SPECIAL REPORT

The Great East Japan Earthquake, Tsunamis, and Fukushima Daiichi Nuclear Power Plant Disaster: Lessons for Evidence Integration from a WADEM 2017 Presentation and Panel Discussion

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Abstract: In April 2017, some of the health impacts of the 2011 Great East Japan Earthquake, tsunamis, and resultant Fukushima Daiichi nuclear power plant disaster (Okuma, Fukushima Prefecture, Japan) were presented at the 19th Congress of the World Association for Disaster and Emergency Medicine (WADEM; Madison, Wisconsin USA) in Toronto, Canada. A panel discussion was then opened by asking audience members about their experiences in their own countries, and how they would suggest taking steps to reach the goals of the *Sendai Framework for Disaster Risk Reduction 2015-2030*. This paper summarizes the presentation and panel discussion, with a particular focus on the common problems identified in understanding and reducing health risks from disasters in multiple countries, such as the ethical and practical difficulties in decision making on evacuating vulnerable populations that arose similarly during the Fukushima nuclear disaster in 2011 and Hurricane Ike's approach to Galveston (Texas USA) in 2008. This paper also highlights the need for greater integration of research, for example through increased review and collation of evidence from different disaster settings to identify common problems and possible solutions, which was identified in this panel session as a precursor to fulfilling the goals of the Sendai Framework.

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Introduction

The Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework), adopted by the UN General Assembly (New York, USA) in June 2015, places a strong emphasis on health. A main goal of the Sendai Framework is the "substantial reduction of disaster risk and losses in lives, livelihoods, and health and in the economic, physical, social, cultural, and environmental assets of persons, businesses, communities, and countries".[1] The authors of this paper engaged with a group of disaster medicine professionals in dialogue about how this goal can be achieved, introducing the example of the 2011 Great East Japan Earthquake, tsunamis, and the Fukushima Daiichi nuclear power plant disaster (Okuma, Fukushima Prefecture, Japan). This paper summarizes the themes that arose in

Abbreviations:
UNSCEAR: United Nations Scientific Commission on the Effects of Atomic Radiation
WADEM: World Association for Disaster and Emergency Medicine

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discussion, and the areas that were identified as necessitating greater research from the similar experiences of professionals across different countries.

Report

On April 25, 2017, a presentation and panel discussion were led by the authors of this paper at the 19th Congress of the World Association for Disaster and Emergency Medicine (WADEM; Madison, Wisconsin USA) in Toronto, Canada. The aim was to present the key health issues after the Great East Japan Earthquake, tsunamis, and Fukushima nuclear disaster (hereinafter referred to as the "triple disaster"), and to engage health care professionals in discussion on how to inform policy and practice and work towards achieving the goals of the Sendai Framework.

To preface the panel discussion, a brief overview was presented with the triple disaster explained in terms of three extreme events that have caused many cascading effects. By focusing on the nuclear disaster in particular, continued secondary outcomes were identified, including mass evacuation (planned and unplanned), and demographic changes in disaster-affected areas such as shrinking and aging populations.[2,3] However, difficulties have arisen in achieving a clear picture of evidence for the health risks of the nuclear disaster. From the evidence presented, it was recognized that the health effects of these secondary outcomes (such as evacuation) have potentially been larger than the direct impacts of radiation itself.[2-7] There were no deaths or cases of acute health effects of radiation reported in the general public in the immediate aftermath of the Fukushima nuclear disaster,[2] and the United Nations Scientific Committee on the Effects of Atomic Radiation Exposure (UNSCEAR; Vienna, Austria) has predicted that there will be no deterministic health effects of radiation to the general public.[7]

However, there has been publication of controversial and contradictory findings; for instance, one study found an increased risk of thyroid cancer in children from Fukushima,[8] a finding that contradicts the UNSCEAR reports[7] and empirical studies on the internal radiation contamination levels in the same population.[5] The study on thyroid cancer was later criticized for faulty study design by the scientific community,[6,9] yet its findings were widely reported in the media and caused confusion among both scientists and the general public.[6,9]

Confusion about evidence can lead to less organized practice. Difficulties have existed in determining the best course of action following the nuclear disaster, in both short-term decisions such as nursing home and hospital evacuations, and long-term decisions such as how to advise patients in radio-contaminated areas on lifestyle choices[6,10] and how long-term radiation-related population health screenings should be carried out.[11,12]

The authors of this paper presented three case studies to highlight unexpected health impacts of the disaster and difficulties in decision making:

- The first case study reflected on the immediate aftermath of the nuclear disaster, where the setting of evacuation zones, specifically the creation of a voluntary evacuation zone/indoor sheltering zone, resulted in an outflow of residents who were able to evacuate, while the most vulnerable were often left alone without resources,[13] leading to reports of extreme outcomes such as some deaths associated with starvation in the evacuation zones.
- The second case study recognized that evacuation itself may also become a mortality risk factor, as seen in the case of nursing home evacuations. Reports of these evacuations being associated with inadequate food, water, or mattresses, and the experience of dramatic environmental change associated with co-exiting cold weather and poor handover between health care professionals are considered to have resulted in these concerning results.[14,15] For example, one study found that the risk of mortality was 3.37 times higher for nursing home patients who were immediately evacuated, in comparison to those not evacuated.[16]
- The third case study considered that, even if vulnerable patients had remained in place rather than being evacuated, there may not have been sufficient numbers of health care professionals to take care of them, as a problem concurrent with evacuation was the partial collapse of the local health care systems in disaster-affected areas due to dramatic reductions in hospital staff, particularly nurses.[17]

These selected case studies highlight that the process of health impacts from the nuclear disaster was not a simple event of radiation contamination, but a series of primary events and secondary outcomes, which contributed to the deterioration of the health of residents in affected areas through intermediate factors. These case studies were presented as demonstrating the need for accumulation of evidence-based knowledge and prioritization of interventions and risk reduction measures in response to this disaster, and in learning for future disasters.

Discussion

Following the presentation, the audience was given the following questions:

- Have you grappled with similar problems in your own countries?
- How should we work towards achieving the goals of the Sendai Framework?

A constructive discussion resulted, focused on two main themes: evacuation and evacuation-related health crises, and problems in understanding evidence.

Evacuation and Evacuation-Related Health Crises

This first stream of discussion centered around the widely observed difficulty of evacuating vulnerable populations such as elderly nursing home residents.[16,18,19] Some countries or regions have special procedures for vulnerable populations in the case of a disaster, for example the registry of residents who are oxygen dependent or have special needs in the state of Florida, USA,[20] indicating progress in disaster preparedness for vulnerable populations in certain places. An issue brought up with evacuating vulnerable populations, specifically the elderly, was the question of how to keep families in contact with each other, as audience members spoke of cases where elderly individuals had evacuated and not been able to communicate with their families. This scenario also occurred in the aftermath of the Fukushima nuclear disaster, where, although telephone lines remained, telephone services were not available in evacuation shelters, causing confusion to those attempting to find family members. Another point raised was how to look after people with awareness of their rights. In terms of evacuation, for elderly individuals who chose not to be evacuated, issues around end-of-life care might need to be considered.[21,22] Do people have the right to choose how they die in disaster settings? To what extent can

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individuals understand what will happen to them when they remain in a disaster setting? The health risks involved with non-evacuation can be profound, as seen in the Hurricane Ike aftermath on Galveston Island (Texas, USA) in 2008, where some residents decided to stay put despite mandatory evacuation orders.[23,24] After this disaster, there was a significantly higher prevalence of posttraumatic stress disorder and depression in those who remained compared to those who evacuated.[23,24] Evacuation and its health risks present difficult issues in relation to the rights to self-determination, particularly in vulnerable populations.

Problems in Understanding Evidence

Problems in understanding evidence were brought up in relation to scientists and professionals, and the general public. For scientists and professionals, it was pointed out that contradictory evidence is published every day, and is a normal aspect of science, yet in disaster situations, the process of sorting out evidence-based information adds to the burden of managing immediate incident response. One way to relieve individuals from "wading through evidence" by themselves is for advice to be issued from a single trusted national authority on health, such as Public Health England (London) in England, or the Centers for Disease Control and Prevention (CDC; Atlanta, Georgia) in the USA. However, in the case of the triple disaster in Japan, some suggest it was not possible for a single health focal point at a local, regional, or a national authority to present comprehensive advice because of a lack of available information in the immediate aftermath of the disasters.[25] A lack of guidance, or incomplete guidance, can result in preventable increases in health burdens and is therefore an area that necessitates attention in disaster medicine – a point that was agreed upon in the discussion.

The necessity of communication between health care professionals and the general public was also pointed out by the participants, and it was particularly noted that trust must be established before a disaster strikes in order to promote clear links in times of disaster. Problems in the trust between professionals and community members may result in misunderstandings of risk in the general public. For example, in the case of Fukushima, researchers and public health workers often know communities, but may not have the authority or means to communicate with them, which has led to issues in building effective risk communication.[26-28] Misperceptions of radiation risk in the general public in Fukushima, particularly parents and children, has been noted as a problem and in response to this, individual physicians have led community meetings and visited schools to spread information and answer questions about radiation.[28] It has been noted that there is a similar need, and difficulty, to spread correct information on the Flint water crisis (Michigan USA), a case of city water contamination with lead, and related health risks in ways that can be understood by the public.[29] In both Flint and Fukushima, misunderstandings of health risks by local residents were potentially exacerbated by media outlets,[30,31] and may be considered as a factor that can worsen the mental health effects of disasters, highlighting the importance of clear explanation of research findings and health risks.

In light of problems that can occur with unclear evidence or in the spread of information, the discussion turned to how it could be possible to comprehensively understand the full effects of disasters, in order to respond appropriately and reduce risks in future events. Along these lines, KAMEDO —a Swedish disaster medicine study organization— is one of the few groups who have systematically reviewed incidents over years,[32] and may provide an example of how such documentation can be shared. It is notable that, despite the similarities in experiences of disaster health impacts across different countries identified in the panel session, there does not appear to be a collation of this type of evidence from different disaster events to date. For instance, it has so far not been possible to find publications that address these issues, and ways to overcome them, particularly in widespread difficulties such as evacuating vulnerable populations, with perspectives from different countries and their local cultural mores. This signifies a gap in evidence integration in disaster risk reduction and management that calls for further disaster event reporting and using these issues to further research to fill these gaps.

Limitations

The present report outlines a 2017 WADEM presentation and panel discussion, however it is not a systematic literature review, nor does it report original research findings, which are limitations that should be recognized. There remains a need for further research to systematically collate evidence from multiple disaster settings.

Conclusion

This paper introduces the presentation and panel discussion undertaken on the Great East Japan Earthquake, tsunamis, and Fukushima Daiichi nuclear power plant disaster at the WADEM Congress on Disaster and Emergency Medicine on April 25, 2017. The presentation and panel discussion highlighted that there are common difficulties in managing disaster risk across many countries, in terms of evacuation, identifying risks to vulnerable populations, and attaining a clear picture of evidence.

The review of disaster impacts, particularly those with multiple secondary effects such as the 2011 triple disaster in Japan, requires a high-level explanation of the processes involved, monitoring of the event, and shared learning. The discussion at this WADEM session highlighted some of the ways in which shared learning can happen, while signaling areas that are in need of further research, particularly in regard to integration of evidence. Understanding of disaster risks to health, and how they may be reduced, is paramount to achieving the goals of the Sendai Framework. This WADEM session ended on the note that increased review and collation of evidence from different contexts and disasters is necessary to understand and reduce disaster risk in terms of the "losses in lives, livelihoods, and health," as the Sendai Framework prompts.

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