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LESSONS FROM CHERNOBYL

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Abstract : The Chernobyl disaster on April 26th, 1986, led to the emission of radioactive substances such as iodine-131 and radioactive cesium. As the Soviet Union did not control food distribution and intake, residents were exposed to high levels of internal radiation, leading to the internal radiation exposure of the thyroid gland by iodine 131. As a result, the number of people who had thyroid cancer increased drastically among those who had been under 15 years old at the time of the accident. The age predilection is about to move to 25 or older. However, there has been no scientific evidence of impacts for solid tumor other than thyroid cancer, leukemia, benign diseases, or inheritance including unborn babies. On the other hand, the accident was thought to have caused social unrest and mental damage which had far more impact than that caused by radiation exposure.

In this paper, we would like to summarize the impacts on the health of the people in Chernobyl compared to those caused by the accident at the Fukushima Daiichi Nuclear Power Plant.

Key words : Chernobyl Nuclear Power Plant, internal exposure, thyroid cancer, iodine131

INTRODUCTION

The accident took place on April 26 in 1986 at the Chernobyl Nuclear Power Plant located 130 km north from Kiev, the capital of Ukraine. The reactor 4 exploded and caught fire. This was to be the worst radiation disaster in history. At the time no specific information was publicized due to the cold war. Lack of information and fear of invisible radiation caused panic around the world. Substantial international support began only after 1990 when the Soviet Union stepped towards disorganization along with perestroika (economy reform) and glasnost (publicity).

The scientific knowledge we learned from health impacts on inhabitants around the Chernobyl Nuclear Power Plant and workers in the plant provides us with critical information when considering countermeasures for health impacts on the people and workers involved in the accident at the Fukushima Daiichi Nuclear Power Plant.

In this study, we would like to briefly explain health impacts caused by the accident in Chernobyl and study similarities and differences in the accident in the Fukushima Daiichi Nuclear Power Plant. We would like to consider the lessons which must be learnt from the accident in Chernobyl.

EMITTED RADIOACTIVE NUCLIDES AND COUNTERMEASURES FOR INTERNAL EXPOSURE

For the Fukushima Daiichi Nuclear Power plant, we have to wait until inspections reveal details of radioactive nuclides emitted in the accident. In Chernobyl, one of the dominantly emitted radioactive nuclides was assumed to be harmless xenon 131. Some of the other nuclides have short half-life such as that of iodine-131 of which is eight days and tellurium-132, which turns into iodine-132 within a very short period of time. Radioactive cesium which has a relatively long half-life was also thought to be included[1)] (Table 1).

Since iodine 131 and radioactive cesium were the dominantly emitted substances in Chernobyl, it is thought that this is the similar case in Fukushima. However, whereas only trace quantities of radioactive strontium and plutonium, which

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Table 1. Radionuclide emitted in the accident at the Chernobyl Nuclear Power Plant (Modified the data in Reference 1)

Radionuclide	Half life	Radiation	Emission amount (PBq)*
Neptunium 239	58 hrs	β-rays, γ-rays	95
molybdenum 99	67 hrs	β-rays, γ-rays	>168
tellurium 132	78 hrs	β-rays, γ-rays	1,150
xenon 133	5 days	β-rays, γ-rays	6,500
iodine 131	8 days	β-rays, γ-rays	1,760
barium 140	13 days	β-rays, γ-rays	240
cerium 141	33 days	β-rays, γ-rays	196
ruthenium 103	40 days	β-rays, γ-rays	>168
strontium 89	52 days	β-rays	
zirconium 95	65 days	β-rays, γ-rays	196
curium 242	163 days	α-rays	
cerium 144	285 days	β-rays, γ-rays	116
ruthenium 106	1 year	β-rays, γ-rays	>73
cesium 134	2 years	β-rays	
plutonium 241	13 years	β-rays	
strontium 90	28 years	β-rays	
cesium 137	30 years	β-rays, γ-rays	85
plutonium 238	86 years	α-rays	
plutonium 240	6,850 years	α-rays, γ-rays	0.042
plutonium 239	24,400 years	α-rays, γ-rays	0.030

*PBq is equivalent to 10^{15} becquerel.

led to safety concerns regarding MOX fuel, were found outside the Fukushima nuclear plants, a significant amount of those radioactive materials was released in Chernobyl. The emitted amount (approx. 520 TBq) in Chernobyl was approximately seven times more than that in Fukushima as of today even though these two accidents are in the level 7 of INES.

Among the substances mentioned, radioiodine, especially iodine-131 is thought to be the one which most affected people's health around Chernobyl. Iodine 131 accumulated in thyroid glands particularly through food intake and resulted in internal exposure. Infants in Chernobyl also suffered internal exposure due to the intake of milk containing high density of iodine-131. Because the Soviet Union then did not control either food distribution or intake, people were unaware of ingesting contaminated milk, vegetables, water etc. This was considered to be the main reason of internal exposure[2)].

The most dominant nuclide emitted during the accident at the Fukushima Nuclear Power Plant was iodine-131. Another major component of the emissions was radioactive cesium (cesium-134 and cesium-137), which has long half-life. Iodine-131 was detected in various produce including food, drink, and beef cattle immediately after the accident. Panic was caused not only through the reality of the accident but also by the widespread of groundless rumors through media and the Internet. As a countermeasure, the Japanese government specified values of radioiodine and cesium contained in food and drink as the provisional standard. They regulated shipping produce with higher content of radioiodine and cesium in order to prevent people from ingesting contaminated foods and drinks. We must remember the tough decision taken by the people working in the primary sector of industry in Fukushima Prefecture. Without this sacrifice, the chance of internal exposure to contaminated food could not be decreased. This countermeasure was taken based on the experiences of internal exposure in Chernobyl described above. Careful health evaluation is still required from now on ; however, we assume the impact on people's health that we will see in the future will be far different from those in Chernobyl even though the accident was categorized in the same level seven.

IMPACTS ON HEALTH OF PEOPLE IN CHERNOBYL

In 2006, 20 years after the Chernobyl accident, the World Health Organization (WHO) evaluated impacts on health of people in Chernobyl dealing with International Atomic Energy Agency (IAEA). The materials the group of experts examined were

mainly internationally-reviewed manuscripts. They also used publications in countries around Chernobyl (The Republic of Belarus, Russian Federation and Ukraine),. Those experts primarily evaluated two health-related issues[3]. One of the issues was health impacts which were directly related to radiation exposure, and the other was diseases that were not thought to be directly related to radiation exposure, however, the relation with the accident could be in doubt. After the evaluation, they submitted a report to the relevant governments.

The results showed the drastic increase of thyroid-gland cancer among children who had been younger than 15 years at the time of the accident. According to the report, nearly 5,000 operations of thyroid-gland cancer have been implemented for children in this age group in Russian regions around Chernobyl, Ukraine, and The Republic of Belarus by 2002 (the number of operations increased to 6,000 by 2006). The age predilection is about to move to 25 or older to middle aged. As described above, the increase in thyroid cancer in infants attributed to excess internal exposure to thyroid gland via ingestion of radioiodine immediately after the accident. It is possible to assume that the chronic iodine deficiency at that time further increased the number of sufferers[4]. Additionally, the occurrence frequency of thyroid cancer in infants and the dose of internal exposure to the thyroid gland had positive correlation[4]. It was very fortunate that 99% of patients had good prognosis and survived after the operations. Radioiodine therapy after the total extirpation of the thyroid gland against lung metastasis showed significant effects and metastasis treatment had a high cure rate[6]. However, the problems of long prognosis, recurrence, and other complications still remain and further tracing and appropriate treatment are essential.

On the other hand, no increase in leukemia has been seen among citizens including infants and adults though that was primarily concerned from the experiences of atomic-bomb survivors in Hiroshima and Nagasaki. This is probably because people in Hiroshima and Nagasaki suffered mainly from external exposure while it was internal exposure to radioiodine immediately after the accident in Chernobyl. Despite the fact that enormous efforts were expended to analyze genetic abnormality of radiation-induced thyroid cancer, the analyses have not been able to distinguish between induction by radiation and spontaneity at the molecular level[7].

Apart from thyroid cancer, increase in solid cancers, benign diseases, genetic effects, or effects on unborn babies among residents living around the Chernobyl Nuclear Power Plant has not been scientifically demonstrated. However, social unrest and mental damage caused by the accident is thought to be more serious than the physical damage due to direct radiation exposure. Especially those who were forced to evacuate immediately after the accident and those who were forced to move have issues related to social and economic unstableness. In addition, problems of current health fears and strong anxiety over health impacts on future generations have come up. A paucity of scientific research is available on psychological effects and many psychological effects are not determined as health disorder. The WHO report mentioned above states that what the residents are suffering from is at a potential subclinical level which is not clinically identified as abnormal. The report also requires future resolution.

When we look at the current situation in Fukushima, we should see the radiophobia brought by mass media. Rumors have widely spread among the residents due to lack of accurate information. The same fear has been found in other areas including Tokyo metropolitan area even though they are far from Fukushima. This panic like phenomena can be attributed to the internet societies which magnified irresponsible groundless information or rumors. To provide accurate information and thorough mental care is critically required in order not to let people in Fukushima, especially mothers and their children, have the similar fear of potential health problems that people had in Chernobyl. Farmers and workers engaged in the primary industries are under another threat. Primary industries have been thriving in Fukushima, however, their products are vulnerable to harmful rumors or misinformation. The people are anticipating financial damages and some have even committed suicide because of the fear of the future. Immediate action must be taken to prevent such tragedy. A correct information source and the proper passing of information by the media are required in health risk communication with regards to radiation. However, preceding those, the health risk communication requires individual awareness of risk to understand and judge risk. To develop such risk awareness, mutual trust must be built between the information source, media, and recipients of information.

IMPACT ON WORKERS' HEALTH IN CHERNOBYL

Radioactive fallout caused internal exposure among residents in Chernobyl. However, workers who were in the nuclear plant when the accident happened and those who did the recovery operation after the accident had a potential risk of high-level external exposure. The same is true in the Fukushima Daiichi Nuclear Plant. In Chernobyl, 134 people were diagnosed with acute radiation syndrome (ARS). ARS killed 28 of them immediately and 19 of them died due to various reasons between 1987 and 2004. According to the follow-up survey for the workers who registered in the emergency work in the Russian Federation, 116 people died because of solid cancers and 110 people died due to cardiovascular diseases. However, causality with radiation exposure is unknown. The survey also identified that 24 death cases were attributed to acute leukemia, however, the cause was difficult to prove since the average radiation was 115 mSv[5]. Another follow-up survey conducted for the decontamination workers in the Ukraine reported that 18 workers died due to acute leukemia and their radiation exposure was between 120 and 500 mSv[6]. The impacts on cardiovascular and immune systems of the decontamination workers have been argued in Chernobyl, however, until today, nothing explicit has suggested the relation between radiation exposure and the impacts. Analysis of other confounders and long-term accurate investigation and examination are essential.

Currently, the uppermost radiation exposure is specified as 250 mSv for the workers in the Fukushima Daiichi Nuclear Power Plant. Although this value is recommended by International Commission on Radiological Protection (ICRP), long-term follow-up is needed for the workers as well as monitoring their potential cancer risk. Establishing a system to protect the well-being of citizens in Fukushima Prefecture and the decontamination workers is urgently required.

CONCLUSION

Despite the fact that almost half year has passed since the disaster, we are still recovering from the nuclear accident. Those who were forced to evacuate have been suffering from unbearable agony. It is crucially important to learn lessons from the accident at the Chernobyl Nuclear Power Plant, which happened 25 years ago, in order to revive Fukushima and to provide the citizens with a sense of security.

In this paper, we wrote evidences which were approved by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), IAEA, WHO, and other autholized organizations because we believe that scientists are required to be sensitive to the accuracy of information when they send it to the society. Unfortunately, some professionals have presented health impacts in Chernobyl through mass media when that fact was not internationally agreed with and we think that is beneath one's dignity.

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