Environment

Janet Raloff reports from the Health Physics Society annual meeting in Baltimore

Plutonium's lung hazard . . .

Though plutonium is a "bone-seeking" radionuclide, Gerald Dagle and colleagues at the Battelle Pacific Northwest Laboratory in Richland, Wash., now report "lung and lymph nodes, in addition to skeleton and liver, may be critical organs [damaged] following inhalation of soluble forms of plutonium."

In their study, 12 adult beagles were exposed to high doses of plutonium-239 nitrate aerosols, such that when sacrificed 3 to 10 months later, all dogs exhibited lung burdens of between 5 and 65 microcuries. (A curie is used to measure the decay rate of a radioactive substance.) Eleven dogs exhibited "respiratory distress," appetite loss, weight loss and a form of viral enteritis. Postmortem exams further revealed extensive lung damage in these dogs — including radiation-induced inflammation of the lungs, arterial necrosis (dead arterial tissue), pleural fibrosis, and epithelial and mesothelial hyperplasia (abnormal tissue bulk). "Certainly mesothelioma [a lung cancer now associated solely with asbestos exposure] could be a complication of plutonium at these doses," Dagle said, adding that lung doses probably ranged from 3,000 to 5,000 rads.

Tracheobronchial lymph nodes also showed signs of inflammation, atrophy and being filled with scar tissue. Dagle said low white-blood-cell counts, beginning two weeks after exposure, likely resulted at least in part from lymph-node scarring.

. . . and reproductive hazard

Reproductive organs are among those sites in the body known to retain deposited plutonium. It has been suspected that germinal tissue in animals internally contaminated with plutonium might receive damaging radiation doses. Research by John J. Russell and co-workers at Argonne National Laboratory, near Chicago, now confirms that at least in laboratory animals, the ovaries — and hence, fertility — are indeed susceptible to severe radiation damage, even when the ovaries' cache of plutonium is small.

In their studies, 70-day-old female mice were given a single (10 microcuries per kilogram of body weight) intravenous injection of plutonium-239 citrate. At 6 days, 100 days, 200 days and 360 days following the injection, a group of mice was sacrificed and their ovarian tissue compared with that from age-matched mice that had received only a saline injection.

Russell says that even after a year, only 0.002 percent of the injected plutonium had reached the ovaries, so their radiation dose ranged from just 1.56 rads per day on day 6 to 0.48 rads per day at one year. However, the cumulative dose — roughly 50 rads at 100 days, less than 200 rads by 360 days — was sufficient to seriously impair fertility. (A rad is a measure of absorbed radiation dose.)

In mammals, ovarian follicles are the immature structures from which eggs develop. And Russell's group found that by day 100, irradiated mice had lost half their lifetime supply of follicles. By day 360, the total had fallen to 12 percent of normal, and those follicles that remained were, on average, less developed than those of the nonirradiated mice.

How good are animal tests?

To better model human-lung exposure from soluble radioactive aerosols of cerium, selenium, americium, plutonium, curium and iron, researchers at the Lovelace Inhalation Toxicology Research Institute in Albuquerque are comparing rates at which these nuclides are cleared biochemically in hamsters, mice, rats and dogs. Admitting "we've only looked at a limited number of cases," William C. Griffith of the institute said, "rates of solubility in aerosols in the lung were quite similar for different species." And, he added, "limited data indicate humans may be similar."

Biomedicine

Cola decreases lead absorption

Lead poisoning could possibly be prevented simply by drinking a cola, Bruce J. Aungst, a research pharmacist at DuPont Co. in Glenolden, Pa., and Ho-Leung Fung of the State University of New York at Buffalo report. The effects of phosphate-containing household products, such as colas and laxatives, on lead solubility *in vitro* and lead absorption in rats were reported in the April JOURNAL OF PHARMACEUTICAL SCIENCES. The rats drank a solution of lead paint, then received a small amount of either cola or water. The rats that drank cola absorbed significantly less lead than those receiving water, suggesting that cola, given immediately after lead ingestion, could help prevent absorption of the toxic metal through the digestive tract. While the phosphate-containing laxative precipitated lead *in vitro*, it did not reduce lead absorption in the rat.

Aungst and Fung tested these products because they were "looking for something that might be a remedy [for lead poisoning] and would be readily available around the house," says Aungst. Lead must be dissolved in the gastrointestinal tract fluids to be absorbed, he notes. And phosphates react with lead compounds to form insoluble salts. So if the solubility of lead in the intestinal tract can be decreased by adding phosphates, then the absorption of lead from the gut will also be decreased, he says. "It doesn't completely inhibit absorption, but we think it would help," he adds. Aungst suggests that, in addition to contacting a professional, "it couldn't hurt" to give a cola to a child suspected of eating lead paint.

A simple home test for lithium

A new procedure for analyzing lithium levels in urine may soon join a growing number of at-home medical tests. Gilbert E. Pacey, assistant professor of chemistry at Miami University in Oxford, Ohio, has developed a simple paper strip test for Abbott Laboratories that can detect small amounts of lithium — a drug used in the management of manic-depressive illness — in urine. The strip measures blood lithium levels indirectly by changing color according to the level of lithium present in the urine.

Monitoring these levels is important, Pacey points out, because "there's a narrow range of therapeutic value" for lithium. "If you go below [the therapeutic level], you're a manic-depressive; if you go above it, you're a much worse manic-depressive," he notes. At present, patients on lithium must have blood drawn and analyzed in a clinical laboratory — a procedure that is both expensive and time-consuming.

Even when laboratory tests are performed once or twice a month, Pacey says, the information is inadequate because stress or unusual activity can cause lithium levels to rise or fall rapidly. Pacey contends that the strip test "is really preventive medicine." If lithium levels can be monitored on a daily basis, he notes, the patient knows whether he or she is in the safe range.

Pacey is also developing strip tests for potassium and sodium — ions of importance to heart disease and hypertension patients, respectively. "The key," he says, "is to find a compound that has a desire to grab [the ion]," while avoiding other similar ions. A type of compound that works well is the "crown" ether, so named because it has a ring structure in which oxygen atoms and ethylene (CH_2) groups alternate, with the oxygens pointing up and the ethylenes pointing down. Inside the ring is an electron-rich cavity, which creates an appetizing environment for cations (positive ions) such as lithium. Pacey modifies the size of the cavity and the solvent used so the ether will select certain ions. Then he adds a chemical that will change color according to the amount of cation present. "The tests are very specific," he says, "because we control the exact size of the cavity in the crown ether." In fact, he says, "we have one test that can detect 5 parts per million potassium in the presence of 3,000 parts per million sodium. *That's* specificity."