The purpose of this department is to develop theories and their applications for analyses of medical, biological and environmental data. The main research projects carried out in 2010 and in the process of making plans in this department are summarized as follows:

1. Estimation of geographical distribution of cancer mortality among atomic bomb survivors in Hiroshima
2. Evaluation of effects of atomic bomb survivors' health handbook on their health promotion
3. Study of estimation of incidence of lung cancer among workers in Ohkuno-Jima poison factory based on a mathematical model on carcinogenesis
4. Study of spatial-time trend of air dose rate of radiation in eastern Japan after the Fukushima Daiichi Nuclear Power Plants accident
5. Study of dose and dose-rate effectiveness factor for unstable-type chromosome aberrations after continuous irradiation with low-dose-rate gamma-rays

We developed computer algorithms/software for these studies and to apply the methodologies for analyses of real data. We also cooperated with many other researchers in the environmental or biomedical fields and gave their studies all aspects of support in theoretical and technological methodologies, such as biometrics, mathematical science, information science, and computer science.

In this fiscal year, Professor Ohtaki organized the 17th Hiroshima International Symposium: Lessons from unhappy events in the history of nuclear power development which was held at Hiroshima on January 25th–26th, 2012. As for personal affairs, Dr. Tetsuji Tonda has been transferred to Prefectural University of Hiroshima as an associate professor on March 31st, 2012.

1. **Estimation of geographical distribution of cancer mortality among atomic bomb survivors in Hiroshima**

   Tonda T, Satoh K, Otani K, Sato Y*, Maruyama H*, Kawakami H*, Tashiro S**, Hoshi M** and Ohtaki M (\(^*\)Division of Radiation Information Registry, \(^*\)Department of Epidemiology, \(^*\)Department of Cellular Biology, \(^*\)Department of Radiation Biophysics)

   **Purpose:** To evaluate risk with respect to individual location at the time of atomic bomb exposure instead of radiation dose.

   **Methods and results:** While there are considerable number of studies on the relationship between the risk of disease or death and direct exposure from the atomic bomb in Hiroshima, the risk for indirect
exposure caused by residual radioactivity has not yet been fully evaluated. One of the reasons is that risk assessments have utilized estimated radiation doses, but that it is difficult to estimate indirect exposure. To evaluate risks for other causes, including indirect radiation exposure, a statistical method is described here that evaluates risk with respect to individual location at the time of atomic bomb exposure instead of radiation dose. In addition, it is also considered to split the risks into separate risks due to direct exposure and other causes using radiation dose. The proposed method is applied to a cohort study of Hiroshima atomic bomb survivors. The resultant contour map suggests that the region west to the hypocenter has a higher risk compared to other areas. This in turn suggests that there exists an impact on risk that cannot be explained by direct exposure. According to the results on the geographical distribution of Black Rain, the area of rainfall appears roughly similar to the region of high risk in the estimated map. This similarity suggests that Black Rain might be a possible risk factor accounting for the geographical distribution of cancer mortality.

2. Evaluation of effects of Atomic bomb survivors’ health handbook on their health promotion
   Otani K, Ohtaki M, Tonda T and Satoh K

   **Purpose:** To evaluate effects of ‘A-bomb survivors’ health handbooks’ focusing on the relationship between a mortality risk and a length of having handbook.

   **Method and results:** Subjects were selected from the Database of Atomic Bomb Survivors (ABS) in Hiroshima Prefecture, which satisfied having been followed up to 2009/12/31. A survival analysis was carried out to examine relationship between a mortality risk and a length of handbook’ possession. Start point is one’s age registered as an A-bomb survivor, end point is one’s age of death from cerebral vascular disease (CVD), or cardiac disease, or malignant tumor. As for CVD, handbook’s effects on health promotion, that means decreasing of mortality risk, revealed in only in male. Regular medical checkup, rapid cure of disease are considered to be included in the reasons.

3. Study of estimation of incidence of lung cancer among workers in Ohkuno-Jima poison factory based on mathematical model on carcinogenesis
   Ohtaki M and Tonda T

   **Purpose:** To estimate incidence of lung cancer among workers in Ohkuno-Jima poison factory based on two type of K-stage model.

   **Methods and result:** For cohort survey data of workers in Ohkuno-Jima poison gas factory, we have applied survival analysis and case-control study. In this study, we evaluated incidence based on two phase K-stage model on carcinogenesis which was well fitted for evaluating effect of radiation exposure on mortality among atomic bomb survivors in Hiroshima. We here used two models on carcinogenesis. One is ordinary K-stage model that radiation exposure affects intensities in all stage. Other is two phases K-stage model that radiation exposure affects intensities in only first two stages. According to the real data analyses, two phase model was well fitted for radiation exposure and one phase model was well fitted for poison gas exposure. This suggests that the period from poison gas exposure to incidence is shorter than that of radiation and poison gas exposure affects intensities in late stages.

4. Study of spatial–time trend of air dose rate of radiation in eastern Japan after the Fukushima Daiichi Nuclear Power Plants accident
   Ohtaki M, Otani K, Tonda T and Satoh K

   **Purpose:** East Japan major earthquake of M9 struck East Japan in March 11, 2011. Subsequently, tsunami attacked Fukushima 1st Nuclear Power Plants. Then, significant amounts of radioactive material have been released into environment. The purpose of this study is to search environmental
factors, other than decreasing of radioactive materials according to their half-lives, that effect on air dose rate of radiation in each spot of the East Japan. We are especially interested in ‘an effect of air dose rate of the day before’, ‘that of elapsed days from the accident’, and ‘that of weather condition of the day (rainy and windy)’.

**Method and results:** The data we dealt with are ‘the spot-specific air dose rates of radiation those were observed at 36 spots in eastern Japan’, which were published in the morning edition of Asahi Shinbun from 13 April 2011 to 13 August 2011. Using a non-linear regression model based on a composite half-life model for radio-activities, we analyzed the data. As results, the reduction of an air dose rate per year is expected to be 19% of the theoretical values obtained by the half-life model. Rain effect on the air dose rate represented a characteristic spatial pattern, that is, when it was rainy day the air dose rates became lower in a neighborhood of the nuclear power plants, on the other hand they became higher in distant regions from the nuclear power plants.

5. **Study of dose and dose-rate effectiveness factor for unstable-type chromosome aberrations after continuous irradiation with low-dose-rate gamma-rays**

Tanaka K*, Kohda A* and Satoh K (*Institute for Environmental Sciences)

**Purpose:** To evaluate the chromosome aberration rates of splenocytes from specific pathogen-free mice after continuous and long-term exposure to low-dose-rates by multiple regression analysis.

**Methods and results:** Chronically exposed individuals, such as nuclear workers, medical radiologists, residents in high-background radiations areas, and residents in radiation-contaminated buildings in Taiwan, have higher incidences of chromosome aberrations than non-exposed individuals; however, the relationship between chromosome aberration rates and the total accumulated dose with continuous low-dose-rate radiation exposure have not been well investigated. Epidemiological studies of human populations have uncertainties and are influenced by confounding factors such as smoking and medical radiation exposure. Animal experiments are therefore needed to complement risk assessment from epidemiological studies. The primary aim of the present study is to identify chronological changes in chromosome aberration rates and the relationship between accumulated doses and chromosome aberration rates in mice after continuous gamma irradiation at low dose rates of 1mGy/day and 20mGy/day. The second aim is to investigate whether dose-rate effects are observed in vivo on chromosome aberration rates for some dose rates by using multiple linear regression models.

A. **Original Papers**

1. Horiguchi J*1, Yamamoto H*2, Arie R*3, Kiguchi M*1, Fujioka C*1, Ohtaki M, Kihara Y*2 and Awai K*4 (*1Dept Clinical Radiology, *2Dept Cardiovascular Medicine, *3Chuden Hospital, *4Graduate School of Biomedical Sciences): Is it possible to predict heart rate and rage during enhanced cardiac CT scan from previous non-enhanced cardiac CT?, *J of Digital Imaging* **24**(4), 688-693, 2011. (I)


### B. Meeting Presentations


21. Otani K and Ohtaki M: Spatial- time trend on air dose rate of radiation in eastern Japan: from the Fukushima 1st nuclear power plants accident, Conference supported by Grant-in-Aid for Scientific
(****Division of Radiation Information Registry, ***Dept Epidemiology, **Dept Cellular Biology, *Dept
Radiation Biophysics): Investigation on circular asymmetry of geographical distribution of mortality
risk in Hiroshima atomic bomb survivors, The 17th Hiroshima International Symposium ‘Lessens from

23. Otani K, Ohtaki M, Tonda T, and Satoh K: Time trend on air dose rate of radiation in eastern Japan :
from the Fukushima 1st nuclear power plants accident, The 17th Hiroshima International Symposium

Tests among Inhabitants in the Semipalatinsk Area, The 17th Hiroshima International Symposium

Ohtaki M (**Division of Radiation Information Registry, ***Dept Epidemiology, ****Dept Radiation
Biophysics, *****Dept Cellular Biology): Outline of database of atomic bomb survivors in Hiroshima
prefecture (ABS) and toward practice, International Symposium 50th Anniversary of RIRBM,
Hiroshima University, Hiroshima, 2012.

geneses of obesity on an University student health survey - report 3, The Annual Meeting of Hiroshima

C. Others

1. Takada H, Matsuba J and Ikeda M (Teikyo University of Science): Translation of “NeuroKinetic

2. Takada H and Matsuba J (Teikyo University of Science): Translation of “A Massage Therapist’s Guide

3. Takada H, Matsuba J and Ikeda M (Teikyo University of science): Translation of “Clinical Massage in