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Report

Radiation Safety and Public Health for Radiological Professionals: Meeting Report on The 5th Educational Symposium on Radiation and Health (ESRAH) by Young Scientists in 2018

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The nuclear power plant accident on March 11 2011 in Fukushima prefecture in Japan greatly increased the interest in the effect of radioactivity and low-dose exposures on the environment and human beings. Our symposium "Educational Symposium on RADIATION AND HEALTH (ESRAH) by young scientists" has shifted more to providing information on radiation protection and inviting international researchers rather than basic radiation research. Since 2014, this symposium has provided an international forum for information exchange and discussions on a wide range of subjects related to radiation effects on the environment and the human body, radiation protection, radiation detection and emergency medical care. The 5th Symposium was held in Hokkaido University in 2018 under the theme of "Radiation Safety and Public Health for Radiological Professionals". In this article, we summarize and review of the ESRAH2018.

Key words: ESRAH, radiation safety, meeting report

1. Introduction

Japan has experienced many nuclear and radiological events (Table. 1). One of the worst in history is the detonation of atomic bombs over *Hiroshima* and *Nagasaki* cities in 1946. On August 6, 1945, "black rain" drops continued to fall on the heads of *Hiroshima*-atomic-bombing survivors[1)]. Three days later, the explosion of the second atomic bomb devastated *Nagasaki* city. Decades after atomic bombs dropped, many studies on the long-term health effects have been conducted[2-4)]. Although Japanese people have experienced such tragedy from the harmful effects of radiation exposure, technological advances have seen industries use more radioisotopes to the benefit of the Japanese population. By 2010, Japan developed 19 nuclear power plants with 54 reactors supplying 30% of the country's total electric power[5)].

Since 2008, an exchange meeting for scientific study between Hokkaido University and Hirosaki University in Japan has taken place annually as an opportunity to

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Table 1. Major nuclear and radiological events in Japan

Year	Incident description	Location	Notes
1945	Nuclear bombing	Hiroshima city	About 70,000 died
	Nuclear bombing	Nagasaki city	About 39,000 died
1981	Overexposure (INES Level 2)	Tsuruga	100 workers exposed
1999	Uranium in solution exceeded (INES Level 4)	Ibaraki	2 workers died More than 100 received lesser dose
2011	Meltdowns (INES Level 7)		

Note: INES is an abbreviation of the International Nuclear Event Scale which classifies the safety significance of nuclear and radiological events to the public ranging from a Level 1 anomaly to a Level 7 major accident[17]. Any event without safety significance is classified as Level 0.

discuss radiation effects on the human body. However, on March 11, 2011, the *Fukushima Daiichi* nuclear disaster occurred after the Great East Japan Earthquake and tsunami, and it brought a big change in people's lives and even in our exchange meeting[6, 7]. This disaster gave rise to a greater interest in the effect of radioactivity and low-dose exposures on the environment and human beings. As a result of this, to promote a better understanding of radiation and human health, the meeting was upgraded in 2014 to an international conference renamed as "Educational Symposium on RADIATION AND HEALTH (ESRAH) by young scientists". Since then, this symposium has provided an international forum for information exchange and discussions on a wide range of subjects related to radiation effects on the environment and the human body, radiation protection, radiation detection, emergency medical care, and so on[8-11].

The 5th Symposium was held in Hokkaido University in 2018 under the theme of "Radiation Safety and Public Health for Radiological Professionals". In this symposium, three honorable researchers gave educational lectures and five outstanding researchers made their presentations as invited speakers. A poster session was organized for graduate students and young researchers. In this article, we summarize and review ESRAH2018.

2. Educational Lectures and Invited Talks

2.1. Overview of Educational Lectures and Invited Talks

Although seven years have been passed since the *Fukushima Daiichi* Nuclear Power Plant accident, there is still strong public interest on radiation effects and protection while environmental radiation levels continue to decrease. Researchers have a responsibility to provide evidence, suggest the relevant techniques and measures, and share current status and most up to date knowledge of radiation effects and protection. Therefore, the eight distinguished speakers mainly focused on public health aspects of environmental and occupational radiation and their presentations were classified into three themes.

1. Biological Health Impacts Safety management
2. Radiation Dose Measures and Dosimetry
3. Public Health and Roles of the Radiation Expert

2.2. Radiation-Induced Bystander Effects

Dr. Fiona M. Lyng from Dublin Institute of Technology Centre for Radiation and Environmental Science gave us a lecture on "Radiation Induced Bystander Effects" observed in non-targeted cells. Radiation induced Bystander Effects are responses in unirradiated cells to signals produced by irradiated cells, which is dominant at low dose and not necessarily proportional to dose. The field started from research on "abscopal effects" in the 1960's and it developed to open up a new paradigm of radiation biology. The bystander signals can be transferred in various ways: by gap junctional intercellular communication, by the production of soluble factor in media (Irradiated Cell Conditioned Media, ICCM) and by exosomes. Dr. Lyng showed us a lot of valuable data from experiments. Dr. Lyng found out some signaling processes via calcium (known as a ubiquitous intercellular signal), activated Mitogen-activated Protein Kinase (MAPK) proteins, membrane signaling, Reactive Oxygen Species (ROS) and Nitric Oxide (NO) signaling in bystander cells. Each phenomenon can increase apoptotic cells, which is observed as the loss of mitochondrial membrane potential. These processes occur quickly, within minutes after the irradiation, starting from ROS signaling in the irradiated cells, followed by membrane signaling and calcium influx in the recipient cells. It was shown that exosomes are also involved in the bystander effect. Further, she carried out experiments on ICCM in prostate cells to confirm "out-of-field effects", and is now working on new research on the *in vivo* effects of partial body irradiation.

2.3. Dose Estimates to Medical Practitioners Following a Radiological Incident

Dr. J. E. Davis of the Radiation Emergency Assistance Center/Training Site (Oak Ridge, Tennessee, USA) gave a lecture on dose estimates to medical staff following a radiological incident. In the lecture, three patterns of contaminated injuries; (a) A uniformly contaminated patient, (b) A contaminated patient after clothing was removed, (c) An embedded radiological source, were assumed, and the estimated doses to the medical staff treating injuries were reported. Next, estimated results of the dose to medical staff who responded to historic radiation incidents were introduced.

In the case of a uniformly contaminated patient, the dose to medical staff at the distance of about 20 cm from the patient was 4.47×10^{-10} mSv h^{-1} Bq^{-1} for ^{60}Co and 1.60×10^{-10} mSv h^{-1} Bq^{-1} for ^{137}Cs. In addition, the time to reach occupational dose of 250 mSv was 7.9 h in the case of ^{60}Co and 23.9 h in the case of ^{137}Cs (assuming there is uniform contamination of 37 GBq m^{-2} in each simulation). Dr. Davis noted that the dose to the medical staff is lower than the above result when the patients were unevenly contaminated. In the next session, it was reported that there were 471 accidents involving significant overexposure to individuals from 1944 to 2018. Among them, estimated dose to medical staff responding to the Stationary Low Power Reactor No. 1 (SL-1) accident in 1961[12] and Indiana incident (loss of an ^{192}Ir source) in 1992[13] were provided as examples.

At the end of the lecture, it was stated that, based on past cases, medical staff would not receive a lethal exposure from contaminated patients, and it is important that medical staff attend to life-threatening medical conditions before considering decontamination efforts. Dr. Davis also emphasized that these results could be used for risk education for medical staff who are first responders at radiation accidents.

2.4. Study of Public Dose Due to Natural Radioactivity in High Background Area at Mamuju Regency, West Sulawesi, Indonesia

Dr. Eko Pudjadi from the Centre for Technology of Radiation Safety and Metrology (BATAN), gave a lecture on the radiation environmental dose monitoring of Mamuju Regency, West Sulawesi, Indonesia. Due to its mountainous topography and presence of rare earth metals such as uranium and thorium, the area experiences high natural background radiation dose when compared to other places in Indonesia and the world[14]. The minimum annual effective dose in Botteng (2.93-10.89 mSv) and Takandeang (4.14-15.87 mSv) residents in Mamuju was higher than the world average of 2.4 mSv. The effective dose was calculated by summing up external and internal dose measured. There were 63 houses in Botteng village and 85 houses in Takandeang village that participated in this exercise. External dose was monitored with Exploranium® gamma spectrometer GR-135 Plus and Optically Stimulated Luminescence dosimeters. Internal dose was estimated from raw water sources, food and inhaled airborne particles. Upper respiratory tract diseases were among the most common disorders in the Mamuju community, but the direct impact of internal radiation has not been examined and will be explored in the future.

2.5. Radiation Safety and Health for the Public and Radiological Professionals

Dr. Margaret Chege of Kenyatta University, Kenya has a lot of experience on mathematical modeling of radionuclide transport and transfer, measurement of radon and thoron in traditional mud-walled/bare-floored (earthen) dwellings, naturally occurring radionuclides in soil, building materials, crops and well water, and heavy metals in well water. Dr. Chege gave a lecture on "Radiation safety and health for the public and radiological professionals". As we know, radiation is broadly classified as non-ionizing and ionizing. The non-ionizing radiation has insufficient energy to dislodge an electron from an atom and is located at the lower end of the electromagnetic spectrum. In contrast, ionizing radiation is electromagnetic or particle energy capable of removing an electron from an atom, which is considered more dangerous than non-ionizing radiation owing to its higher energy. Dr. Chege gave an overview of natural and artificial sources of radiation, their risk to human health and introduced the safety measures against radiation exposures. Finally, she pointed out that it is essential to fully understand radiation exposure for the purposes of the application of safety measures, continued research on radiation sources, health impacts, and resource development in radiation protection.

2.6. Re-evaluation of Pediatric 18F-FDG Dosimetry

Dr. Kitiwat Khamwan from the Chulalongkorn University (Thailand) introduced his study outcome entitled "Re-evaluation of Pediatric 18F-FDG Dosimetry". The study was conducted by using two types of computational phantoms. Currently, almost every pediatric absorbed dose is estimated from adult pharmacokinetic data with radionuclide S-values considering the anatomical differences between adults and children based on the older Cristy-Eckerman (C-E) stylized phantoms. In his work, absorbed dose of 18F-FDG was calculated using the S values with hybrid phantoms generated by the University of Florida/National Cancer Institute (UF/NCI) and the C-E stylized phantoms for a newborn, 1-year-old and 5-year-old. The results show that absorbed dose coefficient estimates in UF/NCI hybrid phantoms and the C-E stylized phantoms are different from each other for the lungs, ovaries, red bone marrow, and urinary bladder wall. The effective doses coefficient computed with the UF/NCI hybrid phantoms with the S values are slightly different from those with the C-E stylized phantoms for all three ages. The absorbed dose coefficients of the brain and urinary bladder wall are highest in both the UF/NCI and C-E phantoms. The anatomical features of the phantoms bring about the difference in the internal organ dosimetry calculations for pediatric nuclear medicine studies.

2.7. Development and Specialization in Radiological Nursing: Nursing Diagnosis and Collaboration with other Academic Fields

Specialization and establishing a more effective education on radiological nursing were introduced by Dr. Toshiko Tomisawa from Hirosaki University, Japan. Dr. Tomisawa talked about ensuring specialization in certified nurse specialist (CNS) for radiological nursing (RN). The subjects of radiological nursing are people who have been exposed to radiation, people who worry about exposure to radiation, and it will cover a wide range of concepts including all developmental stages and environments for everyone from unborn children to elderly people, communities to medical facilities, and patients to health professionals. Dr. Tomisawa showed the academic field of RN overlaps with cancer nursing on radiotherapy and pain management with cancer patients. It also partially covers disaster nursing or emergency nursing and overlaps with community health nursing after a nuclear accident. In Japan, to get a license to be a CNS for RN, students need to get 38 units for graduating from the course, take general subjects, specialized subjects, conduct research and gain experience in general nursing practice in a hospital. However, there are some problems educating nursing students in the area of radiological nursing. They express negative responses to radiation such as it is scary, difficult to understand, it is not required. Most education in Japanese Universities are conducted through one-sided lectures by the lecturer. The learning pyramid from the National Training Laboratories showed that only 5% of the knowledge learned during a lecture is retained shortly after the lecture[15]. On the other hand, learning through discussions retained 50%, actual practice by the students retained 75%, and teaching someone else retained 90% of the knowledge. This is why using active learning has a more potent effect on education than passive learning. Dr. Tomisawa concluded that, to ensure specialization in radiological nursing, we have to teach students by more effective methods such as an active learning.

2.8. Radioisotopes as Materials Enhancing Health and Beauty?

Dr. Tibor Kovács of the University of Pannonia, Hungary, introduced the current study entitled "Radioisotopes as materials enhancing health and beauty?". The study surveyed the health damage caused by ionizing radiation from commercial products including radionuclides. The products were developed and sold in the early 1900's when there was incomplete knowledge about radioactivity. Examples included, radioactive toothpaste that can kill bacteria, beauty creams containing radium, shoe-fitting fluoroscopes to ascertain how well the shoe fits the foot, etc. At that time, naturally occurring radionuclides were believed to improve health and to lengthen lifespan. However, they caused the cancer or serious skin inflammation, thus they were found to be harmful to our health. The incomplete knowledge about radioactivity causes unnecessary radiation exposure, significant collective dose and preventable cancer cases. These problems could be minimized by the rules and regulations set down by the authorities.

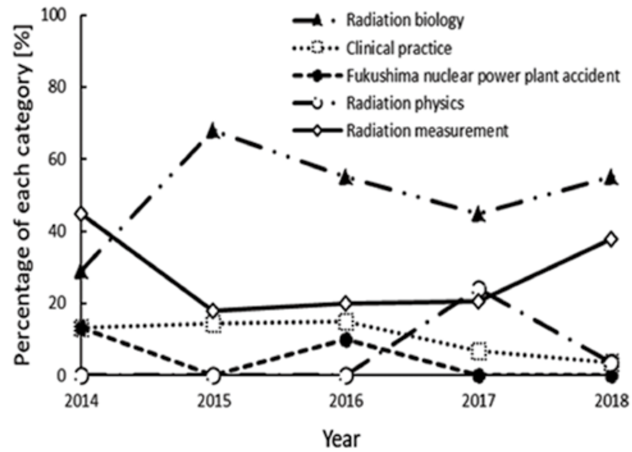

Fig. 1. Percentage of each category in the poster session from 2014 to 2018

2.9. Clinical Trial Dosimetry Results of 18F-FDG Application with a Positron Image Guided Cancer Surgery Medical Device

Dr. Domokos Mathe of Semmelweis University, Hungary, talked about the clinical trial dosimetry results of 2-Deoxy-2-[^{18}F] fluoro-D-glucose (FDG) applications with a positron image guided cancer surgery medical device. In clinical oncology, Positron Emission Tomography (PET) is an extremely valuable tool for tumor diagnosis, staging, restaging and for treatment response follow-up. In addition, FDG is the most commonly used tracer, which is able to assess the typically enhanced glucose transport and metabolism in malignant tumors, and is superior in detecting residual tumor growth, tumor recurrence and distant metastasis compared to morphologic imaging procedures[16]. Although application of FDG tumor imaging results in a reduction in operating procedures and time, absorbed radiation doses of medical personnel might be the limiting factor for such surgeries. This study, therefore, reports the absorbed doses of medical personnel in radioactive open abdominal surgeries, such as gastric or pancreatic cancer, and the limiting factors in

Table 2. List of poster presentation by young scientists

No.	Title of poster presentation	First author	Affiliation
1	The evaluation of clinical laboratory indicators that affect the cell-cycle progression index	K. Yanagidate	Hirosaki University, Japan
2	Effect of ultraviolet on ciliary zonules	Y. Shiroto	Hirosaki University, Japan
3	Modeling for colony formation of human lens epithelial cells following ionizing radiation exposure	J. Oikawa	Hokkaido University, Japan
4	Response characteristics of ultraviolet rays for CR-39	T. Suzuki	Hirosaki University, Japan
5	CORRELATION BETWEEN RADON CONSENTRATION AND SEASON INSIDE TUNNEL IN WEST KALIMANTAN, INDONESIA	M. A. Saputra	Center for Nuclear Minerals Technology, Indonesia
6	Regulation of cancer cell radiosensitivity by hyaluronan synthesis inhibitor results in radioresistance	K. Hasegawa	Hirosaki University, Japan
7	Cell surviving fraction model for multi-fractionated radiotherapy considering cancer stem cells (CSCs)	S. Naijo	Hokkaido University, Japan
8	The IκB kinase β inhibitor, IMD-0354, attenuated the radiation-induced individual death in mice exposed to ionizing radiation	K. Waga	Hirosaki University, Japan
9	One-phase LSC method application in ^{222}Rn(^{226}Ra) determination in waters	I. Stojković	Novi Sad University, Serbia
10	Direct measurements of attached and unattached radon/thoron progeny using LR-115 detector based progeny sensors for dose assessment	M. Prasad	Indian Institute of Technology Roorkee, India
11	A performance test of the filters used for ambient radioactive aerosols	Y. Tamakuma	Hirosaki University, Japan
12	Short-term follow-up of intestinal flora in radiation-exposed mice	T. Tsujiguchi	Hirosaki University, Japan
13	The Risk Assessment of Indoor Radon and Thoron Based on a Stochastic Method	H. Jun	Hirosaki University, Japan
14	Regulation of radiosensitivity by 4-methylumbelliferone via suppression of interleukin-1 in fibrosarcoma cells	R. Saga	Hirosaki University, Japan
15	The effect of chronic inflammation on chromosomal aberrations and radio-sensitive organs in T2DM mouse model	G. V. Swee Ting	Hirosaki University, Japan
16	Cytogenetic analysis of raccoon (*Procyon lotor*) in Namie town, Fukushima	Y. Fujishima	Hirosaki University, Japan
17	Estimation of biological effects on normal and tumor cells in IMRT	T. Miyao	Hokkaido University, Japan
18	Comparison of the spectrum estimate performance of the different unfolding method	K. Baba	Hokkaido University, Japan
19	A gene expression analysis of the Keap1-Nrf2 biological defense system in mice exposed to ionizing radiation	T. Nishida	Hirosaki University, Japan
20	Improvement Calibration of Indonesian Radon Detector with Spot-injection method using Hirosaki laboratory Radon Chamber	E. D. Nugraha	Hirosaki University, Japan
21	Radiation exposure changes metabolites of gut bacteria	Y. Sakamoto	Hirosaki University, Japan
22	Dose response and model analysis of radioresistant cancer stem cells	R. Takahashi	Hirosaki University, Japan
23	Investigation of dose distribution in 320-row multi detector CT (MDCT)	M. Terashima	Hokkaido University, Japan
24	The effects of X-ray on alveolar elastic fibers	Y. Kitayama	Hirosaki University, Japan
25	Passive radon detectors in the field intercomparisons: experiences and perspectives	F. Leonardi	National Institute for Insurance against Accidents at Work, Italy
26	Cotreatment with retinoic acid-inducible gene-I-like receptor agonist and ionizing radiation effectively induces apoptosis through caspase-8 mediated apoptotic pathway in human non-small cell lung cancer A549	Y. Sato	Hirosaki University, Japan
27	Geogenic radon potential and ambient gamma dose equivalent rate investigation in a granitic area in Hungary	S. B. Torres	Eötvös University, Hungary
28	Effects of X-ray energy spectrum and electron track structure on DNA damage	Y. Yachi	Hokkaido University, Japan
29	Investigation of the fingerprint of climate changes in Tinovul Apa Roșie peat bog (central Romania) by using ^{210}Pb dating method	T. Piroska	Babes-Bolyai Univrisity, Romania

a first clinical study. They conducted a clinical trial in open abdominal surgeries where patients were injected FDG intravenously with an average of 109 (±26 of standard deviation) MBq radioactivity before the operation. For each surgery each staff member was equipped with a whole body dosimeter for $H_P(10)$ and optically stimulated luminescence dosimeter placed on the forehead and right hand to estimate $H_P(3)$ eye lens dose and $H_P(0.07)$ hand skin entrance dose. They presented the maximum absorbed dose values in each surgery staff member (the data is not presented here as it is not yet published). These results suggested lead surgeons, in most cases, were exposed to the highest doses compared to other staff. Based on an annual dose limit for occupational workers (20 mSv effective dose), $H_P(10)$ is the limiting factor for lead surgeons which corresponds to an average of 56 surgeries per year. If mean measured values are used, a maximum of 208 surgeries per year are feasible. By limiting the injected activity to below 125 MBq per patient, the number of surgeries of pancreatic cancer has no limitation. For higher incidence and more frequent cancer surgeries like gastric cancer, they proposed a yearly limit per lead surgeon for this type of image-guide procedures.

3. Poster Presentations by Young Scientists

There were 29 entries in total for poster presentations by young researchers, consisting of sixteen posters on radiation biology, one on medical treatment, one on radiation physics, and eleven on radiation measurement. The percentages of the research subjects from 2014 are traced in Figure 1. At the beginning of the session, every presenter gave a short talk on his/her poster for one minute in sequence. After the short talk session, the presenters enthusiastically explained and discussed the poster contents with the audience in front of their posters, for 60 minutes. The titles of all presentations are summarized in Table. 2.

At the closing ceremony of the symposium, two of the poster presenters were awarded for excellence, which was judged by a committee including the educational lecturers, the invited speakers and the teaching staff. This poster session provided a valuable and meaningful opportunity for the young scientists and students to accept helpful advice and ideas on their research.

4. Summary and Future Prospects

The 5th Symposium was held in Hokkaido University in 2018. This meeting brought young researchers closer to understanding biological health impacts of low- and high-dose radiation, the methods of radiation measurement, and the safety practices for radiation workers and the public. Through the meeting, many valuable research results and new knowledge was shared by honorable guest speakers and young researchers, however, many aspects of this area still remain unknown and are unclear. It also brought a new insight that transdisciplinary research is increasingly important to provide sufficient knowledge and information to the public.

This meeting will be takes place annually. We expect researchers in different fields, nations, and countries share their knowledge and information for the better use of radiation sources. Finally, we express our sincere gratitude to those who accepted our offer to give the educational lectures and invited talks.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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