Slide 1: Radiation and Cancer Risk

Radiation Effects Research Webinar “Radiation and Cancer Risk”

These slides provide a basic understanding of the effects of radiation exposure on cancer risk.

Slide 2: Health Effects of Radiation Exposure

1. Health effects of A-bomb radiation exposure can be classified generally into “acute radiation symptoms” and “late effects of radiation.”
2. Acute radiation symptoms are considered to be caused by cell death resulting from high-dose exposure.
3. Symptoms such as hair loss, vomiting, and internal bleeding appear a short time after exposure.
4. Unlike acute radiation symptoms, late effects of radiation are considered to be caused by DNA mutations and other changes in cells brought about by radiation exposure.
5. Late effects include leukemia and other cancers that develop several years after radiation exposure.
6. The Radiation Effects Research Foundation investigates long-term effects of A-bomb radiation on the development of cancers and other diseases by monitoring the health status of A-bomb survivors throughout their lives.

Slide 3: Life Span Study

1. A research program called the “Life Span Study” forms the basis for determining radiation health effects.
2. The objective of the Life Span Study is to investigate the effects of radiation on the health of A-bomb survivors over their lifetimes, based on an epidemiological study design.
3. Long-term effects of radiation exposure have been investigated by periodically analyzing data obtained in this study concerning cancer incidence as well as mortality from cancer and other causes.
4. The Life Span Study comprises about 120,000 subjects in total, including around 94,000 A-bomb survivors.
5. Subjects were selected from among individuals confirmed to be living in the cities of Hiroshima and Nagasaki in Japan’s 1950 National Census.
6. In this study, mortality from cancer and other causes as well as cancer incidence have been studied since 1950 and 1958, respectively.
7. First, interviews concerning exposure status were conducted with the subjects of the Life Span Study to estimate the radiation dose to which each individual was exposed.
8. Subsequently, information on lifestyle, disease development, and mortality has been obtained through mail questionnaires and other methods.

Slide 4: Studying Radiation Effects

1. How are radiation health effects studied?
2. For the Life Span Study, investigation into such effects is conducted using a cohort study method.
3. A simple example of the method is the consideration of two groups composed of individuals of similar characteristics in terms of age, sex, and year of birth. One group has been exposed to radiation, and the other group has not been exposed.
4. The health status of each of the individuals in the respective groups is followed to study the development of diseases such as cancer.

5. Cancer incidence is calculated to determine the likelihood that the subjects in each of the two groups will develop cancer.
6. The incidence rate of the development of diseases such as cancer is calculated by dividing the number of disease cases by the total years of the follow-up period.
7. Radiation effects on cancer development can be shown by the ratio of the incidence rates for the two groups.
8. This ratio is called the “relative risk” of radiation, and is calculated in this example to be 1.18.
9. Calculation of the relative risk in this case showed that the cancer incidence in the exposed group was 1.18 times higher than the incidence in the unexposed group.
10. In other words, the study demonstrates that the cancer incidence in the exposed group increased by 18% compared with the incidence in the unexposed group.
11. This percentage is the “excess relative risk” of radiation.

Slide 5: A-bomb Radiation and Cancer Risk

1. What is the relationship between A-bomb radiation and cancer risk?
2. This slide shows excess relative risk of radiation for development of solid cancers, in other words, cancers excluding leukemia, among the Life Span Study participants.
3. Here, sex-averaged risks at age 70 among those exposed at age 30 are estimated for groups classified by radiation dose.
4. Based on these results, cancer risk appears to increase in proportion to dose.
5. In this case, the excess relative risk after exposure to 1 Gy of radiation is 0.47, indicating that the cancer risk increases by 47% at that level of exposure.
6. However, what cannot be determined based on these data is whether risk increases from low-dose exposure.
7. For example, let’s enlarge this part of the figure.
8. Assuming that the risk is proportional to dose, we would expect risk to increase 4.7% in the case of exposure to 100 mGy. However, the effects of such low radiation doses cannot be differentiated from variation in the data, making it unclear how the risk actually increases.
9. It is known that the relative risk of cancer due to radiation among females is slightly higher than among males when comparisons are made at the same dose levels.

Slide 6: Changes in Risk with Age

1. Cancer risk due to A-bomb radiation is considered to differ substantially not only by radiation dose but also by age at exposure.
2. At the same dose level, as seen here, the lower the age at exposure, the higher the risk tends to be.
3. Relative risk tends to decrease with time since exposure and as subjects age.

Slide 7: Extent of Lifetime Effects

1. What effects from radiation exposure are there over a lifetime?
2. Here, lifetime cancer risk is estimated as the probability of someone, after a certain age, contracting cancer and then dying.
3. The chart indicates the risk of cancer deaths among unexposed subjects in the Life Span Study population after ages 10, 30, and 50.
4. In comparison, changes in lifetime risk when subjects are exposed to 100 mGy of radiation at each of the same ages are indicated here.
5. For example, among unexposed subjects, the probability of cancer from cancer after age 10 is about 30% in males and 20% in females.

6. After exposure to 100 mGy at age 10, the risk is estimated to increase by about 2% in both males and females.
7. The older an individual is at exposure, the smaller the increase appears to be in lifetime risk due to radiation exposure.

Slide 8: Percentage of Diseases Related to Radiation Exposure

1. Next, let's think about the percentage of diseases associated with radiation exposure.
2. This percentage represents cases caused by radiation, in other words, cases that would not have developed in the absence of exposure.
3. As shown in this figure, the higher the radiation dose, the higher is the percentage of cases related to exposure.
4. Among all A-bomb survivors, about 11% of the 7,851 cancer cases are considered to be caused by radiation exposure.
5. In the case of leukemia, the percentage of cases considered to be caused by radiation is high—about 46%.

Slide 9: Percentage of Cancer Cases Related to Radiation by Site

1. Radiation effects differ substantially depending on cancer site.
2. This slide shows the percentages of cases associated with radiation at sites where cancer rates are increased among A-bomb survivors.
3. The sizes of the circles represent the number of cancer cases by site among all A-bomb survivors.
4. The red sections within the circles show the percentage of cancer cases considered to be caused by radiation exposure.
5. Stomach cancer and lung cancer are frequently observed among A-bomb survivors. The percentages of stomach and lung cancer cases caused by radiation exposure are estimated to be about 10% and 15%, respectively.
6. Breast cancer and thyroid cancer are considered to be sensitive to radiation, with the percentages of breast and thyroid cases caused by radiation exposure estimated to be about 27% and 25%, respectively.

Slide 10: Long-term Radiation Effects

1. The effects of A-bomb radiation exposure differ substantially depending on time since exposure.
2. This figure shows how many disease cases developed due to A-bomb radiation exposure by different time periods following exposure.
3. Many acute symptoms developed immediately after exposure.
4. Leukemia started to increase several years after exposure, reaching its peak in 5–8 years and decreasing thereafter.
5. Cancer started to increase about 10 years after exposure, and is considered to be at an excess due to radiation even more than 50 years after exposure.

Slide 11: Radiation and Cancer Risk: Summary

1. This slide summarizes the information on "radiation and cancer risk" explained thus far.
2. Cancer among A-bomb survivors was understood to tend to increase with radiation dose.
3. Cancer risk at age 70 among those exposed to 1 Gy at age 30 is estimated to be about 40–50% higher than among unexposed people.

4. Lifetime risk of cancer mortality increases about 1% among those exposed to 100 mGy at age 30 compared with unexposed people.
5. The lower the age at exposure is, the higher the risk. The risk decreases in relative terms as subjects become older.
6. Effects of radiation on cancer development differ substantially by site.
7. Radiation effects appear to remain even more than 50 years after exposure.

Slide 12: Findings Anticipated through Future Research

1. It is expected that the effects of radiation on cancer risk will be further elucidated by continuation of studies of A-bomb survivors. For example:
2. Is there any difference in the manner of cancer increase between those exposed at young versus older ages?
3. Will there be any change in the future regarding the development of cancers that have thus far not increased among A-bomb survivors?
4. In addition to radiation, how do lifestyle factors, such as smoking and diet, affect cancer development?
5. How does radiation exposure cause cancer?
6. What kinds of genetic factors are related to individual differences in sensitivity to diseases and radiation health effects?

We anticipate that future research will be able to answer these questions.

This marks the conclusion of the radiation effects research webinar titled “Radiation and Cancer Risk.”