Society of Nuclear Medicine Procedure Guideline for Thyroid Uptake Measurement

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I. Purpose

The purpose of this guideline is to assist nuclear medicine practitioners in recommending, performing, interpreting and reporting the results of thyroid uptake measurements.

II. Background Information and Definitions

Thyroid uptake determination is the measurement of the fraction of an administered amount of radioactive iodine that accumulates in the thyroid at selected times following ingestion. Thyroid uptake can also be determined using intravenously administered Tc-99m pertechnetate and a gamma camera.

In this document, hyperthyroidism refers to an excess of circulating thyroid hormone due to an overactive thyroid gland as well as due to other causes.

III. Common Indications

A. Assist in determining the amount of I-131 to be administered to patients for therapy of hyperthyroidism due to Graves' disease or toxic nodular goiter. The uptake should be performed as close in time as possible to the treatment.

B. Differentiate subacute or painless thyroiditis and factitious hyperthyroidism from Graves' disease and other forms of hyperthyroidism.

C. Assist in diagnosing and confirming diagnosis of hyperthyroidism.

D. Measurement of uptake is of limited value in diagnosing hypothyroidism.

IV. Procedure

A. Patient Preparation

1. Avoidance of Interfering Materials

The concentration of radioiodine in the thyroid is affected by many factors such as:

a. Medications such as thyroid hormones and antithyroid agents which affect the pituitary-thyroid axis.

b. Iodine-containing food (e.g. kelp) and medications (e.g. iodinated contrast, amiodarone, betadine).

Uptake measurement usually should be delayed for a period long enough to eliminate the effects of these interfering factors. A low-iodine diet is sometimes followed for 3–10 days before the radioiodine is given.

2. Large meals can slow absorption of ingested radioiodine and may interfere with early uptake measurements.

B. Information Pertinent to Performing the Procedure

1. Possibility of interfering medications (e.g. thyroid hormone, antithyroid drugs, iodine containing medications)
2. Prior iodinated contrast
3. Ingestion of iodine-rich foods
4. Pertinent laboratory data including the results of thyroid function tests
5. Pregnancy / nursing status

Elective studies using I-131 in lactating women should be postponed for at least 2 wk to decrease the radiation dose to the breast. Breast feeding following the administration of I-131 should be stopped to keep the radiation dose to the infant to less than 1 mSv (100 mrems).

6. Results of prior thyroid imaging tests
7. Results of prior thyroid uptake
8. Recent administration of radionuclides

C. Precautions

Prolonged discontinuation of antithyroid medication may be hazardous in some patients.

D. Radiopharmaceutical
   1. Radioiodine is generally preferred.
   2. Uptakes may be performed in conjunction with Tc-99m pertechnetate thyroid imaging. Careful validation of this technique is required.
   3. Radiation Dosimetry (see Tables)

E. Data Acquisition
   1. Instrumentation
      A probe with a 2-inch thick sodium iodide crystal at least 2 inches in diameter with suitable shielding and a flat-field collimator providing a field 10 cm in diameter at the surface of the patient's neck should be used.
   2. Measurement of Uptake
      a. The measurement of thyroid uptake is usually performed 24 hr after administration of the radioiodine. In some circumstances, it may be performed between 2 and 6 hr after radioiodine ingestion as well as 24 hr after ingestion.

         The uptake is usually measured with 25–30 cm between the face of the crystal and the anterior neck or phantom. Neck counts, lower thigh counts and counts of a calibrated standard in a neck phantom and background counts are preferably obtained at each counting session. Alternatively, the radioiodine capsule can be counted in the neck phantom before oral administration and the counts obtained can be corrected for decay at each patient counting session.

         The ORINS, IAEA or a comparable neck phantom is recommended.
      b. Thyroid uptake can be measured using a scintillation camera, LEAP collimator and appropriate regions of interest. Validation of gamma camera techniques by comparison with a reliable standard is recommended. This technique may also be combined with extended whole-body radioiodine imaging to measure uptake in thyroid remnants following surgery for differentiated thyroid cancer.

F. Interventions
   None

G. Processing
   The radioiodine uptake (RAIU) is calculated using the following relationship:

$$\text{RAIU} = \frac{\text{Neck Counts (cpm)} - \text{Thigh Counts (cpm)}}{\text{Administered Counts (cpm)} - \text{Background Counts (cpm)}} \times 100\%$$

   Administered counts are obtained either by counting the tracer actually administered to the

Radiation Dosimetry in Adults

Radiopharmaceutical	Administered Activity MBq (mCi)	Organ Receiving the Largest Radiation Dose mGy/MBq (rad/mCi)	Effective Dose* mSv (rem)
Na-I-131 iodide[1]	0.15 – 0.37 p.o. (0.004 – 0.01)	360 Thyroid (1300)	11 (41.0)
Na-I-123 iodide[2]	3.7 – 7.4 p.o. (0.1 – 0.2[4])	3.2 Thyroid (12.0)	0.11 (0.41)
Tc-99m pertechnetate[3]	74 – 370 i.v. (2 – 10)	0.062 ULI[5] (0.23)	0.013 (0.048)

[1]ICRP 53, page 277, assuming 25% uptake
[2]ICRP 53, page 265, assuming 25% uptake
[3]ICRP 53, page 199
[4]0.04 mCi may be used to measure biological half-life
[5]ULI—upper large intestine
*Per MBq (per mCi)

Radiation Dosimetry in Children (5 year old)

Radiopharmaceutical	Administered Activity MBq (mCi)	Organ Receiving the Largest Radiation Dose mGy/MBq (rad/mCi)	Effective Dose* mSv (rem)
Na-I-131 iodide[1]	0.15 – 0.37 p.o. (0.004 – 0.01)	1900 Thyroid (7000)	56 (210)
Na-I-123 iodide[2]	3.7 – 7.4 p.o. (0.1 – 0.2)	16 Thyroid (59)	0.54 (2.0)
Tc-99m pertechnetate[3]	37 – 185 i.v. (1 – 5)	0.21 ULI[4] (0.78)	0.04 (0.15)

[1]ICRP 53, page 277, assuming 25% uptake
[2]ICRP 53, page 265, assuming 25% uptake
[3]ICRP 53, page 199
[4]ULI—upper large intestine
*Per MBq (per mCi)

patient or by counting a standard in a neck phantom, with correction for decay if necessary.

H. Interpretation Criteria

Reference values for thyroid uptake determinations must be obtained from the older literature, since it is not possible for each facility to determine contemporary values for radioiodine uptake in euthyroid individuals. In the literature, the customary normal range of values is usually given as between 10 and 35% for 24-hr uptake, and between 6 and 18% for 4-hr uptake. These values must be interpreted loosely, since they were determined with a variety of equipment, standards, uptake phantoms, and in individuals from populations with different iodine intakes, which may not be directly comparable to the patients under study.

Since the primary usefulness of the radioiodine uptake is to confirm hyperthyroidism and to differentiate Graves' hyperthyroidism from that caused by subacute or painless thyroiditis and factitious hyperthyroidism, uptakes are therefore not the primary diagnostic criteria for hyperthyroidism. Such diagnosis is more effectively made with measurements of serum thyroid hormones, thyroxine and triiodothyronine, and with TSH assay (suppressed in hyperthyroidism). Since the precision of thyroid uptake is decreased with poorer counting statistics, low uptakes necessarily have a lower statistical accuracy. This procedure is therefore of relatively little value in diagnosing hypothyroidism.

The uptake is also susceptible to a variety of interfering medications and materials, most of which act to lower the uptake. Therefore, a higher net uptake generally carries more clinical significance than a lower uptake. However, it is difficult to draw a sharp line above which the patient is considered definitively hyperthyroid. On the other hand, in the presence of clinical hyperthyroidism and elevated levels of blood thyroid hormones, one expects to see a substantial thyroid uptake of radioiodine, if not a markedly elevated one.

Interpretation of the results therefore requires some knowledge of the patient's history and laboratory data, as well as a physical examination. The medication history is of particular importance, and efforts should be made to ensure that the patient is not ingesting iodine-containing materials, thyroid hormone or antithyroid drugs, all of which can influence the radioiodine uptake. The actual time of ingestion of the last

such medication is also of significance in evaluating results.

I. Reporting
Reports should indicate the patient's thyroid uptake, as well as the generally-accepted normal range. Variations in uptake should be discussed in the context of the factors outlined above. Variations in uptake value itself do not diagnose the level of function of the thyroid (i.e. more or less hyperthyroid), but must be seen in the context of many different factors including iodine content of diet, history of medication, etc.

J. Quality Control
1. Energy spectrum of the probe should be examined approximately yearly.
2. Absolute sensitivity (CPM/(μCi) should be determined approximately monthly.

K. Sources of Error
1. Variations in neck to detector distance
2. Inappropriate neck phantom
3. Improper centering of the probe over the patient's neck
4. Electronic instability
5. Background variation
6. Interfering food/medications
7. Contamination of the neck phantom
8. Recent administration of other radionuclide
9. Radioactivity in an adjacent area

V. Issues Requiring Further Clarification

Stunning
Thyroid follicular cells are sensitive to even relatively low doses of radiation which can interfere with such cell functions as collection of radioiodine. Radiation emitted by large diagnostic amounts of I-131, as in extended scintigraphy for differentiated thyroid cancer, can potentially decrease ("stun") subsequent uptake in thyroid tissue.

VI. Concise Bibliography

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VII. Disclaimer

The Society of Nuclear Medicine has written and approved guidelines to promote the cost-effective use of high quality nuclear medicine procedures. These generic recommendations cannot be applied to all patients in all practice settings. The guidelines should not be deemed inclusive of all proper procedures or exclusive of other procedures reasonably directed to obtaining the same results. The spectrum of patients seen in a specialized practice setting may be quite different than the spectrum of patients seen in a more general practice setting. The appropriateness of a procedure will depend in part on the prevalence of disease in the patient population. In addition, the resources available to care for patients may vary greatly from one medical facility to another. For these reasons, guidelines cannot be rigidly applied.

Advances in medicine occur at a rapid rate. The date of a guideline should always be considered in determining its current applicability.