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

PREAMBLE

This document is an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. Practice Parameters and Technical Standards 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 and our collaborating medical specialty societies caution against the use of these documents 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 practitioner in light of all the circumstances presented. Thus, an approach that differs from the guidance in this document, 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 this document 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 this document. However, a practitioner who employs an approach substantially different from the guidance in this document 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 the guidance in this document 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 this document is to assist practitioners in achieving this objective.

1 Iowa Medical Society and Iowa Society of Anesthesiologists v. Iowa Board of Nursing, ___ N.W.2d ___ (Iowa 2013) Iowa Supreme Court refuses to find that the ACR Technical Standard for Management of the Use of Radiation in Fluoroscopic Procedures (Revised 2008) sets a national standard for who may perform fluoroscopic procedures in light of the standard’s stated purpose that ACR standards are educational tools and not intended to establish a legal standard of care. See also, Stanley v. McCarver, 63 P.3d 1076 (Ariz. App. 2003) where in a concurring opinion the Court stated that “published standards or guidelines of specialty medical organizations are useful in determining the duty owed or the standard of care applicable in a given situation” even though ACR standards themselves do not establish the standard of care.
I. INTRODUCTION

This practice parameter was revised collaboratively by the American College of Radiology (ACR) and the Society for Pediatric Radiology (SPR).

This practice parameter is intended to guide interpreting physicians performing tumor scintigraphy in adult and pediatric patients. Properly performed imaging with gamma-emitting radiopharmaceuticals that localize in tumors is a sensitive method for assessing certain tumors. See the ACR–SPR Practice Parameter for the Performance of Parathyroid Scintigraphy, ACR–SPR Practice Parameter for the Performance of Gastrointestinal Scintigraphy, ACR–SPR Practice Parameter for the Performance of Liver and Spleen Scintigraphy, ACR–SPR Practice Parameter for the Performance of Skeletal Scintigraphy (Bone Scan), and ACR–SPR Practice Parameter for the Performance of Scintigraphy and Uptake Measurements for Benign and Malignant Thyroid Disease [1-5] for specific tumors. This practice parameter will center on gamma-emitting radiopharmaceuticals rather than organ systems.

Tumor scintigraphy is a rapidly evolving field. Discussion will be confined primarily to gamma-emitting radiopharmaceuticals that the US Food and Drug Administration (FDA) has approved for use as of January 2014 but will also consider some gamma-emitting radiopharmaceuticals used for tumor imaging under specific physician direction. As with all scintigrphic examinations, correlation of findings with results of other imaging and nonimaging modalities, as well as with clinical information, such as serum tumor biomarkers, is necessary for maximum diagnostic yield.

Application of this practice parameter should be in accordance with the ACR–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals [6].

(For pediatric considerations see section VI.)

II. DEFINITION

Tumor scintigraphy involves the intravenous or oral administration of a gamma-emitting radiopharmaceutical that localizes in certain tumor tissues, allowing subsequent imaging. This practice parameter is limited to scintigraphic agents used for gamma camera imaging. Positron emission tomography (PET) imaging is covered in the ACR–SPR Practice Parameter for Performing FDG-PET/CT in Oncology [7]. Information concerning the imaging of tumors not discussed in this practice parameter may be found in organ-specific parameters, 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 local (primary), regional nodal, distant metastatic, and residual or recurrent tumor tissue by producing images of diagnostic quality.
IV. INDICATIONS

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

1. Detection of certain primary and metastatic tumors
2. Tumor staging
3. Assessment of tumor response to therapy
4. Detection and restaging of residual disease after completion of therapy
5. Detection and restaging of recurrent disease in patients who had been clinically and radiologically free of disease after prior therapy
6. Evaluation of abnormal imaging and nonimaging findings in patients with a history of certain tumors
7. Planning of treatment with unsealed radiopharmaceuticals using either empirical or dosimetric dosage calculations

Specific clinical applications depend on the specific radiopharmaceutical.

For information on radiation risks to the fetus, see the ACR–SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation [8].

V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals [6].

VI. RADIOPHARMACEUTICALS

A. Gallium-67 Citrate

(See the ACR–SPR Practice Parameter for the Performance of Scintigraphy for Inflammation and Infection [9].) Injected intravenously, gallium-67 is bound by plasma transferrin and lactoferrin. Although the exact mechanism is not known with certainty, its localization within a tumor is believed to relate to intracellular ferritin and/or lactoferrin [10]. Though many different tumors are reported to have a variable affinity for gallium-67, this radiopharmaceutical has been used most commonly in assessing Hodgkin lymphoma, non-Hodgkin lymphoma, melanoma, lung cancer, and hepatocellular carcinoma [11-19]. Note that FDG-PET/CT has replaced gallium-67 citrate for Hodgkin and non-Hodgkin lymphoma, melanoma, and lung cancer [20]. Although CT and MRI are mainstay modalities for the evaluation of hepatocellular carcinoma, gallium-67 might be useful in differentiating hepatocellular carcinoma from regenerating nodule [21].

The usual adult administered activity is 5.0 to 10.0 millicuries (185 to 370 MBq) injected intravenously. Due to the high radiation exposure, gallium-67 should not be used in children younger than 14 years of age, unless there is a clear evidence of malignancy and imaging with gallium-67 is absolutely necessary to address the clinical question [13]. Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality [22].

B. Radioiodinated Metaiodobenzylguanidine (MIBG)

MIBG is a chemical analog of norepinephrine. Iodine-123-labeled MIBG is used specifically for evaluating neuroendocrine tumors such as pheochromocytoma, paraganglioma, neuroblastoma, ganglieneuroma, ganglioneuroblastoma, carcinoid tumors, medullary thyroid carcinoma, Merkel cell tumor, and multiple endocrine neoplasia (MEN) type 2 syndromes [23-29].
In adults, the administered activity is 5.0 to 10 mCi (185 to 370 MBq) of iodine-123 MIBG injected intravenously [23-25,29,30]. For children, the administered activity should be as low as reasonably achievable for diagnostic image quality [22,27,31]. For children, the minimum administered activity is 1.0 mCi (37 MBq), and the maximum administered activity is 8.8 mCi (326 MBq). See table 4 below.

### Table 4: Activity values and effective doses for a whole-body scan with $^{123}$I-MIBG (ICRP 80 [7])

<table>
<thead>
<tr>
<th>Age</th>
<th>1 year</th>
<th>5 years</th>
<th>10 years</th>
<th>15 years</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal weight (kg)</td>
<td>10</td>
<td>19</td>
<td>32</td>
<td>55</td>
<td>70</td>
</tr>
<tr>
<td>2007 EANM dosage card [1]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administered activity (MBq)</td>
<td>80°</td>
<td>130</td>
<td>204</td>
<td>326</td>
<td>400</td>
</tr>
<tr>
<td>Effective dose (mSv)</td>
<td>5.4</td>
<td>4.8</td>
<td>5.3</td>
<td>5.5</td>
<td>5.2</td>
</tr>
<tr>
<td>North American consensus guidelines [3]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administered activity (MBq)</td>
<td>51</td>
<td>99</td>
<td>166</td>
<td>286</td>
<td>364</td>
</tr>
<tr>
<td>Effective dose (mSv)</td>
<td>3.5</td>
<td>3.7</td>
<td>4.3</td>
<td>4.9</td>
<td>4.7</td>
</tr>
<tr>
<td>2014 EANM dosage card [2]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Administered activity (MBq)</td>
<td>76</td>
<td>130</td>
<td>204</td>
<td>326</td>
<td>400</td>
</tr>
<tr>
<td>Effective dose (mSv)</td>
<td>5.1</td>
<td>4.8</td>
<td>5.3</td>
<td>5.5</td>
<td>5.2</td>
</tr>
</tbody>
</table>

*aMinimum activity
*bChanges to the 2007 version (as denoted in orange in Fig. 1)

C. Indium-111 Capromab Pendetide

Capromab pendetide is an indium-111-labeled immunoconjugate of the murine monoclonal antibody that reacts with a prostate-specific membrane antigen expressed by prostate epithelial cells [32]. The examination can be performed to either stage newly diagnosed prostate cancer prior to definitive treatment [33-37] or more commonly to detect prostate cancer recurrence after definitive treatment in the setting of rising prostate-specific antigen (PSA) [32,36,38]. The examination is considered more effective for detecting local and nodal regional or metastatic disease than for detecting osseous metastatic disease [37,39,40].

The usual adult administered activity of indium-111 capromab pendetide is 4 to 7 millicuries (150 to 260 MBq).

D. Indium-111 Pentetreotide

Indium-111 pentetreotide is an octapeptide similar to the active component of somatostatin [41-45]. It interacts with somatostatin receptors both in normal tissue and in certain tumors, especially those of neuroendocrine origin that have high expression of somatostatin receptors (eg, sympathoadrenal system tumors [pheochromocytoma, neuroblastoma, ganglioneuroma, and paraganglioma]), gastroenteropancreatic tumors (GEP) [eg, carcinoid, gastrinoma, insulinoma, glucagonoma, VIPoma, etc], medullary thyroid carcinoma, pituitary adenoma, Merkel cell carcinoma, and small-cell lung carcinoma [44]. However, certain non-neuroendocrine tumors and non-neoplastic conditions can express somatostatin receptors, resulting in indium-111 pentetreotide avidity [44].

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 (Thallous Chloride)

(See the ACR–SPR Practice Parameter for the Performance of Parathyroid Scintigraphy [1].) Thallium-201 is a potassium analog that enters cells in proportion to local blood flow. For reasons that are not well understood, it

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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.
appears to have an affinity for certain tumors (eg, glioblastoma, osteosarcoma, soft-tissue tumors, and lymphoma) [46-50]. Currently, thallium-201 is rarely used as a tumor-imaging radiopharmaceutical, but it might be helpful as a problem-solving tool, for example in differentiating toxoplasmosis from lymphoma in the brain and for differentiating radiation necrosis from glioma recurrence [49,50].

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–SPR Practice Parameter for the Performance of Parathyroid Scintigraphy [1].) 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. In addition to imaging of parathyroid lesions, this radiopharmaceutical is useful for evaluating breast lesions [51-60].

The usual adult administered activity is 20 to 30 millicuries (740 to 1,110 MBq) for single-detector breast-specific gamma-imaging devices. Molecular breast imaging with a dual-headed configuration with solid-state (nonscintillating) detectors allows for a lower administered activity (eg, 8 millicuries or less) [61-63]. Administered activity in children should be determined based on body weight and should be as low as reasonably achievable for diagnostic imaging quality [13].

Although technetium-99m sestamibi has an affinity for many other tumors (eg, bone and soft-tissue, lung, head and neck, and thyroid tumors [64-71]), it is rarely used for tumor imaging other than parathyroid and breast due to widespread availability of 18F-FDG-PET/CT. At the present time, technetium-99m sestamibi retains a prominent role in tumor imaging only when 18F-FDG PET/CT is not available.

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–SPR Practice Parameter for the Performance of Scintigraphy for Inflammation and Infection [9].)

Patient Preparation: In the pregnant patient, risks versus benefits need to be considered prior to performing any procedure. For gallium-67 tumor imaging, breastfeeding should be discontinued for at least 1 month to avoid exceeding dose of 100 mrem to the breastfeeding infant [72]. Food and liquid restrictions are not mandatory, and bowel preparation is optional [13]. Normal colonic radiopharmaceutical activity may interfere with evaluation of abdominal disease; mild laxatives (given at least 18 hours prior to imaging) 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. The procedure should be avoided within 24 hours after blood transfusion or gadolinium-enhanced MRI scanning, which may alter gallium-67 biodistribution [13].

Imaging Technique: Imaging is normally performed 48 to 96 hours after administration and may be repeated daily for as long as 7 to 10 days afterwards, using the lower 2 or lower 3 photopeaks (93, 184, and 300 keV [13-15]). The patient should be instructed to fully empty the bladder, change incontinence pad, or empty urine drainage bag immediately prior to positioning on the imaging table. Whole-body imaging is obtained, supplemented by spot images or a series of static planar images of the whole body. For whole-body imaging, anterior and posterior views are obtained; with approximately 1,500,000 counts; matrix 256 or 512 x 1024 x 16; scan speed 5 to 10 cm/min. For spot images of the chest, abdomen, and pelvis, at least 500,000 counts should be obtained, with desirable counts ranging between 1,000,000 and 2,000,000; matrix 256 or 512 x 512 x 16. Due to moderate hepatic activity, images of the chest and pelvis should avoid including the liver. Single photon emission computed tomography (SPECT) imaging can be performed to increase contrast resolution for detecting disease in deep structures to better separate intraluminal gallium in the gastrointestinal tract from intra-abdominal lesions and to correlate with other cross-sectional imaging modalities. For single-headed SPECT cameras, a 64 x 64 matrix, 360° rotation, and 64 or 128 stops with 20 to 25 seconds per stop are recommended. For multiheded SPECT cameras, a 128 x 128 matrix, 360° of data collection with 3° steps, and 20 to 40 seconds per stop are suggested. SPECT/CT imaging of relevant sites may be of additional diagnostic benefit, providing attenuation correction of the SPECT image data and improving anatomic lesion localization and characterization.

B. Radioiodinated Metaiodobenzylguanidine (MIBG)

Patient Preparation: Many classes of drugs (eg, tricyclic antidepressants and sympathomimetic amines) may interfere with the uptake or vesicular storage of MIBG [23]. Patients should be screened for interfering medications, which should be discontinued whenever possible in coordination with the referring physician. For a majority of medications, a withdrawal time of 24 to 48 hours is sufficient, however for some medications a withdrawal period of up to several weeks is optimal [23]. Over the counter decongestants and “cold” remedies also should be discontinued. Thyroid blockade can be achieved by administering oral potassium iodide (130 to 300 mg/day) or potassium perchlorate (400 to 600 mg/day) [23-25,27,29]. Thyroid blockade may be administered 1 day prior to or at the time of planned radiopharmaceutical injection and should be continued for 1 to 2 additional days for iodine-123 MIBG. Oral potassium iodide preparation include tablets (65, 130, and 170 mg), supersaturated potassium iodide solution (SSKI 1,000 mg/ml), or Lugol’s solution (1% solution contains 25.3 mg/ml). For solutions dispensed as drops, 1 drop is 0.05 ml (20 drops per milliliter). Suggested pediatric dosing of potassium iodide is 32 mg/day for children from 1 month to 3 years; 65 mg/day for children 3 to 13 years; and 130 mg/day for children over age of 13 [27]. Newborns may receive 16 mg potassium iodide only on the day before tracer injection [27]. For iodine-123 MIBG, breastfeeding should be discontinued for 12 hours (4 mCi dosage) or 24 hours (10 mCi dosage).

Imaging Technique: For iodine-123 MIBG, imaging typically is performed at 24 hours (18 to 48 hours) after administration using low-energy or medium-energy collimators [23,24,73]. Total-body imaging (5 to 10 cm/min) or 500,000 counts static images are obtained. SPECT or SPECT/CT imaging of areas of abnormality or clinical concern (128 x 128 x 16 matrix, 3° stops, 30 seconds per stop) can be performed and may be of additional diagnostic benefit [74-76].

C. Indium-111 Capromab Pendetide

For indium-111 capromab pendetide ° imaging, no patient preparation is required, although bowel cleansing may be useful. Newer indium-111 capromab pendetide imaging protocols performed 5 to 7 days after the radiopharmaceutical injection, combining delayed planar whole-body imaging (scan speed 5 cm/min) with limited area SPECT/CT, provides attenuation correction for SPECT imaging data and may improve anatomic lesion localization and characterization and thus obviate the need for immediate imaging and technetium-99m RBC.
imaging [77-79]. The field of view (FOV) should include the penile blood pool at the bottom of the FOV and as much of the pelvis and abdomen as possible (early regional nodal and osseous metastatic disease typically occur in the pelvis). Additional body regions can be included as needed. For multiheaded SPECT systems, a 128 x 128 x 16 matrix, 360° of data collection with 3° steps, and 60 seconds per stop are suggested. If SPECT/CT is not available, 2 SPECT imaging acquisition procedures may be utilized [32]. The first, and preferred, technique uses the simultaneous dual radiopharmaceutical SPECT acquisition performed 4 to 5 days after the injection of indium-111 capromab pendetide and shortly after technetium-99m autologous-labeled red blood cells injection. The abdomen and pelvis, extending below the level of the pubic symphysis, should be included in the FOV [36]. The technetium-99m window should be centered 140 keV with a 10% window. The indium-111 windows should be centered at 173 keV and 247 keV with a 10% and 20% window, respectively. The second, and less desirable protocol due to potential anatomical misalignment, consists of indium-111 capromab pendetide imaging of the abdomen and pelvis caudal to the symphysis pubis performed 30 minutes after injection of indium-111 capromab pendetide to obtain a blood-pool image set; the second imaging session is performed 4 to 5 days after injection and should be as identical as possible in position and location of the abdomen and pelvis as the first day. Another consideration 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. Planar imaging with SPECT or SPECT/CT imaging practice parameters are similar to those described in sections VII.A and VII.C.

D. Indium-111 Pentetreotide

Patient Preparation: For indium-111 pentetreotide imaging, interruption of breastfeeding is usually unnecessary since a radiation dose to the child is unlikely to exceed 100 rem. No dietary restrictions are necessary; however, patients should be encouraged to drink fluids. A mild laxative taken the evening before the injection may facilitate detection of abdominal and pelvic lesions. The examination should be carefully considered in patients who have severely impaired renal function, as this is the primary route of excretion for the radiopharmaceutical. Hemodialysis might improve image quality [44]. Temporary withdrawal of somatostatin analogue therapy prior to indium-111 pentetreotide imaging (eg, 1 day for short-acting and 3 to 4 weeks for long-acting somatostatin analogues) is controversial and should be performed (if feasible) in coordination with the referring physician [44]. Indium-111 pentetreotide should not be administered through a total parenteral nutrition (TPN) line or injected into TPN solution. In patients with insulinoma or in patients with diabetes receiving high dosages of insulin, administration of pentetreotide can cause severe hypoglycemia; in these patients, blood glucose should be checked prior to pentetreotide administration, and an intravenous line with 5% dextrose in 0.9% NaCl (D5 NS) should be continuously infused prior to and during radiopharmaceutical administration.

Imaging Technique: Imaging with indium-111 pentetreotide is usually performed 4 to 24 hours, or 24 and 48 hours, after injection using medium-energy collimators (172 and 245 keV photopeaks [44]). Additional imaging at 48 to 72 hours after injection may sometimes be helpful. Between 24 and 48 hours, laxative therapy can be administered to achieve clear physiologic bowel activity [44]. Planar imaging, SPECT, and SPECT/CT practice parameters are similar to those described in section VII.A.

E. Thallium-201 (Thallous Chloride)

For thallium-201 tumor imaging, no special patient preparation is required. Breastfeeding should be discontinued for 2 weeks after thallium-201 [72]. No special preparation is required. Imaging may be performed 15 to 20 minutes (early) or 2 to 4 hours (delayed) after injection. Imaging at multiple time points might be helpful in distinguishing benign and malignant tumors or assessing tumor aggressiveness or response to therapy [80]. Planar and SPECT or SPECT/CT imaging is performed using low-energy high-resolution parallel hole collimator with 20% windows centered at 80 and 167 keV. Imaging may be limited to the area of interest (eg, brain).
Alternatively, whole-body planar imaging (scan speed 5 to 10 cm/min) with SPECT (64 x 64 x 16 matrix; 360° in 64 projections of 40 seconds each) or SPECT/CT of areas of interest may be performed.

F. Technetium-99m Sestamibi

The whole-body radiation doses from scintimammography are substantially higher than the dose of a digital mammogram, thus scintimammography is not indicated for routine breast cancer screening in its present form [81-83]. However, scintimammography may be useful in selected patients (eg, breast cancer screening in selected patients, evaluation of indeterminate breast abnormalities, initial staging, and recurrence detection) [84].

Patient Preparation: For scintimammography, no special patient preparation is required. Known hypersensitivity to technetium-99m sestamibi and pregnancy are contraindications. Scintimammography should preferably be performed between days 2 and 12 of the menstrual cycle in premenopausal patients and at least 3 months after cessation of lactation. To minimize false-positive results, scintimammography ideally should be performed either prior to interventional procedures or at least 2 weeks after fine-needle aspiration of a cyst and at least 3 weeks after core or excisional biopsy. False-positive results also are less likely if scintimammography is performed within 72 hours of an interventional procedure.

Imaging Technique: Prior to imaging, the patient should remove clothing from the waist up and should wear a mammography cape or gown. After the venous catheter injection of 20 to 30 millicuries (740 to 1,110 MBq) of technetium-99m sestamibi followed by a 10 to 29 mL flush of normal saline, the intravenous line is removed. To decrease vascular trapping of the radiopharmaceutical, patients may raise their arm above their head for one minute while squeezing a ball. Radiopharmaceutical injection should be in the arm opposite the side of clinical concern or in a foot vein if bilateral disease is suspected.

For image acquisition, the sitting position is preferred; however, the patient may need to stand to optimize lesion detection. Imaging is performed 5 to 10 minutes after radiopharmaceutical injection with a low-energy high-resolution small-field-of-view (FOV) gamma camera dedicated for breast imaging (140 keV photopeak, 20% energy window). Planar images are acquired with light breast compression for 10 minutes each or 175,000 counts (7-minute minimum), with acquisition mimicking the mammographic projections (eg, 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). Routine 4 views include right and left craniocaudal and right and left mediolateral oblique; additional views, most often mimicking mammographic views, may be obtained to optimize lesion detection.

VIII. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Parameter for Communication of Diagnostic Imaging Findings [85].

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

A relevant oncologic history should also be included with a brief overview of any prior oncologic treatments, emphasizing the specific indication for the current study.

IX. EQUIPMENT SPECIFICATIONS

A gamma camera with low-energy collimation is used for thallium-201 and technetium-99m sestamibi imaging (including scintimammography). For gallium-67 citrate and indium-111-labeled radiopharmaceuticals, medium-energy collimation (up to about 300 keV) is used. For iodine-123, a low-energy high-resolution or medium-energy collimator may be used. A SPECT/CT hybrid camera may provide additional diagnostic benefit, as discussed above.
X. 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). 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.

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Nationally developed guidelines, such as the ACR’s Appropriateness Criteria®, 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® for children (www.imagegently.org) and Image Wisely® for adults (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).

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 website (http://www.acr.org/guidelines).

Equipment performance monitoring should be in accordance with the ACR–AAPM Technical Standard for Medical Nuclear Physics Performance Monitoring of Gamma Cameras [86].

ACKNOWLEDGEMENTS

This practice parameter was revised according to the process described under the heading The Process for Developing ACR Practice Parameters and Technical Standards on the ACR website.
Tumor Scintigraphy

PRACTICE PARAMETER

(http://www.acr.org/guidelines) by the Committee on Practice Parameters and Technical Standards – Nuclear Medicine and Molecular Imaging of the ACR Commission on Nuclear Medicine and Molecular Imaging and the Committee on Practice Parameters – Pediatric Radiology of the ACR Commission on Pediatric Radiology in collaboration with the SPR.

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*Practice parameters and technical 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 practice parameters and technical standards published before 1999, the effective date was January 1 following the year in which the practice parameter or technical standard was amended, revised, or approved by the ACR Council.

Development Chronology for this Practice Parameter
1996 (Resolution 10)
Revised 2000 (Resolution 28)
Revised 2005 (Resolution 23)
Amended 2006 (Resolution 35)
Revised 2010 (Resolution 28)