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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, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. 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.

Amended 2006 (Res. 35)\*

## **ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF TUMOR SCINTIGRAPHY (with Gamma Cameras)**

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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 on 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 has been developed by the American College of Radiology (ACR) to guide interpreting physicians performing tumor scintigraphy in adult and pediatric patients. Properly performed imaging with radiopharmaceuticals that localize in tumors is a sensitive method for assessing certain tumors. Although several ACR guidelines for scintigraphy address applications for specific tumors, this guideline will center on radiopharmaceuticals rather than organ systems.

Tumor scintigraphy is a rapidly evolving field. Discussion will be confined primarily to agents approved as of March 2004 for use by the Food and Drug Administration (FDA) but will also consider some approved agents used for tumor imaging under specific physician direction. As with all scintigraphic studies, correlation of findings with results of other imaging and nonimaging modalities, as well as with clinical information, is necessary for maximum diagnostic yield.

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

(For pediatric considerations see section VI.)

## II. DEFINITION

Tumor scintigraphy involves the intravenous administration of a radiopharmaceutical that localizes in certain tumor tissues and subsequent imaging and computer acquisition of data. This guideline is limited to gamma camera imaging. (Positron emission tomography [PET] imaging using dedicated positron cameras or gamma cameras modified for coincidence imaging is covered in the [ACR Practice Guideline for the Performance of FDG-PET Scintigraphy in Oncology](#). Imaging of tumors not discussed in this guideline may be found in organ-specific guidelines, such as those for thyroid, parathyroid, and gastrointestinal procedures.)

## III. GOAL

The goal of tumor scintigraphy is to enable the interpreting physician to detect and evaluate primary, residual, metastatic, or recurrent tumor tissue by producing images of diagnostic quality.

## IV. INDICATIONS

Tumor scintigraphy may be used for, but is not limited to, detection of certain primary, metastatic, and recurrent tumors, evaluation of abnormal imaging and nonimaging findings in patients with a history of certain tumors, and reassessment of patients for residual tumor burden after therapy. Specific clinical applications depend on the specific radiopharmaceutical.

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

## V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

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

## VI. RADIOPHARMACEUTICALS

A. Gallium-67 citrate (see the [ACR Practice Guideline for the Performance of Scintigraphy for Infections and Inflammation](#))

Injected intravenously, gallium-67 is bound by plasma transferrin and lactoferrin. While the exact mechanism is not known with certainty, its localization within a tumor is believed to be due to intracellular ferritin. While many different kinds of tumors are reported to have a variable affinity for gallium-67, this agent is used most commonly in the assessment of Hodgkin's lymphoma, non-Hodgkin's lymphoma, melanoma, lung cancer, and hepatoma. The usual adult administered activity is 6.0-

12.0 millicuries (222-444 MBq) injected intravenously. Administered activity in children should be reduced based on weight or body surface area, and should be as low as practically achievable for appropriate image quality.

B. Radioiodinated Metaiodobenzylguanidine (MIBG)

Iodine-131 MIBG is a chemical analog of norepinephrine and is used specifically for evaluation of neuroendocrine tumors such as pheochromocytoma, neuroblastoma, and ganglioneuroma. The routine adult administered activity is 0.5 millicurie (18.5 MBq) injected intravenously. Administered activity in children should be reduced based on weight or body surface area, and should be as low as practically achievable for appropriate image quality. Iodine-123 MIBG is available to some centers and is preferred to iodine-131 MIBG because of its better imaging characteristics and lower radiation dose to the patient.

C. Radiolabeled Monoclonal Antibodies<sup>1</sup>

1. Satumomab pendetide (OncoScint<sup>®</sup> CR/OV) is an indium-111-labeled immunoconjugate of the B72.3 monoclonal antibody, which reacts with an adenocarcinoma protein, TAG-72, which is present in a variety of adenocarcinomas including breast, ovarian, and colorectal cancers. The usual adult administered activity is 4-5 millicuries (148-185 MBq). At this time, this agent has not been reported to have been used in children.
2. Capromab pendetide (ProstaScint<sup>®</sup>) is an In-111-labeled immunoconjugate of the murine monoclonal antibody that reacts with a prostate specific membrane antigen expressed by prostate epithelial cells. The usual adult administered activity is 5 millicuries (185 MBq).
3. Arcitumomab (CEA-Scan<sup>®</sup>) is a Tc-99m-labeled murine monoclonal antibody Fab fragment which reacts with CEA, a tumor-associated antigen expressed by a variety of carcinomas, particularly adenocarcinoma of the colon. Because it is an antibody fragment, less than 1% of patients have an elevation of human anti-mouse antibody (HAMA) levels. The labeling of this antibody with Tc-99m allows for more optimal imaging with standard gamma cameras.

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<sup>1</sup>Radiopharmaceuticals made from murine sources may cause immunologic response in some patients. Anaphylactic reactions are uncommon, but injection should be carried out where resuscitation equipment and personnel are available. Some patients develop human antimouse antibodies (HAMA), and this may interfere with subsequent imaging and nonimaging procedures that use murine antibodies (e.g., radioimmunoassays for carcinoembryonic antigen).

The usual adult administered activity is 1 mg of Arcitumomab labeled with 20-30 millicuries (740-1,110 MBq) of Tc-99m. Administered activity in children should be reduced based on weight or body surface area, and should be as low as practically achievable for appropriate image quality.

#### D. Indium-111 Octreotide

Octreotide (Octreoscan<sup>®</sup>) is an octapeptide similar to the active region of somatostatin. It interacts with somatostatin receptors both in normal tissue and in certain tumors, especially those of neuroendocrine origin (e.g., medullary thyroid carcinoma, gastrinoma, pheochromocytoma, neuroblastoma, and carcinoid). The usual adult administered activity is 4-6 millicuries (148-222 MBq). Administered activity in children should be reduced based on weight or body surface area, and should be as low as practically achievable for appropriate image quality.

#### E. NeoTect (Technetium-99m Detreotide)

NeoTect is an imaging agent approved for the noninvasive characterization of pulmonary masses. The active component in NeoTect is a synthetic peptide (depreotide) that has an affinity for the somatostatin receptor. Before injection, depreotide is radiolabeled with technetium-99m for imaging. In lung cancer, somatostatin receptors are commonly overexpressed by malignant cells. Because NeoTect binds to somatostatin receptors, it can be highly accurate in characterizing pulmonary masses when used in conjunction with CT and/or chest X-ray. Sensitivity measurements in a number of series were approximately 97%, while specificity was in the range of 75%. NeoTect can be particularly useful for patients who are poor candidates for biopsy, who refuse biopsy, or who have a low probability of malignancy. There have been no reports of serious adverse events associated with the use of NeoTect. The usual adult administered activity is 20-25 millicuries (740-925 MBq). Administered activity in children should be reduced based on weight or body surface area, and should be as low as practically achievable for appropriate image quality.

#### F. Thallium-201 (Thallos Chloride)

(See the ACR Practice Guideline for Cardiac Scintigraphy and the [ACR Practice Guideline for the Performance of Parathyroid Scintigraphy](#).) Thallium-201 is a potassium analog that enters cells in proportion to local blood flow. For reasons that are not well understood, it appears to have an affinity for certain tumors (e.g., glioblastoma, osteosarcoma, lymphoma, and thyroid carcinoma). It may be useful in helping to differentiate benign from malignant breast tumors. The usual adult administered

activity is 3-5 millicuries (111-185 MBq). Administered activity in children should be reduced based on weight or body surface area, and should be as low as practically achievable for appropriate image quality.

#### G. Technetium-99m Sestamibi

(See the [ACR Practice Guideline for the Performance of Cardiac Scintigraphy](#) and the [ACR Practice Guideline for the Performance of Parathyroid Scintigraphy](#).) Technetium-99m sestamibi is a nonpolar lipophilic radiopharmaceutical that crosses the cell membrane, undergoes deamination, and becomes trapped within the cell. Localization is dependent on local blood flow. The agent may prove to have utility in guiding patient management by helping to differentiate between benign and malignant breast masses. The usual adult administered activity is up to 30 millicuries (1,110 MBq). Administered activity in children should be reduced based on weight or body surface area, and should be as low as practically achievable for appropriate image quality. Technetium-99m sestamibi as Miraluma<sup>®</sup> is approved by the FDA for breast tumor imaging.

## VII. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for tumor 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. Gallium-67 Citrate (see the [ACR Practice Guideline for the Performance of Scintigraphy for Infections and Inflammation](#))

Imaging is normally performed at 48 to 96 hours after administration, and may be repeated for as long as a week afterwards. Normal colonic tracer activity may interfere with evaluation of abdominal disease; mild laxatives or

enemas may occasionally be necessary for colon cleansing. Whole-body imaging is obtained, supplemented by spot images or a series of spot images to include the entire body. SPECT imaging is performed not only to increase sensitivity for deep structures but also to correlate with other cross-sectional imaging modalities. For single-headed SPECT, a 64 x 64 matrix, 360° rotation, and 64 stops with 20 to 25 seconds per stop are recommended. For multiheaded SPECT cameras, a 128 x 128 matrix, 360° of data collection with 3° steps, and 20-25 seconds per stop are suggested.

#### B. Radioiodinated Metaiodobenzylguanidine (MIBG)

Imaging may be performed as early as 24 hours and as late as one week after injection. Because unbound iodine-131 is accumulated by the thyroid, Lugol's solution or supersaturated solution of potassium iodide (SSKI) should be given orally as directed by the package insert or under specific physician's instructions. One suggested protocol is an administered activity of one drop per day for 6 days, beginning the day of or the day prior to the tracer injection. Planar static images are usually obtained of the entire body. For I-123 MIBG, imaging is performed 18 to 24 hours after administration.

#### C. Radiolabeled Monoclonal Antibodies (OncoScint<sup>®</sup>, ProstaScint<sup>®</sup>, and CEA-SCAN<sup>®</sup>)

For OncoScint<sup>®</sup> imaging is normally carried out at 48 to 120 hours after injection, and acceptable planar images – but not SPECT images – can be obtained, even at 144 hours after injection.

For ProstaScint<sup>®</sup> two SPECT imaging acquisitions may be utilized: the first should be imaging of the pelvis, performed 30 minutes after injection to obtain a blood pool image; the second should include the abdomen and pelvis and be performed between 72 and 120 hours after injection. Alternatively, a single SPECT acquisition may be performed 4 days after ProstaScint<sup>®</sup> injection, using a dual isotope technique with technetium-99m-labeled red blood cells. In-111 ProstaScint<sup>®</sup> SPECT imaging techniques are similar to those described above in Section VII.A.

For CEA-SCAN<sup>®</sup> imaging is normally carried out 3-5 hours after injection. An 8-12 hour delay may be obtained to resolve “lesion-or-bowel” questions on the 3-hour planar image. Planar whole-body images and SPECT imaging of the abdomen and pelvis (to the groin) are usually performed.

#### D. Indium-111 Octreotide

Imaging is usually performed 4 to 24 hours after injection. Additional imaging at 48 to 72 hours after injection may sometimes be helpful. Some authors recommend bowel-cleansing regimens if the disease is suspected in the abdomen or pelvis. Imaging parameters are similar to those described above in section VII.A.

#### E. NeoTect (Technetium-99m Detreotide)

Chest imaging is usually performed 2-4 hours after injection. Anterior/posterior planar and SPECT images are usually acquired. NeoTect has been shown to be effective in characterizing solitary pulmonary nodules and lung masses in the parenchyma, but not in characterizing hilar or mediastinal masses.

#### F. Thallium-201 (Thallos Chloride)

Imaging is normally begun within 30 minutes after administration of the radiopharmaceutical. Imaging parameters are similar to those described above in section VII.A. In the brain a variety of semiquantitative analysis techniques have been reported to separate recurrent or active tumor from post-treatment residual tumor or scarring.

#### G. Technetium-99m Sestamibi

For breast imaging, dependent lateral as well as anterior and axillary images should be obtained.

### VIII. DOCUMENTATION

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

### IX. EQUIPMENT SPECIFICATIONS

A gamma camera with low-energy collimation is used for thallium-201 and technetium-99m sestamibi imaging. For gallium-67-citrate and indium-111-labeled radiopharmaceuticals, medium-energy collimation (up to about 300 keV) is used. For iodine-131, a high-energy collimator (up to about 400 keV) is optimum.

### X. RADIATION SAFETY

Radiologists, imaging technologists, and all supervising physicians have a responsibility to minimize radiation dose to individual patients, to staff, and to society as a whole, while maintaining the necessary diagnostic image quality. This concept is known as “as low as reasonably achievable (ALARA).”

Facilities, in consultation with the radiation safety officer, should have in place and should adhere to policies and procedures for the safe handling and administration of radiopharmaceuticals, in accordance with ALARA, and 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.

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

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 Concerns appearing elsewhere in the ACR Practice Guidelines and Technical Standards book.

Equipment performance monitoring should be in accordance with the [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Nuclear Medicine Imaging Equipment<sup>2</sup>](#).

### **ACKNOWLEDGEMENTS**

This guideline was revised according to the process described in the ACR Practice Guidelines and Technical Standards book by the Guidelines and Standards Committee of the Commission on Nuclear Medicine.

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<sup>2</sup>In 2008, this standard was revised and renamed: [ACR Technical Standard for Medical Nuclear Physics Performance Monitoring of Gamma Cameras](#).

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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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