

Survey of Radioiodine Therapy Safety Practices Highlights the Need for User-Friendly Recommendations

Richard T. Kloos, M.D.¹⁻³

FETUSES WHOSE MOTHERS ARE TREATED WITH radioiodine after approximately 10–12 weeks of pregnancy are at high risk of developing iatrogenic hypothyroidism (1). Other than this well-documented occurrence, there is no evidence of harm to others from radiation originating from patients treated with radioiodine. Given that radioiodine is concentrated in breast milk and radioiodine has been documented to be taken up by the thyroid in nursing newborns whose mothers were given diagnostic activities of radioiodine (2), discontinuing lactation before radioiodine therapy and avoiding breastfeeding after radioiodine treatment is justified despite the lack of a case report of infantile hypothyroidism ascribed to radioiodine ingestion from breastfeeding. Aside from circumstances relating to pregnancy and lactation, the harm that a radioiodine-treated patient could inflict upon another person while following common sense instructions appears to be low. Patients, who themselves receive a much higher dose of radiation because they ingest the full radioiodine treatment, suffer relatively few side effects. For the most part these occur in tissues that actively take up the radionuclide, and the adverse effects occur in a dose-dependent manner (3). This provides some reassurance that the small amount of radiation exposure to the public from those who receive radioiodine treatment is unlikely to cause harm, even if the treated patients ignore nearly all of the radiation safety instructions they receive. On the other hand, it is known that thyroidal exposure to higher levels of radiation, especially in children, can result in harm (4) and by extrapolation with a linear no-threshold dose–response relationship, one may assume that exposure to low levels of radiation might result in some harm. Thus, this theoretical possibility of increased harm at any increase of radiation exposure beyond background radiation, combined with no evidence of benefit of radiation exposure to the public, has led to the practice of keeping radiation exposure to others As Low As Reasonably Achievable (ALARA).

High levels of radiation exposure are dangerous. It has been estimated that half of the people receiving a dose to the whole body over a few minutes to a few hours of between 3500 and 5000 mSv would die within 30 days (multiple mSv

by 100 to convert to mrem). Similarly, high-dose exposure (starting somewhere between 100 and 1000 mSv) over a relatively short period of time, is associated with the development of a number of malignancies. Conversely, the average yearly radiation exposure from natural sources to an individual in the United States is approximately 3 mSv. Radon gas accounts for two thirds of this exposure, while cosmic, terrestrial, and internal radiation account for the remainder. No adverse health effects have been demonstrated from these levels of natural radiation exposure. In addition, artificial sources of radiation from medical, commercial, and industrial activities contribute another 0.6 mSv, for a total average yearly radiation exposure of 3.6 mSv. Doses (in mSv) from common medical imaging procedures include the following: bitewing dental x-ray, 0.004; chest x-ray (posterior-anterior), 0.02; lateral lumbar spine x-ray, 0.3; mammography, 0.7; lung ventilation/perfusion scan, 1.5; barium swallow, 1.5; technetium-99m bone scan, 4.4; barium enema, 7; 2-deoxy-2-[F-18]fluoro-D-glucose positron emission tomography scan, 7; chest or abdominal computed tomography scan, 8–10; and coronary angiogram, 5–16. A personalized annual radiation dose estimate can be calculated at the website <http://www.epa.gov/radiation/understand/calculate.html>.

Although radiation may cause cancers at high doses and dose rates, currently there are no data that unequivocally establish the occurrence of cancer following exposure to low doses or dose rates (e.g., below about 100 mSv). People living in areas with high levels of background radiation (>10 mSv per year) such as Denver, Colorado, have shown no adverse biological effects. Keep these millisievert values in mind as you read the next paragraph.

Effective May 29, 1997, and updated on July 29, 2009, the Nuclear Regulatory Commission (NRC) revised Federal Regulation 10 CFR 35.75, which permits NRC-licensed facilities to release a patient treated with radioiodine from their control if the total effective dose equivalent to any other individual from exposure to the released individual is not likely to exceed 5 mSv. Further, a licensee must provide the released individual, or the individual's parent or guardian, with instructions (including written instructions) on actions

¹Secretary/Chief Operating Officer, The American Thyroid Association.

²Divisions of Endocrinology and Nuclear Medicine, The Ohio State University; ³Co-Director, The Ohio State University Thyroid Cancer Unit; Columbus, Ohio.

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recommended to maintain doses to other individuals ALARA if the total effective dose equivalent to any other individual is likely to exceed 1 mSv. Several studies of the current practice have reported that radiation exposure to household members of patients receiving outpatient radioiodine therapy for hyperthyroidism or thyroid carcinoma were almost always well below the 5 mSv limit (5–8). No levels of contamination were found in home surveys by Panzgrau *et al.* (9), and patient satisfaction with outpatient therapy was high. Supporting the low potential for significant radiation exposure to the public are the data of Venencia *et al.* (10) who treated 14 patients with 30–221 mCi of ^{131}I and monitored them with dosimeters placed on the pectoral muscle. Using this dosimetry and assuming that another person was always 1 m from the treated patient (100% occupancy factor), their exposure did not approach 5.0 mSv until the treatment activity was greater than 187 mCi.

In this issue of *Thyroid*, Greenlee and colleagues (11) surveyed 311 endocrinologists, nuclear medicine physicians, surgeons, radiation safety officers, and other health professionals on behalf of the American Thyroid Association (ATA). The survey sought to identify the advice most commonly provided to patients receiving ^{131}I for hyperthyroidism, goiter, and thyroid cancer regarding the safety of others who could potentially be exposed to radiation from them. The majority of respondents were endocrinologists, from North America, and affiliated with universities. The survey offers a snapshot into current practice and highlights several areas of opportunity for education, harmonization, and communication between health-care providers and patients. The survey also has limitations. The respondents likely accounted for only a small fraction of those invited to respond or those involved in radioactive iodine treatment. Moreover, the similarities and differences between respondents and nonrespondents are not known. Respondents were not able to ask for questions to be clarified, and an explanation for why a respondent gave their answer was not provided. Additionally, although the study addressed therapeutic activity ranges for radioiodine, no distinction was made between treatments for hyperthyroidism, goiter, or thyroid cancer. These are situations in which the patient's uptake and retention of radioiodine over time are significantly different.

The survey results were reassuring in that within the first 24 hours after treatment, the majority of respondents indicated that they restricted exposure to young children, recommended that the patient limit time and proximity to others, avoid public transportation, and did not recommend staying in a hotel. They also recommended sleeping alone and avoiding sexual contact.

The survey also identified areas of concern and opportunities for improvement. For example, patients often receive radiation safety advice from multiple sources. Multiple sources of information are often a good thing, except when the recommendations disagree with each other. Only 50%–88% of respondents, however, could say that the information their patients receive from multiple sources was comparable. Similarly, there seemed to be a gap across the various disciplines regarding which care provider was ultimately responsible for providing the patient with radiation safety instructions.

Designing and interpreting survey questions can be a challenge. While most respondents indicated that they always

screen for pregnancy before giving radioiodine, 9.5% indicated that they did this “sometimes.” Perhaps these respondents do not screen for pregnancy in certain circumstances such as those who have been in menopause for many years or in very young children. It is surprising that some respondents accepted written or verbal patient statements of being not pregnant and quite concerning that one respondent indicated that they “never” screen for pregnancy. Also concerning was that 5%–11% of respondents apparently had no threshold to advise patients regarding certain practices to follow in the first 24 hours after treatment. These desirable practices include avoiding children ages 2–10 years of age, maintaining a specific time and/or distance from other people, and avoiding public transportation. Similarly, a small minority of respondents did not recommend to patients that they sleep alone or avoid sexual contact. Even more disconcerting is that 7% of respondents recommended avoiding breast-feeding only when the therapeutic activity was >30 mCi, while 27% reported that they did not advise patients to avoid breast-feeding, and half of the respondents apparently did not see a need to avoid breast-feeding beyond the first 48 hours after radioiodine treatment.

Most respondents stated they use a consent form for radioiodine administration, and most consent forms provided information on pregnancy, the need to avoid breastfeeding, and the risk to salivary glands. Still, nearly one third indicated that they did not use a consent form, and of those that did, 30%–40% did not include information about avoiding breast-feeding or the risk of salivary injury. Consent forms were more likely to be used by physicians in the United States (72%), but by only 58% of treating endocrinologists. In my opinion, patients receiving radioiodine (an irreversible event) are confronted with so much information during this stressful life experience that providing both verbal and written information seems both important and prudent. Further, a signed consent by both the patient (or guardian) and the treating health-care professional should document in layman's language the common or severe risks of treatment including the fact that this treatment should not be given if the patient is pregnant, lactating, or breast-feeding or expects to do so within a specified period of time. The consent form should also document that a discussion occurred regarding the benefits of treatment, alternative treatments, safety instructions, and follow-up plans. Finally, it should indicate that the patient's questions have been answered and that consent was given to receive ^{131}I treatment.

Since the NRC rule change to allow outpatient therapy with ^{131}I activities above 30 mCi, some have vocally questioned this practice and urged its repeal. Based on available data, the ATA believes the current NRC regulations regarding the therapeutic use of radioiodine are appropriate and safe. There is concern that repeal of the opportunity to use outpatient radioiodine therapy with activities greater than 30 mCi will increase medical costs and may impair or delay patient care. Also, there is additional concern that the need for hospitalization (rather than medical judgment) may influence the amount of radioiodine activity or eliminate its use entirely. At the same time, the ATA strongly supports individualized patient care and the liberty of patient hospitalization for treatment when medically indicated. These ATA opinions are consistent with those recently expressed by the NRC Advisory Committee on the Medical Use of Isotopes (12). The

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ATA recognized the discordance of information given to patients as reflected in these survey results, or the lack of provided information suggested by other reports. To address this problem, the ATA has created a document that is under review for publication. The document "Radiation Safety in the Treatment of Patients with Thyroid Diseases by Radioiodine (¹³¹I) Practice Recommendations of the American Thyroid Association" aims to provide simplified, consistent, and safe instructions for care providers and patients. The document includes an Eligibility Assessment Checklist, Precaution Requirement Examples, and Special Instructions for Radioiodine Safety for Patients. It is the intention of the ATA to help facilitate implementation and compliance with the current NRC regulations, provide education to professionals and patients, and promote the safety of the patient's family members and friends, the public, and healthcare providers based on the best scientific evidence available. To accomplish these goals, the ATA is grateful for the voluntary service and expertise of colleagues who designed, distributed, collected, analyzed, authored, and revised this survey manuscript, to those who completed the survey, and to those who have created our upcoming Practice Recommendations, which we hope will be recognized as a valuable resource.

Disclosure Statement

ATA opinions were approved by the ATA Board of Directors.

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Address correspondence to:
 Richard T. Kloos, M.D.
 The Ohio State University
 446 McCampbell Hall
 1581 Dodd Drive
 Columbus, OH 43210-1296

E-mail: richard.kloos@osumc.edu