Efficacy of Thyroid Blockade on Thyroid Radioiodine Uptake in $^{123}$I-IBG Imaging

Nicholas C. Friedman1, Aamna Hassan1, Erin Grady2, Dale T. Matsuoka3, and Arnold F. Jacobson4

1Nuclear Medicine, Edward Hines VA Medical Center, Hines, Illinois; 2Christiana Care Health System, Newark, Delaware; 3DTM Consulting, Lynnwood, Washington; and 4Life Sciences, GE Healthcare, Princeton, New Jersey

Although iodinated radiopharmaceuticals usually contain a small quantity of unbound iodine, it is difficult to establish the degree to which thyroid activity on scintigraphic images reflects uptake of free radioiodine. The objective of the present study was to examine the effectiveness of thyroid blockade in subjects undergoing $^{123}$I-meta-iodobenzylguanidine (IBG) imaging and to estimate the relative contribution of bound and unbound radioiodine to imaging findings. Methods: All subjects were participants in prospective trials of $^{123}$I-IBG cardiac imaging in which pretreatment with thyroid blockade was optional unless locally required. In a pilot project, 15 subjects (6 blocked) had thyroid uptake measured at 4 h using a probe system. Fifteen-minute (early) and 4-h (late) anterior planar chest images that included the thyroid region were visually scored for thyroid activity. In nonblocked subjects, an estimated 79% of thyroid counts on late images were significantly higher on the late images of nonblocked subjects than for 131I($P < 0.001$). In the region-of-interest analyses, all thyroid counts were significantly higher on the late images of nonblocked subjects ($P < 0.0001$), and compared with early images, 87% of subjects who received blockade showed decreased or unchanged counts whereas 75% of nonblocked subjects had increased net thyroid activity. In nonblocked subjects, an estimated 79% of thyroid counts on late images could be attributed to unbound $^{123}$I. Conclusion: On the basis of 3 different methods for assessing thyroid uptake of $^{123}$I, use of thyroid blockade pretreatment in $^{123}$I-IBG imaging prevents increase of thyroid activity over time because of uptake of unbound $^{123}$I. In most subjects, there is a low level of $^{123}$I-IBG thyroid activity that probably represents specific uptake in sympathetic nerve terminals. Key Words: thyroid; blockade; $^{123}$I; mIBG

DOI: 10.2967/jnumed.113.124826

In the late 1970s, $^{131}$I-meta-iodobenzylguanidine (mIBG), an analog of norepinephrine, was developed by Wieland et al. at the University of Michigan for the purpose of functional imaging of the adrenal glands (1,2). This agent subsequently became used for diagnostic imaging of neural crest and neuroendocrine tumors (3,4). However, because of the superior dosimetric and imaging properties of $^{123}$I (5,6), most diagnostic imaging with mIBG is now performed using the $^{123}$I-labeled compound.

Routine clinical practice for mIBG imaging (as is the case for most radiiodine-labeled radiopharmaceuticals) includes pretreatment of patients with nonradioactive iodine to reduce radioactive free iodide uptake by the thyroid (5,6). Thyroid protection occurs via inhibition of the Na/I symporter and inhibition of thyroid hormone production via the Wolff–Chaikoff effect (7–9).

Free radioactive iodine is available either by metabolism of mIBG to release free iodide or by free iodine present in the preparation (10). As a result of the high radiation dosimetry associated with $^{131}$I, as well as the long-term harmful effects of radiation to the thyroid gland, particularly to younger patients, aggressive measures to reduce thyroid dose are required. The recommended thyroprotective regimen for diagnostic studies includes administration of saturated solution of potassium iodide (SSKI) or Lugol solution starting 1 d before administration of mIBG and continuing for up to 7 d after injection (5,6). Even using such a regimen, thyroid uptake was identified in 21% of diagnostic and posttherapy mIBG studies in children with neuroblastoma (11). Significant numbers of children treated with therapeutic quantities of $^{131}$I-mIBG have also developed hypothyroidism despite aggressive thyroid blockade regimens (11,12).

Despite the more favorable dosimetric characteristics of $^{123}$I, with 100 times lower estimated radiation dose per megabecquerel than for $^{131}$I (5), recommendations for multiday thyroid blockade regimens in association with $^{123}$I radiopharmaceuticals are still relatively common (3,6). With the use of $^{123}$I-mIBG manufactured with low free iodine content (typically 1%–3%) and considering the 13.2-h half-life of the radiosotope, such extended blockade is probably unnecessary. However, the clinical effectiveness of limited thyroid blockade (such as via a single-dose procedure) for reducing $^{123}$I dose to the thyroid has not been assessed in detail.

Patients evaluated with $^{123}$I-mIBG imaging for cardiac disease are different from those studied for neuroendocrine tumors, with ages typically over 60 y, thus decreasing concerns about the long-term effects of low-level thyroid exposure to ionizing radiation. The studies presented in this report were drawn from the $^{123}$I-mIBG clinical trial called AdreView (GE Healthcare) Myocardial Imaging for Risk Evaluation in Heart Failure (ADMIRE-HF). In ADMIRE-HF, physicians and patients were allowed to choose whether to receive thyroid cytoprotection, consisting of a single dose of blocking agent 1 h before $^{123}$I-mIBG administration. The objectives of the current study, including data from the entire trial population and selected subsets, were to assess the effectiveness of the single-blockade-dose
regimen and provide estimates of the relative radiation doses to the thyroid contributed by $^{123}$I-mIBG and free $^{123}$I.

**MATERIALS AND METHODS**

ADMIRE-HF (Clinicaltrials.gov identifier numbers NCT00126425 and NCT00126438) studied 961 New York Heart Association II–III heart failure subjects with impaired systolic function (left ventricular ejection fraction $\leq 35\%$) and 94 age-matched control subjects without heart disease (13). The study was approved by the Institutional Review Boards and Ethics Committees at each center, and all subjects gave written informed consent before performance of any procedures. All subjects underwent 10-min anterior planar imaging of the thorax beginning at 15 min (early) and 3 h 50 min (late) after administration of 370 MBq (10 mCi) of $^{123}$I-mIBG (AdreView). The anterior neck was included in most images, although for cameras with a smaller field of view, this region was sometimes truncated or completely excluded.

**Thyroid Uptake Measurements**

Fifteen subjects were recruited into the clinical trial at our site. We obtained approval from the sponsor and Human Studies Subcommittee to add a thyroid uptake measurement using a standard thyroid probe after the late image. Six subjects elected to undergo thyroid blockade (130 mg SSKI), and 9 elected not to receive this pretreatment. Thyroid uptake measurements were performed using a Biodex Atomlab 950 thyroid probe using the standard neck uptake measurement protocol as well as a background measure of the thigh. Both regions were counted 4 h after injection for 1 min. The percentage thyroid uptake was calculated by conversion of net thyroid counts to percentage uptake by correction for detector efficiency and geometry as well as decay correction.

**Visual Uptake Assessment**

A first series of visual assessments of thyroid uptake was performed on images from a random selection of 114 subjects. Studies that did not include the lower neck region were excluded from the selection. Three board-certified nuclear medicine physicians who were masked to all clinical information, including whether thyroid blockade had been administered, reviewed the studies for visual scoring of thyroid uptake. Thyroid uptake was assessed semiquantitatively using the scoring system listed in Table 1.

A second series of visual assessments using the same scoring system was performed on images from 52 subjects who were taking thyroid hormone replacement at the time of $^{123}$I-mIBG imaging. These reviews were performed by 2 readers.

**RESULTS**

**Uptake Data**

Thyroid uptake data acquired on the patients enrolled at our institution are summarized in Table 2. There was no statistical difference between the 6 subjects who were administered SSKI (blocked) and the 9 subjects who declined SSKI (nonblocked), although a tendency to higher uptake was noted in the latter group. Mean percentage uptake was 1.4% for nonblocked (range $\pm$ 2 SDs, 0.6%–2.2%) and 1.3% for blocked (range $\pm$ 2 SDs, 0.6%–1.9%).

**Visual Analyses**

Of the 114 randomly selected cases, 14 were deemed uninterpretable because the field of view did not include the entire lower neck. Of the remaining 100 cases, 64 had received thyroid blockade before injection of $^{123}$I-mIBG and 36 had not received thyroid blockade.

For the group that received blockade, the mean visual semiquantitative score on the early images was 1.4 ($\pm$0.8) compared with and without thyroid blockade were compared using the Student t test. Differences at the $P < 0.05$ level were considered significant. Statistical comparisons were performed using t tests and 1-way ANOVA. Differences at the $P < 0.05$ level were considered significant.

**TABLE 1**

<table>
<thead>
<tr>
<th>Score</th>
<th>Characterization</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No identifiable thyroid visualization</td>
</tr>
<tr>
<td>0.5</td>
<td>Faint uptake in neck, not definitively identifiable as thyroid gland</td>
</tr>
<tr>
<td>1</td>
<td>Subtle but distinct thyroid uptake, less than salivary glands if visualized</td>
</tr>
<tr>
<td>2</td>
<td>Moderate distinct thyroid uptake, equal to salivary glands if visualized</td>
</tr>
<tr>
<td>3</td>
<td>Significant thyroid uptake, greater than salivary glands if visualized and less than dome of liver</td>
</tr>
<tr>
<td>4</td>
<td>High thyroid uptake; maximum activity similar to dome of liver</td>
</tr>
</tbody>
</table>

**Analysis and Statistics**

**Thyroid Uptake Measurements.** Mean uptake values for subjects with and without thyroid blockade were compared using the Student t test. Differences at the $P < 0.05$ level were considered significant.

**Visual Reads.** Groups were classified in terms of thyroid blockade status. The mean scores for the readers were used in the analysis. Statistical comparisons were performed using t tests and 1-way ANOVA. Differences at the $P < 0.05$ level were considered significant.

**Image Quantitation.** The rectangular thyroid ROI was used because it was judged infeasible to draw an irregular ROI for the gland in many subjects. The net thyroid counts ($A_t$) were estimated by subtracting background activity from the total counts in the thyroid ROI:

$$A_t = \text{thyroid ROI counts} - (\text{thyroid ROI pixels} \times \text{mediastinum counts/pixel}),$$

where $t = e$ for the early image and $t = l$ for the late image.

These results were compared between subjects who did and did not receive thyroid blockade. In addition, for subjects with interpretable early and late images, change in total thyroid activity was determined as the difference between early and decay-corrected late counts in the thyroid ROI. Mean values were compared using $t$ tests, with a $P$ value of less than 0.05 considered significant.

All study images were visually reviewed by an experienced nuclear medicine technologist to determine whether the region of the thyroid gland was in the field of view. Images that did not include this region were not processed. For the remaining images, the following analysis procedures were used.

Initial processing was performed on the late image. The technologist noted where there was any distinct thyroid uptake and, in those images, whether the superior aspect of the gland was truncated. For images with any visualized thyroid activity, the smallest rectangular ROI of interest (ROI) that included such activity was drawn. If there was no visualized thyroid activity, an ROI in the expected location of the thyroid, above the sternal notch and below the submandibular salivary glands, was drawn. The number of pixels and counts per pixel in the thyroid ROI were then recorded. The technologist then drew a $7 \times 7$ pixel mediastinum (background) ROI in the midline upper chest directly below the thyroid ROI, adjusting the location and size of the background ROI as necessary to avoid including thyroid or high lung activity, and recorded the counts per pixel.

Using the late image as the template, the thyroid and mediastinum ROIs were reproduced in size and location on the early image and the counts and counts-per-pixel data were recorded.

**Table 2**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thyroid ROI counts</td>
<td>A_t</td>
</tr>
<tr>
<td>(thyroid ROI pixels \times mediastinum counts/pixel)</td>
<td></td>
</tr>
</tbody>
</table>

where $t = e$ for the early image and $t = l$ for the late image.

These results were compared between subjects who did and did not receive thyroid blockade. In addition, for subjects with interpretable early and late images, change in total thyroid activity was determined as the difference between early and decay-corrected late counts in the thyroid ROI. Mean values were compared using $t$ tests, with a $P$ value of less than 0.05 considered significant.

**RESULTS**

**Uptake Data**

Thyroid uptake data acquired on the patients enrolled at our institution are summarized in Table 2. There was no statistical difference between the 6 subjects who were administered SSKI (blocked) and the 9 subjects who declined SSKI (nonblocked), although a tendency to higher uptake was noted in the latter group. Mean percentage uptake was 1.4% for nonblocked (range $\pm$ 2 SDs, 0.6%–2.2%) and 1.3% for blocked (range $\pm$ 2 SDs, 0.6%–1.9%).

**Visual Analyses**

Of the 114 randomly selected cases, 14 were deemed uninterpretable because the field of view did not include the entire lower neck. Of the remaining 100 cases, 64 had received thyroid blockade before injection of $^{123}$I-mIBG and 36 had not received thyroid blockade.

For the group that received blockade, the mean visual semiquantitative score on the early images was 1.4 ($\pm$0.8) compared...
with 1.6 (±0.8) for the nonblocked group (P = 0.15). Comparable results on the late images were 0.5 (±0.6) for the blocked group, compared with 2.1 (±1.2) for the nonblocked group (P < 0.0001).

The highest late image score in the blocked group was 2, whereas 15 subjects (37.5%) in the nonblocked group had scores of greater than 2. Representative images are presented in Figure 1.

![Figure 1](image)

**FIGURE 1.** Representative thyroid visual analysis examples: score 0.5 (A), score 1 (B), score 3 (C), and score 4 (D).

Of the 52 thyroid-hormone replacement subjects, 34 had received thyroid blockade. There was no difference in the mean early and late image scores for the nonblocked subjects (0.9 vs. 0.9), whereas the score decreased over time in the blocked subjects (1.0 vs. 0.6, P = 0.005). However, the mean scores between blocked and non-blocked subjects were not different at either imaging time (early: P = 0.66; late: P = 0.09).

### Image Quantitation

Images with any truncation of the upper pole of the thyroid were excluded from these analyses.

At least one anterior planar chest image from 840 subjects (77%) included the entire region of the thyroid gland. Both early and late images were assessable in 669 subjects (61%), whereas only 1 of the 2 images could be analyzed for 171 subjects (16%). To ensure consistency in results for the analyses, the following represent the findings for the 669 paired image analyses.

Thyroid uptake was visualized on both early and late images in 576 subjects. Thyroid uptake was seen on only 1 of the 2 images in 57 subjects, whereas in 36 subjects no uptake was identified on either image.

Of the 669 subjects with 2 assessable images, 442 (64%) had been pretreated with thyroid blockade (306 with potassium iodide preparations, 136 with perchlorate), whereas 227 (36%) had received no pretreatment. As another factor that could influence thyroid uptake of radioiodine, 65 subjects (10%) were taking thyroid hormone replacement, of whom 43 were also pretreated with thyroid blocking medication.

The ROI net thyroid count data (A<sub>t</sub>) are summarized in Tables 3 and 4. On early images, there was no significant difference in A<sub>e</sub> between subjects who had and had not received pretreatment with thyroid-blocking medications. There was a large difference in A<sub>l</sub> on the late images, with most subjects who received blockade showing decreased or unchanged counts whereas most of nonblocked subjects had an increase in A<sub>l</sub>. The largest difference between early and late images was seen in nonblocked subjects who were not receiving thyroid hormone replacement, whereas the smallest difference was

<table>
<thead>
<tr>
<th>Subject</th>
<th>Thyroid counts/min</th>
<th>Background counts/min</th>
<th>Background-corrected thyroid counts/min</th>
<th>Estimated mCi* in thyroid</th>
<th>Percentage uptake of injected dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonblocked</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0002</td>
<td>652,783</td>
<td>117,756</td>
<td>535,027</td>
<td>150</td>
<td>1.8</td>
</tr>
<tr>
<td>0020</td>
<td>590,968</td>
<td>112,988</td>
<td>477,980</td>
<td>134</td>
<td>1.6</td>
</tr>
<tr>
<td>0004</td>
<td>377,888</td>
<td>101,925</td>
<td>275,963</td>
<td>78</td>
<td>0.9</td>
</tr>
<tr>
<td>0007</td>
<td>638,082</td>
<td>135,748</td>
<td>502,334</td>
<td>141</td>
<td>1.7</td>
</tr>
<tr>
<td>0009</td>
<td>543,946</td>
<td>89,304</td>
<td>454,642</td>
<td>128</td>
<td>1.5</td>
</tr>
<tr>
<td>0001</td>
<td>635,952</td>
<td>151,500</td>
<td>484,452</td>
<td>136</td>
<td>1.6</td>
</tr>
<tr>
<td>0005</td>
<td>331,940</td>
<td>178,212</td>
<td>153,728</td>
<td>43</td>
<td>0.5</td>
</tr>
<tr>
<td>0011</td>
<td>644,402</td>
<td>156,117</td>
<td>488,285</td>
<td>137</td>
<td>1.6</td>
</tr>
<tr>
<td>0019</td>
<td>543,283</td>
<td>107,075</td>
<td>436,208</td>
<td>123</td>
<td>1.4</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.4</td>
</tr>
<tr>
<td>Blocked</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0010</td>
<td>484,072</td>
<td>151,916</td>
<td>332,156</td>
<td>93</td>
<td>1.1</td>
</tr>
<tr>
<td>0003</td>
<td>420,677</td>
<td>137,013</td>
<td>283,664</td>
<td>80</td>
<td>0.9</td>
</tr>
<tr>
<td>0008</td>
<td>689,564</td>
<td>161,650</td>
<td>527,914</td>
<td>148</td>
<td>1.7</td>
</tr>
<tr>
<td>0013</td>
<td>556,816</td>
<td>134,898</td>
<td>421,918</td>
<td>119</td>
<td>1.4</td>
</tr>
<tr>
<td>0017</td>
<td>577,106</td>
<td>113,395</td>
<td>463,711</td>
<td>130</td>
<td>1.5</td>
</tr>
<tr>
<td>0018</td>
<td>436,055</td>
<td>101,902</td>
<td>334,153</td>
<td>94</td>
<td>1.1</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.3</td>
</tr>
</tbody>
</table>

*1 mCi = 37 kBq.
Although there remains considerable diversity of opinion about the
suggest that for a short-lived isotope such as \(^{123}\text{I}\), an adequate dose of
before and after exposure to radioiodine, the relevant published data
both with regard to the number and the duration of administrations
regimen that should be used for administering blocking medication,
radiochemical purity of the \(^{123}\text{I}\)-
7
images was likely due to specific uptake of \(^{123}\text{I}\)-
that only a small fraction of the thyroid activity seen on 4-h delayed
reducing progressive uptake of radioiodine over time, suggesting
a trend toward higher uptake in the nonblocked subjects, and this
2 groups, with uptake below 2% for all cases measured. There was
effect of blockade. This sample of 15 subjects showed little dif-
administered activity of 370 MBq (10 mCi) was 7.4 MBq
probe measurements (1.4%) is used as the basis for calculation of
thyroid gland dosimetry (5), the following estimates are obtained:
nonblocked: 70 mGy; blocked: 27.3 mGy; blocked and on thyroid
hormone replacement: 14.6 mGy.

**DISCUSSION**

The present study used 3 different methods to estimate the
effectiveness of thyroid-blocking medication for minimizing thy-
roid uptake of unbound radioiodine from \(^{123}\text{I}-\text{mIBG}\). Because the
radiochemical purity of the \(^{123}\text{I}-\text{mIBG}\) used in this study was
greater than 98%, the maximum amount of free \(^{123}\text{I}\) in the nominal
administered activity of 370 MBq (10 mCi) was 7.4 MBq
(0.2 mCi), similar to the quantity used for conventional thyroid scan-
ing. The pilot study used probe measurements to quantify the
effect of blockade. This sample of 15 subjects showed little dif-
ference between the measured 4-h thyroid uptake of subjects in the
2 groups, with uptake below 2% for all cases measured. There was
a trend toward higher uptake in the nonblocked subjects, and this
finding was supported by the results of the subsequent examina-
tion of visual uptake patterns in a sample of 100 subjects. The final
quantitative analysis of 669 subjects with assessable early and late
planar images confirmed the effectiveness of thyroid blockade for
reducing progressive uptake of radioiodine over time, suggesting
that only a small fraction of the thyroid activity seen on 4-h delayed
images was likely due to specific uptake of \(^{123}\text{I}-\text{mIBG}\).

The reduction of thyroid uptake of radioiodine by pretreatment
with agents such as SSKI and pertechnetate is well established (7–9).
Although there remains considerable diversity of opinion about the
regimen that should be used for administering blocking medication,
both with regard to the number and the duration of administrations
before and after exposure to radioiodine, the relevant published data
suggest that for a short-lived isotope such as \(^{123}\text{I}\), an adequate dose of
blocking medication administered within the 24 h before exposure
will provide acceptable protection for up to 48 h. In a computer
simulation performed by Wootton and Hammond, the optimum time
for administration of blockade was 1 h before administration of radio-
odine (14). This latter recommendation was the basis for the blocking
procedure used in the present study.

Although the results of the visual and ROI-based analyses
confirm the effectiveness of thyroid blockade for reducing radio-
iodine uptake in the gland, it is more difficult to precisely estimate
the magnitude of the reduction in radiation dose. Effective
blockade should result in visualization of only thyroid uptake of
\text{mIBG}, but the observed differences in level of thyroid activity in
blocked patients can be interpreted as reflecting variation in specific
neuronal uptake, ineffectiveness of the blockade, or a combi-
nation of the two. Because published \text{mIBG} biodistribution studies
have usually been performed with subjects blocked, the contribu-
tion of unbound iodine to thyroid dosimetry could be estimated
only on the basis of the level of free iodine in the original injectate
and sodium iodide dosimetry studies (10). There are sympathetic
nerve fibers that reach the thyroid from the superior, middle, and
inferior ganglia of the sympathetic trunk, and these small nerves
enter the gland along with the blood vessels. It is therefore reason-
able to presume that a low level of NET-mediated uptake of \text{mIBG}
ocurs in the presynaptic nerve terminals. The present study pro-
vides the first large body of data allowing comparison of the low
level of thyroid activity in blocked patients (potentially reflecting
specific \text{mIBG} uptake) to the higher uptake in the nonblocked
cohort. In particular, the further uptake suppression produced by
treatment with exogenous thyroid hormone suggests that there is
a certain amount of uptake that cannot be prevented, presumably
reflecting \text{mIBG} uptake in sympathetic nerve terminals in the
gland. The slow decline in thyroid uptake between 15 min and 4
h in these fully suppressed subjects then likely represents normal
physiologic turnover of norepinephrine and \text{mIBG} from the gland.
On average, activity in the blocked and thyroid hormone–treated
subjects was about 46% of that in untreated subjects at 15 min and
21% at 4 h, reflecting the progressive increase in thyroid uptake of
unbound radioiodine over time in the latter subjects.

In principle, reduction of any unnecessary radiation dose to a
patient is desirable. In practice, the benefit of eliminating a small
radiation dose to an older patient (such as the typical heart failure
patient) whose lifetime risk of developing neoplasia from that dose
is minimal might be questioned. The radiation burden to the thyroid
from administration of 370 MBq (10 mCi) of high-purity \(^{123}\text{I}-\text{mIBG}\)
was estimated at 70 mGy in nonblocked subjects, similar to the dose
received by clinical patients undergoing \(^{123}\text{I}\) thyroid scans. The re-
sults of this study indicate that a single dose of SSKI (or equivalent)
is effective in reducing thyroid dose by more than 50%. However, the
clinician should still consider on an individual patient basis whether
such blocking is necessary or worthwhile, particularly for elderly
patients with multiple comorbidities or a possible iodine allergy.

This study had several limitations, the most significant of which
were methodologic. The number of subjects who had probe mea-
surements was small and likely resulted in the lack of significance

### TABLE 3

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Subjects (n)</th>
<th>Mean early thyroid counts</th>
<th>Mean late thyroid counts</th>
<th>Mean net count change (%)</th>
<th>No. with increased (late vs. early) thyroid counts (%)</th>
<th>No. with decreased or unchanged (late vs. early) thyroid counts (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonblocked</td>
<td>227</td>
<td>7,997 (SD, 6,927)</td>
<td>13,864 (SD, 10,423)</td>
<td>+5,867 (73.4%)</td>
<td>171 (75%)</td>
<td>56 (25%)</td>
</tr>
<tr>
<td>Blocked</td>
<td>442</td>
<td>9,033 (SD, 8,855)</td>
<td>5,440 (SD, 6,021)</td>
<td>−3,593 (−39%)</td>
<td>59 (19%)</td>
<td>383 (77%)</td>
</tr>
<tr>
<td>P</td>
<td></td>
<td>0.11</td>
<td>&lt;0.0001</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Early = 15 min after administration; late = 3 h 50 min after administration.
Effect of Thyroid Hormone Replacement and Thyroid Blockade on Net Thyroid Counts on Early and Late $^{123}$I-mIBG Imaging reduces thyroid radiation burden, preventing a progressive titative application of these results should be approached with caution.

Overall, in nonblocked subjects the estimated thyroid activity between 15 min and 4 h after administration. Whether this finding reflected inadequate thyroid ROI and then subtracting background was a practical compromise for obtaining net count estimates but one with definite limitations for achieving high accuracy. The position of the thyroid ROI at the edge of the image field of view in most cases also raises the possibility that field nonuniformities could have affected quantitative reliability. Finally, about 40% of subjects included in the original studies were excluded because the thyroid region was partially or completely absent from at least one image, thereby introducing a potential source of bias because sites that used small-field-of-view cardiac cameras were disproportionately affected. The numbers generated in this study provide a useful indication of the physiologic factors involved in thyroid blockade for adults undergoing $^{123}$I-mIBG imaging, but more detailed quantitative application of these results should be approached with caution.

CONCLUSION
Use of single-dose thyroid blockade pretreatment in $^{123}$I-mIBG imaging reduces thyroid radiation burden, preventing a progressive increase in thyroid activity over time due to uptake of unbound $^{123}$I. Overall, only 13% of subjects who received thyroid blockade showed increased net thyroid activity between 15 min and 4 h after administration. Whether this finding reflected inadequate amounts of blockade medication or an effect of in vivo deiodination of $^{123}$I-mIBG in these subjects is uncertain. Results for subjects who were taking thyroid hormone replacement at the time of receiving thyroid blockade suggest there is a low level of $^{123}$I-mIBG thyroid activity that represents uptake in sympathetic nerve terminals. Overall, in nonblocked subjects the estimated thyroid dose from the preparation used in this clinical trial was similar to that received from a diagnostic thyroid scan.

DISCLOSURE
The costs of publication of this article were defrayed in part by the payment of page charges. Therefore, and solely to indicate this fact, this article is hereby marked “advertisement” in accordance with 18 USC section 1734. Arnold F. Jacobson is an employee of GE Healthcare, which manufactures $^{123}$I-mIBG, and owns shares in the General Electric Company. The studies in which all imaging data were collected and quantitatively analyzed were sponsored by GE Healthcare. No financial support was provided for the probe or visual analyses of the imaging data. No other potential conflict of interest relevant to this article was reported.

REFERENCES
Efficacy of Thyroid Blockade on Thyroid Radioiodine Uptake in \(^{123}\text{I}}-mIBG Imaging

Nicholas C. Friedman, Aamna Hassan, Erin Grady, Dale T. Matsuoka and Arnold F. Jacobson

*J Nucl Med.*
Published online: January 2, 2014.
Doi: 10.2967/jnumed.113.124826