NEW JERSEY DEPARTMENT OF HEALTH
A BETTER STATE OF HEALTH

HEALTH and HAZARDOUS WASTE

A Practitioner's Guide to Patients' Environmental Exposures

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IONIZING RADIATION and Your Patient

Ionizing radiation is energy that can damage tissue by disrupting either the cell or the molecules used or produced by the cell, such as DNA. Ionizing radiation can be produced by unstable radioactive elements which decay in order to reach a stable, non-radioactive molecular configuration. This occurs through the emission of radioactive particles or rays. Particles include alpha and beta radiation, and rays include gamma radiation and x-rays. When these particles or rays are emitted, the remaining product is another element which may also be radioactive. This daughter product, or progeny, will in turn emit particles or rays until ultimately a non-radioactive element is formed.

Units of radiation measurement include the roentgen, gray, rad, curie, and becquerel, and their milli- and micro- derivatives. Radiation dose in humans is measured in *rems* or *sieverts*. Although sievert is the international unit, rem is the term more frequently used in the U.S., and will be used in this article. Rems and sieverts take into account both the quantity and the form of radiation in dose measurements.

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Focus on: WELSBACH AND GENERAL GAS MANTLE SITES

Camden and Gloucester City
Camden County, NJ

Other affected areas
The contaminated properties include two former factories, approximately 23 residential properties, 7 commercial properties, and 9 open areas.

The public health significance of these sites

The processing of monazite ore to extract thorium used in the production of incandescent gas mantles during the early 1900's caused radioactive contamination in the soil at the former Welsbach and General Gas Mantle plant properties and other vicinity properties where tailings were dumped. In some cases, residences and other structures were subsequently built on top of the contaminated areas. The levels of thorium contamination may result in an increased risk of cancer to individuals living in and frequenting the area.

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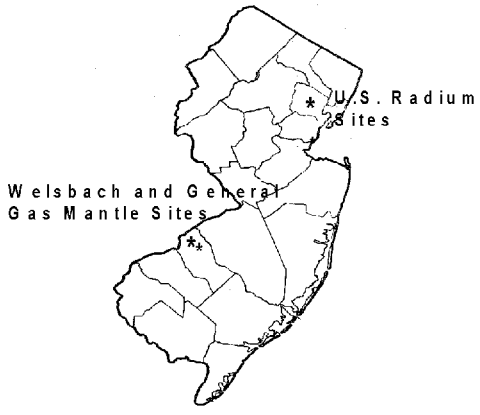

Focus on: U.S. RADIUM

High Street and Alden Street
Orange, Essex County, NJ

Other affected areas
"Vicinity" properties located near the plant, consisting of approximately 300 residential and light industrial properties within 9 city blocks of the site;
"Satellite" properties: approximately 50 non-contiguous residential and commercial properties in Orange, East Orange and South Orange

The public health significance of these sites

Radiological contamination of soil and building materials at these sites includes uranium-238, radium-226, and their daughter products. Over sixty properties (out of almost 200 properties which had been surveyed by 12/95) were contaminated beyond allowable limits. Although it is not possible to accurately reconstruct former doses, it is believed that several hundred individuals may have been exposed to elevated levels of gamma and alpha radiation.

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IONIZING RADIATION and Your Patient continued

Public health significance of ionizing radiation

Ionizing radiation is a known human carcinogen. Radioactive contamination has been found at several New Jersey Superfund and other contaminated sites, including US Radium, the Montclair/West Orange/Glen Ridge sites, Wayne Interim Storage Site, Maywood Chemical Company and vicinity sites, Welsbach and General Gas Mantle site, and Shieldalloy. The health effects of radiation exposure vary according to the amount and time period of exposure, to the chemical properties of the radioactive element or compound. The health effects can range from temporary blood changes to death. The health effects are well studied at higher levels of exposure, but the long-term effects of exposure to low levels of radiation are not clearly understood.

Unusually susceptible populations

Rapidly dividing cells that are poorly differentiated are the most sensitive to ionizing radiation; therefore, the fetus is especially radiosensitive. Also, persons exposed during childhood or adolescence may be at greater risk. For example, children exposed to excessive levels of radium may be at greater risk from the potential health effects of radium, particularly tooth breakage, reduction in bone growth, and breast tumors. Patients with Paget's disease have 10 to 100 times the risk of bone sarcoma than the general population, and therefore may be at higher risk of bone sarcoma from radium exposure than others.

Source

Everyone is exposed to background levels of radiation, which can be naturally occurring or man- made. The average background exposure in the United States (that is, the amount that all people are expected to be exposed to), is 360 millirem per year (please see Table 1). About 82% of an individual's total exposure is to naturally occurring radiation, which includes cosmic radiation and naturally occurring radioactive materials and radon. In fact, about half of our total exposure to radiation is from radon. The remaining 18% is from man-made sources, including x-rays and medical treatment, and fallout from atomic weapons and tests.

Some people have higher than normal exposures to radiation. These include individuals who live on or near contaminated sites, have very high radon levels in the soil beneath their residences, or who undergo more extensive medical treatment or testing which uses radioisotopes or radiographic procedures.

Types of radiation and their effects (general)

The hazard associated with radiation depends on:

1) the form of radiation (alpha, beta, gamma),
2) the element that is radioactive and its decay products, and
3) the route of exposure.

The elements give rise to different radioactive progeny with different radioactive energies, or intensities, and varying half-lives (the length of time it takes for one-half of the atoms to decay to another element).

Alpha (α) radiation is the largest of the particulate forms of radiation, and consists of two protons and two neutrons. This gives it a molecular mass of 4 and a charge of +2. Because of its large size and charge, it does not easily penetrate the body. In fact, the outer layers of skin, clothing, or even a sheet of paper are effective shields against alpha particles. However, if it does enter the body through inhalation or ingestion, it can cause significant damage to the cells with which it comes in contact. Alpha radiation is produced by radon, radium, thorium, uranium, plutonium, and other high molecular weight radioactive elements.

alpha is a heavy particle that is primarily an internal hazard
beta is a light particle that can penetrate the skin
gamma is a ray that can penetrate nearly any substance

Beta (β) radiation is an electron. Its smaller size and charge allow it to penetrate the body more easily (it can move approximately 1/3 inch through skin), and can cause significant damage to the lens of the eye. A thin sheet of metal or several layers of clothing can usually stop beta particles. Some common radionuclides which emit beta particles include hydrogen-3, carbon-14, potassium-40, and some isotopes of strontium, iodine, and cesium.

Gamma (γ) radiation is a penetrating ray without mass or charge and very similar to x-rays. It can easily pass through the body, potentially damaging any cell with which it interacts. Only very dense materials such as lead or concrete can shield against gamma radiation. Potassium-40, cobalt-60, and some isotopes of cesium, radium, uranium, and plutonium are some of the elements which emit gamma radiation during decay.

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TABLE 1. Radiological dose and the expected health effect or occurrences.

Dose	Occurrence or Effect
0.360 rem per year (approximately 0.001 rem per day)	Average background exposure in the United States
0.100 rem per year above background	Maximum allowable dose to citizens through environmental exposures above background
5.0 rem per year	Maximum allowable dose to occupationally exposed individuals
5 to 20 rem	Temporary blood changes, including depression of white blood cell count and platelets in some individuals
10 rem to fetus	Increase in microencephaly and microcephaly to fetus if exposure occurs between 8 and 15 weeks gestational age
15 rem	Moderate oligospermia (approximately 70 percent reduction in sperm count, which may last for months)
up to 25 rem	No detectable clinical effects; small increase in risk of delayed cancer and genetic effects
25 to 100 rem	Gastrointestinal (GI) syndrome (formerly known as radiation sickness) in some people (nausea, vomiting, fatigue, diarrhea, dizziness). Abnormal sensation of taste or smell, decreased blood pressure, increased irritability and insomnia.
100 to 200 rem	GI syndrome likely in all people within the first day. By third week after exposure, loss of hair and appetite, sore throat, hemorrhaging, pallor, weight loss. Fifty percent reduction in WBC count, some fatalities (5 percent at 140 rem, 15 percent at 200 rem). Recovery likely within three months.
250 to 450 rem	Seventy-five percent reduction in white blood count, GI syndrome within a few hours. Loss of hair and appetite may occur in second week after exposure. By third week other symptoms may occur, including nosebleeds and inflammation of the mouth and throat.
350 to 500 rem	LD 50/30 (lethal dose to 50 percent of the population within 30 days). GI syndrome within a few hours. Death may occur die to infections or hemorrhaging. Many organs will sustain damage.
600+ rem	Death within two weeks unless treatable by bone marrow transplant.

NOTE: All doses, with the exception of the first three, are assumed to occur as a single acute exposure. Fractionated doses or doses over time will likely have lesser effects.

A **rem** is a measurement of dose in living beings. It is derived by taking the absorbed dose (the rad) and multiplying it by a quality factor. The **quality factor** (Q) is a number which is used to signify the type of radiation being emitted (alpha, beta, gamma). Because an alpha particle can cause extensive damage to living tissue once it enters the body, it is assigned a Q factor of 20. Beta and gamma radiation are given Q factors of 1. Therefore, if the there are 10 rads each of alpha, beta, and gamma radiation, there would be 200 rems of alpha radiation, and 10 rems of beta and gamma.

Effects of contaminants found at US Radium and Welsbach

Welsbach: Thorium is the major off-site contaminant near Welsbach. Thorium exists as naturally occurring thorium, or as a decay product of uranium. Naturally occurring thorium, the type found at Welsbach, has a half-life of fourteen billion years. It decays through a series of progeny, including a very short-lived radon isotope, by emitting alpha or beta particles or gamma rays, until a stable lead molecule is produced.

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Thorium can enter the body through inhalation, ingestion, and dermal contact; however, very little of it enters the blood. Most inhaled or ingested thorium is excreted through feces. Thorium which does enter the blood generally deposits on the bone surface.

Thorium was used in Thorotrast, a colloid consisting of 25% thorium-232 dioxide. This was used as a radiographic contrast medium from 1928 to 1955. Toxic effects were found at all exposure levels, and were generally due to alpha radiation. These effects include the formation of granulomas termed "Thorotrastomas" at the injection site; blood disorders including hemolytic and aplastic anemia, myelofibrosis, and leukemia; and liver tumors, including cholangiocarcinoma, angiosarcoma, and hepatic cellular carcinoma. An increased frequency of chromosomal aberrations was found among thorium workers with higher body burdens of radioactivity. Most other effects found among people exposed occupationally, including an increase in the mortality rates from pancreatic and lung cancer, and an increased rate of respiratory disease, may have had contributing factors. Developmental and reproductive effects from exposure to thorium-232 are unknown.

U.S. Radium: Radium-contaminated soil has been found on site and in other area facilities. Radium-226, itself a decay product of uranium-238, has a half life of 1,622 years. Through the emission of an alpha particle and gamma radiation, radon-222 gas is formed. Radon-222 has a half-life of just under four days, and is also an alpha emitter. The decay series continues until a stable lead molecule is formed.

Radium can enter the body through ingestion and inhalation (it has not been reported that radium is absorbed dermally). Depending on particle size, inhaled radium may remain in the lungs for months, but gradually a fraction of the inhaled particles enter the bloodstream and is carried to all parts of the body. Radium in the blood fractionally deposits on the trabecular or cortical bone surfaces in proportion to the calcium addition rate for the given bone type. Some radium moves from the bone surfaces to exchangeable and non-exchangeable bone volume for intermediate and long-term retention in the skeleton. The rate of loss from non-exchangeable bone volume is equal to the rate of bone resorption.

Small amounts of ingested radium are excreted daily in feces and urine. Most ingested radium (about 80%) is passed quickly from the body through feces. The remaining 20% enters the blood, and behaves in the same manner as inhaled radium.

There is no clear evidence that long-term exposure to radium at naturally occurring levels is likely to result in harmful health effects. However, exposure to higher levels of radium over a long period of time may result in anemia, cataracts, fractured teeth, bone cancers, and death. Bone sarcomas, carcinomas of the perinasal sinuses and mastoid air cells, and deterioration of skeletal tissue are attributable to internal radium among persons exposed to radium occupationally. The bone and head sarcomas were often seen in radium dial painters.

Radium was used in tonics in the 1920s and available to the public. It was also used for the treatment of tuberculosis, ankylosing spondylitis, and other diseases in Germany after World War II. Radium-226 was given intravenously in the United States until the mid-1930s, often as a treatment for arthritis.

Lab tests for human exposure

Exposure to thorium can be determined by the measurement of thorium or its daughters in feces, urine, and expired air. Exposure to radium can be determined by use of a whole body counter to measure the presence of gamma radiation emitted by radium. Radium levels can also be measured in urine and feces through gamma-ray spectroscopy.

For consultation for treatment of persons exposed to radiation, contact your hospital radiology department, or:

Radiation Emergency Assistance Center/Training Site (REAC/TS)
(423) 576-3131 from 8:00 to 4:30,
or,
(423) 481-1000 after hours (ask for the REAC/TS staff person on call).

This article is based in part on the Agency for Toxic Substances and Disease Registry's Case Study in Environmental Medicine - Ionizing Radiation Toxicity. Also available is a Radon Toxicity Case Study, and the Environmental Protection Agency's "Radon: A Physician's Guide." For your copies, please contact the Editor.

Focus on WELSBACH and GENERAL GAS MANTLE SITE continued

Site history

The former General Gas Mantle Company first appears on the Camden property maps in 1915. However, there is little other information available regarding its activities. Conversely, the Welsbach Company is known to have manufactured incandescent gas mantles during the period 1896 through 1940. The factory property covered about 21 acres in the area of what is now Holt Cargo, next to the Walt Whitman Bridge. The Welsbach Company was for a number of years the largest manufacturer of gas mantles in the world, at its peak making up to 250,000 mantles per day. However, as the demand for gas mantles declined, both companies apparently ceased manufacturing the gas mantles in the early 1940's.

Radiological contamination at the Welsbach and General Gas Mantle Contamination Sites was initially detected during an aerial gamma radiation survey conducted in May 1981. Later monitoring found additional residential and non-residential (commercial) structures and open areas which emitted gamma radiation in excess of the background level for the area. As a result, a number of interim remedial actions were conducted during 1991-1994, including purchasing one residence, paving of parking lots, covering building floors with concrete, and covering several outdoor areas with clean fill. In addition, a portion of the former General Gas Mantle factory building, occupied at the time by Ste-Lar Textiles and Dynamic Blending, was ordered vacated in April, 1991 due to alpha radiation from radon and progeny.

> In some cases, residences and other structures were built on top of areas contaminated by radioactive waste tailings from the thorium extraction process.

Is your patient at risk from this site?

Your patient may be at risk if he or she:

- worked at the locations of the former Welsbach or General Gas Mantle properties
- previously or currently lives at a residence which has been identified as being radiologically contaminated
- has frequently used open areas which have been shown to be radiologically contaminated.

Presently exposed population

The Camden Radiation Sites are located in occupied residential, commercial, and open areas of Camden and Gloucester City. It is estimated that several hundred individuals, including residents and employees of businesses, may currently be exposed to radiological contamination from the Welsbach and General Gas Mantle sites.

Potential for future exposures

Residents or occupants of radiologically contaminated areas will continue to be exposed to ionizing radiation in excess of background levels until the sites are remediated through shielding or removal of contamination.

Prevention strategies for your patient

Residents of contaminated structures should be encouraged to avoid or limit occupancy of basement areas which may have elevated levels of gamma radiation or radon.

> Patients should be encouraged to have their homes tested for radon, if they have not already done so.

Other area Superfund sites

Nearby Superfund sites in Camden County include: GEMS Landfill, Gloucester Township; Swope Oil, Pennsauken.

Sites in Gloucester County include Bridgeport Rental and Oil Services, Logan Township; Helen Kramer Landfill, Mantua Township; Hercules, Greenwich Township; Lipari Landfill, Mantua Township; and Shieldalloy, Newfield Boro.

For further information on this site

Please contact the Camden County Department of Health at 609-374-6037, or the New Jersey Department of Health Environmental Health Services at 609-633-2043.

Focus on: U.S. RADIUM continued

from these sites. In addition, common work practices at the former manufacturing site resulted in ingestion of radium paint by workers. Ionizing radiation, by internal or external exposure, is a known carcinogen.

Site history

From 1915 through 1926, the U.S. Radium Corporation (also known as the Radium Luminous Materials Corporation) extracted radium from carnotite ore at the High Street location, as well as at several of the satellite properties. Between one-half and two tons of the ore, containing 2 to 4 percent uranium dioxide, was processed daily for the eleven years the company was in operation. The ore was used to produce radium for both medical purposes and luminous paint. Large quantities of the waste material was discarded on the property and throughout the area. Luminous dial painting was done on-site and as piece-work by workers at several of the satellite properties. The radium extraction process ended in 1926, although dial painting continued until 1940. The site was used by numerous other businesses since U.S. Radium vacated the area, and some of the buildings continue to be occupied.

Is your patient at risk form this site?

Residents who live on properties with elevated radiation levels which have not been remediated, residents who were exposed in the past but whose properties have been remediated, and workers who are or were employed at contaminated sites may be at increased risk of health effects from the site.

Prevention strategies for your patients

Residents living in homes with elevated radon levels should be encouraged to limit occupancy time in the basement during winter months until remediation takes place.

Other area Superfund sites

Other Essex County Superfund sites include Caldwell Trucking, Fairfield Township; Diamond Alkali in Newark; Glen Ridge Radium, Glen Ridge; and the Montclair/West Orange Radium sites.

For further information on this site

Please contact the West Orange Department of Health, (201) 325-4120; or the New Jersey Department of Health Environmental Health Services at (609) 984-2193.

FOR YOUR REFERENCE:

The Association of Occupational and Environmental Clinics

(202) 347-4976

The Association of Occupational and Environmental Clinics (AOEC) is a non-governmental, non-profit, professional organization based in Washington, DC. AOEC members include over 50 clinics, and over 250 individuals, in the United States and Canada. AOEC member clinics share the following characteristics:

- a commitment to identifying, reporting, and preventing occupational and environmental health hazards and their effects.
- a commitment to ongoing professional education, training, and scholarly work.
- a commitment to a high standard of ethics in their practice of environmental and occupational health (EOH).
- a commitment to pooling clinical data for research purposes, to help develop new knowledge about environmental and occupational health risks.
- a commitment to multi-disciplinary collaboration among staff physicians, nurses, industrial hygienists, health educators, social workers, and other professionals.
- employer-independence, based at academic medical centers, hospitals, and free-standing clinical facilities.
- acceptance of peer review within the Association regarding standards of diagnosis, management, and data handling.

Since its founding in 1987, AOEC has become widely recognized for its efforts in professional training. It has established a large multimedia library at its Washington headquarters, which includes slide shows, videotapes, lecture outlines, books, and other resources, which may be loaned to AOEC members for use in teaching. The materials are appropriate for

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For Your Reference: The ASSOCIATION of OCCUPATIONAL AND ENVIRONMENTAL

CLINICS continued

students of medicine, nursing, and other health professions; primary care practitioners; and specialists in EOH. Many AOEC clinics are based at institutions that include Occupational Medicine residency programs, MPH programs in EOH, fellowships in EOH, and/or other advanced specialty training programs.

AOEC sponsors an electronic bulletin board, the Occupational-Environmental-Medicine-List which is moderated by a board certified occupational medicine physician. This list has become an invaluable resource for occupational and environmental health professionals as well as other health professionals in their search for the most up to date information in the field. Other electronic resources include a "gopher node" and a site on the World Wide Web.

Through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), AOEC has provided health professionals around the United States with training in environmental health. In particular AOEC has worked to educate health professionals about the health effects associated hazardous waste sites on the National Priorities List (NPL).

What can AOEC do for you?

As health professionals you may have questions regarding a variety of areas in environmental and occupational health. Staff at the AOEC office can refer you an AOEC clinic with expertise in the area in question. AOEC may also be able to provide you with teaching materials and/or relevant government publications. Through AOEC's on-line resources you can contact environmental and occupational health professionals world wide who may be able to answer your questions.

Is there an AOEC clinic in New Jersey?

Yes. The AOEC member clinic in New Jersey is the:

Environmental and Occupational Health Clinical Center
Environmental & Occupational Health Sciences Institute (EOHSI),
UMDNJ - Robert Wood Johnson Medical School
P.O. Box 1179
Piscataway, New Jersey 08855-1179
908-445-0123 FAX 908-445-0127

EOHSI is an academically based occupational and environmental health facility. Common diagnoses seen at the clinic include

Multiple Chemical Sensitivity
Hazardous Waste Exposures
Asbestosis
Occupational Asthma
Lead Intoxication
Repetitive Strain Injuries

The staff consists of five physicians, an occupational health nurse educator, a psychologist, a social worker, and consultants in epidemiology, toxicology, and industrial hygiene.

How do I contact AOEC?

The AOEC office can be reached at:

1010 Vermont Ave., NW #513
Washington, DC 20005
202-347-4976 Fax: 202-347-4950
e-mail: aoec@dgs.dgsys.com

The OEM-List can be reached by sending a message to this INTERNET address:
majordomo@list.mc.duke.edu

Include the message:
Subscribe Occ-Env-Med-L

The address for the gopher is:
gopher.mc.duke.edu

The WWW address is:
http://occ-env-med.mc.duke.edu/oem

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Physicians and primary care providers:

Are you interested in a seminar on environmental health issues and your patients? The New Jersey Department of Health, as part of a cooperative agreement with the Agency for Toxic Substances and Disease Registry, can provide a one-hour seminar at your location for physicians, nurses, health educators, and other professionals with patient contact. There is no fee for these seminars, and they are approved for CME and CEU credits by CDC. Please call Sharon Kubiak at the New Jersey Department of Health Environmental Health Services at (609) 984-2193 for more information.

DO YOU NEED ENVIRONMENTAL HEALTH EDUCATION MATERIALS?

The following is a partial list of materials available from the New Jersey Department of Health Environmental Health Services for you or your patients. Please FAX (609-984-2192), telephone (609-984-2193), or mail (NJ Dept. of Health, Environmental Health Services, CN 360, Trenton, NJ 08625-0360 Attn: S. Kubiak) your requests. There is no charge for any of these items. Please be sure to include your address with your orders.

For your patients:

___ Facts on Lead in Drinking Water
___ Facts on Mercury in Drinking Water
___ Am I Exposed to Hazardous Waste?
___ Environmental Exposures and Your Health

ATSDR Public Health Statements:
___ Radium
___ Radon
___ Thorium
___ Complete list of Statements

ATSDR Fact Sheets:
___ Complete listing

For the health care provider:

ATSDR Case Studies in Environmental Medicine:
___ Taking an Exposure History
___ Ionizing Radiation
___ Radon Toxicity
___ Complete listing

Resource Guides for Health Professionals in the following counties:

___ Bergen ___ Middlesex
___ Burlington ___ Monmouth
___ Camden ___ Ocean
___ Cumberland
___ Essex ___ Passaic
___ Hudson ___ Salem

___I would like to receive future and back issues of this newsletter.