How Occupational Health can Contribute in a Disaster and What We should Prepare for the Future—Lessons Learned through Support Activities of a Medical School at the Fukushima Daiichi Nuclear Power Plant in Summer 2011

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Abstract: How Occupational Health can Contribute in a Disaster and What We should Prepare for the Future—Lessons Learned through Support Activities of a Medical School at the Fukushima Daiichi Nuclear Power Plant in Summer 2011: Koji Mori, et al. Department of Occupational Health Practice and Management, Institute of Industrial Ecological Sciences, University of Occupational and Environmental Health, Japan—Background: A nuclear accident occurred at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Company (TEPCO) as a result of a mega-earthquake and tsunami in March, 2011. A large number of workers were engaged in response and recovery operations under a complex structure of involved companies. They were exposed not only to radiation but also to other health hazards. TEPCO implemented programs to prevent radiation exposure, but had no effective systems for managing the other health risks and few occupational health (OH) professionals contributed to the health risk management. Activities: The University of Occupational and Environmental Health (UOEH), Japan, dispatched physicians to a quake-proof building at the plant to provide first-aid services from mid-May, 2011, and took a strategic approach to protecting workers from existing health risks. UOEH presented recommendations on OH systems and preventive measures against heat stress to the Government and TEPCO. The Ministry of Health, Labour, and Welfare issued guidelines to TEPCO and contractors. TEPCO implemented a comprehensive program against heat stress according to the guidelines and in cooperation with UOEH. As a result, we successfully prevented severe heat illness during summer 2011. Discussion: From our experiences, we believe that the following recommendations should be considered: 1) the role of OH and the participation of experts should be defined in emergency response plans; 2) regulations should allow the national government and main companies involved to lead safety and health initiatives for all workers at disaster sites; and 3) OH professionals, response manuals and drills should be organized at a national level.

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Key words: Disasters, Ergency response plan, Heat illness, Manpower, Occupational health

The Great East Japan Earthquake caused a nuclear accident at the Fukushima Daiichi Nuclear Power Plant of Tokyo Electric Power Company (TEPCO). A significant number of workers belonging to various companies were engaged in response and recovery operations at the plant. We report the occupational health efforts of a team compiled by the University of Occupational and Environmental Health (UOEH), Japan, to protect workers from heat stress in coopera-
tion with TEPCO and the Japanese Government, and discuss the lessons learned from our experience with regard to the function of occupational health professionals during a disaster and necessary preparedness for the future.

Case Presentation

Background

A mega-earthquake and subsequent tsunami struck the Fukushima Daiichi Nuclear Power Plant of TEPCO on March 11, 2011. The emergency core cooling system did not function due to the complete loss of electricity supply, resulting in a nuclear accident. Hydrogen explosions occurred in units 1, 3 and 4 of the plant, and a significant amount of radioactive material was released into the atmosphere. A large number of workers belonging to various companies including TEPCO were engaged in operations to stabilize the plant. The potential radiation exposure of these workers was the foremost concern. Some were exposed to more than 250 mSv of radiation during the initial response phase. However, their radiation exposures were carefully monitored and controlled thereafter. All of the workers at the plant were required to wear a standardized set of personal protection equipment, i.e., chemical protection clothing made of polyolefin materials, a full-face respirator equipped with both dust and charcoal filters, double sets of gloves and shoe covers. Heat illness at the plant was classified by the criteria of Yasuoka et al. (grade I, mild; grade II, moderate; grade III, severe). Despite the relatively cool climate in the Fukushima area, a few cases of mild heat illness (grade I) among the workers at the plant were reported between the end of March and early April, 2011.

Regarding the structure of companies involved in the recovery operation, TEPCO contracted services from more than twenty primary contractors, and each of them outsourced groups of workers to subcontractors across multiple layers. At the early stage, the national government and TEPCO implemented first-aid, decontamination and medical evacuation systems for workers, and TEPCO managed the risk of radiation exposure and contamination at the plant. However, TEPCO had no effective systems for managing the other occupational health risks, and few occupational health professionals contributed to health risk management. Under these circumstances, we were concerned about the potential for cases of fatal heat illness resulting from increased temperatures.

Strategic approach for providing occupational health assistance

In 1978, UOEH was established to develop professional occupational physicians and promote occupational health. The university has numerous occupational health specialists and about five hundred graduates working as occupational physicians in companies or occupational health service institutes. Some of them were working for the companies involved in the recovery operation at the Fukushima Daiichi Nuclear Power Plant.

One month after the accident when UOEH received support requests from TEPCO, TEPCO requested us to dispatch physicians for first-aid services to a quake-proof building at the plant on April 15, 2011. However, we were not expected to give professional advice about managing occupational health risks. It was difficult for us to influence the occupational health practices at the plant by just expressing opinions about what they should have done to prevent heat illness from the outside. Moreover, little time was left before the onset of the high temperature and humidity season. We decided to agree to the request from TEPCO on the condition that the Japanese Government also officially requested our support. We then took a three-step strategic approach to contribute to protecting workers from existing health hazards.

The objective of step 1 was to develop trustful relationships with the staff of TEPCO and outside contractors by providing sincere responses to their requests and meeting their existing needs. They had had trouble in securing physicians for first-aid and health check-ups at the plant. We began dispatching a physician to the quake-proof building at the plant to provide daily first-aid and periodic health check-ups for TEPCO employees on May 15, 2011. These services were standardized with a detailed manual and training and continued until late August, 2011.

The objective of step 2 was to develop and recommend practical occupational health programs based on our understanding of the real situation at the plant. We requested every dispatched physician to report the work conditions at the plant and the services they provided. In addition, we established a private study group to discuss necessary occupational health programs with UOEH graduates who were involved in the operations, mainly as occupational physicians of TEPCO or major primary contractors. We then developed practical recommendations about the occupational health systems (Table 1) and programs specific to prevention of heat illness (Table 2) that should be implemented at the plant and presented them to the government and TEPCO.

The objective of step 3 was to provide the necessary technical materials and advice on occupational health. We provided training materials on heat stress, checklists on necessary occupational health practices at the plant for contractors, and so on. We also implemented fitness for duty assessment programs.
and provided advice to workers who were beginning response or recovery operations at the plant.

Comprehensive program to prevent heat illness and the results

Various occupational health programs have been implemented since we initiated support activities. A comprehensive program to prevent heat illness implemented by TEPCO in cooperation with UOEH and under the guidance of the Ministry of Health, Labour, and Welfare in summer 2011 is worthy of mention.

We developed practical recommendations at a private study group meeting, which are shown in Table 1. We presented them to the Ministry of Economy, Trade and Industry on May 19, 2011, and to the Ministry of Health, Labour, and Welfare on June 3, 2011. Hitachi Ltd. was one of the nuclear reactor manufactures, and it dispatched several hundreds of employees and contractors to the plant for recovery works every day. Because it had implemented the most advanced program, we advised the Ministry of Health, Labour, and Welfare to interview the chief occupational physician. The ministry issued guidelines on occupational safety and health at the plant for summer 2011 to TEPCO and the contractors on June 10. The guidelines included work suspension hours, i.e., from 2 pm to 5 pm, till the end of August and reflected most of our recommendations. The Ministry of Economy, Trade and Industry also requested TEPCO than the aggressively implement the programs against heat stress. We provided more detailed advice to TEPCO than recommendations to the ministries, and offered our possible contribution.

TEPCO implemented a comprehensive program against heat stress. It included the development of several new rest stations, daily wet-bulb globe temperature monitoring, suspension of all operations from 2 pm to 5 pm, limitation of successive working hours and encouragement of the use of cool vests and drinking oral rehydration solution. We provided contractors with the necessary training materials for new workers and checklists on measures against heat stress that should be taken through TEPCO. We also provided them with a list of health conditions that they should pay attention to and encouraged them to check the workers’ health conditions regularly. When cases of heat illness occurred, TEPCO requested the contractors concerned to report the root causes and countermeasures put in place to prevent another occurrence.

Following implementation of the program against heat stress, the awareness of heat stress among staff at all operational levels was dramatically improved. Prevention of heat illness became the first topic of general meetings held every morning and evening in the quake-proof building. Each primary contractor of TEPCO checked worker health at morning roll calls. The workers regularly used cool vests and drank oral rehydration solution. Forty-three cases of heat illness were reported between the end of March and early October, 2011, but no severe heat illness (grade III) was observed. In August, only 4 mild cases were reported.

Discussion

In this paper, we reported that severe heat illness among workers who were inexperienced in high-risk conditions at the Fukushima Daiichi Nuclear Power Plant was prevented by government guidance, UOEH’s technical assistance and TEPCO’s efforts.

How occupational health can contribute at a disaster?

During the East Japan Disasters, it was reported that the protection of local government officers against

### Table 1. Key recommendations for occupational safety and health systems that should be implemented at the Fukushima Daiichi Nuclear Plant*

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<thead>
<tr>
<th>Recommendation</th>
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<tbody>
<tr>
<td>a. The roles of each layer of companies involved in managing the safety and health of all workers should be clarified.</td>
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<tr>
<td>b. Occupational safety and health rules for all workers should be enforced.</td>
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<tr>
<td>c. Worker’s health conditions should be assessed to verify whether they meet health requirements.</td>
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<tr>
<td>d. Comprehensive programs against heat stress should be implemented.</td>
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</tbody>
</table>

* Each item has a list of detailed recommendations.

### Table 2. The recommended comprehensive program to prevent heat illness that should be implemented at the Fukushima Daiichi Nuclear Plant

<table>
<thead>
<tr>
<th>Recommended Programs</th>
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<tr>
<td>1. Daily wet-bulb globe temperature monitoring, and awareness of workers</td>
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<td>2. Designing work schedules to prevent heat illness</td>
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<td>3. Establishing rest stations equipped with air conditioners</td>
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<td>4. Arranging oral rehydration solution and encouraging workers to drink it</td>
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<td>5. Arranging cool vests and encouraging workers to use them</td>
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<tr>
<td>6. Providing education programs concerning prevention of heat illness</td>
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<td>7. Health checks for workers at the beginning of work daily</td>
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<td>8. Providing opportunities for health guidance</td>
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radiation exposure was insufficient\cite{5}. A large number of workers and volunteers are engaged in response and recovery operations when disasters such as earthquakes, oil spills and terrorist attacks occur. They are often exposed to multiple health hazards that are classified as either chemical, physical, biological or psychosocial\cite{1-3}. A specific health hazard among them tends to be the primary focus in certain types of disasters, e.g., radiation at a nuclear accident and chemicals at an oil spill\cite{6,7}. There are sometimes trade-offs in the risks associated with them, and countermeasures against a certain hazard sometimes increases the risks of others. Personal risk factors should also be considered in unusual operations\cite{9}. As presented in this report and others\cite{11,8}, occupational health professionals that have the specific expertise for protecting workers’ health and lives can contribute under the complex situations during disasters.

**What we should prepare for the future?**

We should prepare against future disasters with lessons learned through experience. It is important for essential disaster response functions to be incorporated into response plans for quick activation\cite{6,8}. The contribution of occupational health professionals and the implementation of other preventive measures were insufficient during the early phase at the nuclear accident. Two months had passed before UOEH began to provide professional support. Because the accident occurred in March in a relatively cool area, the Tohoku district, we had a certain amount of time before the season changed and the risk of heat stress greatly increased. It might not have been possible to prevent severe heat illness if the accident had occurred during a hotter season.

Significant numbers of workers involved in response and recovery operations after the 2001 terrorist attack on the World Trade Center, New York, USA, suffered from various health illnesses, such as respiratory and posttraumatic stress disorders\cite{8-11}. The United States Government revised the National Response Plan and developed the Worker Safety and Health Support Annex to protect worker safety and health following their experience with the disaster\cite{15}. On the other hand, the prevention of accidents during recovery and reconstruction operations is a written role of the Ministry of Health, Labour and Welfare in the Japan National Response Plan. However, the occupational health support for responders and other workers during the early phase of disasters is not defined\cite{15}. It is assumed that companies and local governments in Japan also do not define occupational health support in their emergency response plans. The participation of occupational health professionals should be clarified in emergency response planning\cite{10}.

The bigger a disaster is, the more complex the organization of disaster response and recovery operations becomes. Workers belonging to various companies and organizations are engaged in risky tasks under a complex chain of orders. Although employers have the overall responsibility to protect the health and lives of employees even at disaster sites, the levels of occupational safety and health functions are quite different among them. These factors make it difficult to establish an effective occupational safety and health system at a site with the current regulations and rules for usual conditions. In the post-nuclear accident operations, a lot of workers belonged to small companies that did not have occupational health experts. The establishment or revision of regulations to allow the national government and main companies greater responsibility for the health and safety of all workers involved in disasters should be considered.

For occupational health support to function in a disaster emergency response, it is necessary to organize occupational health professionals, to develop response manuals and to implement training and drills at a national level. UOEH organized a support team that consisted of UOEH staff and graduates. We did not have any organization or manuals for medical and occupational health support for nuclear accidents. However, because UOEH has specific missions and education programs to develop professional occupational physicians and promote occupational health, we basically drew on the values and concepts learned through providing or receiving education. This made it possible for us to establish an organization and standards for support in a short time. However, occupational health support structures should have already existed in various areas and companies that were damaged by the earthquake and tsunami, as well as in the nuclear power plant. National-level organizations, such as the Japan Medical Association and the Japanese Association for Acute Medicine, provided emergency medicine services during the disaster. Regarding occupational health support functions, it is expected that national-level organizations, such as the Japan Society of Occupational Health, will organize response teams and lead the preparation for disasters in the future.

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**References**

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