Radiation Exposure From Outpatient Radioactive Iodine (\(^{131}\text{I}\)) Therapy for Thyroid Carcinoma

Perry W. Grigsby, MD
Barry A. Siegel, MD
Susan Baker, MBA
John O. Eichling, PhD

Context In May 1997, the US Nuclear Regulatory Commission (NRC) revised its patient release regulations, allowing for outpatient administration of larger activities of sodium iodide \(^{131}\text{I}\) than previously permitted.

Objective To measure the radiation exposure to household members from patients receiving outpatient \(^{131}\text{I}\) therapy for thyroid carcinoma in accordance with the new regulations.


Setting and Patients Thirty patients who received outpatient \(^{131}\text{I}\) therapy following thyroidectomy for differentiated thyroid carcinoma were enrolled, along with their 65 household members and 17 household pets.

Main Outcome Measure Radiation exposure to household members and 4 rooms in each home, as monitored with dosimeters for 10 days following \(^{131}\text{I}\) administration.

Results The patients received \(^{131}\text{I}\) doses ranging from 2.8 to 5.6 GBq (mean, 4.3 GBq). The radiation dose to 65 household members ranged from 0.01 mSv to 1.09 mSv (mean, 0.24 mSv). The dose to 17 household pets ranged from 0.02 mSv to 1.11 mSv (mean, 0.37 mSv). The mean dose to the 4 rooms ranged from 0.17 mSv (kitchen) to 0.58 mSv (bedroom).

Conclusion In our study, \(^{131}\text{I}\) doses to household members of patients receiving outpatient \(^{131}\text{I}\) therapy were well below the limit (5.0 mSv) mandated by current NRC regulations.

METHODS

Thirty consecutive patients willing to participate in the study and all of their household members were entered in this study from October 1998 to June 1999. All patients signed a study-specific consent form approved by the Washington University Human Studies Committee. All patients previously had undergone a total thyroidectomy for papillary or mixed papillary-follicular thyroid cancer.
The estimated TEDE to the maximally exposed person was calculated using the formula given in equation B-5 of regulatory guide 8.39.\textsuperscript{2} The TEDE calculated by this method depends on several different variables, including the fractional uptake of \textsuperscript{131}I in thyroid tissue, the effective half-lives of \textsuperscript{131}I in thyroid and extrathyroidal tissues, and the occupancy factor (ie, the fraction of time the exposed person resides at a distance of 1 m from the patient). We also used the \textsuperscript{131}I effective half-life values and the occupancy factors recommended in the guide.\textsuperscript{2}

To estimate the fractional uptake of \textsuperscript{131}I in thyroid tissue before therapeutic administration of \textsuperscript{131}I, we performed a 48-hour total-body \textsuperscript{131}I-retention study. Patients scheduled for their first postthyroidectomy \textsuperscript{131}I treatment received 37 MBq of \textsuperscript{131}I for the retention study. These patients subsequently underwent whole-body imaging 3 to 5 days after the therapeutic \textsuperscript{131}I administration. Patients undergoing follow-up evaluation for thyroid uptake in this study, the 10-day cumulative exposure accounts for 84% of others for the first 10 days after outpatient therapeutic \textsuperscript{131}I administration.

Patients were instructed to sleep alone, drink fluids liberally, and avoid prolonged close personal contact with others for the first 2 days after \textsuperscript{131}I administration. Patients and family members were told that they could resume normal activities thereafter. All participants were instructed to wear the dosimeters 24 h/d for the 10-day period.

RESULTS

The patient population consisted of 22 females and 8 males, ranging in age from 9 to 76 years old (mean, 42 years). Sixty-five household members participated in this study: 41 males and 24 females, ranging in age from younger than 1 year to 78 years old (mean, 28 years). Thirty household members were younger than 19 years (range, 1-18; mean, 9.4; median, 9.5 years). Doses also were monitored in 17 household pets.

The 48-hour whole-body \textsuperscript{131}I retention ranged from 0.7% to 21.5% (mean, 8.4%). The patients were treated with 2.8 to 5.6 GBq of \textsuperscript{131}I (mean, 4.3 GBq). The estimated TEDE to the maximally exposed person (spouse, parent) ranged from 1.63 to 4.83 mSv (mean, 3.12 mSv).

The measured radiation dose to all household members ranged from 0.01 mSv to 1.09 mSv (mean, 0.24 mSv) (FIGURE and TABLE). The dose to household pets was of similar magnitude, ranging from 0.02 to 1.11 mSv (mean, 0.37 mSv). The measured radiation in the patients’ homes was greatest in their bedrooms (Table).

The estimated radiation dose to all household members ranged from 0.01 mSv to 1.09 mSv (mean, 0.24 mSv) (FIGURE and TABLE). The dose to household pets was of similar magnitude, ranging from 0.02 to 1.11 mSv (mean, 0.37 mSv). The measured radiation in the patients’ homes was greatest in their bedrooms (Table).

Table. Radiation Exposure in Household Rooms

<table>
<thead>
<tr>
<th>Room</th>
<th>Range</th>
<th>Mean (SD)</th>
<th>Median</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedroom</td>
<td>0.01-2.89</td>
<td>0.58 (0.66)</td>
<td>0.35</td>
</tr>
<tr>
<td>Bathroom</td>
<td>0.01-0.76</td>
<td>0.24 (0.22)</td>
<td>0.18</td>
</tr>
<tr>
<td>Kitchen</td>
<td>0.01-0.71</td>
<td>0.17 (0.15)</td>
<td>0.14</td>
</tr>
<tr>
<td>Living room</td>
<td>0.01-1.90</td>
<td>0.34 (0.39)</td>
<td>0.23</td>
</tr>
</tbody>
</table>

©2000 American Medical Association. All rights reserved.
the exposure, to infinity. Another limitation of our study was the potential for noncompliance of family members: if they did not wear their dosimeters as instructed, the reported absorbed doses would be underestimates. One can assume that the doses recorded in the 4 living areas reflect 100% compliance and that household pets were 100% compliant. As expected, among the doses to the living areas, the bedroom doses were the greatest. The bedroom doses and the doses to the pets are of the same magnitude as the doses to the household members, and, therefore, we believe that recorded doses in household members are reasonably accurate. Finally, this is a small series; thus, it is possible that larger exposures than we observed might be encountered in some household members of patients treated with $^{131}$I.

Our method of estimating the TEDE to the maximally exposed person is very conservative, because we assume that the total-body $^{131}$I retention at 48 hours is the thyroidal component with a long half-life. This study demonstrates that patients can be administered outpatient $^{131}$I therapy for thyroid carcinoma and that the resultant radiation exposure to household members is well below the limit mandated by the new US Nuclear Regulatory Commission regulations. Advantages of outpatient $^{131}$I therapy for thyroid carcinoma likely include reduced expense of treatment and less psychological strain on patients and their families.

REFERENCES