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Radiation's Unknowns Weigh on Japan

By **MATTHEW L. WALD**

As officials in Japan agonize over what constitutes a safe radiation dose for people who live near the **Fukushima Daiichi** nuclear reactors, the state of the science has been a daunting problem. Studies on the effects of exposure are based mostly on large doses delivered quickly by atomic bombs, while radiation from the Fukushima disaster would more likely result in small doses delivered over many years.

So far the debate in Japan has centered on the risks to children. Government guidelines set after the disaster allowed schoolchildren in Fukushima Prefecture to be exposed to 20 times the radiation dose previously permitted. The new level is equal to the international standard for adult workers at nuclear power plants.

After a **huge outcry** from parents, the government promised that it would lower the permissible level and that it would pay to remove contaminated topsoil from school grounds.

But the debate is not limited to children; the authorities have to weigh the risks of allowing thousands of people, including the elderly, to be exposed to levels that remain far above natural background radiation.

The general assumption is that when people are exposed to small doses for decades, the incidence of cancer will rise over time. But that prediction is based on extrapolating from data on people who were exposed to acute brief doses when atomic bombs were dropped on Nagasaki and Hiroshima in 1945 — not on observing individuals exposed to small doses over decades.

Some researchers argue that all humans are regularly exposed to a low natural level of radiation, and that it is not harmful when below a certain threshold, although fetuses may be an exception. Another vocal minority argues that there is statistical evidence for higher cancer rates among people exposed to tiny incremental doses.

Still, the mainstream view is that extrapolating from the Hiroshima and Nagasaki data is more prudent.

“There’s a point beneath which you just don’t know, and a straight line is the simplest assumption,” said Dr. Richard R. Monson, an epidemiologist and chairman of the committee that wrote **an influential report** released in 2006 by the National Academy of Sciences on low-level radiation exposures.

His committee based its recommendations on a hypothesis known as the “linear, no threshold model.” Under this hypothesis, if a given dose will cause fatal cancers in a certain number of people in a population, then half that dose will cause fatal cancer in half as many people, and a millionth of that dose will cause fatal cancer in a millionth as many people.

Dr. Monson’s committee largely extrapolated from the health records of thousands of Japanese civilians exposed to a sudden burst of high-energy gamma radiation by atomic bombs. Over the next 65 years, most of those people died from cancers that may or may not have been caused by radiation, and others from causes common to old age.

Their death rate from cancer exceeded the one recorded for populations of Japanese not exposed to the radiation. But applying this data to the risks faced at Fukushima Daiichi is problematic, experts say, and could lead to overstating or understating the risk to people who live near the plant.

The most obvious difference is that the bomb survivors’ exposure in 1945 was nearly instantaneous. People in the Fukushima area are confronting regular levels of contamination in the range of 5 to 10 times what people are normally exposed to in natural background radiation.

What is more, some of the radiation to which people are being exposed around Fukushima is inside the body; it comes from radioactive materials that contaminated their food or water. At Hiroshima and Nagasaki, many of the victims experienced only a quick external irradiation.

Evan B. Douple, the associate chief of research for the Radiation Effects Research Foundation, a joint Japanese-American science institute that analyzes health data from the bomb survivors, said that a dose delivered slowly over time was less damaging than an equal dose delivered quickly.

“It is well known in radiation biology that radiation-induced damage from a given dose of radiation is less effective if it is protracted or fractionated,” he said. The reason, he said, is that the body’s repair mechanisms work during the extended period of exposure.

The 2006 report by the National Academy of Sciences estimated that the effect of a given amount of radiation is 1.5 times worse when the dose is given all at once than when it is extended. But there are no authoritative details on varying doses over time.

As if this were not complex enough, another school of thought suggests that the radiation effect on people exposed at Hiroshima and Nagasaki was worse than the official statistics show.

This theory holds that weaker individuals were killed off by the bombs and by the hardships suffered in those cities at the end of World War II. The people who survived past that period, on whom the estimates are based, are not representative because they were stronger than average.

So the deaths counted in the following decades occurred among a hardier-than-average population, critics say.

In the United States, most of the policies involving radiation exposure involve people who are exposed to low levels on the job, like nuclear plant workers. If the United States faced decisions like those now confronting Japanese officials, “there really isn’t any coherent policy,” said Robert Alvarez, a former senior staff member at the Energy Department who works as a consultant for groups worried about nuclear risks.

[Kuniko Tanioka](#), a member of the Japanese Parliament who traveled to Washington to research how the United States government conducts independent inquiries after major technological disasters, said that advising the public after a nuclear accident poses grave challenges in both countries.

Ms. Tanioka suggested that the best course that Japan could take would be to distribute all the raw data it has on radiation exposure to the international community and allow outside interpretations.