



**Late Health Effects from Radiation:
Knowledge gained from the 60 years'
experience in Japan**

Sponsored by

WHO and Nagasaki University 21st COE Program

Friday 9 September 2005

Executive Board Meeting Hall

WHO/HQ

Geneva, Switzerland



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Location: Executive Board Meeting Room

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DRAFT AGENDA

Session 1. Opening

Chair: Dr M Repacholi (WHO) and Dr T Kanematsu (Nagasaki University)

- 09.05 Welcome, WHO/HQ representative
D. Aitken
- 09.10 Greetings from Nagasaki University
H. Saito
- 09.20 Greetings from Nuclear Safety Commission of Japan
S. Kusumi
- 09.30 Activities at the Atomic Bomb Survivors Health Care Commission
Y. Sasaki
- 09:50 Greetings from Radiation Effects Research Foundation
T. Okubo
- 10.00 Overview of different types of studies conducted at the RERF
B. Bennett

Session 2. Health Studies on Atomic Bomb Survivors

Chair: Dr Y Shibata (Nagasaki University) and Dr E Ron (NCI)

- 11.00 Late Effects in the Atomic Bomb Survivors
K. Kodama
- 11.30 Late Medical Effects of Atomic Bombs Still Persisting Over Sixty Years
M. Tomonaga
- 12.00 Cancer incidence in the Life Span Study of Atomic Bomb Survivors
E. Ron
- 12.30 Multiple Primary Cancers in Aged Survivors
M. Nakashima
- 13.00 Lunch

Session 3. WHO Programmes on Radiation and Health

Chair: Dr S Yamashita (WHO)

- 14.00 Key Radiation Projects at WHO
M. Repacholi
- 14.30 WHO Role and System of Preparedness and Response to Radiation Emergency
Z Carr
- 15.00 Medical Diagnostic Radiological Programs
H Ostensen
- 15.30 General Discussion
- 16.00 Close
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Welcome Message

D. Aitken

Director General's Office

Acting Director of Sustainable Development and Healthy Environment,

World Health Organization, Geneva, Switzerland

Dr Saito, President of Nagasaki University, Distinguished Guests ladies and gentlemen, on behalf of our Director General, Dr. Lee, it is a pleasure for me to open the International Joint Seminar, "Late Health Effects from Radiation; Knowledge gained from the 60 years' experience in Japan". This International Seminar is jointly organized with Nagasaki University and is the first time that WHO has held such a comprehensive seminar on radiation effects on health.

Our guests from abroad may notice this morning that over 70 ornamental cherry trees have been planted on the WHO premises, along the paths in front of and behind the main building here. These cherry trees, or Sakura in Japanese, and symbol of Japan, were kindly donated mainly by Nagasaki University School of Medicine and some current and former Japanese staff of the WHO in commemoration of the 60th anniversary of Atomic Bombing for the purpose of achieving World Peace.

Today the main objectives are to review the latest information on late radiation-induced effects in the survivors after 60 years the atomic bombing. Such information has served as a cornerstone of our understanding of how radiation affects human health and is used as a reference point for modern radiation safe and protection. Since most studies have been conducted at the Radiation Effects Research Foundation (RERF), jointly funded the governments of Japan and the USA, and at Hiroshima and Nagasaki Universities, the leading scientists from these institutions have been invited. The morning session will provide a comprehensive summary of health studies on

Atomic Bomb survivors in Hiroshima and in Nagasaki.

This afternoon we will learn about the WHO programs on Radiation and Health and have an opportunity to discuss them with the staff members and maybe establish joint projects with our Japanese colleagues.

On behalf of WHO, I really wish you all a fruitful meeting and also enjoyable stay in Geneva and that the seminar will be both scientifically stimulating and worthwhile.

Thank you.

Opening Remarks

H. Saito

President, Nagasaki University, Nagasaki, Japan

Exactly sixty years have passed since unforgettable days for Hiroshima and Nagasaki. At 11:02 a.m. on August 9, 1945, the explosion of the second atomic bomb devastated Nagasaki almost completely. The ferocious heat and blast indiscriminately slaughtered its inhabitants. More than 75000 people were killed and 70000 also injured. Even the people who managed to survive continue to this day to suffer from late health and mental effects of radiation exposure.

Nagasaki Medical University, now Nagasaki University School of Medicine, is only one medical university in the world that had been completely destroyed by the atomic bombing, and almost 900 staffs and students had been instantly killed. During such miserable tragedy, survived medical staffs and students made a tremendous effort for the rescue of atomic bomb survivors, in spite of insufficient medical facilities and poor knowledge about acute radiation syndrome. After the termination of World War II, our university was reconstructed and newly launched the Atomic Bomb Disease Institute in 1963, in order to clarify the late effects of radiation exposure, and to take an initiative of medical care of Atomic Bomb survivors. Furthermore, as one of the WHO Collaborating Centers we have contributed to the medical care of radiation-exposed victims in the world, such as Chernobyl and Semipalatinsk more than 10 years through the joint projects of Chernobyl Tissue Bank, Chernobyl Telemedicine and Emergency Radiation Medicine, respectively. Based on our international medical aid achievements together with medical care for atomic bomb survivors, Nagasaki University has been selected as one of the 21st Century of Excellence (COE) Research Centers on Radiation Medicine in Japan since 2002. Today's seminar has been, therefore, co-sponsored with the WHO and Nagasaki University to promote an

international radiation-related medical research and health care for the radiation-exposed, and also to develop the global network of radiation health sciences in the world.

As the president of Nagasaki University, I do hope that all participants will recognize the importance of peace without nuclear weapons as well as the necessity of investigation on long-term effects of radiation on atomic bomb survivors in Hiroshima and Nagasaki, through the scientific discussion of this meeting. Our sad experience and valuable knowledge in Hiroshima and Nagasaki can be used for more strengthening of radiation safety and risk assessment in the world.

Opening Remarks

S. Kusumi

Commissioner, Nuclear Safety Commission, Tokyo, Japan

Ladies and Gentlemen,

It is my great pleasure to be here to participate in the Joint International Seminar of WHO/HQ and Nagasaki University entitled “Late Health Effects from Radiation; Knowledge gained from the 60 years experience in Japan” as a Commissioner of Nuclear Safety Commission of Japan.

First of all, I would like to express my appreciation to the Secretariat for their excellent arrangements of this Seminar in memory of the 60th anniversary of “Hiroshima” and “Nagasaki”.

Unfortunately, the use of nuclear energy started as atomic bombings to Hiroshima and Nagasaki in 1945, followed by producing a great number of people in pain with diseases due to radiation exposure and those in continued anxiety for health disturbance. I feel greatly regret that there remain many people in difficulty and in anxiety.

On the other hand, the peaceful uses of nuclear energy have been well developed. Currently, nearly 450 units of commercial nuclear power plants are operating in 30 countries all over the world. In addition, radiation applications have been remarkably advanced particularly in medical uses as well as in industrial uses these days.

In this context, it is no doubt that the role of scientific knowledge about the relation between radiation and human health has become increasingly important.

For this background, the Japanese government launched the center of excellence (so-called COE) program for the 21st century in 2002. Since then, we have actively promoted three projects on the relations between radiation and human health under this COE program.

Today's seminar is held in connection with one of three projects, that is “International Consortium for Medical Care of Hibakusha and Radiation Life Science” of Nagasaki University.

The other two projects are “Radiation Casualty Medical Research Center” of Hiroshima University and “Environmental Monitoring and Prediction of Long-and Short-Term Dynamics of pan-Japan Sea Area” of Kanazawa University.

Hiroshima University is to establish a world center for all aspects of medical development of radiation disaster, while Kanazawa University is to construct a system of detection, preservation and measurement in the pan-Japan Sea area against environmental changes, including those of radiation.

I am quite sure that the results of these projects will contribute to various research activities being promoted all over the world.

In addition, Professor Ohtsura NIWA's group of Kyoto University has made remarkable advance in the molecular biology research on genomic instability. For such achievements, he was conferred the Roentgen prize in Wurzburg, Germany, on the 30th of April, this year.

Furthermore, in Japan, National Institute of Radiological Science is carrying out a big project for cancer treatment with Heavy-Ion Medical Accelerator in Chiba, which is called HIMAC. Professor Yasuhiro SASAKI, the next speaker to me, is leading the project as president of the Institute.

The Radiation Effects Research Foundation, which is a Japan-US joint research

organization, has been conducting the research and analyses of life-span study of 120,000 atomic bomb survivors for more than forty years.

Their results have provided an important basis of scientific knowledge to the UNSCEAR and ICRP activities, and have contributed to the development of the use of nuclear energy and radiation.

In July 2004, the Nuclear Safety Commission of Japan announced “Prioritized Plan for Nuclear Safety Research” The plan expresses Japan’s priority in the safety research of nuclear and radiation safety, and also provides the basic direction of the safety-related research activities performed by the new agency, which is to be established in coming October by the unification of JAERI, Japan Atomic Energy Research Institute, and JNC, Japan Nuclear Fuel Cycle Development (employee:4400, budget:2 billion dollars).

The major seven research fields identified in the plan are shown on the slide.

As you can see, (6) In the field of radiation effects, the plan points out the importance of various research activities in relation to radiation effects and its mechanism on human health and on environment. (7) In the field of disaster prevention, the plan puts the priority in the research of dose evaluation, radioactivity reduction and medical treatment technique in emergency.

Since the experience of the atomic bombs in 1945, Japan has carried out various research activities in the area of relation to the radiation effects on human health, and has accumulated valuable findings for the last 60 years.

I believe that it has a meaning only when we share such records and knowledge by linking each other directly or indirectly, and utilize them on a world-wide scale.

In this regard, I would like to express my sincere appreciation again to WHO and Nagasaki University for organizing this Seminar.

Lastly, I would like to reemphasize that, needless to say, it is essential to utilize such the knowledge under our strong determination to restrict the use of nuclear technology only for the peaceful purposes.

I sincerely hope that this Seminar will be fruitful and will greatly contribute to the further progress of the safe use of nuclear energy.

Thank you very much for your attention

Activities at the Atomic Bomb Survivors Health Care Commission

Y. Sasaki

President, National Institute of Radiological Sciences, Chiba, Japan

This commission officially runs as subcommittee of Examination Committee of Certification of Sickness and Disability, a commission in the Ministry of Health, Labor and Welfare (MHLW) of Japan. This subcommittee is constituted by the law to support A-bomb survivors (HIBAKUSHA).

The mandate given to the subcommittee is to examine applications for the special medical care allowance submitted by HIBAKUSHA. In order that an application is approved, the following issues have to be clarified; (1) the claimed diseases or injuries are caused by A-bomb radiation and (2) the condition needs to be treated or when (1) (2) are not applicable, (3) the curability of the condition is affected by A-bomb radiation. The judgment of the sub-committee is reported to Minister of MHLW, who authorizes the allowance. When the special medical allowance is authorized, the HIBAKUSHA receives monthly support of approximately 1,260 US\$ for the period of 3 years, when health condition is reevaluated.

The subcommittee consists of 20 members maximum. At present there are 16 MDs from various specialties, one epidemiologist and one specialist in health physics. The subcommittee meets once in a month and examine around 40-70 new applications and additional 10-20 protests against non-approval.

In cases of cancer, probabilities of causation calculated for each type of cancer are used as an indication for the decision if the disease condition is attributable to A-bomb radiation. Probabilities of causation are calculated on the basis of epidemiological studies of A-bomb survivors by RERF. If the probability of causation is over 50%, applied disease condition is regarded as attributable to A-bomb radiation with certain likelihood. If it is less than 10%, it is unlikely that the

disease condition is caused by A-bomb radiation.

The overall judgment is made by the comprehensive consideration of exposed dose estimates, past history, environmental factors, life style, etc. including careful evaluation of necessity to be treated.

Difficulties remain in the judgment of (1)non-cancer diseases, (2)adoption of newly developed scientific knowledge, (3)precise dose estimates based on the actions taken by an applicant 60 years ago, and so on.

Greetings from Radiation Effects Research Foundation (RERF)

T. Okubo

Chairman, Radiation Effects Research Foundation, Hiroshima and Nagasaki, Japan

The Radiation Effects Research Foundation (RERF) is a unique institution exclusively dedicated to research on late effects of radiation exposure from the A-bombings of both Hiroshima and Nagasaki. In 1975, RERF took over 28 years of invaluable research from the Atomic Bomb Casualty Commission (ABCC), and since then, both US and Japanese governments have shared in supporting RERF's indispensable research activities. This collaborative research function has been successful, with many results reported internationally. Many of the results have been referenced for establishing guidelines of exposure limits to ionizing radiation by international organizations and national governments. In November 2005, RERF will celebrate the 30th year since its establishment. As of July first, due to term expirations, new members were appointed to RERF's board. I was inaugurated as the new chairman. Five different individuals preceded me as chairman, making me the 6th chairman since RERF's establishment.

At the time of the A-bombings 60 years ago, the estimated populations of Hiroshima and Nagasaki were 330 thousand and 250 thousand, respectively, with about 120 thousand and 80 thousand of these totals estimated to have been killed immediately after the bombings or to have died within a few months later of acute effects from the bombs. Along with a national census in 1950, a special survey regarding A-bomb exposure was conducted in the two cities. As a result, 159,000 people in Hiroshima and 125,000 in Nagasaki were confirmed to have been exposed to the bombs.

From these exposed populations, RERF established several cohort groups or subgroups and, owing to the cooperation of these selected subjects, all research projects have successfully followed up the study groups over long study periods. The major cohorts are the Life Span Study (LSS), the Adult Health Study (a subgroup of the LSS), the

In-Utero Sample and the Children of Survivors Sample. Drs. Bennett, Kodama, and Ron will introduce the major research results from these observations elsewhere in this seminar.

Radiation Effects Studies of RERF

B.G. Bennett

Radiation Effects Research Foundation, Hiroshima and Nagasaki, Japan

For nearly the entire period of 60 years since the atomic bombings, the Radiation Effects Research Foundation, continuing on from the Atomic Bomb Casualty Commission, has been studying the effects of radiation in survivors of the bombings in Hiroshima and Nagasaki. The large study cohort from a general population of both sexes and all ages, encompassing a wide range of accurately known doses and incorporating accurate disease incidence and mortality recording makes this a very valuable and informative study. The results are heavily relied upon to establish radiation protection guidelines used throughout the world.

The core epidemiological project of RERF is the Life Span Study. Both cancer incidence and mortality from all causes are investigated. A clinical study of a sub-cohort of the Life Span Study, called the Adult Health Study, is being carried out to study age- and radiation-related physiological changes and to evaluate the radiation-related risk of non-cancer diseases.

The children of atomic-bomb survivors are being studied to determine whether genetic effects might be apparent that could be related to parental exposures. Initial study of post-natal defects did not demonstrate discernable effects. The mortality follow up is continuing. A clinical study of survivor children is also under way to determine if radiation effects on multifactorial diseases might be evident. These diseases, which become prevalent in middle age, have both environmental and genetic relationships.

There is a clear need to continue these informative studies for the full duration of the lifetimes of the survivors. This seems to be recognized by our government sponsors, who are presently making firm commitments for future funding.

Late Health Effects in the Atomic Bomb Survivors

K. Kodama, Y. Shimizu and T. Okubo

Department of Epidemiology, Radiation Effects Research Foundation,
Hiroshima, Japan

To determine the possible late health effects of atomic-bomb radiation, Radiation Effects Research Foundation (RERF) has been conducting mortality surveillance on a fixed cohort (Life Span Study, or LSS, of 93,000 atomic bomb survivors and 27,000 non-exposed residents of Hiroshima and Nagasaki) since 1950. Deaths are routinely identified through the family registry system and ascertainment is virtually complete. Through record linkage with local cancer registries in Hiroshima and Nagasaki, RERF also embarked on cancer incidence studies in 1957. Data analyses have been conducted on a periodic basis, with release of a report on mortality analyses that took place between 1950 and 1997. Meanwhile, a report was published on 1958-1987 cancer incidence analyses, with an up-to-date report now being prepared.

The present report mainly describes the results of the analyses of cancer and non-cancer mortality in the LSS. As of 2002 approximately 55 % of the cohort members had died. About 22 % of the deaths are attributed to cancer, 73 % to other diseases and 5 % to external causes. A comprehensive analysis on site-specific cancer mortality in the LSS for the period through 2002 is currently underway and part of the results will be presented at the seminar.

The central finding of the LSS is an increase in cancer risk. Besides the increase in leukemia, increases in solid cancer such as cancers of the lung and stomach have also been demonstrated. Radiation-induced leukemia occurred 2 to 3 years after exposure, reached its peak within 6 to 8 years after the bombing, and has since declined steadily.

However, this has not been the case for solid cancer. Radiation- related solid cancer began to appear at later years when survivors reached age cancer is normally prone to develop. Relative to background rates, an increase of solid cancer is larger for those exposed as children than those exposed as adults. However, since a majority of those exposed as children are still alive and risk estimates for them are uncertain at this stage, it is essential to continue their follow-up. Other issues include the shape of dose response and evidence for heterogeneity in site-specific excess solid cancer risk.

Recently, the LSS also demonstrates an excess risk of death from non-cancer diseases, largely from cardiovascular, digestive and respiratory diseases. Further investigation is of absolute necessity in order to determine the excess be caused by atomic bomb radiation or not.

Late Medical Effects of Atomic Bombs Still Persisting Over Sixty Years

M. Tomonaga

Department of Hematology, Atomic Bomb Disease Institute,
Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan

60 years ago, on August 6th and 9th 1945, two atomic bombs with similar physical powers were used to destroy military-involved cities Hiroshima and Nagasaki, respectively. Physical effects of the bombs were ever most enormous as a weapon and destroyed almost completely two moderate-size cities in Japan. About 120,000 and 75,000 persons including many civilians and children of two cities died instantaneously or died of acute effects of radiation exposure, respectively. Almost the same number of people could survive the acute effects but eventually faced to the fear of late appearing effects of atomic bomb irradiation such as leukemia and cancers.

Induction of cancer among proximally irradiated persons began to appear as early as three years after bombing. The first cancer was leukemia. The incidence rate of leukemia quickly elevated within five years and reached the peak around 1950-55. There were three major types of leukemia, acute myeloid leukemia (AML), acute lymphoid leukemia (ALL) and chronic myeloid leukemia (CML). AML and CML were most prevalent among adults and ALL among children. Especially among children the rate was almost fifty-fold elevated. The most recent summary results of statistics suggest that the leukemia risk begins to elevate upwards at approximately 200mSv exposure dose as a linear quadratic curve. This dose response curve is the direct evidence that the atomic bomb irradiation actually induced human leukemia.

The elevated leukemia incidences declined rapidly for ALL and CML after 1955-1960 and gradually for AML over 1970~1980. However recent epidemiological investigation suggests an elevated incidence of myelodysplastic syndromes (MDS) among the proximally exposed persons during 1980-2004. MDS is a disease closely

related to leukemia that was previously called pre-leukemia. Anemia is the main symptom of MDS patients and about 25% of them later develop acute leukemia. This finding is being observed both in Hiroshima and Nagasaki.

Solid tumors such as cancer of thyroid, breasts, stomach, lungs, colon, ovaries, skin and brain began to increase in incidence after 1960-65 following the decline of leukemia incidences. The most recent statistical summary suggests that the elevated incidences of solid cancers are still persisting in 1980-2004. A statistical estimation was recently reported from Radiation Effects Research Foundation (RERF) for the number of future cancer occurrence based on an assumption that cancer and MDS risk will never cease and persist over whole lives of the proximally exposed survivors; about one third of solid cancers have been developed from the proximally exposed population during 1965-2004 period and two third of solid cancers will be supposed to develop during 2005-2020.

We have studied in 1995 on chromosome abnormality of blood cells circulating in proximally exposed persons with moderate (1Gy) to high (4Gy) exposure doses who are otherwise healthy. We found that 5 to 20 % of blood cells carried chromosome abnormalities. The percentage increased proportionately to exposure dose. This is good evidence that the atomic bomb irradiation actually induced chromosome abnormalities.

Such chromosome abnormalities were compared between lymphocytes that are immune cells and red blood cells. In several persons chromosome abnormalities were identical between lymphocytes and red blood cells, strongly suggesting that blood forming stem cells are target of radiation damage. It is also well known that only stem cells can continue to live long enough to maintain blood formation over whole life of a person. Thus, it could be a reasonable hypothesis that the stem cells were irradiated and damaged at chromosome and eventually DNA by the atomic bomb irradiation in 1945 and they are persisting over half century, giving rise to cancers.

Stem cell theory for carcinogenesis is being widely accepted. Based on this theory we are speculating that not only blood stem cells but also other stem cells in various

organs of survivors gained chromosome damage hence DNA injury. Further studies are being conducted to prove this stem cell hypothesis to explain life-long effects of atomic bomb.

If proved, nuclear weapons must be considered more dangerous than we have thought previously. Our study on atomic bomb survivors conducted by joint teams of Nagasaki University, Hiroshima University and Radiation Effect Research Foundation thus clearly indicated that the atomic bomb irradiation-induced genetic damage persists over half century and probably whole lives of survivors. This finding provides discrete evidence that all nuclear weapons are dangerous because of emitting radiation and should be abandoned.

Solid Cancer Incidence among Atomic Bomb Survivors: A Second Follow-Up

E. Ron¹, D. Preston², S. Tokuoka³, S. Funamoto³,

N. Nishi³, M.Soda³, K.Mabuchi¹ and K. Kodama³

¹National Cancer Institute, Bethesda, MD, ²Hirosoft International, Eureka, CA and

³Radiation Effects Research Foundation, Hiroshima and Nagasaki, Japan

More than a half century after the atomic bombings in Hiroshima and Nagasaki, an increased risk of cancer incidence is still apparent among the Life Span Study (LSS) cohort of survivors. Between 1958 and 1998, almost 17,500 first primary solid cancers were identified among over 105,000 LSS members, with estimated DS02 doses. About 850 of these solid cancers are estimated to be radiation-related. With an additional 11 years of follow-up, the updated solid cancer incidence data indicate that the shape of the dose response is well described by a linear model and that the elevated cancer risk continues throughout life. The excess relative risk per weighted colon dose in gray (ERR/Gy) for solid cancer is higher for women than men and decreases with increasing age at exposure and attained age. The excess absolute risk per 10,000 person years per weighted Gy (EAR/10⁴ PY Gy) is also higher among women and decreases with increasing age at exposure, but increases with increasing attained age. When gender-specific cancers are excluded from the analyses, the ERR/Gy remains significantly higher for females than males, but the gender difference disappears when an absolute risk model is used. Patterns of organ (or site) specific risks generally are similar to those seen in the previous follow-up, but the risk patterns have become clearer for several cancers. While a great deal has been learned about radiation risks from the current LSS report, the lifetime radiation risks for persons who were less than 20 years of age at the time of the bombings still need to be quantified. Thus, it is important to continue the follow-up of the atomic bomb survivors for at least another 20 years.

Multiple Primary Cancers in Aged Atomic-Bomb Survivors

M. Nakashima¹, H. Kondo¹, M. Soda², T. Hayashi³,
T. Matsuo⁴, S. Yamashita^{1,5} and I. Sekine¹

¹Atomic Bomb Disease Institute, Nagasaki University Graduate School of Biomedical Sciences, Nagasaki, Japan, ²Radiation Effects Research Foundation, Nagasaki, Japan, ³Department of Pathology, Nagasaki University Hospital, Nagasaki, Japan, ⁴Nagasaki Tumor Tissue Registries, Isahaya, Japan and ⁵ Radiation and Environmental Health, World Health Organization, Geneva, Switzerland

This year is the 60th anniversary since two atomic-bombs were exploded in Japan and the average age of survivors is now approximately 73 years. Cases of multiple primary cancers (MPC) are a reflection of severe exposure to carcinogens. To elucidate the effects of radiation on survivors, the present study analyzed the correlation between incidence of MPC in atomic-bomb survivors and exposure distance. There were 511 confirmed cases of MPC in the 29,647 tumor-bearing survivors (the crude incidence rate was 27.6 per 100,000 person-years). Relative risks of MPC in the survivors significantly increased when exposed closer to ground zero and in those of younger age at the time of the bombing, suggesting the radiation effects on MPC in survivors. Furthermore, the incidence of MPC in those exposed closer to ground zero began to increase since 39 years after the explosion of the atomic-bomb, and has continued to increase into the 1990s. It is likely that the survivors who have been exposed at a younger age still have a higher risk for a wide range of cancers after reaching a cancer-prone age, even at 60 years after the bombing. Most importantly, 48% of the survivors are still alive, who were mostly children at the bombing. These results, on the incidence of MPC in the tumor-bearing survivors and its correlations with the atomic bombing of 60 years ago, are described for the first time in this report. They also strongly support the necessity of a long-term health care follow-up for the aged

survivors of the atomic-bomb, and also emphasize the need for special attention on other victims of radiation-associated accidents around the world.

Key Radiation Projects at WHO

M. Repacholi

Radiation and Environmental Health, World Health Organization, Geneva, Switzerland

WHO recognizes the social and economic importance of the exploitation of radiation and nuclear technology and that exposure to radiation is a natural and unavoidable consequence of living in the Earth's environment. However, it is recognized that exposure to radiation, both man-made and natural, is detrimental to health. Thus, there is a need to balance the benefits of the exploitation of radiation and nuclear technology against the risks of consequential exposure, in order to ensure a net benefit. Furthermore, it is necessary to ensure an equitable distribution of the risks and benefits. These needs can only be met from a sound knowledge of the distribution of exposures and of the effects of radiation exposure on health.

While WHO has a mandate to deal with the health consequences of radiation exposures, the acquisition and evaluation of knowledge concerning environmental exposure to radiation is not the direct responsibility of WHO but lies within the UN mandated remit of the International Atomic Energy Agency (IAEA). It is therefore vital that the two organizations work in close co-operation for WHO to be able to:

- evaluate the health impact of exposures, and
- where appropriate, advise on the instigation of mechanisms to control exposure through the setting of standards and guidance for radiological practices and interventions in the case of unplanned or excessive exposures.

Within its Global Strategy for Ionizing Radiation and Public Health, WHO is developing a coherent and scientifically credible program at the international level that will enable it to adopt an independent position, based on technical excellence, from

which it can

- Assist and advise member states dealing with the health consequences of environmental radiation exposures
- Protect the public health from undue risks from the exploitation of radiation
- Provide leadership at the international level in developing strategies to protect public health.

With the limited resources available, programs need to be prioritized. RADs priorities are based on reducing exposures in areas of highest exposure to population groups, responding to WHO's responsibility under UN conventions to provide emergency medical responses in the case of radiation exposures and providing sound advice on health risks. The key activities at WHO can be summarized as follows:

- International radon project started in 2005 to raise awareness at the public and political level about the hazards of radon exposure, to determine the extent of health burden from lung cancer caused by indoor radon, and to develop strategies for reducing the health burden. Exposure to radon represents the highest natural radiation exposure that people receive, its can be easily mitigated, and so should be one of the highest priority activities.
- The Radiation Emergency Medical Preparedness and Assistance Network (REMPAN) is WHO's response to its obligations as a signatory to the UN Notification and Assistance Conventions. These conventions require WHO to provide emergency medical assistance to cases of radiation exposures, when requested by a Member State. This activity is coordinated with the IAEA.
- Reviews of the health effects of major radiation exposures (e.g. Chernobyl, Techa River, Semipalatinsk). These reviews are conducted with the purpose of identifying areas where further research is needed, developing public health actions, and providing a sound scientific basis for recommendations on radiation health effects to Member States. These reviews are normally conducted in

collaboration with UNSCEAR, ICRP and the IAEA. The most recent review on the health effects of the Chernobyl accident was conducted to provide reliable information to people most affected by the accident in Belarus, Ukraine and Russia.

- Medical applications of ionizing radiation represent the highest man-made source of exposure, and so should rate as a high priority activity. Recent scientific reviews have indicated the possibility of a high cancer detriment coming from the misuse of CT. This seems especially to be the case in Japan and possibly in rapidly developing countries such as China. This is currently being investigated jointly with the Essential Health Technologies Department in WHO.
- Provision of information and advice on various topical radiation issues such as cosmic radiation, depleted uranium, high background area etc

This presentation will provide further details of current and future activities of the Radiation and Environmental Health Unit.

The Role of the WHO in Preparedness and Response to Radiation Emergency

Z. Carr

Radiation and Environmental Health, World Health Organization,
Geneva, Switzerland

In the time when the world is shaken by terrorist attacks and natural disasters, the need for strengthening national emergency preparedness of Member States and a well-coordinated mechanism of an international response is a matter of highest priority. This became even more apparent in the wake of September 11, terrorist attacks in Madrid and London, devastating tsunami of December 2004, and recent hurricane Katrina disasters.

To address this priority with the view of potential threat of radionuclear events, the World Health Organization is mandated by the UN to:

- provide intervention support and public health advice for preparedness and response to radionuclear accidents or terrorist situations
- build national capacity and provide information
- act as directing and coordinating authority on international health issues
- provide technical assistance and aid upon the request or acceptance of member states
- establish and maintain effective collaboration with UN, specialized agencies, government health authorities, NGOs
- assist Member States to strengthen health service

Years passed after the horrifying times in history, healing the scars left by the atomic bombing of Hiroshima and Nagasaki, and the Chernobyl disaster. Both events taught the international community their lessons. Aside from political and moral lessons

learnt from these events, a fundamental scientific knowledge on health effects has been acquired and continues to build on the experience coming from Japan. A new concept of international cooperation was developed and implemented after the Chernobyl accident: two international conventions: Convention on Early Notification and Convention on Assistance in case of radio-nuclear emergency were adopted in 1987. In the framework of the two conventions the system of the international response to radio-nuclear emergency has been set up under the leadership of the International Atomic Energy Agency and including WHO, WMO, FAO, EC, NEA, and other parties members of the Inter-Agency Committee on Response to Nuclear Accidents (IACRNA). The mechanism of the response and roles of each party are defined in the Joint Plan of the International Organizations for the Response to Radiation Emergency.

In 1987, to fulfil its' responsibilities under the two Conventions and the Joint Plan the WHO established a network of medical and research institutions. Today, the WHO Radiation Emergency Medical Preparedness and Assistance Network (REMPAN) comprises some 30 centers around the world. Members of the network are medical institutions specialized in the various fields of medical response to radiation emergency. In Japan, REMPAN is represented by the nation's leading centers, such as RERF in Hiroshima, Nagasaki University and NIRS in Chiba.

The terms of reference for the network include:

- the network maintains regular communication before, during and after accidents
- upon official notification from IAEA, WHO immediately disseminates information to network members for action as appropriate
- in emergency, WHO identifies a network member/s to address specific medical assistance requests of a Member State

- the network provides a clearing house for information by sharing databases on over-exposed patients, radiation injuries, diagnosis, treatment outcomes, and long-term follow-up.
- the network convenes biennial coordination and planning meetings providing professional forum
- the network members advise to Member States, provide information to public, education/training and practical tools for professionals, and promote harmonized protocol for medical and public health response to radiation emergencies.

Besides medical assistance upon a Member State's request in case of radiation emergency, The REMPAN's key objectives include building national capacity on preparedness. There is no success in responding to emergency without being well prepared. This task is implemented in the network by various activities, including development of guidelines and recommendations, providing forum for professional discussions and delivering information to medical community, as well as providing professional training through education of medical and public health workers involved in emergency response, and emergency exercises.

Today, REMPAN arrived at a crossroad where important choices have to be made. It took time to build the network and today the WHO unites world's leading centers and agencies under the umbrella of REMPAN. However, now it is time to review the network's priorities and the strategy in order to identify the gaps and map out the best way forward.

The centers of the network contain a unique knowledge and expertise. The accumulated knowledge should be preserved and shared with the international professional community. This is especially pertinent for the developing countries embracing the age of nuclear technology. The REMPAN resources are not yet available

to some the Member States in Middle-East and South-East Asian regions of the WHO, in regions where political situation is not always stable (e.g. India, Pakistan, Afghanistan, North Korea, Iran and Iraq).

The WHO is now exploring opportunities for developing an international training program that would comprise good practices and experience acquired in the USA, Japan, and European Countries, and harmonize the approach to training in radiation emergency medicine. One of the key issues for REMPAN's future programs planning and implementation is resource mobilization. This is a priority task for strengthening the WHO's system of radiation emergency response, which will be accomplished through the REMPAN development.

Diagnostic Imaging in a Global perspective

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“Diagnostic imaging”, including examinations based on ionizing radiation, ultrasound, magnetic resonance and others, are regarded to be crucial in any medical setting in order to decide upon, plan and follow-up medical treatment. According to generally accepted, clinical experience within the medical community, some sort of medical imaging is necessary in a minimum of 25% of all patients seeking medical help.

Although most people living in highly developed areas of the world takes it for granted that these type of services are available, it is estimated that around two-thirds of the world's population, i.e., more than three billion people has very limited or no access even to the most basic diagnostic imaging services, such as radiography of the chest or limbs.

In other words, few of us living in the highly developed parts of the world are aware of the fact that some 95% of diagnostic imaging services in the world is made available to less than 30% of the world's population, and that large areas of the world has a "density" of radiologists of about one radiologist for up to 10 million people!

Various factors are contributing to this unfortunate situation, and some the most important ones can be summarized as follows:

1. Not enough equipment installed
 - 1.1. Reason: Lack of resources, lack of awareness
2. When equipment in place, it is often not functioning

- 2.1. Reason: Lack of spare parts and preventive basic maintenance
- 3. When equipment installed and functioning, it is often inadequately operated
 - 3.1. Reason: Insufficient training and education of medical staff

The WHO activities within the field of diagnostic imaging is concentrating on three main issues:

- Practical education and training, i.e., “Capacity transfer” to end-user
- Advocacy to governments aiming at increased awareness on the need for diagnostic imaging
- Advocacy and research for “new”, affordable technology and equipment to improve safety, quality and equity of diagnostic imaging services to a largest possible portion of the world's population

Comments made by Dr. Lee

It is an irony that Nagasaki city is one of the two victims of A-bombing 60 years ago while it had been the place of contact between Japan and the western world, and the place where Christianity, western medicine, and many other cultural exchanges first took place.

The late effects of radiation as a huge contribution by the Japanese researchers from Nagasaki and Hiroshima presented at this seminar show us that nuclear weapons should be strictly banned and never used again. Today when we are talking about the anti-nuclear proliferation or the safety of nuclear reactors, we all owe it to the lessons we learnt from Hiroshima, Nagasaki, and Chernobyl.

There is also a discussion how we can use medical radiation in a balanced way so that the benefits are maximized but the risks are decreased. This should be based on evidence and the experience gathered in Nagasaki, Hiroshima, Chernobyl and Marshall islands are the proof for such late effects of radiation on human health.

I would like to stress the importance of further in-depth studies on these important issues which are of the main issues in the 21st century.

General Discussion

Dr. Yamashita: At this point, I would like to invite the speakers and also others attending this seminar to present their comments or questions for a final discussion of the most important issues presented at the seminar.

Dr. Saito: I have a proposal to the chairman of the seminar. I wish to quote some comments made by Dr. Nagataki, the Professor Emeritus of Nagasaki University, the retired chairman of RERF and the responsible person of WHO Collaborative Center on Thyroid Diseases in Nagasaki, Japan. Ten years ago, Nagasaki University held the 50th anniversary of Nagasaki A-bombing in Nagasaki city. Dr. Nagasaki was the dean of the medical school then and organized an international symposium on the issue. Dr. Nagataki also promoted the Chernobyl-Sasakawa Project and I believe all of you participants know how Dr. Yamashita worked in Chernobyl and Semipalatinsk. But as a matter of fact, Dr. Yamashita started his research life as a graduate school student of the first department of internal medicine at Nagasaki University Hospital where Dr. Nagataki was the chairman and professor of the same department. Therefore Dr. Nagataki has an important role in encouraging Dr. Yamashita to become the researcher he is now and this is the reason I recommend you to listen to Dr. Nagataki's comments.

Dr. Nagataki: Thank you, Dr. Saito, for your kind words. I was Dean of Nagasaki University School of Medicine when we had the 50th anniversary symposium in Nagasaki to appeal on the Health Effects of Atomic Bombs. When I retired from Nagasaki University, I left a message to the University, "Appeal Nagasaki to the world" and distributed my message with my photo in the First Department of Internal Medicine. I am very happy to attend this International WHO-Nagasaki Seminar and I would like to take this opportunity to express my sincere thanks to Prof. Yamashita, Prof. Kanematsu, Prof. Saito and others for their tremendous efforts to bring Nagasaki University to the current status. I have made similar presentations as this in the past on behalf of the Dean of Nagasaki University, as directors of WHO Collaborating Centers, as Chairman of RERF and as chairman of the health control committee of people surrounding JCO. Listening to the presentations today as a senior and as the third person, I feel very strongly that this meeting is a tremendously important opportunity to appeal on our experience of the Atomic Bombs dropped on Japan to the international society.

The message must be very clear, not long, maybe one or two paragraphs to seriously appeal on our 60 years of experiences to the world and the international community. I am looking forward to the discussion time to make a clear message based on our 60 years of experiences.

Finally, I believe that a clear message to WHO will encourage it to strengthen the Radiation Health Program further. Thank you.

Dr. Yamashita: Thank you Dr. Nagataki. Your suggestion is exactly our objective not only to summarize the late health effects of atomic bombings but also to strengthen our collaborative work between Japan and WHO. So I would like to open this suggestion to more discussion and I hope there will be comments on how to send this message.

Dr. Nagataki: Another point is that I believe the message should not only be defined on Radiation Protection but also on utilization of radiation. So I think the Nagasaki University and WHO should work both on radiation protection and also the utilization of radiation for human purposes.

Dr. Hayashi: I am from BHN Association, an NGO in Japan specializing in the use of telecommunications technology for humanitarian aid. The BHN Association actually provided the telemedicine system connecting Nagasaki University to Gomel Medical University and also to the Semipalatinsk region.

I would like to first briefly introduce the BHN Association and its activities. Our organization was created as an NGO in 1992 and our first project was the establishing of a microwave link between Obninsk and Moscow for the purpose of helping research in radiation induced diseases. Because of this history, we have been very interested in the Chernobyl accident and built the telemedicine system to help with them. In other areas, we have provided telecommunication systems in under-developed regions mostly for medical use. For example we established a wireless system in Laos where telephone lines does not exist in most areas. Another example is provision of telecommunications systems in disasters such as the Tsunami in Indonesia and Sri Lanka.

Some projects included setting up of an FM radio station and providing some receivers for the Tsunami victims. We also provided wireless telecommunication systems, terminal equipment and repeaters for local agencies which worked for disaster relief activities. So we are very much interested in participation in WHO programs in the field of telecommunications in case your program needs such

means in developing countries.

Mr. Roger: I am from the United Nations office for disarmament research and have a small request. I would like to know if it is possible to circulate and receive by E-mail a copy of presentations made by the panelists today.

Dr. Yamashita: Yes, we will summarize the presentations and can send it to you if you leave us your E-mail address.

Dr. Takamura: I have a question from Dr. Ostenson. Probably everyone knows about the Lancet report on the higher risk of cancer caused by medical irradiation in Japan than the other countries. But that was actually just a risk estimation and not a real epidemiological study, so I wonder if WHO has a plan to do a multifocal epidemiological study to evaluate the risk and benefits of medical irradiation as an international project.

Dr. Ostenson: We have a lot of ideas and a lot of wishes, and currently I am the only person in WHO working on this field. So I need resources and I will be able to answer your question after I get them.

Dr. Cardis: I am Elizabeth Cardis from the International Agency for Research on Cancer which is the cancer research agency of WHO with a mandate to do research into the causes and prevention of cancer. I run the radiation group there and most of our work is to run epidemiologic studies on the effects of low dose radiation, also effects of different kinds of radiation and the modifying factors.

In fact, we became very interested in doing a multinational study of the health effects of pediatric CT exposures, and we have been discussing it with Professor Yamashita and Dr. Elaine Ron of the NCI the setting up of a small feasibility study first in some countries to see if such an international study would be possible.

Dr. Ian Chell: I am from the UK. There were a few comments directed at Dr. Ostenson and medical X-ray generators. Basically I know the big manufacturers of medical X-ray equipment and how they want to sell modern technology based on circuit boards and software.

This has absolutely no use in the third world and I think it would be useful if you found out globally and put together a list of manufacturers who produce the low tech equipment that can be repaired by local tools and equipment. For example in India for many years there was old technology manufactured and it could be repaired

by hand tools.

Dr. Ostenson: This is a very important issue and we are helping and trying to get this information into a database, yes. As you know, the WHO developed in 1980s specifications for a basic X-ray machine. This idea was killed at first because nobody liked the term basic, but now it has been re-baptized and improved a little bit and is called the World Health Imaging System for Radiography.

It is a solid, easy to use and very easy to maintain (almost maintain-less) equipment with which you can do 99% of the practical work you in a small or mid-size hospital anywhere in the world. This is the equipment we want to put in with low cost and direct read system. So we can substitute the film cassette with an electronic cassette and put it in a small case and get it up on the lap-top as a JPEG image and transmit it to the University Hospital within the country or anywhere there is the capacity to have it read.

We are looking into low tech and low price systems and some Indian systems that we know are very good. This work is being done with involvement of a major international society here. So we are heavily working on this idea.

Dr. Nagataki: These are one example of the reports of A-bomb survivors in Japan. As you said, CT scans are being used extensively and much more in Japan which was reported by the Lancet and we also had a kind of symposia on the validity of these papers. These are all based on the assumption of atomic bomb survivors' data.

I discussed this issue with Dr. Clark, the chairman of ICRP how he thought about this report and the conclusion was that the calculation was true but the benefit side had not been studied at all. This issue is also a good example how research on atomic bomb survivors can be used for radiation protection and also appropriate utilization and justification of medical used of radiation.

Dr. Ostenson: What you said is very important and I appreciate it very much because it underlines what we are trying to accomplish. As a private radiologist, I would postulate in the most of the industrialized world, at least 50% of the CT scan examinations are useless, misuse, or over use such that the diagnostic work could have been done with much simpler and easier equipment.

This is a very important issue that we want to communicate to the governments so that they look into the justifications. Why take a spiral CT scan when you are looking for pneumonia; this is unacceptable.

Dr. Yamashita: Thank you all so much for your active contribution and useful discussion. Before closing the seminar, I would like to invite Dr. Ropecholi to summarize these sessions to make a message we want to send to Hiroshima and Nagasaki and especially to the WHO itself.

Dr. Ropecholi: I think today sessions have been very good in a number of respects. It is appropriate also that it was also coincident with the review of the health effects of the Chernobyl accident, because we could compare what occurred in Japan and what has happened in Chernobyl, and make an assessment. So many lessons can be learnt from both types of accidents in two different cultures and under different circumstances. I think it is most appropriate that Nagasaki University was able to help with organization of this seminar and to bring the profile and the information that people would like to have in a nice and concise symposium.

Professor Yamashita has done an excellent job in this respect. If you look at the radiation programs overall, the WHO unfortunately does not put radiation up at the same priority as malaria or AIDS or bird flu, and so as WHO is looking at all the health issues, the budget is divided into very small amounts. But we struggle along as there is a lot that can be done in this area; it is a very important area, a high tech area is going on, a low tech is needed in the developing countries and so there is a lot WHO can do.

WHO is highly respected as an international organization and when it is going to have a project, and so politicians and those affected take notice of what is going on. Therefore there is a great burden of responsibility on WHO staff to make sure that they are doing and saying the right thing at the time they are working on their projects.

I am personally especially interested in the WHO getting involved in the health effects and getting the clear and concise information across. WHO as an organization has a clear mandate to make sure it gets the best and most sound advice from the best scientists around the world, bring them into seminars, workshops and meetings, have them work on clear terms of references and come up with conclusions and recommendations that can be given to the rest of the Member States.

This is how the WHO works and it is something that is needed and has to be in the form of an umbrella organization which is able to provide good, sound, unbiased, purely scientific, and well established advice. In this case if we look at the Chernobyl accident, one of the criticisms was that why the health effects were much lower than we thought. People's perception of radiation is much different from scientists and

overcoming those perceptions is very difficult. People see Chernobyl exploded and massive radioactive clouds everywhere, and no doubt it was a disaster but the dimensions of the disaster are always blown up in the minds of people.

We learnt a lot from the Japanese atomic bomb survivors how we can protect people, what we can do to make sure the doses they receive are as low as possible, they are public health policies that need to be developed and these are what the WHO can facilitate.

Also as Dr. Ostenson said, there is the issue of getting the benefit of imaging technologies to the developing world, and we have to do that. The radiation program of WHO was primarily a radiation and health program and the health program is important. They are a lot of players in the radiation area, the ICRP as an international commission that develops standards, the IAEA that has a UN mandate for radiation safety and in many cases and in many instances the roles of the two organizations tend to overlap a little.

IAEA and WHO's radiation program size is like an elephant and a mouse working together because we have such a small program and they have such a huge program that is devoted only to radiation. There can be criticisms resulting from that, if people feel that WHO is going to be totally influenced or dominated by IAEA and its recommendations.

I know that the WHO has a certain authority that it will look after the health effects and I tell to my IAEA colleagues that health effects is a WHO issue and if you want to give more credence to NGOs that WHO is in the pocket of IAEA, then please leave WHO to do the health effects part. And I have been making sure in the Chernobyl Forum that WHO was totally independent in the development of the health effects section.

The WHO has a small radiation program that has developed over the years from one professional and one secretary to seven professionals and three secretaries. It is still small compared with what they have in the UK, or Germany or France working on the similar issues while we are an international organization. Then we need partners, we have to work through specialized agencies that have a lot of information, a lot of resources and a lot of expertise and this is why we develop our REMPAN program.

Effectively RAD becomes the administrator or the umbrella of the partners looking after a network of organizations working towards a common project to come up with the best advice we can have. Therefore we can enhance the value of the program very significantly by working with good partners.

And we see Japan as a major partner to work with in our radiation programs. It has a huge experience and a lot of knowledge that can be passed on to the other Member States in the world (192 countries) and we need our key partners to be able to help us to provide the best advice we can provide for them. So we do see Japan as a key partner and of course we have been working with the Nagasaki University for a number of years on the telemedicine project, the tissues bank project, and other projects which have been very important in taking the knowledge to the countries that needed it most.

I really look forward to the same kind of collaboration going on to help other parts of the world because I think Japan as a key major high tech country can do a lot of good in the world and we can identify who needs the most information and advice and resources.

So I would like to thank Dr. Yamashita and his colleagues for organizing this seminar and since his time here he has had a major influence on our programs. Our team has become maybe more Japanese than global but that has been for good and I thank him for that and all the people who supported this seminar.

Dr. Saito:

I would like to add a final comment. Nagasaki University has three unforgettable memorial days. First is November 18th 1857, which is the day of foundation of our university. Our university was founded by a Dutch physician Dr. Pompe and is the oldest national university in Japan. This is a cause for our pride. The second one, is 9th August 1945, the day of the atomic bombing of Nagasaki, and the third one I believe is today because Nagasaki's goal is to promote world peace through science and education, and this joint seminar between the WHO and Nagasaki University is the first step of Nagasaki University to start a new international collaborative project based on our 21st century COE research program. I ask all participants to support and encourage Nagasaki University in its mission. Thank you.

Available URL sites

WHO Radiation Program

http://www.who.int/ionizing_radiation/en/

http://www.who.int/diagnostic_imaging/en/

Nagasaki University 21st COE Program

<http://www-sdc.med.nagasaki-u.ac.jp/coe/index.html>

Nagasaki Association for Hibakushas' Medical Care (NASHIM)

<http://www.nashim.org/e/index.html>

Radiation Effects Research Foundation

<http://www.rerf.jp/>

National Institute of Radiological Sciences

<http://www.nirs.go.jp/ENG/nirs.htm>

Nuclear Safety Commission

<http://www.nsc.go.jp/english/english.htm>