

## Report from the Field

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### Corresponding author:

Toyoaki Sawano,  
Email: [toyoakisawano@gmail.com](mailto:toyoakisawano@gmail.com).

# Emergency Hospital Evacuation From a Hospital Within 5 km Radius of Fukushima Daiichi Nuclear Power Plant: A Retrospective Analysis of Disaster Preparedness for Hospitalized Patients

Toyoaki Sawano MD<sup>1,2,3</sup> , Yuki Senoo<sup>4</sup>, Izumi Yoshida<sup>5</sup>, Akihiko Ozaki MD, PhD<sup>3,6</sup> , Yoshitaka Nishikawa MD, PhD<sup>7</sup> , Arinobu Hori MD, PhD<sup>8,9</sup>, Tomoyoshi Oikawa MD, PhD<sup>10</sup>, Koichi Tanigawa MD, PhD<sup>11</sup>, Shuichi Shigetomi MD, PhD<sup>12</sup> and Masaharu Tsubokura MD, PhD<sup>2,3</sup>

<sup>1</sup>Department of Surgery, Jyoban Hospital of Tokiwa Foundation, Fukushima, Japan; <sup>2</sup>Department of Radiation Health Management, Fukushima Medical University School of Medicine, Fukushima, Japan; <sup>3</sup>Research Center for Community Health, Minamisoma Municipal General Hospital, Fukushima, Japan; <sup>4</sup>Faculty of Medicine, Comenius University, Bratislava, Slovakia; <sup>5</sup>Semmelweis University, Budapest, Hungary; <sup>6</sup>Department of Breast Surgery, Jyoban Hospital of Tokiwa Foundation, Fukushima, Japan; <sup>7</sup>Department of Internal Medicine, Soma Central Hospital, Fukushima, Japan; <sup>8</sup>Department of Psychiatry, Hori Mental Clinic, Minamisoma, Fukushima, Japan; <sup>9</sup>Department of Neuropsychiatry, Fukushima Medical University School of Medicine, Fukushima, Fukushima, Japan; <sup>10</sup>Department of Neurosurgery, Minamisoma Municipal General Hospital, Fukushima, Japan; <sup>11</sup>Futaba Medical Center, Fukushima, Japan and <sup>12</sup>Futaba Kosei Hospital, Fukushima, Japan

## Abstract

Emergency evacuation during disasters may have significant health impacts on vulnerable populations. The Japanese Government issued evacuation orders for surrounding residents of the Fukushima Daiichi nuclear power plant (FDNPP) immediately after the March 11, 2011, nuclear accident. Little is known of difficulties associated with the disaster-specific evacuation from health care facilities located in this area. Among the 338 patients hospitalized at Futaba Hospital, located 4.6 km west of FDNPP, at the time of the accident, 39 patients (11.5%), predominantly critically ill patients who were bedridden or disabled, died before the evacuation was completed. The shortage of hospital staff and disruption of infrastructure resulted in a lack of adequate care provision, such as infusion therapy or sputum suctioning, leading to premature death of some hospitalized patients during the emergency hospital evacuation. As hospital evacuation is sometimes unavoidable during disasters, potential health impacts of hospital evacuation should be recognized and reflected in disaster preparedness plans.

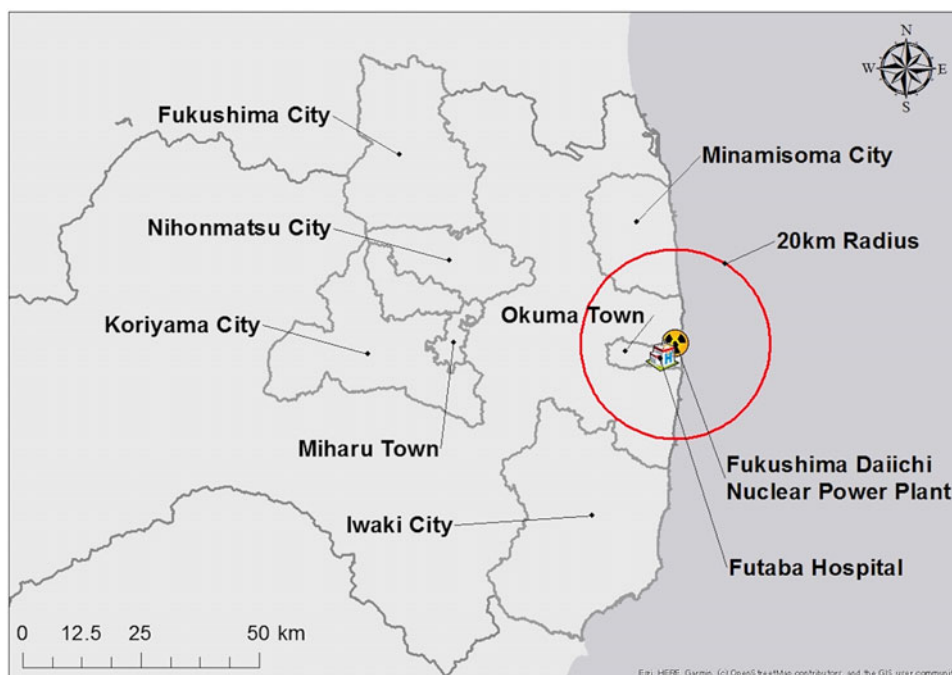
## Introduction

In natural or man-made disasters, evacuation has significant health impacts on vulnerable populations.<sup>1,2</sup> Older individuals and individuals with disabilities are particularly vulnerable during disasters.<sup>3,4</sup> Nursing home residents evacuated in hurricane-ravaged areas have higher mortality rates than residents with similar demographics in non-evacuated areas.<sup>5,6</sup> Against a background of increased frequency and intensity of disasters, it is crucial to understand the risks of post-disaster evacuation among vulnerable populations to minimize its adverse health outcomes.

Following the Fukushima Daiichi nuclear power plant (FDNPP) accident on March 11, 2011, the Japanese Government issued a mandatory evacuation order to nearby residents.<sup>7,8</sup> No deaths were reported among the patients transported by the Japan Self-Defense Force (JSDF) from the hospitals located within a 20- to 30-km radius of the FDNPP.<sup>9,10</sup> In contrast, an increased mortality rate was reported among nursing home residents who were voluntarily evacuated from the same area.<sup>11–14</sup> However, there is limited information available on the full range of processes and difficulties related to the medical transportation within a 20-km radius of the FDNPP.<sup>15</sup>

This report describes the hospital evacuation procedures and evacuation-related deaths at the nearby Futaba Hospital. While fully acknowledging and respecting the efforts in patient evacuations of the Futaba Hospital under such difficult circumstances, the assessment of these cases is considered necessary to reveal factors that led to the patient deaths during the emergency hospital evacuation in the area most affected following the FDNPP accident in order to minimize the health impact of evacuations on vulnerable populations in future disasters.

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**Figure 1.** Location of municipalities during the evacuation process from Futaba Hospital. The geographical relationships between the Fukushima Daiichi nuclear power plant and Minamisoma, Iwaki, Koriyama, Nihonmatsu, and Fukushima cities and Miharu Town are depicted.

## Methods

Futaba Hospital, which has internal medicine and psychiatric wards, is located 4.6 km west of the FDNPP in Okuma Town and is 1 of 7 hospitals within a 20-km radius that received orders for immediate evacuation. This study retrospectively reviewed the evacuation process at Futaba Hospital and analyzed the deaths among evacuated patients based on publicly available judicial records (Tokyo District Court 2013, Case Numbers 15136, 15137, 15615, 18760; Tokyo District Court 2014, Case Number 2903), books, news articles, and testimony from hospital officials, that identified difficulties with the evacuation procedures. Hospitalized patients were categorized into 3 groups to better understand the evacuation process.

## Results

### Process of Hospital Evacuation

On the morning of March 12, an area within a 10-km radius from the FDNPP was designated as an evacuation zone. However, Futaba Hospital evacuation was delayed presumably due to a lack of proper communication between the disaster management headquarters, local government, and the JSDF, despite repeated help requests from the hospital. Futaba Hospital had no agreement with external organizations for assistance with evacuations. After a major earthquake and tsunami preceding the nuclear accident, the hospital experienced disruption of its power and water supplies. At this time, 338 patients were hospitalized, approximately 40% of whom were older adults (ages > 65 years); more than 20 patients required parenteral nutrition; more than 40 patients required enteral feeding tubing; less than 10 patients required supplemental oxygen; and no patients required mechanical ventilation.

### Outcome of the Patients in Each Group

#### Group 1

Patients able to walk independently ( $n = 209$ ) were evacuated by 5 tourist coaches, arranged by the local government, at approximately 2:00 PM on March 12. As this was the largest group of evacuees and the hospital officials considered this evacuation to be temporary, to be followed by further evacuations, most of the medical staff from the hospital were onboard. Almost all evacuation shelters were crowded, and they managed to find only a temporary evacuation shelter in Miharu Town after 5.5 hours of traveling. The patients were then transported to Iwaki City on March 13 (Figure 1). There were no deaths in this group.

#### Group 2

Patients unable to move independently ( $n = 34$ ) were evacuated by JSDF vehicles (coaches and ambulances) by the JSDF on March 14. Though JSDF staff placed as many patients as possible in the vehicles, they could not evacuate all the patients who remained in the hospital. Consequently, medical staff from Futaba Hospital remained behind to care for the remaining patients and were unable to be onboard to provide patient care. They were transported to a gymnasium in Iwaki City after a 10-hour journey (see Figure 1). Three patients died en route and 11 more died the next day.

#### Group 3

Patients not able to move independently, but not in Group 2 ( $n = 94$ ), were evacuated by the JSDF on March 15 and 16. Four died before evacuation. Twenty-four patients died on the journey to the evacuation facilities. No hospital staff traveled with this group.

One patient with dementia was reported as missing during the evacuation and was not included in these groups.

## Case Presentations

### Case #1 (A Representative Case of Death Among Patients in Group 2)

A 97-year-old bedridden man with severe dementia was receiving parenteral nutrition. Despite recurrent pressure ulcers and urinary tract infections, his condition was stable.

After the initial evacuation on the afternoon of March 12, the hospital was no longer able to provide sufficient medical care because of a severe shortage of health care staff. Additionally, the electricity disruption forced caregivers to manually perform sputum aspiration using a syringe.

The patient was evacuated at 10:00 AM on March 14 with other Group 2 patients. Parenteral nutrition was discontinued and no infusion was administered during the evacuation. He was screened for body surface radiation contamination at the Soso Healthcare Centre, Minamisoma City, and then, following a 10-hour journey, transferred to Koyo Gymnasium Facility in Iwaki City (see Figure 1), where he died on the morning of March 15. The death certificate documented cardiac arrest as the cause of death; judicial records indicate that dehydration due to discontinuation of fluids and the physical burden of evacuation were potentially the primary causes of death.

### Case #2 (A Representative Case of Death Among Patients in Group 3)

A 73-year-old man with schizophrenia was hospitalized due to psychomotor excitation. Although he was unable to communicate verbally or move independently, he could eat with assistance and was in a stable physical condition.

On March 11, following infrastructure damage, the hospital could not be heated or serve meals. In addition to insufficient medical care after the initial evacuation, due to a lack of infrastructural supply, the patient may have experienced hypothermia and dehydration. He was evacuated by the JSDF at 12:35 AM on March 16. No medical treatment or intravenous hydration was administered during the evacuation. The patient was transported to Nihonmatsu City for radiation contamination screening and, thereafter, to a hospital at 3:40 PM (see Figure 1). Death, due to dehydration, was confirmed at 4:10 PM on the same day.

## Discussion

Of the 338 patients in Futaba Hospital, 39 (11.5%) died and 1 went missing during the emergency evacuation.

The interruption of medical care such as intravenous infusions and sputum aspirations may have resulted in patient deaths.<sup>16</sup> Patient evacuations from hospitals close to a nuclear power plant were inevitable; however, those who were bedridden or in poor overall health, were unable to bear the evacuation burden and sustained an increased mortality. The fatalities presented occurred in ill but stable patients who needed continuing medical support.

Lack of basic infrastructure, health care staff, and medical supplies must be considered in an emergency hospital evacuation. The human resources required for an evacuation must be balanced with the need to maintain sufficient staff for the remaining patients. Prioritizing in-hospital medical care for remaining patients, while utilizing external health care resources for evacuation, may reduce mortality.

For hospital evacuations in nuclear disasters, the development of a strategy to prioritize allocation of limited health care resources is a key challenge. Ongoing medical care is necessary, particularly

for bedridden and critically ill patients. While it required a long time to complete the evacuation of Futaba Hospital, there were no deaths of patients or staff caused by radiation exposure. If the infrastructure and workforce can be maintained, the option of not evacuating critically ill patients – shelter-in-place – may be reasonable with due credence to ethical considerations, such as the risk of radiation exposure among remaining staff. Ideally, the evacuation of vulnerable populations to a safe location needs to be well organized with an abundance of health care resources.<sup>16</sup>

This study has several limitations. First, as no official report regarding hospital evacuation in Futaba Hospital was available, it was impossible to verify whether the judicial records used in this study were medically consistent. Second, it was not possible to clarify why there was a lack of communication between Futaba Hospital and external organizations. Further studies are needed to enhance the understanding of who should manage the emergency response, and how this should be implemented in a hospital evacuation during a disaster.

## Conclusions

During the emergency evacuation of a hospital, located 4.6 km from the FDNPP, insufficient health care resources, lack of coordination, command, and control, and lack of communication between external organizations contributed to the premature death of hospitalized patients who required ongoing medical attention. Based on the lessons learned in this tragedy, it is imperative that the potential health impact of an evacuation on vulnerable populations is recognized and that this is reflected in disaster preparedness policies, pre-planning, training, and pretesting of these plans.

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