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The American College of Radiology will periodically define new practice parameters 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 parameters and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice parameter 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 parameters 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 parameter and technical standard by those entities not providing these services is not authorized.

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ACR–SPR PRACTICE PARAMETER FOR THE PERFORMANCE OF LIVER AND SPLEEN SCINTIGRAPHY

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 care¹. 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 assist physicians performing and interpreting liver and spleen scintigraphy. Properly performed imaging with radiopharmaceuticals that localize in the reticuloendothelial system or in the blood pool of the liver and spleen can be used to assess certain disorders of the liver and spleen. Imaging of the hepatobiliary system is discussed separately in the [ACR–SPR Practice Parameter for the Performance of Hepatobiliary Scintigraphy](#) [1]. Imaging of radiopharmaceuticals delivered via the hepatic artery in preparation for Y-90 radioembolization of primary and metastatic liver tumors is discussed separately in the [ACR–SIR Practice Parameter for Radioembolization with Microsphere Brachytherapy Device \(RMBD\) for Treatment of Liver Malignancies](#) [2]. As with all scintigraphic examinations, correlation of findings with the results of other imaging and nonimaging procedures, as well as clinical information, is necessary to maximize the diagnostic yield.

Application of this practice parameter should be in accordance with the [ACR–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) [3].

II. DEFINITION

Liver and spleen scintigraphy involves the intravascular administration of radiopharmaceuticals that localize in the reticuloendothelial cells or blood pool of the liver and/or spleen. Imaging is performed with a gamma camera.

III. GOAL

The goal of liver and spleen scintigraphy is to enable the interpreting physician to image hepatic and/or splenic tissue and to detect or characterize abnormalities of the liver and/or spleen by producing images of diagnostic quality.

IV. INDICATIONS

The indications for liver and spleen scintigraphy include, but are not limited to, the following:

1. Assessing the size, shape, and position of the liver
2. Differentiating hepatic hemangiomas and focal nodular hyperplasia from other liver mass lesions
3. Assessing the size, shape, and position of the spleen
4. Evaluating for residual or ectopic functioning splenic tissue and suspected functional asplenia

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](#) [4].

V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the [ACR–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) [3].

VI. RADIOPHARMACEUTICALS

For all radiopharmaceuticals below, administered activity for children should be determined based on body weight and should be as low as reasonably achievable for diagnostic image quality, as outlined in the *Pediatric Radiopharmaceutical Administered Doses: 2010 North American Consensus Guidelines* [5].

A. Technetium-99m Sulfur Colloid (SC)

Technetium-99m SC consists of particles composed of technetium-99m sulfide stabilized with gelatin. These particles range in size from 0.1 to 1.0 μm . Given intravenously, they are phagocytized by the reticuloendothelial cells of the liver, spleen, and bone marrow in proportion to relative blood flow, functional capacity of the phagocytic cells, and particle size. Maximum concentration in the liver and spleen occurs within 10 to 20 minutes, and the rate of biologic clearance from the reticuloendothelial cells is very slow. The usual administered activity is 111 to 222 MBq (3 to 6 mCi) for planar imaging in adults and up to 370 MBq (10 mCi) for single-photon-emission computed tomography (SPECT) imaging. Technetium-99m SC is frequently used to identify the size and location of functional splenic tissue. In the liver, technetium-99m SC can also be used to identify focal nodular hyperplasia (FNH). Due to the presence of adequate Kupffer cells, these lesions will most often appear as normal hepatic tissue and are infrequently seen as increased activity on a liver scan, the latter related to a greater number of Kupffer cells relative to the surrounding liver parenchyma and other liver tumors. Only a small number of FNH will be photopenic on a liver scan [6]. Alternatively, technetium-99m IDA can be used to evaluate FNH. (See the [ACR–SPR Practice Parameter for the Performance of Hepatobiliary Scintigraphy](#) [1].)

B. Technetium-99m-Labeled Autologous Red Blood Cells (RBCs)

See the [ACR–SPR Practice Parameter for the Performance of Gastrointestinal Scintigraphy](#) for RBC-labeling techniques. See the [ACR–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) for handling of radiolabeled cells [3,7].

Hepatic hemangiomas are conspicuous with technetium-99m-radiolabeled RBC imaging because of their relatively greater blood volume than that of the surrounding liver parenchyma. They are typically identified when the radiolabeled RBCs reach equilibrium within the intravascular space of the hemangioma, which may be 30 to 60 minutes postinjection or longer. Usual intravenously administered activity of technetium-99m labeled autologous RBCs ranges from 740 to 925 MBq (20 to 25 mCi). Procedures must be followed to ensure that the patient is injected with only autologous radiolabeled RBCs.

C. Technetium-99m Heat-Damaged Autologous RBCs

Autologous RBCs are radiolabeled, preferably by the *in vitro* method, with an activity of 37 to 222 MBq (1 to 6 mCi) for planar imaging or 555 to 1,110 MBq (15 to 20 mCi) for SPECT imaging and heated for 15 minutes in a preheated water bath at 49.0 to 50.0° C. After cooling to at least body temperature, the heat-damaged RBCs are administered intravenously, with imaging performed 20 to 30 minutes postinjection. The heat-damaged RBCs will be preferentially sequestered by splenic tissue. The technique requires meticulous attention to detail, as either insufficient or excessive damage to RBCs may alter the biologic distribution of the radiopharmaceutical. See the [ACR–SNM Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) [3] for handling of radiolabeled cells.

VII. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for liver and spleen 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. Planar Liver and Spleen Scan

Approximately 10 to 20 minutes after intravenous administration of technetium-99m SC, static planar images of the liver and spleen are obtained. Flow studies obtained during injection are occasionally useful. Anterior, posterior, right anterior oblique (RAO), left anterior oblique (LAO), right posterior oblique (RPO), and right lateral images should be acquired if possible. Additional views (left posterior oblique [LPO] and left lateral) may be indicated for more comprehensive evaluation of the spleen. Another anterior image may also be acquired with a lead marker of known length to identify the right inferior costal margin and xiphoid process. This marker can also be used to calibrate the pixel size for organ size measurement. For small field-of-view gamma cameras and standard administered activity, 300,000 counts per image is the usual minimum. For large field-of-view gamma cameras, 500,000 to 1,000,000 counts per image are usually acquired in the anterior projection. Subsequent views may then be obtained for the same length of time as the first image.

B. SPECT Liver and Spleen Imaging

For a single-detector, large field-of-view SPECT gamma camera, a 128 x 128 matrix, 6° angle of sampling (60 images in a 360° arc), and 20 to 30 seconds per image are appropriate parameters. For a multidetector SPECT camera, a 128 x 128 matrix with a 3° angle of sampling (60 images per head for a dual-detector camera or 40 images per detector for a triple-detector camera) can be used. SPECT/CT may be helpful for anatomic localization, particularly when evaluating mass lesions such as focal nodular hyperplasia.

C. Radiolabeled RBC Hepatic Blood Pool Imaging

A rapid-sequence series of images (1 to 3 frames per second for 60 seconds) immediately upon injection may yield useful information about regional variations in blood flow. The projection should be chosen to optimally show the hepatic lesion (usually discovered during a previous imaging examination). Planar and SPECT imaging parameters are similar to those for technetium-99m SC liver and spleen images (as described above in sections A and B). SPECT or SPECT/CT imaging is particularly helpful in identifying lesions smaller than 3 cm. Both early (0 to 30 minutes) and delayed (60 to 120 minutes) images are commonly acquired.

D. Spleen (Heat-Damaged RBC) Imaging

The radiopharmaceutical, technetium-99m heat-damaged RBCs, is administered intravenously. Imaging of the abdomen may commence 30 minutes to 120 minutes later. Planar and SPECT or SPECT/CT imaging parameters are similar to those for liver and spleen imaging. If the test is being performed to identify residual or ectopic splenic tissue, the abdomen and pelvis should be imaged. If the patient has had prior trauma that might have ruptured the diaphragm, the chest should be imaged as well.

VIII. DOCUMENTATION

Reporting should be in accordance with the [ACR Practice Parameter for Communication of Diagnostic Imaging Findings](#) [8].

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

IX. EQUIPMENT SPECIFICATIONS

A gamma camera with a low-energy all-purpose (LEAP) or low-energy high-resolution collimator may be used. SPECT or SPECT/CT may be used as indicated.

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) http://www-pub.iaea.org/MTCD/Publications/PDF/Pub1578_web-57265295.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®](#), 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](#) [9].

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