NEXUS

Your link with current trends in radiation dosimetry

BACKGROUND RADIATION: WHERE DOES IT COME FROM, AND SHOULD WE BE WORRIED?

An interview with Edward A. Christman PhD, CHP, Supervising Radiological Physicist, Rutgers University, New Brunswick, New Jersey.

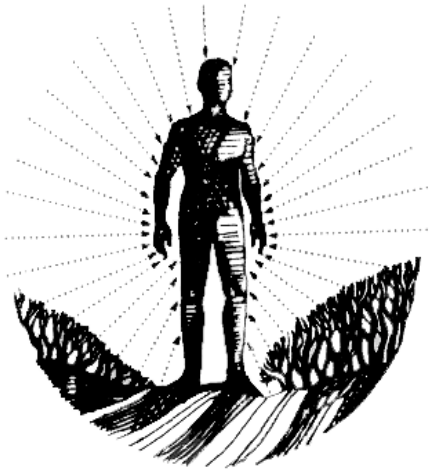
Nexus: Rumor is that we're constantly being exposed to ionizing radiation, wherever we are and however many precautions we may take. Is that true?

Dr. Christman: Yes, it is. You're referring to natural, or background radiation, and it does exist nearly everywhere: in the atmosphere, soil, soil-gases, groundwater, and even rain. Scientists have determined that no matter who you are or where you live, you are probably being exposed to an individual dose equivalent rate of anywhere from 80 to 200 mrem of radioactivity per year, just in the course of walking through life. There's no escaping it.

Nexus: That sounds dreadfully dangerous. Is it?

Dr. Christman: In the normal course of events, not at all. The typical U.S. resident will be exposed to about 100 mrem of background radiation per year—a scant 2% of the 5000 mrem per year which is the Maximum Permissible Dose (MPD) established by the National Commission on Radiation Protection and Measurements for occupational exposure. To put this in perspective, a typical barium enema x-ray series may deliver several hundreds to a thousand mrem, and some cardiac catheterization procedures, several thousand mrem. (Most x rays deliver a far lower dose—typically, no more than 100 mrem for all x rays the average person will have in a year.)

There are the occasional accidents of nature, however. In some parts of the country, for instance, deposits of the gaseous chemical element radon (formed by the disintegration of radium) are prevalent. In such areas, doses from 10 to 100 times the MPD have been charted. This creates a potentially dangerous situation when it is combined with today's nearly airtight "energy-efficient" homes. Radiation enters through the soil and foundation and cannot escape. But, for most of us, background radiation is a very negligible factor.



Nexus: Does background radiation show up on the radiation badges worn by x-ray technologists and others?

Dr. Christman: This radiation is, of course, recorded by the badge, which cannot differentiate between background and some other sources of radiation. But it does not appear on the report issued by the badging laboratory. That's because a control badge is exposed at the same time, well away from any radiation emitting equipment, so that it will record only the background radiation. This figure is deducted from that registered on the badges worn by exposed individuals. It's done this way so that the figures reported reflect only true occupational exposure: that portion of exposure over which individuals and the organization can exercise control, and which is governed by MPD regulations.

Nexus: Well, what are the kinds of radiation that we cannot control?

Dr. Christman: One of the biggest generators of background radiation is cosmic radiation, coming from somewhere decidedly extraterrestrial. Worldwide, this delivers a whole body dose rate from 30 to 280 mrem per year. In the U.S., this rate is 40 to 80 mrem, depending upon elevation above sea level and geographical latitude.

Another major source is "terrestrial" natural sources: radionuclides created when cosmic radiation bombards atoms of the atmosphere, soil, and water, as well as the radionuclides generated during the slow decay of chains of primordial, naturally occurring radionuclides, such as uranium 238, uranium 235, and thorium 232. Such natural terrestrial sources contribute 30 to 95 mrem per year to the whole body dose equivalent. (This broad range reflects the uneven distribution of radionuclides in the environment, depending upon their chemistry and their geological history.)

Nexus: That's a total so far of 60 to 375 mrems per year, depending on where you live in the world.

Dr. Christman: That's right. Then, beyond that, we have all the radionuclides created by man since he discovered nuclear power, generated by such activities as atmospheric weapons tests, the preparation of fuels for nuclear electric power plants, etc. All together, these man-made sources of radiation add no more than a few mrems per year to each person's exposure. That's very negligible, compared to nature's contribution.

Nexus: You can't see, feel, taste, smell, or hear these rays…and yet somebody, somewhere had to figure out for the first time that they were there and could be dangerous. How did that happen?

Dr. Christman: It all started in the mid-1890s when Wilhelm Karl Roentgen happened to leave photographic plates wrapped in light-tight paper in the path of a cathode ray tube. When he looked at them, they were fogged. *Something* had done that…something invisible to all the human senses, yet powerful. He called this unknown "x rays", to denote its mysterious qualities. About the same time Henri Becquerel, working in Paris, found similar effects from uranium ore samples. And once science knew it existed, scientists all over Europe took on this challenge: what is it, where does it come from, what does it do?

Nexus: And what did they find out about where it came from?

Dr. Christman: A pantheon of the day's leading scientists, including the legendary Mme. Curie, discovered that radiation emanated strongly from certain elements at the heavy end of the Periodic Table, such as uranium, thorium, radium, and polonium; that it was also present, in measurable amounts, everywhere around us; that the most penetrating component in this "background radiation" came from the sky; and that the source of these rays might be the transformation of unstable atoms to a more stable condition.

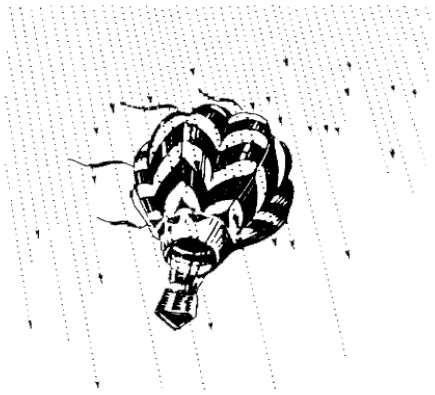
Nexus: That sounds like science fiction... "Death rays from outer space." How did they figure that out?

Dr. Christman: You have to remember that Victorian scientists were working with far less sophisticated equipment than we have today. As a matter of fact, that particular theory was initially proven by sending an electroscope up into the sky in a series of balloon ascents. The higher it went, the greater the radiation levels that were recorded.

Nexus: Did they also learn what radiation was and what it could do beyond fogging up photographic plates?

Dr. Christman: Early discoveries included the fact that rays could ionize air molecules, heat their surroundings, color glassware purple, and cause some crystals to scintillate. They also learned that large amounts of the rays caused severe skin rashes and burns. And, in time, some of those scientists paid with their lives for the knowledge that very large doses of radiation could also kill.

Nexus: So it really wasn't so much a science fiction story as a detective story.



Dr. Christman: That's right—and a most remarkable one, at that. What really is amazing is that all the drama I've described took place over a four-year period at the close of the 1800s. Before 1895, no one even knew there was such a thing as ionizing radiation. By 1900—despite the very primitive equipment then available—much of the basic information was in place that would lead to the dawn of the Atomic Age.

Nexus: As well as to the ability of medical science to see into the innermost parts of the human body.

Edward A. Christman, PhD, CHP

Dr. Christman is the supervising radiological physicist at Rutgers University, New Brunswick, New Jersey. He is responsible for the radiation protection program within the University and in the Rutgers Medical School (UMDNJ). He is also an associate faculty member in the radiation science graduate program at Rutgers, where he lectures and conducts research. He serves as a consultant in radiation protection and dosimetry to various industrial as well as research and development concerns. He has toured and lectured in the Peoples Republic of China.

Dr. Christman is a member of the Health Physics Society, the American Board of Health Physics, the Radiation Research Society, the American Association of Physicists in Medicine, Sigma Xi, and Sigma Pi Sigma.