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Overview

Emergency Responses and Health Consequences after the Fukushima Accident; Evacuation and Relocation

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Abstract

The Fukushima accident was a compounding disaster following the strong earthquake and huge tsunami. The direct health effects of radiation were relatively well controlled considering the severity of the accident, not only among emergency workers but also residents. Other serious health issues include deaths during evacuation, collapse of the radiation emergency medical system, increased mortality among displaced elderly people and public healthcare issues in Fukushima residents. The Fukushima mental health and lifestyle survey disclosed that the Fukushima accident caused severe psychological distress in the residents from evacuation zones. In addition to psychiatric and mental health problems, there are lifestyle-related problems such as an increase proportion of those overweight, an increased prevalence of hypertension, diabetes mellitus and dyslipidaemia and changes in health-related behaviours among evacuees; all of which may lead to an increased cardiovascular disease risk in the future. The effects of a major nuclear accident on societies are diverse and enduring. The countermeasures should include disaster management, long-term general public health services, mental and psychological care, behavioural and societal support, in addition to efforts to mitigate the health effects attributable to radiation.

Key words: Evacuation; health effects; medical response; mental effects; nuclear accident; relocation

Statement of Search Strategies Used and Sources of Information

This paper reflects expert opinion and current literature accessed by the authors; no formal search strategy has been defined.

Introduction

The Three Mile Island nuclear power plant (NPP) accident in 1979, the Chernobyl accident in 1986 and the Fukushima accident in 2011 have issues in common that were not directly related to the physical effects of radiation exposure. Of course, in the Chernobyl accident, acute radiation injuries in acute phase and thyroid cancer in the paediatric population were reported [1]. However, the other health effects, such as mental health issues, behavioural changes and lifestyle-related health problems, have become more significant as those have not been properly addressed as general health risks after major nuclear accidents [2]. An extreme example was the loss of life in the evacuation of hospital inpatients in the Fukushima accident [3]. Evacuation of the inpatients and elderly residents of nursing care facilities was hurriedly carried out by buses shortly after the accident. No medical personnel accompanied the evacuees who were laid down on the seats of the jam-packed buses with full protective suits on. No medical care, even food or water, was provided for many hours during the evacuation. As a result, scores of patients died in an evacuation that was

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supposedly intended to minimise radiation exposure. The life-threatening risk to these people was not radiation, but discontinuation of daily medical care. A recent study indicated that the severe health risk associated with the rapid evacuation of elderly residents from nursing care facilities after the Fukushima accident was 30 times higher than the radiation risk of the reference levels for evacuation that are recommended by the International Committee for Radiological Protection [4].

Presently, more than 400 NPPs are operated in the world, and more will be built in developing countries in search of efficient and stable energy sources. Of course, we should never underestimate the menace of nature that can lead to a compound disaster, such as in Fukushima. We need to prepare for the worst case scenario even if the chance of a severe nuclear accident is quite rare. We need to clarify what we have learned from the Fukushima accident and how we will utilise it, what are the unanswered questions we are faced with and what we need to share with the next generation.

This overview describes the initial medical responses after the Fukushima accident and the health consequences encountered in the evacuation and relocation of residents, with a special emphasis on not only medical but also psychological and societal perspectives related to the Fukushima accident.

Fukushima Daiichi Nuclear Power Plant Accident

Before the Fukushima accident, there were 54 NPPs in operation, producing one third of the electricity in Japan [5]. On 11 March 2011, a 9-magnitude earthquake occurred off the east coast of Japan, generating massive tsunamis, which severely damaged coastal areas. The earthquake and tsunami also hit the NPPs located in the coastal area in Tohoku and led to the loss of the entire core cooling capacity of the three reactors of Fukushima Daiichi NPP and severe damage to the nuclear cores. Consequently, substantial amounts of radioactive substances were released into the environment [6–8].

Emergency Responses after the Nuclear Power Plant Accident

In Fukushima, the radiation emergency medical system had been developed within the framework of the national radiation emergency medical system. Six hospitals were designated as primary radiation emergency medical facilities, which assumed roles in providing initial treatment and decontamination; one was designated as a secondary radiation emergency hospital to provide advanced treatment of radiation injuries.

At the time of the accident, up to 76 000 people lived within an area of a 20 km radius from the Fukushima Daiichi NPP. After the accident occurred, more than 97% of residents living in the 20 km radius had evacuated by 15 March, when the highest amount of radioactive plume was released from the plant [9]. However, the evacuation of residents did not go well. As the situation of the nuclear reactors became more unsure the government progressively expanded evacuation zones from within a radius of 3, 10 and 20 km of the NPP. More than 20% of evacuees were obliged to relocate more than six times as the evacuation zone expanded, due to the lack of evacuation plan, which extended greater than a 10 km radius from the NPP [6]. In addition, information about radiation levels and the evacuation process itself were not available, i.e. how to prepare, how long it may last; nor were instructions on how to protect oneself from radiation exposure or how to vacate their homes provided. Insufficient transportation and disruptions in electricity, water, gas supply, telecommunications and radiation-monitoring systems caused by the earthquake made it more difficult to implement an organised evacuation [6].

On 12 March, the first hydrogen explosion took place at the Unit 1 reactor building and five workers sustained injuries. Although most of the injuries were not severe, no field triage or initial treatment was carried out. On 14 March, the Unit 3 reactor building exploded and 11 workers sustained injuries. In this explosion, an emergency doctor, who coincidentally stayed at the off-site centre located 5 km from the NPP, triaged the injured individuals. However, it was quite difficult for the injured workers to access medical services because local emergency medical hospitals had either closed or were not functional [10].

Japan's radiation emergency medical system was developed to address work-related accidents [10], not for such large-scale natural disasters as with Fukushima [6]. Accordingly, after the accident, six hospitals designated as primary radiation emergency hospitals closed or failed to function properly owing to evacuation or indoor sheltering orders, damaged facilities and infrastructure disruption caused by the earthquake and the outflow of medical staff in fear of radiation danger [11]. Fukushima Medical University, which was designated as a secondary radiation emergency hospital, was the only hospital to respond to emergency medical needs [12]. To support Fukushima Medical University's efforts, a nationwide network of radiation emergency medical services was established by the end of March 2011 [12,13].

Evacuation of Hospitals and Nursing Care Facilities

The Fukushima accident underscored critical issues regarding the evacuation of hospitals and nursing care facilities. After the government issued evacuation orders, the emergency evacuation of about 2200 inpatients and elderly people at nursing care facilities was arranged. On 14 March, more than 800 patients, who were hospitalised and remained behind at medical or nursing facilities located within a 20 km radius from the plant, were urgently evacuated. Information on the patients, i.e. patients' names, conditions, even the exact number of patients, was not available. They were transported by buses or police vehicles for a relatively long time, in some cases for more than 48 h. However, no medical personnel were in attendance and no

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