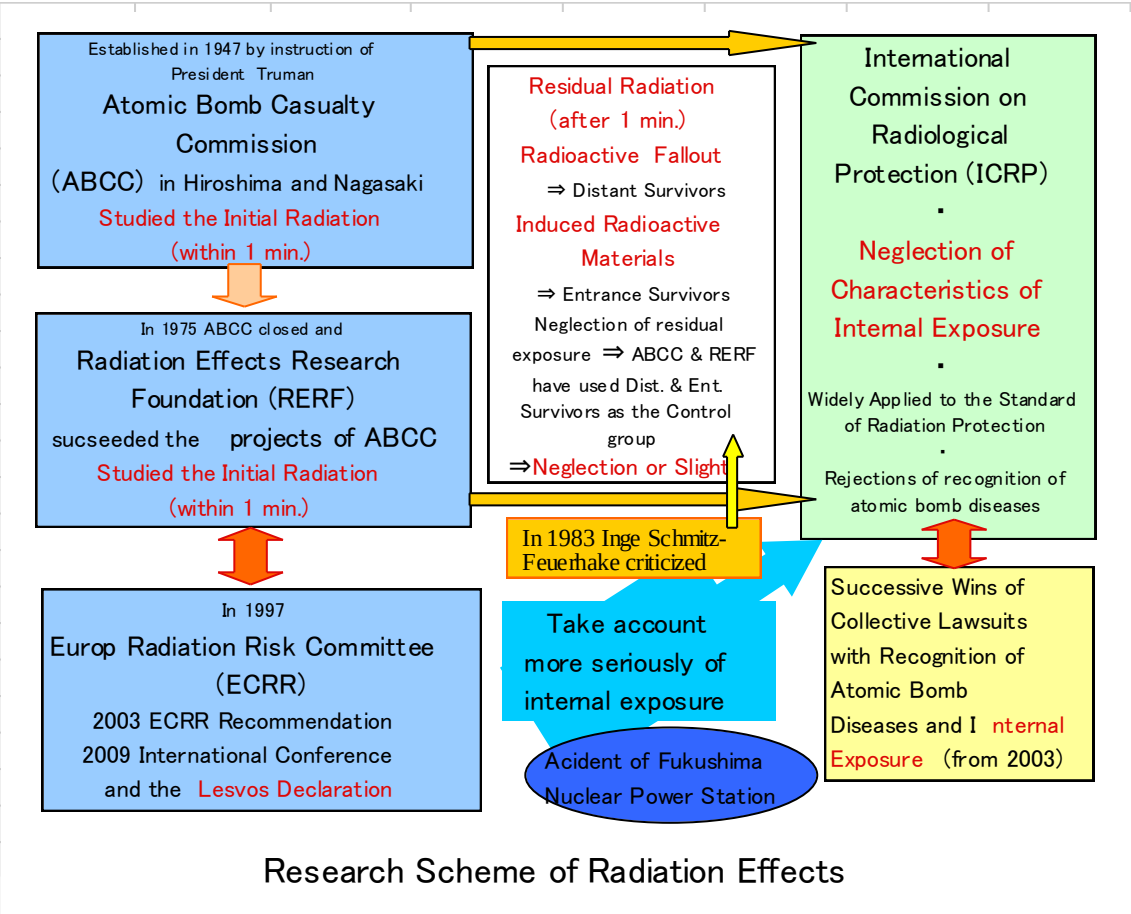
Report in the symposium in the occasion of the 1st general meeting of the Association for Citizens and Scientists Concerned about Internal Radiation Exposures (ASCIR)
22 April 2012

Toward a World without Threat of Radiation Exposures

Shoji Sawada

Disregard of residual radiation exposure by ABCC-RERF

The figure below shows systems that have studied the effects by radiation on atomic bomb survivors of Hiroshima and Nagasaki. The Atomic Bomb Casualty Commission (ABCC) was established in 1947 instructed by President Truman. The ABCC placed great importance on effects by the initial radiation emitted within one minute after atomic bomb explosion and did not care about residual radiation emitted after one minute. The first of the residual radiation is emitted from radioactive fallout which fell from the atomic bomb cloud.



Research Scheme of Radiation Effects

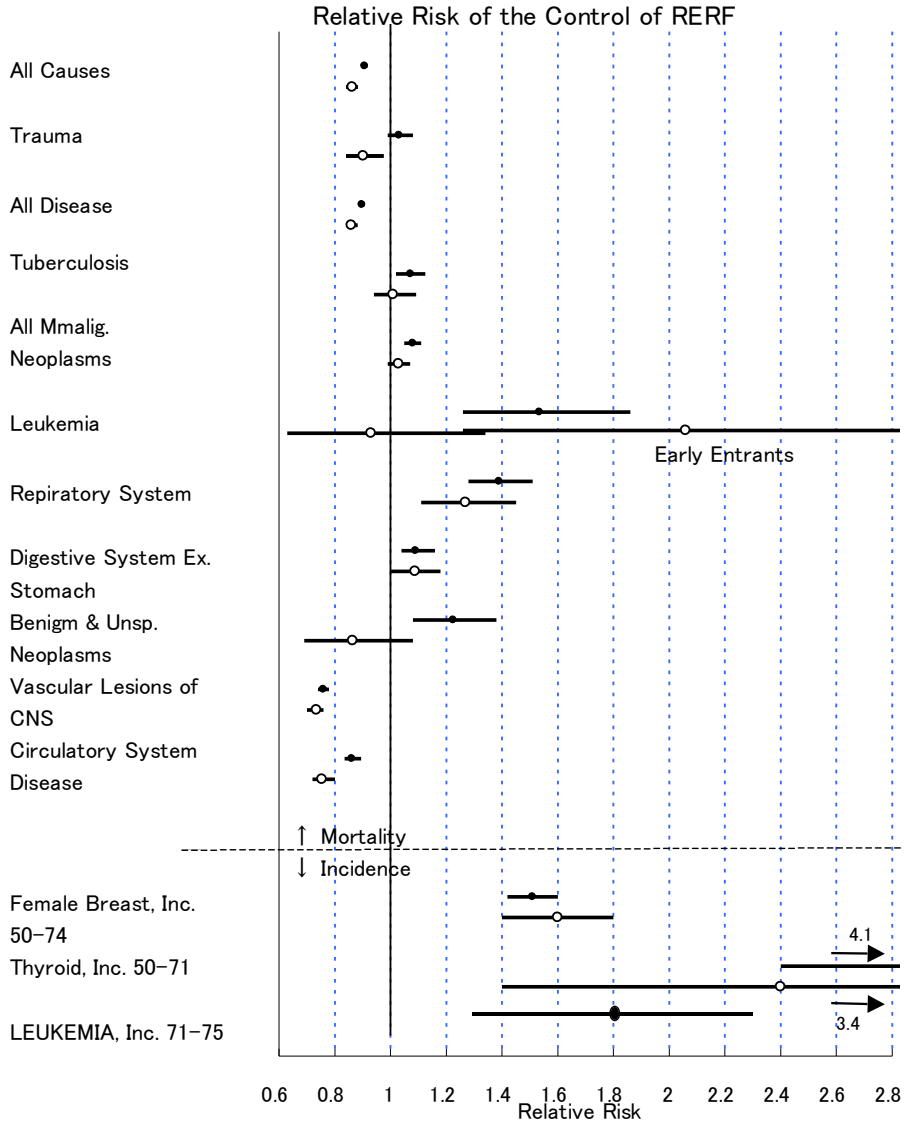
This fallout affected even the long distant survivors scarcely reached by initial radiation. The second of the residual radiation is emitted from the material which was induced to radioactive by absorption of initial neutron heavily injected in the region near the hypocenter. The entrant survivors who entered in this region before these materials were washed out by typhoons after 40days later were exposed by this residual radiation. The internal exposure became important in these exposures from residual radiations. In 1975 the ABCC closed and the Radiation Effects Research Foundation (RERF) putting under the joint control of Japanese and USA governments was established and succeeded the research programs which placed great importance on effects by the initial radiation. The results of research by the RERF were sent to the International Commission on Radiological Protection (ICRP) and the ICRP has prepared the standards of radiation protection which ignored the characteristics of internal exposure. These standards were used for the standards in many countries in the world.

Exposure Effects among Distant and Entrant Survivors of the RERF: Study by Professor Inge Schmitz-Feuerhake

Professor Inge Schmitz-Feuerhake, who is the president of the ECRR and send a celebration message to our general assembly of establishment of ACSIR, obtained various relative risks of mortalities and incidence of the distant and entrant survivors in comparison with those of the average of Japanese as the comparison group in 1982. Her thesis did not submit in peer journal but only a “letter” by rejection of referee of the journal. The obtained relative risks of distant survivors are shown by closed circles and those of entrant survivors by open circles in the figure in the next page which are obtained from the rates of mortalities or incidences dividing by those of the Japanese average.

The fact that the relative risks of all death and all diseases among survivors are less than 1 can be explained by a reason that the survivors are provided the health care notebook and are conducted regular medical and for cancer examination every year and by the result of early detection and early treatment. The fact that the mortality relative risks of cancers of the respiratory organs and leukemia among early entrant survivors are considerably large and furthermore the relative risks of incidence of the breast cancer, thyroid cancer and leukemia are very large among distant and entrant survivors shows the exposure effects by the residual radiation are large. Professor Inge pointed

out that the research of the RERF in which the distant and entrant survivors with exposed effects by the residual radiation have used as the control group have severe problems.



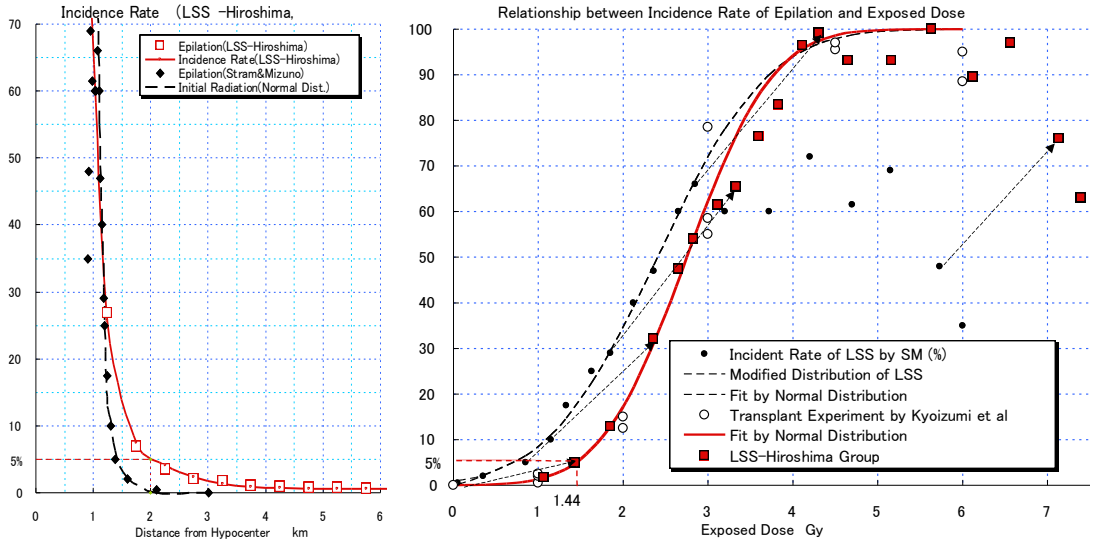
Estimation of the Fallout Exposure in terms of the Incidence Rates of Acute Radiation Diseases

Previous estimations of the fallout exposure were based on the measurements of radiation emitted from radioactive material which were brought by fallout rains and soaked into ground and did not carried off by heavy rain caused by fire immediately after bombing and by flood accompanying typhoon. Among fallout not only so called

‘black rain’ but also a huge amount of fine particles filled atmosphere in the wide region under atomic cloud which were produced from small rain drop of the atomic cloud evaporated during their descent. Atomic bomb survivors took the radioactive fine particles into their body through respiration and/or eating and drinking and received internal exposure by radiation emitted from these fine particles. Differently from the cases of the prepared nuclear explosion tests the effects by radioactive fine particles which were dispersed with movement of atmosphere could not been measured by physical methods after the dispersion. Then the radiation doses of atomic bombing can be estimated from the exposed effects among the survivors. Though there are many material recorded various examinations of effects among atomic bomb survivors research to clarify the radiation from these materials had been done scarcely.

One of ways to clarify rather accurately the exposed radiation dose may be incident rate of depilation examined by ABCC around 1950 among the Life-Span-Study（LSS）group. From this data of incidence rates the exposed radiation dose were derived on the basis of relation between incidence rates of depilation and exposed dose. On the basis of this approach I obtained the exposed doses from the initial and fallout atomic bomb radiations wrote English article and submitted pear review magazine but rejected because if this article might appeared there will occur disorder due to much difference from common sense in the past as well as political. However finally my English article was inserted in “Bulletin Social Medicine” last year. In the following I will show some parts of the article.

Red squares in the left side figure below show incidence rates of depilation at distances from the hypocenter of Hiroshima examined by the ABCC around 1950.

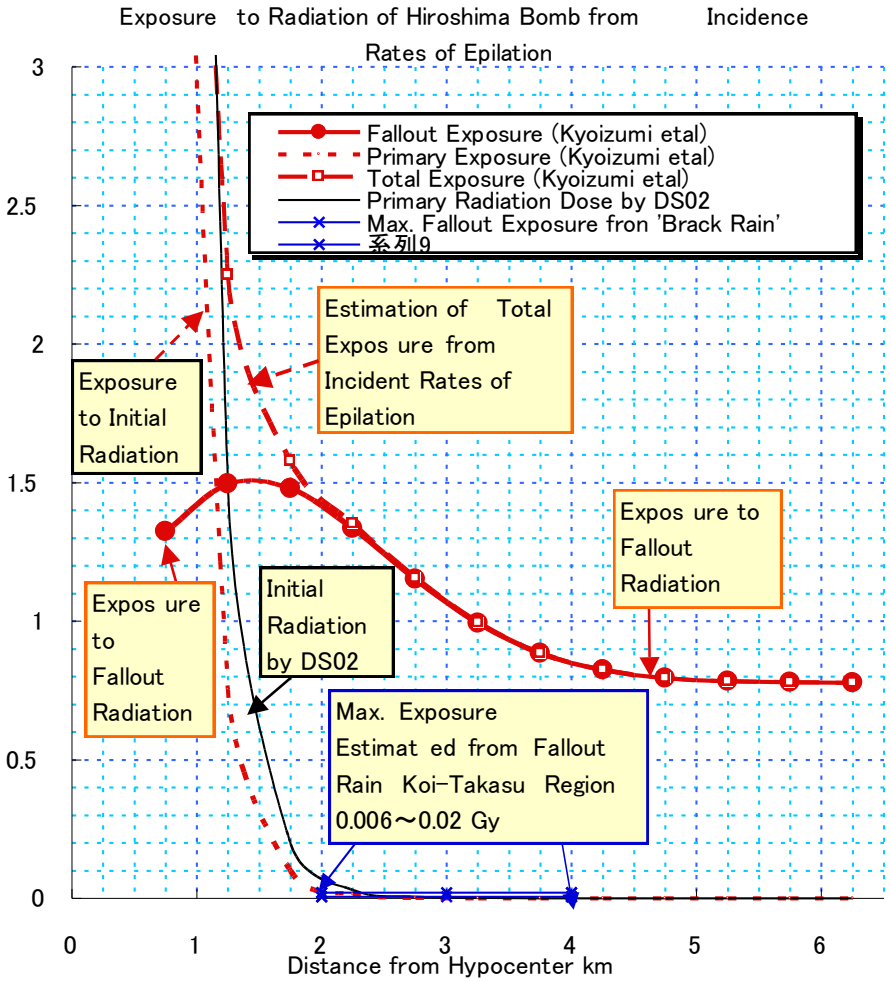


From this data Stram and Mizuno obtained relation between exposed doses by initial radiation and incidence rate of depilation by use of the Dosimetry System of Atomic Bomb Radiation (DS86). Their results were shown by black circles in the right side figure. The reason that the black circles become flat or even decreasing in the regions beyond 3 Sv is explained as follows. In the LSS cohort which was set up in 1950 and contain only survivor who could survived more than 5 years in spite of heavy exposure around the half death dose exposure about 4 Sv which means a half people dead within 60 days after exposure as pointed out by Alice Stewart et. al. Furthermore Stram and Mizuno made large subtraction of incidence rates in the short distance from the hypocenter as the background effects by other than the initial radiation. Diamond-shaped marks in the left side figure show incidence rates of depilation for distance from the hypocenter obtained from the black circles in the right side figure by use of the DS86. The difference between square marks and the diamond-shaped marks is corresponded to the exposure effects by fallout radiation. Open circles in the right side figure are incidence rate of depilation for exposed dose obtained by Kyoizumi et. al. based on experiment in which head skins of died fetus are implanted into immunity removed mice and exposed by X-rays. On the basis of the difference between black circles and diamond-shaped marks in the right side figure it is inferred that the relation of incidence rates and total exposed dose by both of the initial and fallout radiation will almost coincide to the open circles those obtained by Kyoizumi et. al by moving black circles obtained by Stram and Mizuno towards higher dose. From animal experiments it is known that most of incidence or mortality rates are distributed as the normal distribution (the normal distributions are most popular distribution such as appear in the height and weight distributions). By fitting the open circles with a normal distribution a red curve shown in the right side figure is obtained. By use of this normal distribution with expectation value 2.751 Sv and standard deviation 0.793 Sv and the incidence rates shown by square marks in the left side figure the chi-square method leads a figure in the following page for the exposure effective doses of initial, fallout and total radiations.

Without the chi-square method one can get total exposure dose as follows: At 2 km from the hypocenter, for example, the incidence rate of depilation is about 5% from the square marks in the left side figure and the incidence rate 5% corresponds to exposed dose 1.44 Sv as shown in the right side figure. Thus at 2 km the total exposure dose is

estimated as 1.44 Sv. Since the initial radiation dose at 2 km is estimated as 0.04 Sv by the DS86 or DS02, then the fallout exposure dose is 1.4 Sv. These obtained values of doses almost coincide with those in the figure below. The reason that the curve of fallout exposure does not drawn in the region below 1 km from the hypocenter is that the initial radiation doses enough large to cause depilation almost 100% incidence rate in this region then one can not estimate the fallout exposure contributions.

As seen in this figure the initial radiation dose (both of reached dose estimated by DS02 and shown by black curve and exposed dose with shielding effects shown by thin red broken line) rapidly decreases beyond 1.2 km from the hypocenter. Then beyond 1.2 km fallout radiation gave dominant contributions for exposure effects. The measured external exposure from radioactive materials brought by fallout rains and absorbed into soil are from 0.006 Sv to 0.02 Sv shown by crossed marks in the above figure and these values are underestimation about 100 times compared to those obtained from incidence rates of depilation.

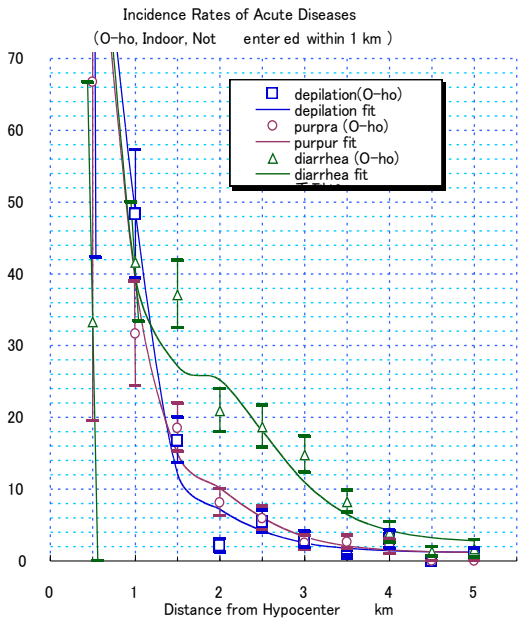


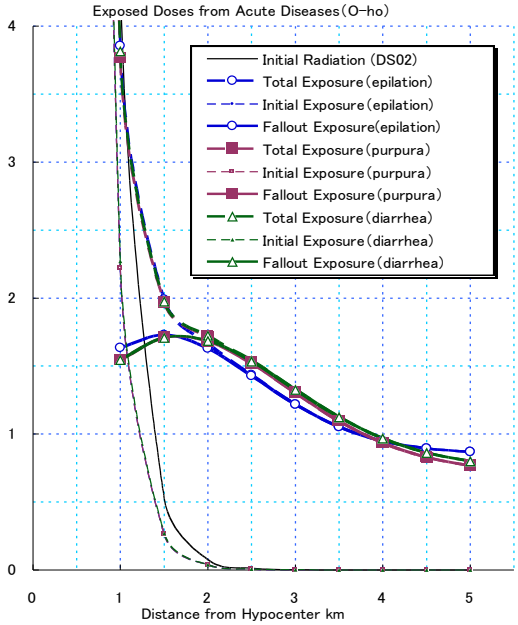
Main Effects from Fallout were Internal Exposure

On the basis of incidence rates comparison among diarrhea, depilation and purpura it is possible to show that the main contributions of fallout exposure effects were those of internal exposure due to intake of radioactive fine particles. O-ho, a medical doctor of Hiroshima, examined incidence rates of various acute radiation diseases among Hiroshima atomic bomb survivors, who were bombed indoors or outdoors, entered or not entered within 1 km from the hypocenter within 3 months after bombing, separately. The right-hand figure in the next page shows incidence rates of depilation (square), purpura (caused by decrease of blood platelets. shown by circle) and diarrhea (triangle) examined by O-ho among survivors bombed indoors and not entered into regions within 1 km from the hypocenter. Both of incidence rates of depilation and purpura behave almost similarly. Then for the relation of incidence rates of purpura and exposed dose the same normal distribution with that for depilation examined by ABCC is used. But those of diarrhea are smaller below 1.5 km and larger beyond 1.5 km compared with depilation and purpura. This can be explained by the fact that in regions near the hypocenter the initial radiations were very strong and fallout radiation was relatively weak prevented by very strong ascending current following the atomic cloud caused by fires. Diarrhea was caused by exfoliation of dead cells of intestinal wall which are replaced by new cells about 4 days and very sensitive to radiation. Even if gamma rays or neutron flux of the initial radiation with strong penetrativity could reached to the cell of intestinal wall these radiation passed away without damages to these cells because strong penetrativity means very sparse ionization effects. Then it is known that in the case of external exposure diarrhea is caused only in the case of exposure which exceed much beyond the half death dose. Survivors bombed indoors within 1 km and survived until 1957 were considered with strong resistance to radiation which lead to small incidence rate of diarrhea.

On the other hand in the distant regions survivors took radioactive fine particles of fallout into their body by inhalation and digestion and the beta ray and alpha ray with weak penetrativity emitted from the fine particles on the surface or in the capillary of intestinal wall and caused very dense ionization within the cells which leaded to diarrhea. Then for the analysis of incidence rates of diarrhea the normal distribution N(3.o26 Sv, 0.873 Sv) shifted towards higher dose of 1.1 times than that used for depilation for initial radiation exposure and the normal distribution N(1.981Sv , 0.572

Sv) shifted toward lower dose of 0.72 times than that used for depilation for fallout radiation exposure. The fitted results are shown by thin curves in the right-hand figure and obtained exposure doses are shown in the right-hand figure of the next page It should be notified that the results of the initial radiation exposures and fallout exposures from incidence rates of three kinds acute diseases, depilation, purpura and diarrhea almost coincide with each other and with that obtained from incidence rates of depilation examined by ABCC. In the regions beyond 1.2 km from the hypocenter the exposures by fallout exceed than those from the initial radiation and reached to 1.5 Sv at about 1,5 km from the hypocenter, then decrease slowly with distance and become 0.8 Sv at the distance 5 km. The incidence of diarrhea by fallout is caused essentially by the internal exposure, then the coincidence of fallout exposure indicates that the incidence of depilation and purpura in the distant regions were caused also mainly by the internal exposure of fallout radiation. From the incidence rates of acute diseases, which are representative of actual situation of radiation exposure, it is clarified that the main exposure effects of the fallout radiation were the internal exposure and that the severe effects by the internal exposure from fallout have not been reflected in the studies by RERF which have ignored this fact and international radiation protection standard proposed by ICRP which are based mainly on the studies by RERF.



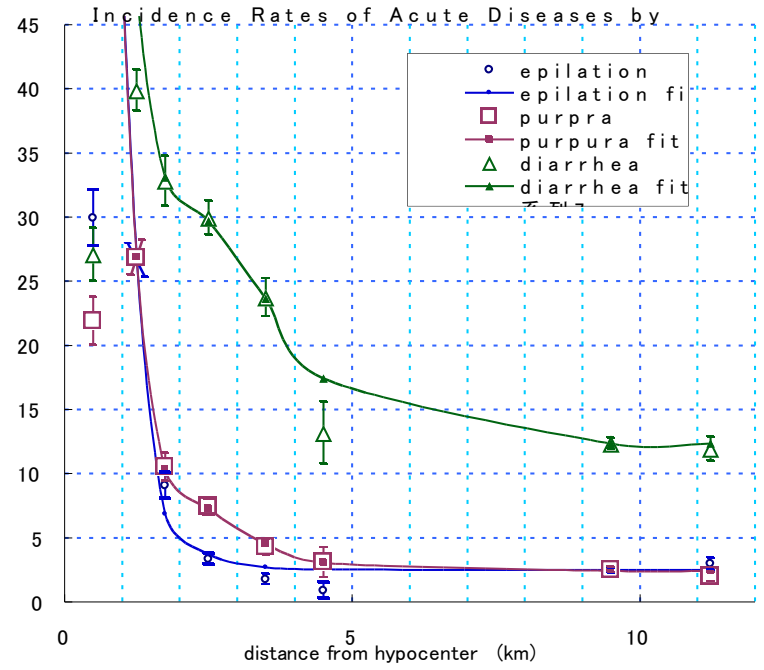


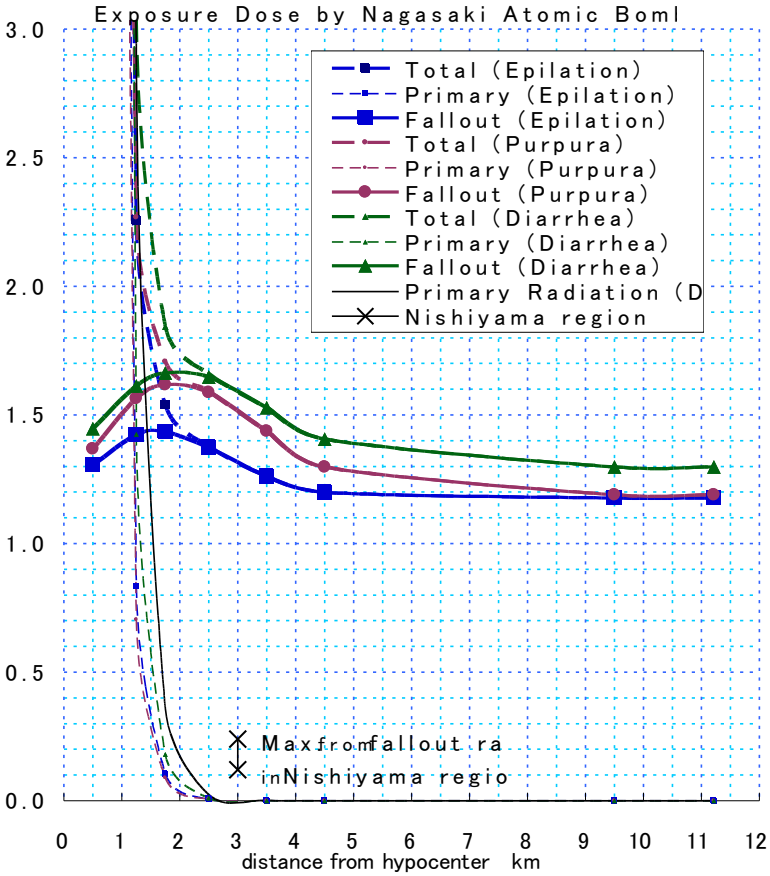
Exposure Dose from Nagasaki Atomic Bomb

For estimation of radiation exposure by Nagasaki atomic bombing from the incidence rates of acute diseases in the region within 5 km from the hypocenter the results of incidence rates of depilation, purpura and diarrhea examined in 1945 by Nagasaki Medical College are used. For the people who were bombed by Nagasaki atomic bombing in the regions between 5 km and 12 km from the hypocenter and not provided the health care notebook for atomic bomb survivors are called as "atomic bomb experienced person" by the Japanese government. For results on the same diseases are used which were examined in 1999 and 2000 by Nagasaki city for newly incorporated regions into Nagasaki city (the averaged distance from the hypocenter is 9.5 km) and by Nagasaki prefecture for outside of Nagasaki city (the averaged distance from the hypocenter is 11.2 km). Among these data it is seen some unevenness for direction from the hypocenter and for towns and villages but can be understand as the statistical fluctuation without systematic meaning, then the two average values are used for inside and outside of Nagasaki city.

Incidence rates of acute diseases, depilation, purpura and diarrhea for both regions inside and outside of 5 km from the hypocenter are shown in the figure below. The incident rates of depilation and purpura behave similarly as in Hiroshima except for in a region between 2 km and 5 km where the rates of depilation slightly smaller than those of purpura. Incidence rate of diarrhea within 1 km is small as in Hiroshima but both incidence rates of depilation and purpura are also small. This fact may be explained that most of people bombed in this region already dead in October 1945 at the time of examination and can not derive meaningful results due to low reliability. Then these data did not used in the present analysis as in the Hiroshima case. Incidence rates of diarrhea are about 5 times of those of depilation and purpura which is similar or slightly larger as has seen in Hiroshima.

Similar analysis as done in Hiroshima the exposure doses from Nagasaki atomic bombing are obtained as shown in the above figure. The effective dose including the internal exposure by fallout exceed those of initial radiation at about 1.2 km from the hypocenter as in Hiroshima. The exposure doses from fallout reach to the maximum value at about 2 km from the hypocenter for purpura and diarrhea and almost constant values 1,2 Sv ～1.3 Sv beyond 5 km from the hypocenter. This fact may be corresponded to the observation of Nagasaki atomic cloud that thickness of surrounding





part of cloud was almost constant from 5 km to 15 km from the center of the cloud. The measured results of radiation from residual radioactive matter brought by fallout rains are 0.12 Sv～0.24 Sv at Nishiyama region located 3 km east from the hypocenter

as shown by ×marks in the figure. The estimated "averaged value" from incidence rates at this distance become 5 to 10 times than the measured maximum values.

Exposed doses of 1.2 Sv～1.3 Sv from the fallout of Nagasaki bomb are about 1.5 times of those from Hiroshima bomb 0.8 Sv. This difference can be explained by the facts that the explosion yield of Nagasaki bomb is 1.4 times of that of Hiroshima which means the amount of radioactive fission products were 1.4 times and that more amount of induced radioactive equipment and container of the bomb were produced by absorption of much neutrons compared to Hiroshima and that radio-activities of plutonium remained without chain reaction are much stronger than uranium of Hiroshima bomb.

In Nagasaki, directly bombed survivors who were provided the health-care notebook for survivors (the legal certificate of atomic bomb survivor) are only people who lived in the old Nagasaki city and in the very restricted surrounding regions. The territory of old Nagasaki city was very long from south to north and narrow from west to east and the hypocenter is located in Uragami region in the northern part of old city. Then people who lived in the old city at point of even 12 km from the hypocenter were provided the notebook. On the other hand people who were bombed in the regions with distance 5 km～12km from the hypocenter but not belong to the old city of Nagasaki are not provided the health care notebook. The examinations within 12 km from the hypocenter made by Nagasaki city and Nagasaki prefecture are related to the demand to provide the notebook by these people. As shown before people bombed in these regions were exposed 1.2 Sv～1.3 Sv from fallout radiation in average then it should be provided the notebook. Committee members who inspected the examined results by Nagasaki city and Nagasaki prefecture submitted a report to the government that the effects of fallout radiation can be neglected but these people might be received mental shock by atomic bomb experiences. On the basis of this report the Japanese government introduced an item "atomic bomb experienced person" whose mental diseases are recognized as the effects by the atomic bombing except people who were child under age 4 at the bombed time because of no memory of bombed experience in their brains.

Among "atomic bomb experienced person" cancers occur frequently and the multiplex of cancer are seen then more than 500 people among them are suing now demanding to provide the health care notebook. In the last year with a meteorologist

Yoshinobu Masuda and a doctor Hajime Kikima I took the witness stand of the court and testified about exposure by the fallout radiation described above. Against my opinion presented to court a scientist of government side submitted opposed document in which he insisted that depilation occurred in distant regions had originated from mental effects and diarrhea was due to an insanitary circumstance and denied radiation origins without any scientific ground. Furthermore, in spite of a great mistake in his document, among 20 co-authors singed in this document anyone did not discovered this mistake showing their shabby viewpoint. This fact shows a regrettable conditions that the government side scientists studying the radiation effects have not study based on the real situations among atomic bomb survivors and only borrowed the RERF.

Underestimation of the risk of malignant tumor mortality in the RERF study

The RERF have derived the risks of various cancers from atomic bomb survivors comparing essentially with distant survivors ignoring the exposure from fallout radiation (See Appendix : Poisson recursion method used by the RERF which leads to make distant survivor group to the control group of epidemiology). In order to examine to clarify how amount of underestimations for the cancer risks in the RERF research I use results on the mortality of malignant tumor obtained by the Research Institute for Nuclear Medicines and Biology of Hiroshima University (RINMB) which is obtained from survivors compared with those not survivors living in Hiroshima Prefecture from 1968 to 1972 (N. Kurihara, et. al.).

Table I shows that the mortalities by malignant tumors per a year for male, female and total among survivors for division of bombed distance and not survivors obtained by Kurihara et. al. In Table 2 for every divisions, averaged exposed doses of the initial radiation on the basis of DS02, estimated exposed doses by fallout radiation obtained from the incident rates of depilation examined by ABCC and sums of these doses are shown. Furthermore Table 2 shows the relative risks of malignant tumor of directly bombed survivors obtained by use of the population without survivors and by use of the distant survivors beyond 2 km from the hypocenter taking as the comparison group (control cohorts), and increase values of the relative risks for 1 Sv increase of exposed dose for these two cases by assumption that the relative risk increase linearly. In the RERF research the distant survivors with exposed dose less than 0.005 Sv of the initial radiation essentially used as the control correspond to those bombed beyond 2.75 km

Table 1 Mortalities by Malignant Tumor per Year among Atomic Bomb Survivors by the Research Institute for Nuclear Medicines and Biology, Hiroshima University

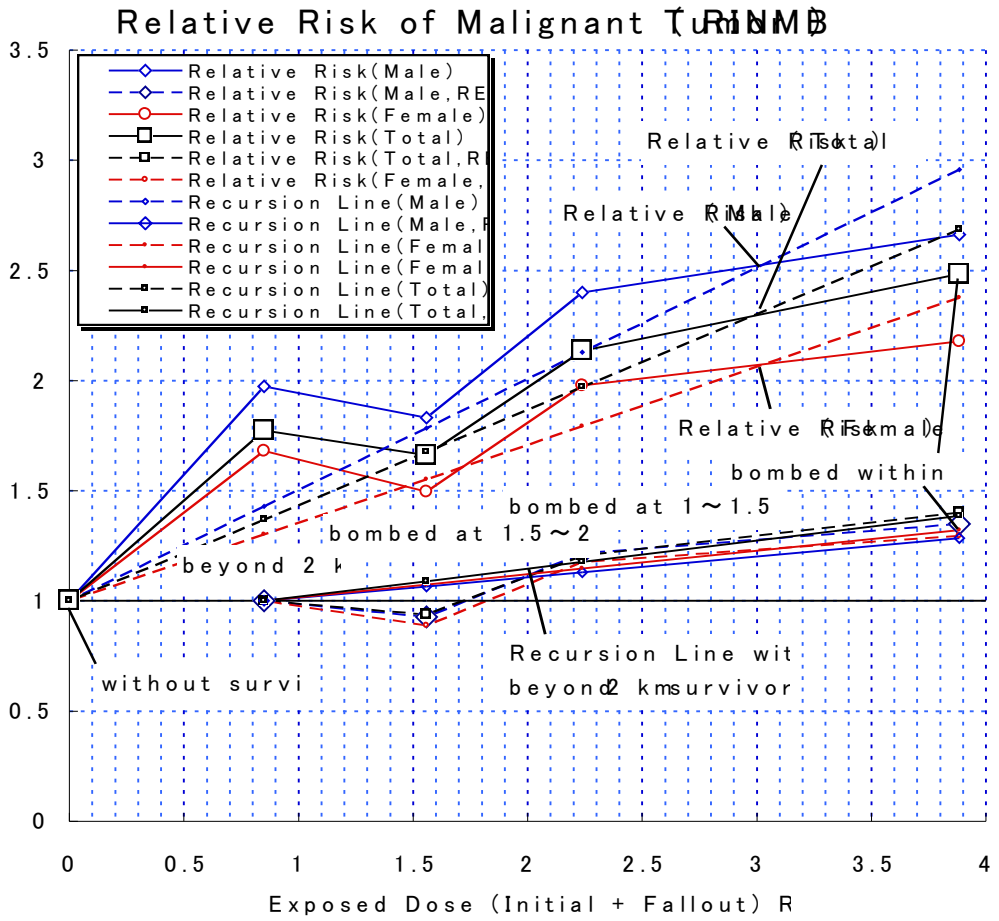
		Directly Bombed Survivors				Total Survivors	Not Survivors
		Within 1km	1～1.5km	1.5～2km	Beyond 2km		
Male	Persons-years1968--72	19,637	42,025	60,505	75,968	370,343	3,537,580
	Death Number by MT	99	191	210	284	1,729	6,700
	Mortality per year	0.504	0.454	0.347	0.374	0.467	0.189
Female	Persons-years1968--72	18,968	61,222	172,919	116,992	421,266	3,884,180
	Death Number by MT	58	170	153	276	1,037	5,451
	Mortality per year	0.306	0.278	0.210	0.236	0.246	0.140
Total of Male and Female	Persons-years1968--72	38,605	103,247	133,424	192,960	791,609	7,421,760
	Death Number by MT	157	361	363	560	2,766	12,151
	Mortality per year	0.407	0.350	0.272	0.290	0.349	0.164

and exposed dose of initial radiation is at 2 km 0.0768 Sv by the DS02, this difference between the initial radiation doses is negligible compared with exposed doses from the fallout radiation between 1.1 Sv and 1.4 Sv in these region.

The relative risks shown in Table 2 are plotted in Figure in the next page. The relative risk of population of Hiroshima Prefecture without survivors which is made as the control is 1, then the gradients of recursion lines which pass this point and comprehensively represent all relative risks gives the increase of relative risk for 1 Sv increase of exposed dose. The values for male, female and total of both sex are 0.50, 0.35 and 0.43, respectively. On the other hand if ignoring the fallout exposure the distant survivors beyond 2 km with averaged exposure dose of 0.85 Sv as in the RERF research the gradients of recursion lines, that are increases of relative risks for increase of exposed dose are 0.094, 0.11 and 0.13, respectively. Then the mortality risks of the malignant tumor with the population without survivors as the control become 5.4, 3.3 and 3.4 times of of mortality risks obtained with the distant survivors as the control. Then it is clear that under estimation of the mortality risks in the case where the distant survivors are used as the control as in the research by the RERF.

Table 2 Mortality Risks of Malignant Tumor among Survivors in Hiroshima Prefecture

		Directly Bombed Survivors				Without Survivors
		Within 1 km	1～1.5km	1.5～2km	Beyond 2 km	
Ex-posed Dose	Average Exposed Dose from Initial Radiation	1.614	0.77	0.1	0	0
	Average Exposed Dose from Fallout Radiation	2.27	1.469	1.458	0.85	0
	Total Sum of Averaged Exposed Dose	3.884	2.239	1.558	0.85	0
Male	Relative Risk by RIRMB	2.662	2.400	1.833	1.974	1
	Relative Risk by RERF	1.3476	1.2139	0.9278	1	–
	Increase RR for 1Sv	RIRMB 0.504 /Sv, RERF 0.0939 /Sv				
Fe-mail	Relative Risk by RIRMB	2.1857	1.9857	1.5000	1.6857	1
	Relative Risk by RERF	1.2966	1.1780	0.8898	1	–
	Increase RR for 1Sv	RIRMB 0.354 /Sv, RERF 0.106 /Sv				
Total	Relative Risk by RIRMB	2.4817	2.1341	1.6585	1.7683	1
	Relative Risk by RERF	1.4034	1.2069	0.9379	1	–
	Increase RR for 1Sv	RIRMB 0.434 /Sv, RERF 0.127 /Sv				



Dr. M. V. Malko of Belarus who visited Japan this April obtained incidence rates of various cancers caused by Chernobyl power plant accident and compared with those of atomic bomb survivors of the Life-Span-Study (LSS) of RERF. Table 3 compared increase of solid cancer incidence per year exposed 1 Sv among 10 thousands population (excess absolute risks) for both cases. Confidence Interval of 90% represent the excess risks lie between these intervals with 95% probability and only 5% probability in the outsides of this interval if the statistical errors are taken into account.

If we take into account the effects of fallout radiation exposure as in the RERF research the excess values increase 3.3 ～ 5.5 times but there remain some factors in the compared ratios between the Belarus population and atomic bomb survivors. The remaining factors may be explained by that in the measurement in Belarus whole body counters were mainly used which could measure the gamma ray from decay of the excited level of Ba137 to its ground state following to the beta decay of Cs137 into The excited level of Ba137 and calculate the total exposure effects both of the gamma decay and beta decay into Sv on the basis of the ICRP estimation rule in which both of the Relative Biological Effectiveness of gamma ray and beta ray are taken equally 1 even in the internal exposure. As is seen in the case of diarrhea the beta ray gives several times stronger effects than gamma ray in the internal exposure. The remaining factors between Belarus and LSS may be explained by these factors. If this is the case the similar problem will be applied to the whole body counter measurements in the Fukushima accident and estimations of internal exposure values needs reconsideration.

Table 3 Comparison of Incidence Risks of Solid Cancer among Belarus population with Life-Span-Study (LSS) Cohort of RERF (Atomic Bomb Survivors) (10^4/person・year・Sv).

Organ of Cancer	Population of Belarus		Atomic Bomb Survivors LSS		Ratio
	Excess of Relative Risk	95% Confi-dence Interval	Excess of Relative Risk	95% Confi-dence Interval	
Thyroid	4.4	4.2 ～ 4.6	1.2	0.5 ～2.2	3.7
Stomach	69.1	44.5 ～ 79.5	9.5	6.1 ～14	6.5
Lung	60.2	41.7 ～ 78.9	7.5	5.1 ～ 10	8.0
Breast	44.3	17.9 ～ 70.9	9.2	6.8 ～12	4.8
Bladder	37.8	31.3 ～ 44.4	3.2	1.1 ～ 5.4	11.8

Atomic bomb survivors (LSS) 30 years old at that time and survived 70 years old were examined (D. L, Preston et. al. ; Solid Cancer Incidence in Atomic Bomb Survivors; 1958-1998,Radiation Research, 168, 1-64 (2007).).

Role of the Association for Citizens and Scientists Concerned about Internal Radiation Exposure

As mentioned above, the studies about the effects of radiation to the atomic bomb survivors done by the RERF which have get great international authority, have large defects due to ignorance of fallout exposure lead to the large underestimation of radiation exposure effects. Affected by these RERF studies, the international standard of radiation protection proposed by the International Commission on Radiological Protection (ICRP), UNSCAER and IAEA also have large underestimation. Furthermore, ICRP have ignored special characteristics of internal exposure as saying that the effects by internal exposure is complete the same with external exposure if measured dose is same. This is not valid as is seen in the diarrhea among atomic bomb survivors and should not ignore the special character of internal exposure. In the radiation protection standards by ICRP the different limits to maximum exposure between workers treating radiation and usual people by taking a balance of convenience or utility. However there are no difference among resistance ability between radiation workers and usual people. I claim that the protection standard to radiation exposure should be determined in principle that prevent health of people as well as radiation workers from radiation exposure.

In collaboration with world scientists it should be clarify the effects of radiation to the human bodies including internal exposure on the basis of scientific truth. Based on these truly scientific ground it is required the medical examination and treatment system with sufficient scale and facilities. I think that it is now required that the effects of the Fukushima accident are dealt with scientifically and democratically from the viewpoint of citizens and minimize the exposure effects by Fukushima TEPCO accident.