.0)	23 (74.2)	30 (58.8)
Reasons for EMS Call (N, %)						
Abdominal pain, nausea, vomit	0 (0.0)	0 (0.0)	4 (50.0)	1 (10.0)	5 (16.1)	8 (15.1)
Chest pain	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (5.7)
Cardiopulmonary arrest	0 (0.0)	0 (0.0)	0 (0.0)	2 (20.0)	1 (3.2)	3 (5.7)
Disturbances of consciousness	6 (40.0)	0 (0.0)	2 (25.0)	2 (20.0)	5 (16.1)	7 (13.2)
Fever	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (3.2)	2 (3.8)
General weakness	0 (0.0)	0 (0.0)	0 (0.0)	1 (10.0)	1 (3.2)	0 (0.0)
Intoxication	0 (0.0)	0 (0.0)	0 (0.0)	1 (10.0)	1 (3.2)	1 (1.9)
Neurological symptom	1 (6.7)	0 (0.0)	1 (12.5)	1 (10.0)	2 (6.5)	3 (5.7)
Numbness	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (6.5)	6 (11.3)
Pain, unspecified	3 (20.0)	0 (0.0)	1 (12.5)	0 (0.0)	6 (19.4)	2 (3.8)
Shortness of breath	4 (26.7)	0 (100.0)	0 (0.0)	1 (10.0)	2 (6.5)	1 (1.9)
Trauma	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (12.9)	10 (18.9)
Others	1 (6.7)	0 (0.0)	0 (0.0)	1 (10.0)	1 (3.2)	7 (13.2)
Severity (N, %)						
Requiring hospitalization	7 (46.7)	1 (100.0)	2 (25.0)	6 (60.0)	10 (32.2)	5 (9.4)
Not requiring hospitalization	8 (53.3)	0 (0.0)	6 (75.0)	4 (40.0)	21 (67.8)	48 (90.6)

[a] Corresponds to the period from January 1, 2010, to March 10, 2011.
[b] Corresponds to the period from March 11, 2011, to December 31, 2011.
[c] Until October 31, 2015.
EMS = emergency medical services.

FIGURE 1

Geographical Scope of the Location of Fukushima Daiichi Nuclear Power Plant and Takano Hospital. (Futaba District Houses the Fukushima Daiichi Nuclear Power Plant, and Takano Hospital is Located 22 km to the South of the Nuclear Power Plant.)



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Ethics Statement

Ethical approval for this study was granted by the Minamisoma Municipal General Hospital Institutional Review Board on March 7, 2017.

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Conflict of Interest Statement

The authors have no conflicts of interest to declare.

Author Contributions

Yuki Shimada wrote the first manuscript. All authors conceptualized and designed the study, and contributed to the revision of the paper for intellectual content.

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