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REVIEW

Mental health and psychosocial consequences linked to radiation emergencies—increasingly recognised concerns

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Abstract

A major radiological or nuclear emergency may, apart from causing a substantial loss of life and physical damage, also put a substantial strain on affected societies with social, economic and political consequences. Although such emergencies are relatively uncommon, it is now being increasingly recognised that their subsequent psychosocial impact can be widespread and long lasting. Mental health effects, such as depression, anxiety and post-traumatic stress disorder, are highly represented in a population affected by a radiation disaster. In order to reach the majority of the people affected by radiation accidents, we need to be aware of how to distribute relevant and accurate information related to both short- and long-term medical effects. Effective risk communication is associated with improved compliance with any given recommendations. It is important to protect the public from physical radiation damage, but it is also essential to take into account the social and mental health effects that radiation disasters may induce. This article provides a brief review of recent reporting on the psychological consequences after a major radiation emergency.

1. Introduction

A major radiological emergency is an unexpectedly complex event that may affect large geographical areas and involve many people. Such a disaster destabilises both the individual inhabitants as well as the cornerstones of the society and requires the mobilisation of significant human and economic resources to handle the aftermath [1]. The legitimate fear related to radiation-induced harmful health effects, in combination with widespread human, material, environmental and economic damage that follows after a major radiological or nuclear accident, may be significant and persist for a long time. The affected community is often compromised in several aspects with resultant difficulties to deal with each of these areas of damage. Radiation events may also in a unique way pose specific dangers to children and cause fear of long-term effects for future generations. Because of this, the resulting psychiatric and psychosocial effects can be extensive and long lasting. The knowledge about health risks from radiation exposure is to a large extent based on the epidemiological studies carried out by the atomic bomb survivors in Japan as well as on follow-up studies after major accidents, e.g. in Three Mile Island, Chernobyl and Fukushima.

Mental health effects have increasingly been recognised to constitute a major cause of suffering as a result of radiation accidents. It is important to be aware of these effects and their subsequent psychosocial and

socio-economic impact. In particular, health care professionals who encounter people having been exposed to excess radiation, or who are 'worried well', need to possess adequate knowledge on mental health issues. A thorough plan for dealing with psychological effects is therefore an essential part of preparedness for radiation accidents. Here we present a brief summary of recently published experiences gained on the management of psychosocial and mental health issues related to radiological emergencies.

2. Learning from history

Following the Three Mile Island nuclear power plant (NPP) accident in Pennsylvania 1979, which was classified as an INES level 5 nuclear disaster on the International Nuclear Event Scale [2], research began concerning the psychological effects of radiological or nuclear disasters. Despite the limited environmental release of radioactive material, such that sufficiently high levels of radiation to cause 'acute' detrimental tissue reactions in the population of Three Mile Island was not detected, the threat of radiation exposure contributed to the mental illness of the residents particularly in form of severe mental stress, mostly among people living within 5 miles of Three Mile Island and in families with preschoolers, in part linked also to factors such as unemployment and re-start of an undamaged reactor [3, 4].

In the Chernobyl NPP accident in April 1986, about 300 000 residents were relocated and more than 600 000 people were registered as emergency and recovery workers ('liquidators') [5]. Furthermore, the Fukushima Daiichi nuclear accident, which occurred after a huge earthquake and tsunami in March 2011, led to the evacuation of approximately 160 000 residents [6].

Both the Chernobyl and the Fukushima accidents were classified as level 7 nuclear disasters on the INES-scale, but the physical health effects after the Fukushima accident have been significantly lower compared to those reported after the Chernobyl accident [7]. In spite of the fact that no cases or deaths of radiation sickness from the Fukushima accident have been reported so far [6], survivors of the accident still suffer from long-term impaired mental health, strong radiation anxiety and post-traumatic stress as a consequence of this disaster [6, 8, 9]. The suffering of the survivors was not limited to direct physical and mental health but also to the uncertainty related to the exposure and its health effects, the concerns about the environment and the safety of staying outdoors. In addition, food and water supply was a concern especially for mothers of young children [6]. In comparative studies between the accidents in Chernobyl and Fukushima, it has not been possible to identify any major differences in terms of mental health consequences [3, 10], but following the Chernobyl accident, studies show that mental health impairment, e.g. depression and post-traumatic stress still persist elevated two decades later [11, 12].

Historically, researchers differentiate mental health consequences between natural disasters as opposed to technical disasters. Natural disasters are caused by nature, e.g. earthquakes or tsunamis whereas technological disasters are man-made processes such as a release of radioactive isotopes [1]. Although both technical and natural disasters may be afflicted with extensive psychological symptoms, radiation events may result in a unique psychological imprint that is not seen after natural disasters [1]. Possible explanations are that radiation events often occur without any previous warning, the threat is invisible for the subject and that the health effects are not possible to foresee and may pose a long-term threat to the entire society. Furthermore, radiological events compared to natural disasters, result in higher levels of fear based on the uncertainty about the magnitude of the exposure and its effects on the health. There is a significant difference between nuclear and natural disasters regarding psychosocial effects associated with factors such as human and material losses, psychological acceptance, cohesion in society, stigma and media influence [13]. In Fukushima, even though both the earthquake and the tsunami were major disasters independently, the effects of the ensuing nuclear accident (which did not cause a single 'acute' death!) seemed to be of higher importance to the mental health of the inhabitants [13]. As an added complication, protective actions which were taken by the Japanese authorities Fukushima Daiichi NPP, that in many cases, they impacted negatively on the daily lives of individuals and on communities, thus compounding the mental stress [14].

There is now a wealth of published literature related to the Fukushima disaster, which provides us with sufficient evidence to understand the link between radiological or nuclear disasters and mental health effects. However, since the events in Fukushima were a series of tragedies, an earthquake, a tsunami and a nuclear accident, it can be difficult to distinguish health effects that only concern the nuclear accident and not the other two disasters.

3. Mental health consequences after radiological or nuclear disasters

The emotional consequences of radiological or nuclear accidents include both psychiatric and psychological illnesses such as depression, anxiety, post-traumatic stress disorder (PTSD) and medically unexplained somatic symptoms, as well as behavioural consequences, for example increased suicide rates in the

population, sleeping disturbances, and increased smoking and alcohol abuse [8, 15–18]. These effects are often long-term and associated with fear of developing cancer but the risk perception of genetic effects in evacuated people has also shown to be surprisingly high [13, 19]. Several studies have shown that radiation exposure, estimated by proximity to the radiation source, is a common risk factor for mental illness [3].

After experiencing a nuclear disaster, the most common mental health disorders reported are PTSD, anxiety and depression [10]. PTSD can occur as a delayed or prolonged reaction to a traumatic event or situation of exceptionally threatening or catastrophic nature. It is characterised by a strong anxiety and a high level of stress and the most prominent symptoms are excessive alertness, avoidant behaviour and re-experiencing of trauma such as flash-backs or nightmares. PTSD was shown among 14%–59% of evacuees in the first year after the nuclear accident in Fukushima [20, 21]. People are affected in different ways by disasters. Various variables can increase or reduce the risk of deteriorating health in connection with major accidents. Studies have revealed that severe PTSD symptoms were, in addition to pre-existing chronic physical and mental illnesses, also associated with factors such as anxiety about livelihoods, lost jobs and social ties, damage to the home, loss of someone close due to the disaster, and concerns of compensation [10, 20, 21]. Those having other psychological risk factors such as social isolation, or experiencing discrimination, bullying or slander in the aftermath of a nuclear disaster showed an increased the risk of post-traumatic stress and a more prolonged course [22, 23]. It is apparent that many people, especially evacuees, are likely to experience strong PTSD symptoms, which may lead to hesitation in their returning home [13].

The Mental Health and Lifetime Survey (MHLS), is a major population-based mental health survey conducted by Fukushima Medical University and involves people from the evacuated area. As part of this survey studies have shown that adult evacuees had a prevalence for probable depression of 14.6% in 2012 and decreasing slowly to 9.7% in 2014, compared to the general population in Japan where the depression is found in approximately 3% [24]. Residents with a negative perception about radiation and health consequences were significantly more likely to have depressive symptoms [19]. In a before-and-after-study of 438 elderly evacuees in Japan, who did not report depression at the baseline survey (May 2010), 37% experienced a tendency to depressive symptoms at the follow-up survey (May 2013). Less social activities, as well as older age and female sex were associated with depressive tendency [25]. A cross-section study of adults in Japan ($n = 10\,000$), in which participants answered questionnaires, showed that 23% felt anxiety about radiation exposure in their daily life. Participants with higher socioeconomic status tended to report less anxiety compared to those with lower income, but they showed a higher risk-averse behaviour for radiation exposure (12%) [26]. Resilience proved to be a protective factor for both PTSD and depression and was also associated with general health. A healthy lifestyle, including nutrition, physical and social activities as well as having an employment, were significantly associated with greater resilience [25, 27–29].

It is important to notice that according to a study among 189 students in Gomel Medical University (Republic of Belarus) 32 years after the Chernobyl accident, anxiety symptoms can persist for a very long period of time. As a consequence of living in present-day Gomel 54% of the students reported a general anxiety about health effects and 55% express anxiety of genetic effects that might be passed on to the next generation [30].

4. Risk perception and risk communication

People's perception of risk in connection with major disasters has every reason to be noticed, as we learned from the disasters in Three Mile Island, Chernobyl and Fukushima. It is known that people's perceptions of the actual situation affect the way they feel and act, even if the perception is excessive in relation to the actual risk. If a situation is perceived as real for the individual, the consequences will reflect that perceived reality. In order to study the causal relationship between trust in authorities, perceived danger, perceived harm to health and mental distress after the Three Mile Island accident, it was reported that mistrust of Three Mile Island-related authorities increased the perception of danger and perceived health risk. That is, mistrust was associated with intensified perceptions of harmed health and is related as a predictor to distress [31]. Following the Chernobyl accident, the WHO has reported that mental health effects due to fear of radiation exposure, even at non-significant levels of exposure, had important consequences for health behaviour, for use of medical service and for compliance with advice regarding safety precautions [15]. Individuals whose lives have been influenced by the Chernobyl accident were labelled as, or perceived themself as Chernobyl victims according to Chernobyl forum report [32]. This led many individuals to see themselves as helpless, weak, and lacking control over the future, instead of seeing themselves as survivors [32]. In these cases, one must provide the public with complete, truthful and accurate information based on recognised science as well as information on physical and mental health consequences. Worth noting is that proximity to the source of radiation exposure or the actual radiation dose itself, are not necessarily linked to risk perception

[3]. Instead, risk perception related to fear of invisible radioactive material is a common cause of worsened mental health. It is not only linked to the immediate danger but also to future health related issues, (e.g. cancer development and genetic effects) and lower well-being in general [8]. Results from the MHLS revealed that risk perceptions of health after radiation exposure include genetic effects, perceived as very likely [19]. A larger proportion of the respondents had a higher perception of risk regarding genetic effects than delayed health risks to the exposed persons (e.g. development of cancer) [19] and a negative risk perception has also been shown to be strongly associated with depressive symptoms and anxiety [13, 30]. WHO highlights the importance of finding out the public's perception of the processes that affect the introduction, implementation and withdrawal of countermeasures after an emergency, and also involving them in these processes [32].

To deal with the uncertainty in the public perception during severe disasters, we must focus on an adequate risk communication. This is an important issue during the emergency response and is an integral part of every operation. In order for society to recover from a nuclear disaster, the experience of communities in Fukushima Prefecture clearly shows that cooperation between residents, local authorities and specialists is crucial. It is important to gather scientific evidence to organise risk communication with residents [33]. The exchange of information between authorities, experts and the people who are at risk should take place in real time [12]. Risk communication will help to increase awareness and understanding of protective actions and is thus important for compliance. When risk communication does not work optimally, it may lead to increased stress, fear, and mistrust of authorities. In the long-run, well-functioning risk communication is necessary for the return to a normal life. Identified factors associated with residents' intention to return to communities in Fukushima Prefecture show that consultation requests about radiation health effects were positively associated with the intention to return, as opposed to anxiety about personal health effects. Living with children <18 years, reluctance to drink tap water and concern about genetic effects on future generations were associated with not wanting to return [33]. It is therefore important that scientists and local authorities participate in risk communication to the residents involved in returning.

If the risk communication is lacking or inadequate, it increases the risk of healthcare being burdened, or overloaded, by worried-well who seek medical help due to perceived health problems other than radiation exposure [12]. Regarding healthcare professionals, especially nurses, who experienced the Fukushima accident, it was found that those who had more knowledge about radiation tended to have better mental health [34]. It is therefore suggested that nurses and other healthcare professionals be trained in radiation exposure and the health risks associated with this [34]. A WHO guideline development group, prepared a guidance on approaches to strengthen emergency risk communication capacity and sustaining them for potential health emergencies. This guideline also states that one of the research priorities should be to evaluate the effectiveness of the current tools [35].

As society has developed the mass media, as well as social media play an increasingly important and central role in communication with the public in the event of serious disasters and it is therefore extremely important how information through these media is given. The use of plain language versus scientific language is a way to reach a wider audience and for the public to receive and act on the basis of information. It is important that the communicators are credible and reliable sources of information [12].

5. Conclusion

History has shown that psychological and other mental consequences after radiation accidents to a large extent cause deteriorating health in people. Since psychosocial well-being of individuals and communities is the core of resilience, it is critical to minimise mental illness that is likely to affect a large amount of people after a radiation disaster. A high-quality risk communication is required as part of this prevention and should be disseminated by trained communicators who will listen to concerns. This will enable everyone at risk to make informed decisions for protection, increase the effectiveness of protective actions and can reduce fear and may lead to increased compliance. It is therefore important that recommendations on radiation protection guidelines learn from these experiences and contain plans for psychosocial care and an adequate risk communication in the event of disasters. Further studies on mental health and psychosocial consequences after disasters are essential.

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Conflict of interest

The authors claim no conflict of interest.

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