RADIATION EXPOSURE AND THE NEED FOR EFFECTIVE RISK COMMUNICATION: LESSONS FOLLOWING THE 2011 FUKUSHIMA NUCLEAR POWER PLANT ACCIDENT

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Abstract — **The communication of risk information following the Fukushima Daiichi Nuclear Power Plant accident in 2011 was often not transparent, timely, clear, nor factually correct. However, lessons related to risk communication have now been identified, and some of them have already been implemented in national and international emergency response programmes and strategies. As a result of risk and crisis communication failures during the accident, the world is now better prepared for effective communication related to nuclear and radiological emergencies than it was seven years ago. This article discusses the impact of risk communication, as applied during the Fukushima accident and the main lessons learned. It then identifies pathways for transparent, timely, clear, trusted and factually correct risk communication to be developed, practised and applied during future nuclear and radiological emergencies.**

Keywords- **Fukushima Daiichi Nuclear Power Plant, radiation exposure, crisis communication, risk communication, nuclear and radiological emergency.**

I. INTRODUCTION

On March 11, 2011, the world witnessed the unprecedented combined Great East Japan earthquake (magnitude of 9.0), tsunami and a nuclear power plant accident in Fukushima Prefecture, Japan. The nation was unprepared. From a communication perspective, the Japanese authorities, international regulatory authorities, radiation protection experts, mass media, local communities and the public were unprepared for such a triple-disaster event. Both the local Japanese and the international communicators were slow to provide clear, timely and unambiguous communication activities necessary to put the accident in its right context [1,2]. They were not prepared in advance nor trained in the state-of-the-art best practice in risk and crisis communication, resulting in a lack of a transparent, timely, trusted and understandable advice to best protect people and the environment.

II. RADIATION EXPOSURE: BENEFITS AND POTENTIAL HEALTH RISKS

The system of radiological protection is anchored in three fundamental principles: justification, optimisation of protection and dose limitations [3]. The application of the second principle - 'Doses should be kept as low as reasonably achievable (ALARA), taking into account economic and societal factors', is often fraught with difficulties, especially in an uncontrolled, emergency situation. Fig.1 depicts the intricate balance between radiation risk versus cost and benefits, and with other types of risk. The public and authorities (government, experts) have differing views on 'How safe is safe enough?' [4]. This depends on the context and the risks and benefits trade-off. However, we must be cognizant that there is uncertainty around our knowledge of both the risks (especially low-level radiation) and of the benefits [5].

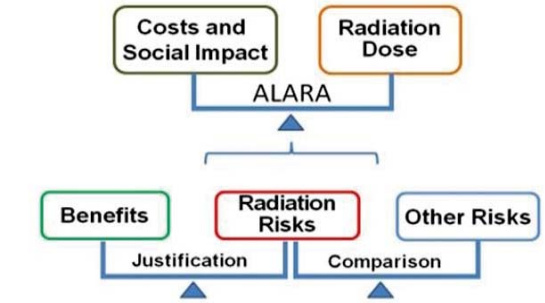

Fig. 1 The concept of ALARA, and the principles of balancing radiation risks with benefits and other forms of risks.

However, past experience of nuclear and radiological emergencies suggests that pressing issues of public concern were not necessarily those physical health problems directly related to radiation exposure, but rather the psychological and social effects which arise from the perceived adverse radiation risk. These perceived risks are highly susceptible to both amplification (over-emphasis) and attenuation (under-emphasis) through the complex processes of risk communication [6]. With the Fukushima accident, the additional implications of evacuation and long-term social displacement created severe health-related problems for the most vulnerable people in the Fukushima Prefecture, such as patients staying in hospitals and the elderly [7].

III. RISK COMMUNICATION: FOR CONTROLLED AND UNCONTROLLED EXPOSURES

Effective risk communication seeks to address the public and stakeholder perceptions of radiation, health and environmental risks in a planned and integrated manner. Best practice risk communication is to engage and have dialogue (multi-way exchange of information) with stakeholders of different perceptions of the risks to resolve their respective concerns [8]. Under crisis conditions, the demands for effective communication of risk become more intense and more urgent. A number of excellent references on risk and crisis communication are available [9-12].

Crisis communication takes place at a different stage of the risk communication life cycle, often it takes place under conditions such as natural disaster or nuclear emergency when it is very difficult to influence people's perceptions of risk [13]. Covello [14] has emphasized this as 'High Concern Low Trust' condition that requires a special mode of communication.

Fig.2 illustrates the inter-relationship of the three-fold objectives of risk communication, i.e. engaging to inform and educate; persuading and convincing those so engaged, and in building or repairing trust. Note that risk communication is a two-way process: the public may also inform, educate, convince and advise experts and others of their needs and concerns with own local knowledge. This important lesson is discussed further below.

Medical physicists are, by training, competent in radiological protection. Traditionally they have a good understanding of controlled exposures such as medical exposure in hospitals. There are various guidelines and procedures; such communication tends to be one-to-one and trusted. We could learn further from a systematic review of communicating cancer risk arising from radiological examinations [15].

When we explain how to do justification and optimisation in the case of medical exposure, we may refer to referral guidelines and diagnostic reference levels. Similarly, we could explain the justification and optimisation regarding nuclear regulations based on certain references consistently.

By contrast, uncontrolled exposures from accidents require a very different level of understanding and communication skills. This requires multi-dimensional techniques given the lack of trust in authorities, difficulty in handling exposure uncertainties, etc. [16] The deficit model attributes mistrust and public skepticism to science and technology due to a lack of understanding, a consequence of deficient in knowledge. This introduces very different sets of problems and challenges as became evident in the case of the Fukushima Daiichi Nuclear Power Plant accident.

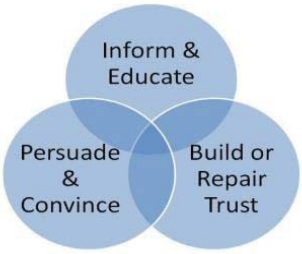

Fig.2 The inter-relationship of risk communication objectives

Contemporary risk communication research shows how non-traditional media has evolved into a multidirectional process whereby information is disseminated at an often uncoordinated and rapid pace and is able to easily reach all kinds of audiences, such as those affected, indirectly affected, or not affected by radiological risks [17]. This lack of control and uncertainty in the nature and effect of communication about radiological risks is perhaps the most challenging circumstance facing radiation protection and public health during emergency conditions in the modern world.

IV. FUKUSHIMA: WHAT HAPPENED

The Great East Japan catastrophe of combined earthquake and tsunami that devastated a large area of Tohoku region and took the lives of some 20,000 people was indeed a time of crisis. The major crisis issues included the uncertainties on decision making from the authorities and the failure of information flow. While radiation effects played a small part in the actual harm that occurred, perceptions of the danger from possible radiation exposure were extremely high – both in Japan and overseas.

As a result, there was a major challenge to both inform and advise citizens rapidly and clearly, but also to listen to and seek to assuage their concerns. Other issues that affected this difficult scenario include grey areas in regulatory authorities' roles and responsibilities, information about reactor design-bases, and stories about safety and food and environmental contamination. These issues are extremely complex and inter-related.

A number of comprehensive and authoritative reports of the Fukushima accident have been published, such as WHO [18], UNSCEAR [19] and IAEA [20].

We now have a better understanding of the communication errors that appear to have been made. These are mistrust of authority, confusing use of quantities and units for radiation exposure, inappropriate risk comparisons, lack of understanding of how risk perceptions affect responses, etc.

V. FUKUSHIMA: SOME LESSONS LEARNED

A. The need for transparency, trust and citizen-centred communication

Risk communication related to nuclear emergencies thus far has not engaged the affected citizens; this is now recognized as one of the biggest pitfalls of traditional approaches to communication [2,21]. Stakeholder engagement was often seen only as a one-way announcement from official experts to citizens, which led to a situation where the messages were the ones already framed and preferred by the authorities [22].

Risk communication related to nuclear emergencies should be developed and prepared in collaboration with various stakeholders [23]. That citizens should be invited into decision making is recognised as crucial for the recovery phase. In particular, citizen-centred communication should address socio-economic, political and ethical issues which arise from the perceived effects of radiation exposure.

The Fukushima experience demonstrated that citizen-centred communication using social media integration is essential for risk communication following nuclear or radiological emergencies in future.

B. Crisis communication should be prepared in advance

The Japanese authorities and regulatory authorities, as well as radiation protection experts, were not specifically trained and were unprepared to provide clear, transparent and timely communications to the affected population. For instance, they did not have ready templates for radiological risk communication to be used (e.g., responses to Frequently Asked Questions - FAQs), and they were not utilizing social media during the accident (e.g., they did not have Twitter accounts). The roles and responsibilities for internal communication were often unclear (e.g., among first respondents), and radiation protection experts were not trained for media or engaging in public communication [2, 24].

C. The communication gap between experts and the public should be narrowed

Risk communication aims to convey accurate information, such as the need to take adequate protection measures during emergencies and to make informed decisions about health and safety in the recovery phase. After the accident, the speed of information in the evacuation and shelter zones varied widely. The residents received no further explanation of the accident or evacuation directions or were unable to understand the messages received about the protective actions to be taken. Hence it is of utmost importance that the authorities and experts use clear language without jargon or excessive technical terms [25, 26]. Otherwise, necessary critical information is not understood, remembered or recalled.

Several studies have demonstrated that there was a huge communication gap between experts and the public about radiation risks, there was mutual misunderstanding [16, 27]. For instance, some research has confirmed that the use of a variety of units and technical jargon in public communication about Fukushima contributed to misunderstandings and confusion worldwide [26,27]. As a result, a number of mistakes and misrepresentations appeared in public communication. This included referring to non-existent ‘normal’ levels, as for example, comparing the radioactive levels for radionuclide content in seawater using a different ‘normal level’ without explaining what it meant [25].

D. Authorities to review and improve risk communication

As a result of the Fukushima accident, national and international authorities and non-governmental organizations worldwide, such as the International Atomic Energy Agency (IAEA), International Commission of Radiological Protection (ICRP) and International Radiation Protection Association (IRPA) reviewed risk communication plans and improved strategies for communication in nuclear and radiological emergency preparedness and response. Nuclear regulatory authorities have now acknowledged the need to include effective communication aspects in emergency preparedness exercises and training [2, 24]. Open-source, citizen-science-centred radiation mapping programmes were developed through collaborative innovation, and citizen science participated in radiation protection, for instance, in the case of ‘Safecast’ in Japan which assists residents in identifying radiological-contaminated hotspots in their vicinity [28].

E. Communication skills of key stakeholders, including medical physicists must be improved

Various key stakeholders provided inconsistent explanations regarding the risks associated with low-dose radiation, thus causing much confusion and mistrust of experts. To enable citizens to come to reasonable personal judgments, basic information about benefit and cost as well as risk needs to be conveyed to the public. This did not happen. The use of jargon did little to help explain the concept of radiation risk that the public did not understand. The magnitude of dose and terminology of risk are unfamiliar to the public (As for example, MBq, GBq, mSv, Sv, relative risk, risk coefficient, etc.) [29].

One critical component of effective communication is active listening and sympathizing with affected residents, and this was demonstrated by some during the post-accident phase [30].

The need to provide information quickly and accurately during a crisis makes social media an extremely valuable tool for regulatory authorities. It is increasingly taking on a crisis communication role.

Educational materials and training should be tested and prepared in advance, to be made easily available to the public and media on a general basis (e.g., Web sites of nuclear safety authorities), and communication channels should be readily implemented. Lessons from Fukushima should be used as a basis for developing communication materials, which should be monitored for effectiveness in future nuclear emergency exercises, preferably with a variety of different stakeholders. We should note that reaction time during a crisis is very short, and it is very difficult for authorities to respond quickly and accurately, so preparation is the key.

Fukushima lessons can also serve to inform experts' training in public speaking and justify investing in social media communication [17, 24] Effective risk/crisis communication is dependent upon the level of preparedness of the organizations involved. Not only does this include planning, training, and practising for public communication in emergency situation, it also depends on the strength of the overall communication program and on a culture of transparency within the organisations involved.

Of course, it is also unfortunate that much of the information on social media is likely to be incorrect or unverified - it can be classified as misinformation. Nevertheless, many users soon learned to figure out the reliable and trustworthy sources of information. Therefore, it is extremely important that the authorities responsible for communication learn to use social media effectively during normal day-to-day operation in order to develop those trusted connections and to perform well during an incident or emergency.

Along with the traditional media, the use of social media has become one of the most important communication channels for emergency conditions and it is no longer an option to be ignored, but to be embraced and enhanced.

VI. CONCLUSION

The Fukushima accident has taught the world community several important lessons, one of which is the need for effective risk and crisis communication during nuclear and radiological emergencies. We cannot overemphasize enough the need to invest in risk communication research and improvements in the organization of risk management before, during and after nuclear emergencies.

We need to empower our colleagues and our citizens to better understand information about radiological protection during nuclear and radiological emergencies to the best of our abilities. This means a more holistic approach to risk communication that embraces the challenges presented by social media so that decisions are informed not only by the best science, but also by human values and are based on our very best understanding of citizens' perceived concerns, their ability to engage and take action, and the likely nature of exposures both in the short and long-term. This means developing trusted communication experts and channels, training, and investment in the future.

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