Fact or Fiction?

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Radiation

"It isn't what we don't know that causes the problems, it's what we think we know that just isn't so."
—Mark Twain

Have you heard?

- Low levels of radiation are beneficial to humans?
- Mice exposed to low levels of radiation lived longer than mice that weren't?
- Fish exposed to low levels of radiation grew faster than fish that weren't?
- Low levels of radiation increase fertility, embryo viability, and decreases sterility and mutations?[1]

More likely you've heard stuff like the following. When radioactivity from the Chernobyl accident reached our West Coast, the popular press warned residents about the dangers of possible fallout, speaking of the number of picocuries of radioactivity detected in high clouds—without ever explaining to the public that a picocurie is one part-per-trillion. The press also didn't mention that a person would have to drink 63,000 gallons of that radioactive rain water in order to ingest one picocurie of radioactivity.[1]

Or perhaps you've heard about the "nuclear disaster" that occurred at the Three Mile Island nuclear power plant. Although the press gave much coverage to this, a report by the U.S. Nuclear Regulatory Commission (NRC) revealed that the average dose of radiation received by two million people in the surrounding area was 0.0014 rems. The highest estimated individual exposure resulting from the TMI release was 0.075 rems. Typically, a person in the U.S. receives about 0.36 rems of radiation annually from naturally occurring radiation, medical uses of radiation and consumer products.[2] As Remmers[3] points out, "The most serious damage from Three Mile Island was the psychological trauma and over-exaggeration from the mishandling of this incident by politicians and the media."

What's a Rem?

OK you say, but what's a rem? A rem is the amount of energy deposited in the human body by ionizing radiation. For ease of understanding, Mark Hart[4] of the Lawrence Livermore National Laboratory in Livermore, CA, equates one rem to one dollar, so one millirem is 0.100 "cents." The yearly limit for safe exposure is five rem (or five "dollars"). Hart has worked hands-on with plutonium over a period of three years, and is a frequent presenter of a talk titled "Radiation—What Is Important?" In this talk, which is often given to youngsters, he refers to more than 100 radioactive items, including antiques, consumer items, fossils and minerals. In his laid-back style, he explains radiation and says he wants to give folks an intuitive feel for radiation around them so that, ultimately, they can make their own decision on what's important. After hearing his talk, it's hard for me to imagine anyone, except the most hard-core environmentalist, who has not changed some of their thinking about radiation.

In one year, Hart receives 37 "cents" of radiation working as a plutonium handler. He has yet to go into an antique store where he didn't find something that was radioactive. He hastens to point out, however, that there is no harm with antiques, even as food plates. "One of the most important aspects of radiation is the public's perception," said Hart, as he drank coffee from an antique, radioactive coffee cup made of green "Depression" glass. The key factor, he discloses, is that the radioactive material stays in the glass and does not enter his body. "These radioactive items won't make other things radioactive," he said. His collection of plates, cups, glasses, vases, jewelry, gravy boats and baby dishes—made of the green or yellow glass that was popular in the 1920s and 30s, or coated with orange uranium oxide glaze—all exhibit some degree of radioactivity above background and pose no health threat.[5]

Radioactivity is a perfectly natural phenomenon. The ground we walk on is radioactive; so is our blood; so is the food we eat; so is the air we breathe.[6] At what elevation do you live? For each 100-meter increase in altitude, the annual radiation dose increases by approximately 1.5 millirem. This increase occurs

because, as elevation increases, there is less atmosphere to shield the secondary cosmic radiation.[7] Therefore, Denver exposure is approximately twice that of Washington, DC, so people residing in Rocky Mountain states receive twice the natural radiation background, because of higher altitudes and large deposits of uranium. Compared with states with lower natural radiation background, however, Rocky Mountain residents experienced less age-adjusted overall cancer deaths, and a lung cancer rate only two-thirds as high.[8]

Do you travel? An airplane passenger flying above 33,000 feet receives between 0.5 and 1.0 millirem per hour. This means that a five-hour flight provides exposure of 2.5 to 5.0 millirem. Yet, the postulated danger of receiving an extra 10 millirems per year from living at the border of a radioactive waste site has received vastly more attention from the press and public.[8]

Radiation exposure varies around the world. Grand Central Station in New York = 0.53 rem/yr, while St. Peter's Square in Rome = 0.80 rem/yr. (Note that the rules that will be applied in the decommissioning of U.S. nuclear power plants would require the stone structures of St. Peter's Square in Rome and the Grand Central Station in New York to be dismantled and buried because of their radioactivity.)[4] Morro Do Ferro in Brazil = 7-14 rem/yr and Ramsar, Iran = 48 rem/yr.

A colony of rats occupies burrows in the mounds in Morro do Ferro. This is a weathered mound, 250 meters tall, that is formed of an ore body containing an estimated 30,000 metric tons of thorium and 100,000 metric tons of rare earths. The radiation level is so high that absorbed radioactivity in vegetation permits photographs (autoradiographs) showing the plants truly glowing in the dark. Yet the mound supports both animal and plant life. Rats in the region breathe between 3,000 and 30,000 rems per year, roughly three times the concentration that should produce tumors or other radiation effects. Yet no abnormalities were found on rats that were trapped and autopsied.[1] Ramsar, Iran, by the way, was host in 1990 to an international conference on high levels of natural radiation (HLNR). Kind of makes sense to hold such a conference in a city with one of the highest natural radiation levels in the world. This conference was a continuation of a series of conferences held previously on this topic. One conclusion from this meeting was that epidemiological studies on HNLRs in a number of countries did not show any evidence of increased health detriment, compared with normal areas.[9]

Hot springs and mineral water resorts usually have elevated amounts of radioactivity. The waters of the English city of Bath, for example, have a radon content of 1730 pCi per liter—compare this with the value of 4 pCi per liter that EPA has set for homes. The radon in natural gas at Bath is 33,650 pCi per liter. Other places similar to Bath include Baden Baden, Warm Springs, Georgia and White Springs, Virginia.[1]

A report[10] on residual radioactivity in the soil in Kazakhstan, which was the site of the first Soviet nuclear explosion in August 1949, provides some interesting data. Altogether, 459 nuclear explosions were conducted at the three technical areas of this site between 1949 and 1989. Of these, 346 were underground explosions. All 113 of the other explosions—26 ground explosions and 87 atmospheric explosions—occurred at one of the areas, Technical Area III. As Robinson[11] reports: "Surely here we can find the nuclear hell on earth of unsurvivable residual radiation. Yet measurements revealed that one hour spent at the site of 113 nuclear explosions over a 40-year period ending in 1989 has about the same negative health effects from radiation as a trip from San Francisco to New York in an ordinary jetliner."

Recently, China and the United Nations signed an agreement to turn China's Lop Nur nuclear test site into a sanctuary for the rare Bactrian camel.[12] This new nature preserve is being set up to protect 400 wild Bactrian camels, which have survived more than 40 overhead nuclear explosions, only to be now threatened by hunters. It's the first such reserve ever to be set up on an atomic bomb site. The two-humped wild Bactrians are thought to be the last representatives of the herds from which all the world's camels are descended.[12]

So why is the public so fearful of radiation? Cameron[13] says the following: "It is my belief that much of the blame for the public's fears and apprehensions with respect to radiation matters are due to our media. There is another criticism that must be directed to the media, namely, their constant use of a small number of individuals, who are clearly out of step with the radiation protection community. In the U.S. alone, there are some 3,500 health physicists and 1,900 radiological physicists. Yet the media will, for some newly breaking news story, seek out some of a half-dozen individuals who are willing to make willfully deceptive statements regarding radiation." He further discourses that, out of a collection of "popular" books published over the past 10 years or so dealing with radiation matters, there is

not a single one that is not riddled with half-truths, untruths and evidence of basic lack of knowledge of nuclear energy or radiation—another insidious practice designed to keep the public alarmed about radiation matters.[13]

Marvel™ comics has more than 70 comic book characters who had developed severe physical and emotional handicaps as a consequence of exposure to radiation.[8] What kind of message does this deliver to young persons and anyone else who reads this material? Genetic defects in offspring because of radiation exposure of the parents are a well-known effect produced in experiments with animals; however, it has never been observed in humans—not even in Hiroshima and Nagasaki—in spite of extremely thorough and intensive investigations.[6]

It's true that very large amounts of radiation can cause cancer or even death. For that matter, a large amount of nearly anything, even water, is dangerous. However, all studies of low-level radiation doses to humans indicate no harm, and many studies suggest that low-level radiation is beneficial. A book by Luckey[14] is a 336-page compendium of actual observations showing beneficial effects of radiation in many aspects, with more than 1,000 references. This beneficial effect of low-level radiation is called radiation hormesis, and will be discussed in a future column.

The two most widespread applications of nuclear energy are generation of electricity and the use of radioisotopes produced in nuclear reactors for diagnosis and treatment of many human conditions, including cancer, cardiovascular disease, metabolic disorders and mental illness.[8] Even those applications, however, are not without controversy. The use of nuclear energy to generate electricity, for example, has encountered so much opposition that no application for a nuclear power plant has been filed since 1977. Yet few people object to nuclear medicine or radiology, even though their contribution to the radiation background in the U.S. is a thousand times greater than discharges from the nuclear power industry.[15] There has not been a single fatal accident involving radiation for more than 20 years, whereas there have been more than two million fatalities from other types of accidents in this country during this same time period.[16] Smokers receive about 1,300 mrem per year from naturally occurring radioactive materials in cigarettes. This is far more radiation than they might ever receive from the nuclear power plant in their community.[17]

Here's a fact for you heavyweights. The loss of life expectancy from being 20-percent overweight is 900 days; from radiation emitted by nuclear power plants, 0.02 days.[18] In 1991, the Johns Hopkins University completed a U.S. Department of Energy-sponsored $10 million study of 700,000 nuclear shipyard workers. Data from this study, which has been described as the largest, best-conducted study on cancer risk from occupational radiation exposure, failed to reveal any risk associated with radiation exposure.[19]

One last bit of trivia. The principal contributor of internal radiation in our bodies is K-40, a long-lived radioactive isotope of potassium. Because the concentration of potassium is higher in muscular tissue, the amounts in men tend to be somewhat higher. So, if you find yourself in a crowded room and want to keep your dose rate to a minimum, you should always stand close to a woman to avoid receiving an unnecessarily high dose from K-40.[17]

Conclusion

Many of the benefits that radiation offers—such as in health, safety and economic development—are frustrated by opposition from pressure groups and are encouraged by the media.[15] In the U.S., surveys continually place nuclear power at the top of the lists of risks in life.[20] This misguided notion that nuclear power plants are seen as "accidents waiting to happen" has stifled this technology for more than 20 years, and is inexcusable. Another issue is food irradiation. We wouldn't be reading about the latest E. coli contamination in food if irradiation had been in place. Fortunately, in December 1997, the FDA approved irradiation of red meat. Once the USDA sets standards, the process can actually be used. I bet we hear from the enviros before all this takes place. P&SF

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