Nagasaki-Chiba-Mainz-Bremen
Radiation Research Initiative

International Symposium on Radiation Health Effects and Protection

Medical Radiation Exposure and Radiation Emergencies Nagasaki 2015

2nd Mar – 3rd Mar 2015
Pompe Auditorium, Nagasaki University, Japan

Radiation Health Effects due to Nuclear Disasters Lessons from Chernobyl and Fukushima

Day 1: Monday, 2 March 2015

Introduction and welcome Chairman: Prof. Noboru Takamura

13:00 **Opening remarks:**
Prof. Yasushi Miyazaki (Vice-Director, Atomic Bomb Disease Institute, Nagasaki University)

13:10 **Keynote:** ***Environmental Radiation and Health – What are the Key Issues?***
Prof. Hajo Zeeb (Leibniz Institute for Prevention Research and Epidemiology - BIPS)

13:40 **Special Lecture:** ***Lessons from Fukushima: The Viewpoint of a Frontline Physician***
Prof. Arifumi Hasegawa (Fukushima Medical University)

14:20 ***The Current Situation of the Internal Radiation Exposure Screening Program in Hama-dori and the Future Tasks***
Dr. Masaharu Tsubokura (Tokyo University)

14:50 ***Post-Chernobyl Papillary Thyroid Carcinoma in Children and Adolescents of Belarus***
Dr. Svetlana Mankovskaya **(**Institute of Physiology, National Academy of Sciences of Belarus)

15:20-50 **Tea break**

Chairman: Prof. Naoki Matsuda

15:50 ***Relevance and Topicality of Studies of Radiation-Induced and Autoimmune Diseases in the Republic of Belarus during the Late Post-Chernobyl Period***
Prof. Vasili Roudenok (Belarusian State Medical University)

16:30 ***Major Health Parameters among Children of Gomel Region after the Chernobyl Catastrophe***
Prof. Alexandr Kozlovsky (Gomel State Medical University)

Young Researchers Session (each 20 min)

Chairman: Dr. Keiichi Akahane

17:10 ***Evaluation of current internal Cs-137 exposure in residents living around the Chernobyl Nuclear Power Plant***
Dr. Yuko Kimura (Atomic Bomb Disease Institute, Nagasaki University)

17:30 ***Evaluation of the risk perception about health effects of radiation among residents of Fukushima***
Dr. Makiko Orita (Atomic Bomb Disease Institute, Nagasaki University)

17:50 ***Potassium Iodide blockage of the thyroid gland – a systematic review and future work***
Dr. Steffen Dreger, Hajo Zeeb (Leibniz Institute for Prevention Research and Epidemiology)

Closing Remarks for Day 1
Prof. Noboru Takamura (Atomic Bomb Disease Institute, Nagasaki University)

Research on Medical Radiation Exposure from Diagnostic and Therapeutic Procedures

Day 2: Tuesday, 3 March 2015

Introduction and welcome **Chairman: Prof. Takashi Kudo**

09:00 **Opening remarks and Keynote:**
Risk of Medical Radiation; Diagnosis, Intervention and Nuclear Medicine.
Prof. Takashi Kudo (Atomic Bomb Disease Institute, Nagasaki University)

09:15 ***Cardiovascular Disease after Exposure to Ionizing Radiation***
Dr. Daniel Wollschläger (Institute of Medical Biostatistics, Epidemiology, and Informatics, Mainz University Medical Center)

09:45 ***Methodological limitations of studies on cancer risks in children exposed to computed topographies and there possible counter-actions.***
Dr. Lucian Krille (International Agency for Research on Cancer, Lyon, France)
Dr. Steffen Dreger (Leibniz Institute for Prevention Research and Epidemiology)

10:15 ***Dose Estimations of Medical Exposures in Japan***
Dr. Keiichi Akahane (National Institute for Radiological Science, NIRS)

10:45-11:00 **Tea break**

Chairman: Prof. Hajo Zeeb

11.00 **Special Lecture:** ***Pediatric CT examination in Japan***
Dr. Osamu Miyazaki (National Center for Child Health and Development, NCCHD)

Young Researchers Session (each 20 min)

Chairman: Dr. Daniel Wollschläger

11:40 ***Changes in Radiological Imaging Frequencies in Children Before and After the Accident at the Fukushima Daiichi Nuclear Power Plant in Fukushima Prefecture***
Dr. Kouji Yoshida (Fukushima Medical University)

12.00 ***Biological Consequence of Radiation Exposure at CT***
Dr. Wataru Fukumoto (Hiroshima University)

12:20 ***Thyroid cancer as second cancer after Childhood radiation therapy***
Dr. Peter Scholz-Kreisel (Institute of Medical Biostatistics, Epidemiology, and Informatics, Mainz University Medical Center)

12:40-13:30 **Lunch**

13.30 **Round Table Discussion for Future Study Projects.**

14:30 **Closing Remarks for Day 2 and the Symposium**
Prof. Takashi Kudo (Atomic Bomb Disease Institute, Nagasaki University)

Environmental radiation and health – what are the key issues?

Hajo Zeeb
Leibniz Institute for Prevention Research and Epidemiology – BIPS, Bremen, Germany

The use of ionizing radiation has been a hallmark of modern life over more than a century. Both the beneficial and the harmful potential of ionizing radiation have been explored intensely. For the public, the most relevant issues of ionizing radiation are medical uses on the one side, and environmental as well as, for a smaller part of the public, occupational exposures and their impact on health. Environmental radiation may derive from natural or man-made sources: exposures associated with nuclear energy generation and particularly, with accidents such as Chernobyl and Fukushima, continue to provide extensive ground for scientific research, public debate and dispute. Several core issues can be identified in this context: a) improving radiation science for better understanding of the range, distribution and intensity of situation-specific environmental exposures of the public b) clear characterization of potential health outcomes linked associated with ionizing radiation particularly in the low dose range c) appropriate risk communication and dialogue between science and the public about findings and their meaning d) identifying and select relevant radiation protection approaches and societal solutions to minimize risks in the future. These issues will be explored in more detail in the talk, using examples involving real or potential environmental radiation exposures.

Lessons from Fukushima: The Viewpoint of a Frontline Physician

Arifumi Hasegawa
Department of Radiation Disaster Medicine, Fukushima Medical University, Fukushima, Japan

In the initial phase after the accident, we were concerned about widespread occurrence of injuries and sickness with the heavy contamination and high exposure doses observed in workers at the Fukushima Daichi Nuclear Power Plant (FNPP). However, none of such cases have occurred. One of the fundamental problems was the serious difficulty in maintaining the medical system in communities around FNPP. There are only three medical facilities within 20 km of the plant, none of which are full-fledged hospitals, and two were under the control of the Tokyo Electric Power Company. Another problem was how to improve workers' awareness about their own health and safety in the plant. Since the accident, lethal heatstroke and the outbreak of infectious diseases in the plant has been prevented by labor health initiatives. On the other hand, lethal injuries from industrial accidents due to the failure to institute simple safe-work procedures occurred frequently over a short period. Unexpected radiation injury and sickness are still a serious concern at the plant and medical specialists should prepare carefully for unexpected emergencies.

More than 60 hospital patients and elderly people in nursing facilities died during evacuation after the accident. We must remember that they did not suffer from radiation exposure, but died during the evacuation efforts intended to avoid it. Since the accident, there has been no direct radiation effect on residents and the possibility of radiation health effects is quite low, according to estimates by the World Health Organization and the United Nations Scientific Committee on the Effects of Atomic Radiation. However, secondary health effects not directly related to radiation have become an important issue. Approximately 130,000 evacuees are still living in temporary housing. Long-term evacuation causes not only disuse syndrome and lifestyle-related diseases, but also psychological challenges with disruptions in local community solidarity. Moreover, there is a gap in risk perception among residents, which creates difficulties in finding consensus on the radiation standards defined by the government. Although the government is promoting the return of evacuees to their hometowns by engaging in decontamination efforts to reduce environmental radiation levels and rebuilding the infrastructure around FNPP, the numbers returning have been lower than expected.

From the viewpoint of a front-line physician, there are thus no direct radiation health effects in Fukushima, but indirect influences have become issues of serious concern.

The current situation of the internal radiation exposure screening program in Hama-dori and the future tasks

Masaharu Tsubokura
University of Tokyo, Minami-soma Municipal General Hospital, Japan.

Since the Fukushima Dai-ichi nuclear power plant disaster on 11 March 2011, a regular internal radiation exposure-screening program has been in place in Fukushima. From this, we now know that the level of chronic exposure among the residents has been kept at a very low level from their current daily practices. The results from the food inspection programmes and a whole body counter test for infants (Babyscan) also showed the similar results.

However, the level of awareness and the feeling of anxiety the residents experience about the current situation vary by individuals. When the number of residents who are no longer interested in radiation and avoid discussing about it increases, people who avoid to consume locally produced food products also exist, especially among the young generation. Within Minami-soma city, close to 70-80 % of parents with small children have answered that they intentionally avoid eating locally produced food products. Many of them are also worried about water safety. When the number of individuals who attend an information seminar or study session is decreasing, there is a strong opposition against using locally produced rice. Furthermore, many students are continuing to feel worried about their future especially about their health, pregnancy and delivery.

There are various causes to the current trend such as the distrust relationship between farmers and consumers, issues associated with compensations and radiation-contamination levels, and the cultural differences. While education and risk communication could be one of the solutions to the current complexity in Fukushima, it is in the process of trial and error. The education on radiation and health is not merely about reducing the overall radiation level, but it is also a part of the public education aiming for children to regain their self-esteem and avoid isolation. Similarly, the interventions in place after the disaster including the internal radiation screening-program are not just for measuring and reducing the levels of exposure. It is also important for maintaining the individual’s dignity, and for protecting the regional culture and history.

In this session, I would like to discuss about the current local situation in the context of radiation issues and other public health problems that have arisen after the incident, and the direction in which we much move forward.

Post-Chernobyl papillary thyroid carcinoma in children and adolescents of Belarus

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This is a retrospective analysis of clinical and histological characteristics of papillary thyroid carcinoma (PTC) that have arisen in the Belarusian childhood population exposed to the radioactive fallout from the Chernobyl accident. 936 children and adolescents (600 girls and 336 boys; 1.8:1; 3-18 years old) with PTC who were surgically treated during the years 1990 through 2005 were investigated. Three subgroups were evaluated: ≤10 years old (I subgroup; n=157; 16.8%), 11 to 14 years old (II subgroup; n=364; 38.9%) and 15 to 18 years old (III subgroup; n=415; 44.3%). Patients in I subgroup compared with II and III subgroups were more frequently observed with advanced regional (82.8% *vs* 72.2% *vs* 71.8%; P<0.001) and disseminate (21.7% *vs* 11.5% *vs* 6.7%; P<0.001) spreading. Classical and solid variants of PTC (P<0.001) with carcinoma showing infiltrative growth (P<0.001) and solid and follicular pattern (P<0.001) were predominant in I subgroup. Furthermore, PTC in I subgroup was characterized by extensive intratumoral fibrosis (P<0.006), blood vessel invasion (P<0.014), peritumoral/intraglandular psammoma body dissemination (P<0.002) and lymphatic invasion (P<0.001). Intrathyroid extension of PTC (P<0.001), multifocal growth (P<0.037) and comorbidity (P<0.001) were typical for III subgroup. Extrathyroidal extension (ETE) can be expected in patients with subcapsular/isthmic location tumor (P<0.0001, OR=3.40), size of the tumor nodule >10 mm (P<0.0001, OR=3.78), infiltrative growth/diffuse sclerosing involvement (P<0.0001, OR=9.48), extensive intratumoral fibrosis (P<0.0001, OR=2.79), vascular (P=0.0002, OR=2.94) and lymphatic invasion (P=0.0002, OR=3.63). Lymph node disease can be expected in patients with ETE (P<0.0001, OR=3.07), size of the tumor nodule >10 mm (P<0.0001, OR=2.94), lymphatic invasion (P<0.0001, OR=23.41) and peritumoral/intraglandular psammoma bodies' dissemination (P= 0.0002, OR=2.26). Distant metastasis associated with ETE (P=0.0065, OR=2.20), N1b (P<0.0001, OR=6.08), subcapsular/isthmic location tumor (P=0.0169, OR=2.21), size of the tumor nodule >10 mm (P=0.0005, OR=3.47), extensive intratumoral fibrosis (P=0.0211, OR=1.77), age 3-10 years (P<0.0001, OR=5.03), age 11-14 years (P=0.0022, OR=2.43).

This research was executed within the framework of the Project B-1910 ISTC.

Relevance and Topicality of Studies of Radiation-Induced and Autoimmune Diseases in the Republic of Belarus during the Late Post-Chernobyl Period

Vasili Roudenok, Natalja Mitkovskaja, Natalja Kononchuk, Alexander Procharav, Aliaksandr Fedulau, Andrei Sokal, Iryna Kraytsova, and Yulia Bondareva
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The studies of radiation-induced diseases have become increasingly topical. Along with the studies of immune and autoimmune disorders they have special significance for Belarus during the late post-Chernobyl period. Radiation-induced diseases encompass damaging effects on the organs and systems that are manifested as both histological changes and clinical symptoms. Radiotherapy for uterine cancer is widely used in Belarus after surgical operations as an adjunctive method of treatment and it is the main mode of treatment for malignant inoperable tumors. In both cases cancericidal doses affect not only tumors but also the surrounding organs and tissues, as well as the blood system, which results in the development of radiation-induced reactions and complications: cystitis, proctitis, enterocolitis and leucopenia, the percentage of which varies from 40 to 60%. The date show a negative impact of radiation therapy on the risk of cardiovascular diseases. Radiotherapy causes damage to the pericardium, myocardium, valves, conductivity system and coronary arteries. Many of the changes are asymptomatic and are diagnosed only by laboratory and instrumental methods. The highest risk of cardiac changes has been detected in patients aged 45 to 55 years with left localization of breast cancer and accompanying cardiac or broncho-pulmonary disorders and obesity after standard radiotherapy with the total dose to the chest area over 40 Gy. The incidence of autoimmune pathology is increasing. In particular, the incidence of myasthenia has gone up. Studies have shown alterations in the immune system including the changes in neuropeptide expression in the thymus which modulate the immune response.

The major health indicators among children in Gomel Region after the Chernobyl Catastrophe

Alexandr Kozlovsky, Tamara Sharshakova, Vladimir Bortnovsky,
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The Chernobyl Disaster, the greatest radiation accident in the world history, happened in 1986. The aftermath of the accident has affected a lot of countries, which allows to state it has a global nature. Belarus, Ukraine and Russia have been affected most of all. However the comparative burden of the accident consequences was considerably heavier for Belarus.

The basis of the medical service for citizens affected by the disaster is mass health check-up, ensuring early detection of illnesses and their timely treatment. There are more than 1.4 million people, including more than 212 thousand children, who are under medical observation in the republic.

Children living in radioactively polluted areas reveal a higher incidence rate in comparison with their contemporaries who do not pass the special medical check-up.

As a result of the iodine radionuclide effect at the early stage of the accident and the insufficient measures aimed at the protection of the thyroid gland, there has been an increase in the incidence rate of thyroid cancer in Belarus since 1990. The number of thyroid cancer cases increased 33.6 times among children and 2.5-7 times among adults depending on age groups after the Chernobyl Disaster in comparison with the pre-accident period. The majority of the thyroid cancer cases are registered in Gomel and Brest regions.

The average annual indices of the leukemia incidence rate among children at the post-accident period stay stable in all the six regions of Belarus. Elderly people have observed a tendency to detect leukemia more often but it is still impossible to relate this to the radiation factor effect.

The increased levels of the incidence rate, registered during the special medical check-up, may be connected not only to the effect of radiation and non-radiation factors of the Chernobyl disaster but also to the so-called “screening effect”. To find out the role of the radiation factor in the changes of health state of the people affected by the accident, we need to conduct long-term radiation and epidemiologic investigations, some of which are already being realized in Belarus in the framework of national and international programs.

Evaluation of current internal Cs-137 exposure in residents living around the Chernobyl Nuclear Power Plant

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The Chernobyl nuclear power plant (CNPP) accident left large areas contaminated by radionuclides including Cesium-137 (Cs-137). After the accident, the residents living around CNPP were revealed to have been exposed to Cs-137 through the intake of contaminated foods they harvested in kitchen gardens and by consumption of wild mushrooms, resulting in internal exposure. In this study, we evaluated the current situation of internal Cs-137 exposure in residents living around CNPP and the contribution of contamination levels of Cs-137 in the soil to this internal exposure in the Zhitomir region, Ukraine. We selected 10 districts from this region that contained a large number of inhabitants who had undergone screening for their Cs-137 body burden by whole body counter (WBC) at the Zhitomir Inter-Regional Diagnostic Center between 2009 and 2012. We used the classification of Cs-137 soil contamination levels to classify these 10 districts into 3 groups (group1: 555–1480 kBq/m^2; group2: 185–555kBq/m^2; group3: 37–185kBq/m^2), and collected soil samples from three family farms and wild forests. The samples were analyzed for 80,000 seconds using a high purity germanium detector coupled to a multi-channel analyzer. The total number of participants was 36,862 (11,458 females and 25,404 males). The annual effective dose was below 0.1mSv per year in 94% of the participants. The median Cs-137 body burden of each sex was below the detectable level, but the concentration of Cs-137 was significantly higher in males than in females ($p=0.025$). A significantly higher Cs-137 body burden was observed in the more contaminated area groups. A relative, but not statistically significant, relationship was noted between the number of inhabitants who had detectable Cs-137 determined by WBC and the Cs-137 concentrations of family farm soils in the area. In conclusion, the Cs-137 body burden was higher in the population living in more heavily contaminated areas. The internal exposure doses were limited, but the consumption of locally produced foods was closely related with the internal exposure of inhabitants around Chernobyl.

Evaluation of the risk perception about health effects of radiation among residents of Fukushima

Makiko Orita, Naomi Hayashida, and Noboru Takamura
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Since the accident at the Fukushima Daiichi Nuclear Power Plant (FNPP) on March 2011, various research institutions have reported measurements of external and internal radiation exposures among residents in Fukushima Prefecture, suggesting that external and internal radiation doses caused by the FNPP accident itself were relatively limited. Nevertheless, the health effects of radiation exposure remain a serious public concern in the area. It is thus important to evaluate the risk perception of the health effects of radiation on residents in order to implement comprehensive risk communication. In this study, we conducted a survey in the village of Kawauchi, which was the first to declare that it was safe for residents to return to their homes. To clarify the factors associated with residents' risk perception of radiation exposure and health effects, we asked residents of the village to answer a questionnaire; 285 residents (141 men and 144 women) who completed the questionnaire were included in the analysis.

In terms of results, 85 residents (29.8%) answered that acute radiation syndrome might develop in residents after the accident at FNPP, 154 (54.0%) residents answered that they had anxieties about the health effects of radiation on children, and 140 (49.1 %) answered that they had anxieties about the health effects of radiation on fetal development. Furthermore, 107 (37.5 %) residents answered that they had anxiety about health effects that would appear in the general population simply by living in an environment with a 0.23 μSv per hour ambient dose for one year, 149 (52.2 %) reported that they were reluctant to eat locally produced foods like rice or vegetables, and 164 (57.5 %) believed that adverse health effects would occur in the general population by eating 100 Bq per kg of mushrooms for one year. The present study showed that the bipolar risk perception about radiation's health effects among residents could have a major impact on social well-being after the accident at FNPP. Specialists have a responsibility to ensure constant and comprehensive risk communication with the public.

Potassium Iodide blockage of the thyroid gland – a systematic review and future work

Steffen Dreger, Hajo Zeeb
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Inhalation or ingestion of I-131 released during a radiological or nuclear accident may cause thyroid cancer as a consequence, as seen e.g. in the major increase in thyroid cancer incidence among young children and adolescents after the Chernobyl accident in 1986. Potassium iodide thyroid blocking (ITB) is known to reduce the risk of subsequent thyroid cancer and its administration in the occurrence of such events is recommended, for example in the WHO "Guidelines for Iodine Prophylaxis following Nuclear Accidents" from 1999. Potential adverse effects of ITB, however, have only been rarely investigated systematically so far, and many questions regarding the timing and the way of administration of ITB remain unanswered.

This presentation briefly summarizes the results of a review on adverse effects of ITB based on a systematic literature search in scientific medical databases. The search resulted in 14 articles relevant to the topic, reporting mostly on surveys, ecological and intervention studies. Only one study from Poland focused on effects (both desired and adverse) of an ITB intervention following the Chernobyl accident. All other studies reported on iodine administration in a different context. Overall, the studies did not reveal severe adverse reactions to potassium iodide in the general public, but neonates and babies as well as hypersensitive persons require special consideration.

The WHO recommendations now require a revision, and some new evidence regarding issues such as the age groups for whom ITB should be recommended needs to be incorporated. Thus, the current systematic review will need to be extended and updated as a basis for the revised version of the WHO guideline. If available, scientific findings from ITB use after the Fukushima accident will be included.

Cardiovascular disease after exposure to ionizing radiation

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Circulatory diseases are common in Western populations and among the leading causes of death. Exposure to ionizing radiation is a known risk factor as it can damage the heart and blood vessels. In studying these effects, low-dose exposure below 1Gy is typically analyzed separately from high-dose exposure. For the cardiovascular impact of mostly low-dose exposure, the LSS A-bomb survivors study is an important source of information, as are the Mayak and WISMUT cohorts. In contrast, high-dose exposure almost exclusively results from radiotherapy in cancer treatment.

In two studies, IMBEI Mainz is investigating the impact of high-dose radiation exposure on cardiovascular health: The CVSS study examines a German cohort of 1000 survivors of childhood cancer with radiotherapy treatment. In addition to clinical treatment records, CVSS takes into account genetic data, as well as results from a comprehensive cardiovascular medical checkup currently underway with about 600 persons examined. Due to the high response rate, the final results expected at the end of 2015 promise reliable information for risk factors as well as for clinical parameters.

The PASSOS study analyzes data from 12500 German women treated with radiotherapy after breast cancer during 1998-2008. Along with clinical hospital records, we ascertained information on mortality and cause of death until 2013. To investigate morbidity endpoints, survivors have been recently sent a questionnaire on cardiovascular events after cancer therapy. The questionnaire also includes lifestyle variables as potentially confounding risk factors. We will present first results from the individual dosimetry that was performed for a sample of the patients, allowing us to characterize the dose distribution in various functional heart structures.

Methodological limitations of studies on cancer risks in children exposed to computed topographies and there possible counter-actions.

Lucian Krille[1], Steffen Dreger[2], Hajo Zeeb[2]
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Computed topography (CT) is an important and indispensable tool in modern medicine. Besides many advantages it exposes the patient to comparatively high doses of ionizing radiation, a known carcinogen. In 2001 Brenner estimated that especially children may be at increased risk of cancer after exposure to CTs. Between 2012 and 2015 the results of five cohort studies from UK, Australia, Taiwan, France and Germany were published. All showed increased cancer risk, albeit the magnitude and the interpretations deviated: The first two studies were the biggest in terms of size. However they missed information on cancer predisposing syndromes (PF) which may have led to an overestimation of the risks, depending on the prevalence of the PF. Furthermore no information on the indications of the scans was available, thus leaving room for the possibility of reverse causation (including cancer-diagnoses related CTs as possible cause for a later occurring cancer). The two last, rather small studies provided different approaches to access these sources of overestimation with slightly different conclusions. Their comparability and applicability in larger pooling studies is still not solved.
All studies so far miss a comprehensive dosimetry, which may distort the risk estimated per unit dose. Precise dose estimation with exposures dating back 30 years have to cope with missing values and uncertainties. However the novel two-dimensional-Monte- Carlo approach may be used in larger pooling studies to assess and reduce the uncertainty in order to obtain more precise risk estimates per unit dose.

Dose Estimations of Medical Exposures in Japan

Keiichi Akahane
Medical Exposure Research Project, National Institute of Radiological Sciences, Chiba, Japan

For radiological protection of medical exposures, the frequency and dose data of radiological procedures should be obtained as well as organ doses for risk estimations. The data can also be the basis for diagnostic reference levels (DRLs) in radiological diagnoses. In recent, the data collecting system on medical exposures by using software, which can collect the X-ray CT examination data from DICOM automatically, has been developed in National Institute of Radiological Sciences (NIRS), and been begun to use collaborating with several medical facilities. The data will be accumulated into the database of medical exposures in NIRS. As a tool of estimating organ doses in X-ray CT examinations, the specialists of Oita University of Nursing and Health Sciences and Japan Atomic Energy Agency (JAEA) have developed WAZA-ARI. It has been in trial operation in NIRS web server. On 30 January 2015, WAZA-ARI v2 was opened to the public as the revised new version of WAZA-ARI. The organ doses of 18 body types of patients including children can be calculated by using WAZA-ARI v2. It also has the database function, and output the statistics of X-ray CT examinations inputted by the registered users. As the hub in the field of medical radiation, Japan Network for Research and Information on Medical Exposures (J-RIME) has established in 2010. From last year, a working group of J-RIME for establishing DRLs has started its activities, and all-Japan DRLs are expected to be established and opened. The database of NIRS would be useful for revising DRLs in the future.

Pediatric CT examination in Japan: How to reduce the radiation dose in daily practice.

Osamu Miyazaki
Department of Radiology, National Center for Child Health and Development, Tokyo, Japan

1. Determine if the ordered CT is justified by the clinical indication

The use of pediatric CT examinations decreased significantly in Japan in the three years after the Fukushima Daiichi nuclear power plant disaster. This finding may reflect the concerns of the medical community, the general population, or both. Independent of the disaster, one children's hospital showed a marked decrease in CT scans owing to a continuous in-house campaign to decrease non-essential CT examinations. This observation suggests that arranging a conference for clinicians on radiation protection for children can be a first step in educating referring physicians.

The use of publicly available appropriateness criteria (ACR [U.S.A], RCR [UK] and domestic guidelines in Japan) provides a standard way of justifying this approach.

2. Optimize pediatric examination parameters

The mAs (milliampere *second)* should be adjusted in response to the patient's physical dimension and the required mAs is also dependent on the specific imaging task. The mAs reduction factors for the pediatric abdomen and thorax are available on the Image Gently website; these have just been republished following last December's update.

Diagnostic reference levels (DRLs) are thought to be a useful tool for optimization. The JSRT Scientific Research Group has finished its study of pediatric CT dosing and DRLs for Japan will be available in April 2015.

Limiting the length of the scout views and the scan length of the clinical images is just as important as limiting the radiation dose to the patient. The extent of the scout views and the scan should be limited to the area of concern.

Performing both unenhanced and contrast-enhanced abdominal CT can result in twice the radiation dose per child. Single-phase scans are usually all that is necessary in children. Unenhanced and delayed enhanced images rarely provide additional information and should be performed infrequently unless there are specific indications.

Changes in Radiological Imaging Frequencies in Children Before and After the Accident at the Fukushima Daiichi Nuclear Power Plant in Fukushima Prefecture, Japan

Koji Yoshida[1,2], Atsushi Kumagai[1], Akira Ohtsuru[1], Naomi Hayashida[2], Takashi Kudo[2], Shunichi Yamashita[2], Noboru Takamura[2]

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[2]Atomic Bomb Disease Institute, Nagasaki University, Nagasaki, Japan

The accident at the Fukushima Daiichi Nuclear Power Plant has raised concerns about radiation exposure, including medical radiation exposure such as x-rays and CT scans, in residents of Fukushima. In this study, we investigated the changes in the numbers of radiological examinations before and after the accident. We collected data on radiological examinations (e.g., x-rays, CT scans, MRI scans, etc.) from April 1, 2008 to March 31, 2013 in outpatients who visited Fukushima Medical University Hospital (Fukushima, Japan), and compared the numbers and the types of examinations between outpatients who underwent examinations before (2008 to 2010) and after (2011 to 2013) the accident. The number and ratio of outpatients less than 10 years old decreased after the accident. The number and ratio of x-ray examinations in outpatients less than 10 years old significantly decreased after the accident. The number and ratio of CT examinations in outpatients less than 10 years old also decreased after the accident. Our results suggested that the numbers of children decreased after the accident in Fukushima due to anxiety about radiation exposure to children and their parents. We should continue to communicate with patients and their families to ensure that they understand the risks and benefits of radiological imaging in order to overcome their concerns about the nuclear disaster and to re-establish the medical system in Fukushima.

Biological Consequence of Radiation Exposure at CT

Fukumoto Wataru[1], Tashiro Satoshi[2], Kajiwara Kenji[1],Kaichi Yoko[1], Honda Yukiko[1] Awai Kazuo[1]

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Objective:
DNA double-strand breaks (DSBs) are considered as the most significant DNA damages induced by ionizing radiation. The purpose of this study was to assess DSBs induced by radiation exposure from coronary CT.

Material and Methods:
After institutional review board approval and written informed patient consent were obtained, 20 patients who had arrhythmia underwent coronary CT before ablation therapy. Blood sample were obtained before and 15 minutes after CT and DSBs were analyzed in lymphocytes using chromosome aberrations and γ-H2AX which were biomarkers of DSBs.

Results:
Chromosome aberrations in blood lymphocytes before and after CT were 5.3×10^{-3}/cell and 7.4×10^{-3}/cell, respectively. γ-H2AX before and after CT were 1.12 and 1.80 foci/cell, respectively. Both biomarkers of DSBs were significantly increased after CT ($p = 0.002, 0.001$).

Conclusion:
A significant increase of DSBs was obtained after coronary CT.

Thyroid cancer as second cancer after Childhood radiation therapy

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Radiation therapy is proven highly effective on curing cancer. Nevertheless, ionizing radiation is associated with a range of late adverse effects including cardiovascular disease, fertility problems, depression and developing second cancer. The Thyroid gland is highly radiation sensitive. Kaatsch and colleagues showed that 8% of all second cancer were thyroid cancers.

Gul and colleagues show an exposure of 6 - 40 Gy to the thyroid by scattered radiation, depending on the localization of the primary neoplasm. Veiga et al reported an exposure of 10 Gy to the Thyroid is associate with a relative risk for thyroid cancer of 13.7 showing a linear rise to a dose of 20 Gy with a decline of risk at higher doses. The preferred ICRP model as published in BER VII is an exponential model with an ERR/Gy = 0.79 exp [– 0.083 (e – 30) and no decline at higher doses. However, there is still much uncertainty in modelling the dose-response curve.

At the Institut for Medical Biostatistics, Epidemiology and informatics (IMBEI) and the German childhood Cancer Registry (GCCR) we are currently performing further investigation to better understand the radiation induced thyroid risk. First, we performed a nested case-control-study, Cohort members are all children with cancer before age 15 reported to the GCCR between 1980 and 2002. Cases are all patients with a second thyroid cancer; controls are patients with no second cancer at least until the age of diagnostic of the corresponding case, matched by age at diagnosis for the first cancer, gender and date of diagnosis. Second, we perform a systematic literature review and a meta-analysis and to estimate dose-response curve after radiation therapy.

The presentation will summarize the actual knowledge on radiation induced second thyroid cancer including the results of our case-control study and discuss the different models and concepts on this topic.

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