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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.

Revised 2010 (Resolution 28)*

ACR–SPR PRACTICE GUIDELINE FOR THE PERFORMANCE OF TUMOR SCINTIGRAPHY (WITH GAMMA CAMERAS)

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), and the Society for Pediatric Radiology (SPR).

This guideline is intended 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 that the Food and Drug Administration (FDA) has approved for use as of July 2009 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–SNM 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 digital 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 Performing FDG-PET/CT in Oncology](#). Information concerning the 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

Indications for tumor scintigraphy include, but are not limited to:

1. Detection of certain primary, metastatic, and recurrent tumors, and tumor staging.
2. Evaluation of abnormal imaging and nonimaging findings in patients with a history of certain tumors.
3. Response of tumors to therapy.
4. Reassessment of patients for residual tumor burden after therapy, and restaging of recurrent tumor.

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–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#).

VI. RADIOPHARMACEUTICALS

A. Gallium-67 Citrate

(See the [ACR–SNM–SPR Practice Guideline for the Performance of Scintigraphy for Inflammation and Infection](#).) 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 and/or lactoferrin [1]. While many different kinds of tumors are reported to have a variable affinity for gallium-67, this agent has been used most commonly in assessing Hodgkin's lymphoma, non-Hodgkin's lymphoma, melanoma, lung cancer, and hepatoma. Note that FDG-PET has replaced gallium-67 citrate for Hodgkin's and Non-Hodgkin's Lymphoma, melanoma and lung cancer. The usual adult administered activity is 5.0 to 10.0 millicuries (185 to 370 MBq) injected intravenously. Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

B. Radioiodinated Metaiodobenzylguanidine (MIBG)

Iodine-131 and iodine-123 labeled MIBG are chemical analogs of norepinephrine and are used specifically for evaluating neuroendocrine tumors such as pheochromocytoma, neuroblastoma, and ganglioneuroma. The routine adult administered activity is 0.5 to 1.0 mCi (18.5 to 37.0 MBq) of iodine-131 MIBG or approximately 5.0 to 10 mCi (185 to 370 MBq) of iodine-123 MIBG injected intravenously [2]. Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality¹. Iodine-123 MIBG is commercially available and is preferred to iodine-131 MIBG because of its better imaging characteristics and lower radiation dose to the patient.

C. Radiolabeled Monoclonal Antibodies²

Capromab pendetide (e.g., ProstaScint[®]) is an indium-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 4 to 7 millicuries (150 to 260 MBq).

¹For more specific guidance on pediatric dosing, please refer to the *Pediatric Radiopharmaceutical Administered Doses: 2010 North American Consensus Guidelines* [3]

²Radiopharmaceuticals 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.

D. Indium-111 Pentetreotide

Indium-111 pentetreotide (e.g., Octreoscan[®]) 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 tumor). The usual adult administered activity is 4 to 6 millicuries (148 to 222 MBq). Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

E. Thallium-201 (Thallos Chloride)

(See the [ACR–SNM–SPR Practice Guideline for Cardiac Scintigraphy](#) and the [ACR–SNM–SPR 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, and lymphoma). The usual adult administered activity is 3 to 5 millicuries (111 to 185 MBq). Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality.

F. Technetium-99m Sestamibi

(See the [ACR–SNM–SPR Practice Guideline for the Performance of Cardiac Scintigraphy](#) and the [ACR–SNM–SPR 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 and mitochondrial uptake. The agent is under investigation to assess its utility in evaluating breast lesions. The usual adult administered activity is up to 30 millicuries (1,110 MBq). Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality. Technetium-99m sestamibi 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–SNM–SPR Practice Guideline for the Performance of Scintigraphy for Inflammation and Infection](#).) Imaging is normally performed at 48 to 96 hours after administration and may be repeated daily for as long as 7 to 10 days afterwards, using the lower two or lower three photopeaks. Normal colonic tracer activity may interfere with evaluation of abdominal disease; mild laxatives or enemas may occasionally be necessary for colon cleansing. Vigorous catharsis should probably be avoided in patients who are on chemotherapy or are otherwise immunosuppressed. Whole-body imaging is obtained, supplemented by spot images or a series of spot images to include the entire body. It is desirable to obtain approximately 1,000,000 counts for spot images of the chest, abdomen or pelvis and 2,000,000 to 3,000,000 counts for whole-body imaging (or a whole-body scan rate of ~5cm/min). Images of the chest and pelvis should avoid including the liver. For whole body imaging, anterior and posterior views are obtained, with approximately 1,500,000 counts. Single photon emission computed tomography (SPECT) imaging is performed to increase contrast resolution for detecting disease in deep structures, to better separate intraluminal gallium in the gastrointestinal tract from intra-abdominal abscesses, and to correlate with other cross-sectional imaging modalities. For single-headed SPECT cameras, a 64 x 64 matrix, 360 degrees rotation, and 64 stops with 20 to 25 seconds per stop are recommended. For multiheaded SPECT cameras, a 128 x 128 matrix, 360 degrees of data collection with 3 degree steps, and 20 to 25 seconds per stop are suggested. SPECT/CT imaging of relevant sites may be of additional diagnostic benefit, providing both attenuation correction of the SPECT image data and improved lesion localization.

B. Radioiodinated Metaiodobenzylguanidine (MIBG)

Imaging with iodine-131 MIBG may be performed as early as 48 hours and as late as 7 days after administration. Because unbound iodine-131 is

accumulated by the thyroid, Lugol's solution or a 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 dose of one drop per day for 6 days, beginning the day of or the day prior to the tracer injection. Planar static images of the entire body are usually obtained.

For Iodine-123 MIBG, imaging is performed 18 to 24 hours after administration. Because unbound iodine-123 is accumulated by the thyroid, Lugol's solution or a supersaturated solution of potassium iodide (SSKI) may be given orally as directed by the package insert or under specific physician's instructions. For adults, one suggested protocol is an administered dose of one drop per day for 2 days, beginning the day of or the day prior to the tracer injection. For pediatric patients, the Lugol's solution or SSKI should be given orally as directed or under specific physician's instructions, at one drop per day for 3 to 4 days beginning the day prior to tracer injection. Iodine-123 is preferred for pediatric evaluation of neuroblastoma and other pediatric neuroendocrine tumors. SPECT imaging of the thorax, abdomen, and pelvis is recommended. SPECT or SPECT/CT imaging may be of additional diagnostic benefit.

C. Radiolabeled Monoclonal Antibodies

For indium-111 capromab pendetide (e.g., ProstaScint[®]) two SPECT imaging acquisitions procedures may be utilized. The first is using the dual isotope simultaneous SPECT acquisition performed 4 to 5 days after the injection of indium-111 capromab pendetide and technetium-99m labeled red blood cells, on the day of imaging, to image the abdomen and the pelvis, ensuring that the caudal portion of the camera extends below the symphysis pubis. The technetium-99m window should be set to 140 keV with a 10% window. The indium-111 window should be 173 keV and 247 keV with a 10% to 20% window, respectively. The second and less preferred method, due to potentially decreased anatomical alignment between the two studies, is composed of two parts using only indium-111 capromab pendetide; first, imaging of the abdomen and pelvis caudal to the symphysis pubis is performed 30 minutes after injection of indium-111 capromab pendetide to obtain a blood pool image set; the second imaging session, performed between 4 to 5 days after injection, should be as much as possible identical in position and location of the abdomen and pelvis as the first day. Two other considerations should be taken into account on day 4 to 5 imaging secondary to the activity in the bladder. If filtered back projection (FBP) reconstruction is utilized for the SPECT images, then consideration should be taken for the use of a catheter with bladder wash. If iterative reconstruction (IR) is utilized, then a bladder catheter may not be as important. Bowel cleansing may also be useful. Planar

imaging with SPECT or SPECT/CT imaging parameters are similar to those described above in section VII.A. SPECT/CT imaging may also be of additional diagnostic benefit, providing both attenuation correction for the SPECT imaging data and improved lesion localization, as well as obviating the need for immediate imaging and technetium-99m RBC imaging.

D. Indium-111 Pentetreotide

Imaging with indium-111 pentetreotide 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. SPECT, SPECT/CT, and planar imaging parameters are similar to those described above in section VII.A.

E. Technetium-99m Sestamibi

For evaluation of the breast, imaging with whole body gamma cameras has been shown to have relatively low sensitivity for nonpalpable and small lesions, and sestamibi breast imaging has not become widely used. More recently, breast-specific gamma imaging (BSGI) which uses a high-resolution, small-field-of-view gamma camera optimized to image breast tumors has been developed. Areas of active investigation concerning potential indications include determination of extent of disease in women with newly diagnosed breast cancer, and evaluation of patients with dense breasts. Additional clinical evidence is needed to assess where BSGI will fit in the imaging algorithm of breast cancer. When BSGI is performed, the ability to correlate BSGI findings with other breast imaging techniques and a defined protocol for evaluation of abnormalities seen only on BSGI should be in place.

Imaging premenopausal patients is preferably performed between days 2 and 14 of the menstrual cycle, and delayed in lactating patients until 3 months after the cessation of lactation. False positives can occur within 2 weeks of needle aspirations or 3 to 4 weeks from a needle or excisional biopsy. This effect, however, is less likely to occur if performed within 72 hours of an aspiration or biopsy procedure.

The patient should remove clothing from the waist up, and should wear a mammography cape or gown. After the venous catheter injection of 740 to 1,110 MBq (20 to 30 mCi) of technetium-99m sestamibi and followed by a 10 to 29 mL flush of normal saline, the intravenous line is removed. To decrease vascular trapping of the tracer, the patients may raise their arms for one minute above their heads while squeezing a ball. Tracer injection should be in the arm opposite the side of clinical concern or in a foot

vein if there is suspected bilateral disease. Tracer infiltrations should be noted.

The energy window is +/-10% centered on 140 keV for technetium-99m. Imaging is then performed 5 to 10 minutes after tracer injection with a low-energy high-resolution small-field-of-view gamma camera dedicated for breast imaging.

For image acquisition, the sitting position is preferred; however, the patient may need to stand to optimize lesion detection.

Two images of each breast are acquired with light breast compression for 10 minutes or 175 K counts per view (axillary views 3 minutes). These acquisitions mimic the mammographic projections (e.g., craniocaudal – detector inferior to the breast; mediolateral oblique – detector positioned at an oblique inferior lateral angle aligning to the long axis of the pectoralis muscle). Additional imaging may be obtained to optimize lesion detection and most often mimic mammographic views.

VIII. 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.

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. A SPECT/CT hybrid camera may provide additional diagnostic benefit, as discussed above. For iodine-123, a low-energy high-resolution or medium-energy collimator (depending on patient weight) may be used.

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

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 page (<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](#).

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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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