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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review and approval. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

Revised 2009 (Resolution 17)\*

## **ACR–SNM–SPR PRACTICE GUIDELINE FOR THE PERFORMANCE OF THYROID SCINTIGRAPHY AND UPTAKE MEASUREMENTS**

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### **PREAMBLE**

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations of available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment. Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

### **I. INTRODUCTION**

This guideline was revised collaboratively by the American College of Radiology (ACR), the Society for Pediatric Radiology (SPR), and the Society of Nuclear Medicine (SNM).

This guideline is intended to guide interpreting physicians performing thyroid scintigraphy and in-vivo radioiodine thyroid uptake measurements. Properly performed imaging and uptake studies provide critical information on a variety of conditions that relate to the thyroid gland. Although certain examination results suggest specific disease entities, the radiologist should correlate the examination with relevant clinical data (e.g., thyroid function tests, the presence of clinically palpable neck masses, and potentially interfering substances such as iodinated radiographic contrast media and medications, vitamins, and health foods containing large amounts of

iodine). Additionally, correlation with other radiographic modalities such as ultrasonography, computed tomography (CT), magnetic resonance imaging (MRI), chest radiography, or with other radionuclide imaging studies may also be helpful. Adherence to this guideline should maximize the probability of detecting and characterizing abnormalities of thyroid anatomy and function.

Application of this guideline should be in accordance with the [ACR–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

(For pediatric considerations see sections V.A.1; V.B.1; and V.C.)

## II. GOALS

Thyroid scintigraphy facilitates the detection of focal and/or global abnormalities of thyroid anatomy, correlation of anatomy with function, and detection of aberrant or metastatic functioning thyroid tissue or residual normal tissue after therapy.

Thyroid uptake allows measurement of global function of the thyroid gland as reflected by the quantitative evaluation of radiopharmaceutical accumulation and evaluation of iodine (and iodine analog) kinetics by the gland.

## III. INDICATIONS AND CONTRAINDICATIONS

A. Thyroid imaging is useful in, but not limited to:

1. Evaluation of the size and location of thyroid tissue.
2. Evaluation of hyperthyroidism.
3. Evaluation of suspected focal (i.e., masses) or diffuse thyroid disease.
4. Evaluation of clinical laboratory tests suggestive of abnormal thyroid function.
5. Evaluation of patients at risk for thyroid neoplasm (e.g., post neck irradiation).
6. Assessment of the function of thyroid nodules identified on clinical examination or ultrasound or by other diagnostic imaging.
7. Evaluation of congenital thyroid abnormalities.

B. Thyroid uptake is useful for:

1. Differentiating hyperthyroidism from other forms of thyrotoxicosis (e.g., thyroiditis and thyrotoxicosis factitia).
2. Calculating iodine-131 administered activity for patients to be treated for hyperthyroidism or ablative therapy (see the [ACR–ASTRO Practice Guideline for the Performance of Therapy with Unsealed Radiopharmaceutical Sources](#)).

C. Whole-body imaging for thyroid carcinoma is useful for:

1. Determining the presence and location of residual functioning thyroid tissue after surgery for thyroid cancer or after ablative therapy with radioactive iodine.
2. Determining the presence and location of metastases from iodine-avid forms of thyroid cancer.

D. Contraindications

Administration of iodine-131 sodium iodide to pregnant or lactating patients (whether currently nursing or not) is contraindicated.

For the pregnant or potentially pregnant patient, see the [ACR–SPR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#).

#### IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

#### V. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for thyroid scintigraphy should provide sufficient information to demonstrate the medical necessity of the examination and allow for its proper performance and interpretation.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). Additional information regarding the specific reason for the examination or a provisional diagnosis would be helpful and may at times be needed to allow for the proper performance and interpretation of the examination.

The request for the examination must be originated by a physician or other appropriately licensed health care provider. The accompanying clinical information should be provided by a physician or other appropriately licensed health care provider familiar with the patient's clinical problem or question and consistent with the state's scope of practice requirements. (ACR Resolution 35, adopted in 2006)

##### A. Thyroid Scintigraphy

###### 1. Radiopharmaceutical

The preferred radiopharmaceutical for thyroid scintigraphy is iodine-123 (sodium iodide) given orally in administered activity of 200 to 400 microcuries (7.4 to 14.8 MBq).

Technetium-99m sodium pertechnetate, given intravenously in administered activity of 2.0 to 10.0 millicuries (74 to 370 MBq), is an acceptable alternative that has higher photon flux and lower thyroid radiation exposure. Technetium-99m sodium pertechnetate is the preferred agent for evaluating congenital hypothyroidism in neonates.

Use of iodine-131 is strongly discouraged for routine use because of its much greater radiation dose to the thyroid. The interpreting physician should be aware that findings, particularly in nodular disease, may rarely be discordant when the radioiodine and technetium images are compared, since pertechnetate is not handled by the same physiologic mechanism as iodine.

Administered activity for children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality. The calculation of the pediatric dosage of technetium-99m sodium pertechnetate should be based on a reduced adult dosage of 2.0 to 5.0 millicuries (74 to 185 MBq).

###### 2. Pharmacologic considerations

Many agents interfere with the accumulation of radiopharmaceuticals in the thyroid gland.

##### Compounds That May Decrease Thyroid Iodine Uptake

MEDICATION	TIME*
Adrenocorticosteroids	1 week
Bromides	1 week
Butazolidine	1 week
Mercurials	1 week
Methimazole (Tapazole)	1 week

<b>MEDICATION</b>	<b>TIME*</b>
Nitrates	1 week
Perchlorate	1 week
Propylthiouracil	1 week
Salicylates (large doses)	1 week
Sulfonamides	1 week
Thiocyanate	1 week
Tri-iodothyronine (Cytomel)	2 to 3 weeks
Thyroid extracts (Synthroid, Proloid)	4 weeks
Iodine solution (Lugol's or SSKI**)	weeks
Iodine-containing antiseptics	weeks
Kelp	4 weeks
Some cough medicines and vitamin preparations	4 weeks
Intravenous contrast agents	1 to 2 months
Oil-based iodinated contrast agents	3 to 6 months
Amiodarone	3 to 6 months

\*Time that patients should wait after medication is discontinued in order to obtain accurate uptake.

\*\*saturated solution of potassium iodide.

A thorough medical history should be obtained prior to administering the radiopharmaceutical and, if necessary, the study should be delayed appropriately.

### 3. Patient

The patient should be placed in a supine position, with the neck comfortably extended. It may be helpful to immobilize the head with gentle restraints. When indicated, the physician should palpate the thyroid gland while the patient is in the imaging position as well as when the patient is upright.

### 4. Imaging

With iodine-123, imaging can commence as early as 3 to 4 hours or as long as approximately 24 hours after administration. Diagnostic-quality images can be obtained as long as 36 hours after administration. Following intravenous administration of technetium-99m pertechnetate, imaging should commence 5 to 30 minutes after injection. Radioactive sources or lead markers may be used to identify anatomic landmarks such as the sternal notch and thyroid cartilage. The location of palpable nodules should be confirmed with a radioactive point source or lead marker image for anatomic correlation.

## B. Thyroid Uptake

### 1. Radiopharmaceutical

If thyroid scintigraphy is performed in conjunction with radioiodine thyroid uptake, the radioiodine administered activity given for the scan will suffice for the uptake as well. If done separately or in conjunction with a technetium-99m pertechnetate scan, as little as 100 microcuries (3.7 MBq) of iodine-123 or 4 microcuries (0.15 MBq) of iodine-131 may be used. If only a thyroid uptake with iodine-131 is obtained, the administered activity should not exceed 15 microcuries (0.55 MBq).

Administered activity for children should be determined based on body weight and should be as low as reasonably achievable to perform the radioiodine uptake.

### 2. Pharmacologic considerations: See section V.A.2.

### 3. Procedure

The usual time of measurement is approximately 24 hours after radiopharmaceutical administration. An additional uptake measurement may also be performed at 4 to 6 hours, particularly in cases of suspected rapid iodine turnover. The percent uptake should be compared to normal values measured at the same time after radiopharmaceutical administration, if available. The patient should sit or lie with neck extended; an open-faced collimated detector probe should be directed at the neck, with the crystal usually no more than 20 to 30 cm away.

There are several acceptable measurement and calculation techniques; the following is one example. Counts are taken for 1 minute over the thyroid gland. Counts are then taken over the patient's mid-thigh for 1 minute and at the same distance (e.g., 20 to 30 cm), taking care to exclude the urinary bladder from the detector field. A source of the same radionuclide of identical activity to that given to the patient is placed in a standardized lucite scattering neck phantom and is counted for 1 minute using the same geometry. The room background is also counted for 1 minute. The radioiodine uptake (RAIU) is calculated using the formula:

$$\text{RAIU} = \frac{\text{Neck Counts} - \text{Thigh Counts}}{\text{Phantom Counts} - \text{Background Counts}} \times 100\%$$

### C. Imaging for Thyroid Carcinoma

In the absence of normal thyroid tissue, many well-differentiated thyroid carcinomas accumulate iodine. Detection of thyroid remnants after surgery and of functioning thyroid metastases is possible using iodine-131 or iodine-123 and, occasionally, other radiopharmaceuticals.

#### 1. Preparation

Thyroid hormone replacement should be withheld for a time sufficient to render the patient hypothyroid (serum thyroid stimulating hormone [TSH] level greater than 30 mU/L), or thyrotropin alpha (Thyrogen) stimulation should be used according to an established protocol.

The use of a low iodine diet may increase the sensitivity of the imaging examination and the efficacy of iodine-131 ablation. Typically the low iodine diet is started 2 weeks prior to radioiodine administration and continued for several days during imaging and/or radioiodine therapy [2].

#### 2. Procedures

Administered activity of 1.0 to 5.0 millicuries (37 to 185 MBq) of iodine-131 sodium iodide is given orally, and imaging of the neck and the entire body is performed 48 to 96 hours later using a collimator designed for iodine-131.

Administered activity for children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

Iodine-131 whole body imaging may also be performed 2 to 14 days (typically at 5 to 7 days) after thyroid ablative therapy to detect residual normal thyroid tissue and/or iodine avid metastases that may not have been detected on pretherapy scans, if performed. Uptake values may also be calculated for the residual thyroid tissue in the thyroid bed using the technique described in section V.B.3.

Whole body scans may be performed with 2 to 5 mCi of iodine-123 administered 18 to 24 hours prior to imaging. Pinhole images of the thyroid bed and parallel hole images of the anterior, posterior, and right and left lateral of the head and neck, chest, or abdomen may improve lesion detection relative to the

whole body scan. Single photon emission computed tomography (SPECT) imaging may be performed as needed. If SPECT/CT imaging is available, it may replace or complement planar and pinhole imaging.

### 3. Alternative protocols

Some investigators have used thallium-201, technetium-99m sestamibi, technetium-99m tetrofosmin, or fluorodeoxyglucose – positron emission tomography (FDG-PET) whole-body imaging as an alternative for follow-up of thyroid remnant and metastases. (See the [ACR–SPR Practice Guideline for the Performance of Tumor Scintigraphy \[with Gamma Cameras\]](#).)

FDG-PET and PET/CT have been used to evaluate patients who have a history of well-differentiated thyroid cancer that is not iodine avid and have elevated thyroglobulin levels. Studies have shown that FDG-PET and PET/CT detect metastatic disease in approximately 70 percent of these patients. Most of the studies have been performed while patients are on thyroid hormone, but there is emerging evidence that the sensitivity of the study may increase in patients with stimulated TSH levels.

## VI. EQUIPMENT SPECIFICATIONS

### A. Thyroid Imaging

Normally, a gamma camera equipped with a pinhole collimator is used. Images are acquired in the anterior and often both anterior oblique projections for a minimum of 100,000 counts or 8 minutes, whichever occurs first. The distance between the collimator aperture and the neck should be such that the thyroid occupies most of the field of view. With pinhole collimators, significant geometric distortion occurs. Additional views with a parallel-hole collimator may be useful when searching for ectopic tissue or estimating thyroid size. Collimator choice should be appropriate to the radiopharmaceutical used.

### B. Thyroid Uptake

A thyroid probe is normally used. A gamma camera with a parallel-hole collimator may be used instead of a probe, but the use of a standardized neck phantom remains necessary.

### C. Imaging for Thyroid Carcinoma

For iodine-131 imaging a high-energy collimator should be used with an appropriately shielded detection head. Pinhole collimator imaging of the thyroid bed may also be useful.

## VII. DOCUMENTATION

Reporting should be in accordance with the [ACR Practice Guideline for Communication of Diagnostic Imaging Findings](#).

The report should include the radiopharmaceutical used and the dose and route of administration, as well as any other pharmaceuticals administered, also with dose and route of administration.

## VIII. RADIATION SAFETY

Radiologists, medical physicists, registered radiologist assistants, radiologic technologists, and all supervising physicians have a responsibility for safety in the workplace by keeping radiation exposure to staff, and to society as a whole, “as low as reasonably achievable” (ALARA) and to assure that radiation doses to individual patients are appropriate, taking into account the possible risk from radiation exposure and the diagnostic image quality necessary to achieve the clinical objective. All personnel that work with ionizing radiation must understand the key principles of occupational and public radiation protection (justification, optimization of protection and application of dose limits) and the principles of proper management of radiation dose to patients (justification, optimization and the use of dose reference levels)

[http://www-pub.iaea.org/MTCD/Publications/PDF/p153interim\\_web.pdf](http://www-pub.iaea.org/MTCD/Publications/PDF/p153interim_web.pdf)

Facilities and their responsible staff should consult with the radiation safety officer to ensure that there are policies and procedures for the safe handling and administration of radiopharmaceuticals and that they are adhered to in accordance with ALARA. These policies and procedures must comply with all applicable radiation safety regulations and conditions of licensure imposed by the Nuclear Regulatory Commission (NRC) and by state and/or other regulatory agencies. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol

Nationally developed guidelines, such as the ACR's Appropriateness Criteria<sup>®</sup>, should be used to help choose the most appropriate imaging procedures to prevent unwarranted radiation exposure.

Additional information regarding patient radiation safety in imaging is available at the Image Gently<sup>®</sup> for children ([www.imagegently.org](http://www.imagegently.org)) and Image Wisely<sup>®</sup> for adults ([www.imagewisely.org](http://www.imagewisely.org)) websites. These advocacy and awareness campaigns provide free educational materials for all stakeholders involved in imaging (patients, technologists, referring providers, medical physicists, and radiologists).

Radiation exposures or other dose indices should be measured and patient radiation dose estimated for representative examinations and types of patients by a Qualified Medical Physicist in accordance with the applicable ACR Technical Standards. Regular auditing of patient dose indices should be performed by comparing the facility's dose information with national benchmarks, such as the ACR Dose Index Registry, the NCRP Report No. 172, Reference Levels and Achievable Doses in Medical and Dental Imaging: Recommendations for the United States or the Conference of Radiation Control Program Director's National Evaluation of X-ray Trends. (ACR Resolution 17 adopted in 2006 – revised in 2009, 2013, Resolution 52).

## **IX. QUALITY CONTROL AND IMPROVEMENT, SAFETY, INFECTION CONTROL, AND PATIENT EDUCATION**

Policies and procedures related to quality, patient education, infection control, and safety should be developed and implemented in accordance with the ACR Policy on Quality Control and Improvement, Safety, Infection Control, and Patient Education appearing under the heading *Position Statement on QC & Improvement, Safety, Infection Control, and Patient Education* on the ACR web site (<http://www.acr.org/guidelines>).

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Gamma Cameras](#).

### **ACKNOWLEDGEMENTS**

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**Suggested Reading** (Additional articles that are not cited in the document but that the committee recommends for further reading on this topic)

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\*Guidelines and standards are published annually with an effective date of October 1 in the year in which amended, revised or approved by the ACR Council. For guidelines and standards published before 1999, the effective date was January 1 following the year in which the guideline or standard was amended, revised, or approved by the ACR Council.

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