Genetics may explain why many near Fukushima nuclear disaster unaffected by radiation exposure

We hear the word radiation and our impulse is to stay away. After all, nuclear weapons, reactor cores, are all extremely dangerous, as everyone knows. Many people don't realize that ultraviolet light from the Sun, even the safer UV that gets through the atmosphere is also radiation, the bad kind to boot, meaning ionizing radiation. That means that it has enough energy to strip off electrons from atoms that it encounters.

But at least the awareness of the Sun's potential to cause skin cancer is better than it was 50 years ago. What's fascinating though, radiation may not be *all* bad, because, like just about anything else, it turns out that the level of exposure, or the dose *matters*. While that seems a reasonable when it comes to lying in the Sun, it's just as true when it comes to other sources of radiation, even nuclear disasters.

As recently as the current year, the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) found cancer rates to be stable around the site of the 2011 Fukushima-Daiichi nuclear reactor accident that released high levels of radiation, due to the earthquake and tsunami that killed almost 19,000 people. This is in sharp contrast to the 1986 Chernobyl nuclear accident associated unequivocally with elevated rates of pediatric and adolescent thyroid cancer -roughly 6,000 cases in nearby areas of Belarus, Russia, and Ukraine by 2005. Less time has occurred since the Fukushima accident, but cases would be appearing were the situation the same as that of Chernobyl.

But the situation is not the same. In the case of Fukushima, evacuation was massive and very rapid. In Japan, roughly 160,000 people rushed out of the area. Furthermore, children in the Chernobyl were drinking milk contaminated with radioactive iodine. This led to damage directed particularly to thyroid tissue. Along with the absence of radioactive iodine-contaminated milk, UNSCEAR thinks that the evacuation and other emergency procedures reduced the exposure both to ionizing radiation and radioactive materials by as much as 90 percent of what it would have been for most people. But might there also be a genetic factor at play?

Over the years, a handful of studies and some epidemiologic work have been dropping hints that different individuals may be more sensitive than others to radiation damage, particularly in settings of low to medium dose exposure. As early as the 1980s, mouse model studies demonstrated varying radiosensitivity embryos at various stages of development. Furthermore, laboratory animal model studies have elucidated possible benefits of exposure to low dose radiation (LDR). Known as radiation hormesis, the mechanism may involve stimulation of cell proliferation and genetic repair systems.

In the past, LDR has been used clinically to treat certain conditions, including pneumonia. It is no longer used in such settings, but during the last few years, therapeutic LDR research has focused on diabetes. Specifically, some promising rodent studies have demonstrated that LDR can prevent diabetes associated kidney damage.

Why then is radiation exposure in health care and industry minimized based on the principle of "as low as reasonably achievable” (ALARA)? Using an extreme case, for instance a pregnant patient declining a dental X-ray, the scientific basis for taking ALARA to such a point is a mathematical estimate of radiation risk known as the linear-no-threshold (LNT) model. Based on cancer rates following radiation exposure events, such as the Hiroshima and Nagasaki atomic bombings, populations receiving radiation doses not high enough to produce acute radiation sickness, but still very high, were assessed for changes in the incidence of certain diseases. For leukemia and solid cancers, especially thyroid cancer, population studies have established a definite causal relationship between moderate to high ionizing radiation doses (more than a few hundred mSv) and malignancy, but the LNT model takes data from the moderate to high dose range and back extrapolates the plot to generate relative risks for individuals exposed to lower doses.

The problem with this is that evaluations using real data, including from the Japanese bombings, show uncertain associations between lower dose exposures and cancer. In the 100-200 mSv range (roughly corresponding to full body computed tomography doses), there may or may not be a causal association, and moving down toward lower doses (10-20 mSv, the range of some flat film chest radiography), the effects of ionizing radiation are simply unknown. The line that’s solid and straight at the high doses may not reach down to these lower doses, so there may indeed be a threshold. Furthermore, based on the rodent studies, there could even be some benefits, even in terms of cancer prevention. And finally, since any thresholds and benefits may depend on cellular and genetic repair mechanisms tolerating and/or being stimulated at particular levels of LDR, it seems logical that there should be variation in the radiation tolerance of different genetic groups or ethnicities.

No doubt, the UNSCEAR assessment accounts for most of what there has been no change in cancer rates following the Fukushima compared with the increase after Chernobyl. But given the complexity of eukaryotic genetics and cell repair mechanisms, it is tempting to wonder whether some more fundamental biology might be at play.

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