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Title: Health Hazards of Exposures to Radioiodine

Author(s): Klumpp, John Allan

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Iodine is a chemical element with atomic number 53. Iodine-127 is stable (non-radioactive) and commonly found in nature. Elemental iodine is a purple-colored solid at room temperature and pressure, but spontaneously sublimates (turns into vapor). Iodine is an essential element for life, and is required for proper functioning of the thyroid. Iodine is present in many foods, and is readily absorbed by the body and concentrated in the thyroid gland.

A fraction of iodine ingested or inhaled is rapidly removed by the kidneys. The rest of the inhaled or ingested iodine is absorbed the by thyroid and retained for many months. Iodine has a biological half-life of approximately 120 days in health individuals. The biological half-life can be shorter in individuals with hyperthyroidism, and longer in individuals with hypothyroidism.

Iodine has a number of radioactive isotopes, most of which have relatively short half-lives (days or weeks). Short half-life iodine isotopes are useful for a variety of medical applications, including imaging and cancer therapy. For example, Iodine-123 (half-life 13 hours) is commonly used for medical imaging of the thyroid, while iodine-131 (half-life 8 days) is used for suppressing thyroid function in individuals with hyperthyroidism or ablating (killing) thyroid cells to treat thyroid cancer.

Iodine-125 (half-life 59 days) is produced in nuclear reactors, and has medical uses. Although iodine-125 can be used for thyroid imaging, Iodine-123 is more commonly used for that purpose because of its shorter half-life and higher-energy emissions. Iodine-125 is more commonly used for cancer treatment, and can be processed into small metal pellets (seeds) inserted directly into a tumor. Iodine-125 emits low-energy x-rays which can kill tumor cells and generally cannot escape the tumor, sparing other tissues.

Medical iodine for imaging or treatment is typically administered orally in the form a pill or liquid solution. A typical adult thyroid scan using iodine-123 involves having the patient swallow between one and four 0.1 millicuries pills, with the exact dose dependent on the patient's weight. This results in a whole-body committed effective dose of 80 – 320 mrem, and a thyroid equivalent dose of 1443 – 5772 mrem. Note that the whole-body effective dose relates to the overall cancer risk, while the larger equivalent dose to the thyroid only indicates that most of this risk is the result of exposure to the thyroid. These doses are considered safe, although the procedure is not recommended for pregnant or breastfeeding women. In contrast, the quantities of iodine-131 used for treatment of hyperthyroidism and thyroid cancers are much higher. For treatment of hyperthyroidism, 4 – 10 millicuries are administered, while for thyroid cancer the administration can range from 50 – 150 millicuries of I-131.

In addition to medical exposures, large populations were exposed to radioiodine as result of the atomic bombings of Hiroshima and Nagasaki in Japan, and the Chernobyl nuclear accident. These populations have been carefully followed for many years to assess the effect of their radiation exposures on cancer risk. As a result, a great deal is known about the cancer risks associated with radioiodine exposure.

Because iodine is concentrated in the thyroid, the principal risk of exposure to radioiodine is thyroid cancer. Children have the highest risk of thyroid cancer after exposure to radioactive iodine. According to a large study of Japanese atomic bomb survivors, an effective dose of one Sievert (100,000 mrem) has been observed to increase the risk of thyroid cancer by a factor of 9.5 in children aged zero to nine years old, by a factor of 3 in children aged 10 to 19 years old, and by barely detectable amounts in adults. Another way of quantifying the risk from radioiodine exposure is from risk coefficients, which provide the risk per unit intake of radionuclides in terms of both morbidity (any cancer) and mortality (death). Both morbidity (risk of cancer) and mortality (death) risks are shown in the table below. Note that because thyroid cancer is almost never fatal, the morbidity coefficients are much larger than the mortality coefficients.

Table. Risks of cancer mortality and morbidity per nCi intake of I-125 (Solubility Type F) among different age groups

Age	0-5	5-15	15-25	25-70
Mortality	8.07E-09	3.92E-09	1.31E-09	4.26E-10
Morbidity	8.07E-08	3.92E-08	1.31E-08	4.26E-09

To illustrate how these coefficients are used, we can apply them to the case of a recent I-125 intake event. In that case, a typical intake was 2,000 nCi. We can multiply this by the risk coefficients for the individual receiving the scan. Assuming the individual is between 25 and 70 years old, the morbidity risk is 2000 nCi × 4.26E-9 per nCi = 8.51E-6, or an increase in risk of thyroid cancer of approximately 0.00085% (about 1 in 120,000). The mortality risk would be 2000 nCi × 4.26E-10 per nCi= 8.51E-7, or an increased risk of death from thyroid cancer of approximately 0.00085% (about 1 in 1.2 million). Thyroid cancer can typically be treated and cured in healthy adults.

In this case, the risk to affected employees and their family members is miniscule. A wealth of general information about radiation exposure is available at the following website: www.radiationanswers.org

If you have any questions, please feel free to contact us.

John Klumpp, 505-667-0325, program lead
Deepesh Poudel, 505-665-1798
Sara de Souza Zanotta Dumit, 505-665-4095

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Additional information on Radioiodine

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