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## **ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF LIVER/SPLEEN SCINTIGRAPHY**

### **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 was developed by the American College of Radiology (ACR) to guide interpreting physicians performing 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 conditions of the liver and spleen. Imaging of the hepatobiliary system is discussed in the [ACR Practice Guideline for the Performance of Hepatobiliary Scintigraphy](#). Correlation of findings with clinical information and the results of other imaging modalities are frequently necessary to maximize the 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

Liver and spleen scintigraphy involves the intravenous administration or administration via a hepatic artery catheter of a radiopharmaceutical that localizes in the reticulo-endothelial cells, precapillary arterioles, or blood pool of the liver and/or spleen and subsequent imaging with a gamma camera.

## III. GOAL

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

## IV. INDICATIONS

The indications for liver and spleen scintigraphy include, but are not limited to, assessing the size, shape, and position of the liver and spleen; detecting, measuring, and monitoring of masses of either organ; differentiating hepatic hemangiomas and focal nodular hyperplasia from other liver lesions; measuring and evaluating hepatic function in cases of acute or chronic liver disease; confirming the patency and arterial distribution of hepatic arterial perfusion catheters; identifying functional splenic tissue; and evaluating suspected functional asplenia.

## V. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

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

## VI. RADIOPHARMACEUTICALS

A. Technetium-99m sulfur colloid (SC): Technetium-99m SC consists of particles composed of technetium-99m sulfide stabilized with gelatin. These particles average about 500 nanometers in diameter (range, 100-1,000 nm). Given intravenously, they are phagocytized by the reticuloendothelial cells of the liver, spleen, and bone marrow in relation to local blood flow and particle size. Maximum concentration in the liver and spleen occurs within 10 to 15 minutes, and the rate of biologic clearance from the reticuloendothelial cells is very slow. The usual imaging administered activity is 3-6 millicuries (111-222 MBq) for planar imaging in adults and up to 10 millicuries (370 MBq) for SPECT imaging. Administered activity for children should be reduced based on weight or body surface area, and should be as low as reasonably achievable for appropriate image quality.

B. Technetium-99m labeled red blood cells (RBCs): See the [ACR Practice Guideline for the Performance of](#)

[Cardiac Scintigraphy](#) and the [ACR Practice Guideline for the Performance of Gastrointestinal Scintigraphy](#) for RBC labeling techniques. See the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) for handling of radiolabeled cells. Technetium-99m RBCs may be used specifically to differentiate between hemangiomas of the liver and other hepatic masses. Because hemangiomas have a relatively greater blood volume than the surrounding liver parenchyma, they usually can be identified when the radiolabeled RBCs reach equilibrium with the intravascular space. Equilibration of the radiolabeled cells with the intravascular space in the hemangioma may take 30-60 minutes or more. Administered activity of up to 20-25 millicuries (740-925 MBq) is commonly used. Procedures must be followed to ensure that the patient is injected with only the correct blood. Administered activity for children should be reduced based on weight or body surface area, and should be as low as reasonably achievable for appropriate image quality.

C. Technetium-99m macroaggregated albumin (MAA): See the [ACR Practice Guideline for the Performance of Pulmonary Scintigraphy](#). Technetium-99m MAA consists of particles of aggregated human serum albumin with a size range of 10-90 nanometers. Given intra-arterially via a hepatic artery perfusion catheter, the MAA particles will localize within the liver in a distribution similar to that of the chemotherapeutic agent being introduced by the catheter. The usual adult administered activity is 1.0-5.0 millicuries (37-185 MBq). Administered activity for children should be reduced based on weight or body surface area, and should be as low as reasonably achievable for appropriate image quality.

D. Technetium-99m heat-damaged RBCs: Autologous RBCs radiolabeled by the in vitro or combined in vivo/in vitro method are heated for 10 minutes in a water bath at  $49.5 \pm 0.5^\circ\text{C}$ . Given intravenously, after cooling to at least body temperature, in an administered activity of 1-2 millicuries (37-74 MBq), the heat-damaged RBCs are selectively sequestered by the spleen. The technique requires precision, as either insufficient or excessive damage to RBCs may produce variation in biologic deposition of the agent. See the [ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals](#) for handling of radiolabeled cells. Administered activity for children should be reduced based on weight or body surface area, and should be as low as reasonably achievable for appropriate image quality.

## VII. SPECIFICATIONS OF THE EXAMINATION

The written or electronic request for liver/spleen scintigraphy should provide sufficient information to demonstrate the medical necessity of the examination and

allow for the proper performance and interpretation of the examination.

Documentation that satisfies medical necessity includes 1) signs and symptoms and/or 2) relevant history (including known diagnoses). The provision of 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 scope of practice requirements. 2006 (Res. 35)

A. Planar liver-spleen scan: Approximately 10 to 15 minutes after intravenous administration of technetium-99m SC, images of the liver and spleen are obtained. Anterior, posterior, right anterior oblique (RAO), left anterior oblique (LAO), and right lateral images are the minimum images acquired. Additional views (left posterior oblique, right posterior oblique, and left lateral) may be indicated for more comprehensive evaluation of the liver and spleen. Another anterior image may also be acquired with a lead marker of known length to identify the costal margin, and xyphoid 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, 500,000-1,000,000 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.

Flow studies obtained during injection are occasionally useful. Breath-holding views may sometimes help to clarify ambiguous findings by eliminating image degradation caused by respiration.

B. SPECT liver-spleen imaging: For single-headed, large-field-of-view SPECT gamma cameras, a 64 x 64 matrix, 6° angle of sampling (60 images in a 360° arc), and 20-30 seconds per image are appropriate parameters. Attenuation correction is sufficient. For multiheaded SPECT camera, a 128 x 128 matrix with a 3° angle of sampling (60 images per head for a dual-head camera or 40 images per head for a three-head camera) can be used.

C. Radiolabeled RBC hepatic blood pool imaging: A rapid-sequence series of images (1-3 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 show the hepatic

lesion (usually discovered during an earlier imaging study) optimally. When the lesion is small (less than 2-3 cm) or if there are multiple lesions, SPECT imaging is preferred. Planar and SPECT imaging parameters are similar to those for liver-spleen images. Both immediate (0-30 minutes) and delayed (60-120 minutes) images are commonly acquired.

D. Perfusion of hepatic tumors: Technetium-99m MAA, in a dosage of 1-5 millicuries (37-185 MBq), is introduced into the hepatic arterial perfusion catheter and infused slowly. Images of the abdomen are obtained immediately in the anterior (with and without external markers), LAO, left lateral, and posterior projections. The distribution can confirm whether the catheter is appropriately positioned and patent.

E. Spleen (heat-damaged RBC) imaging: The radiopharmaceutical, technetium-99m heat-damaged RBCs, is administered intravenously. Imaging of the abdomen may commence 30-120 minutes later. Planar and SPECT imaging parameters are similar to those for liver-spleen imaging. If ectopic splenic tissue is being sought, 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 Guideline for Communication of Diagnostic Imaging Findings](#).

## IX. EQUIPMENT SPECIFICATIONS

A gamma camera with a low-energy all-purpose (LEAP) or low-energy high-resolution collimator may be used. Small-field-of-view gamma cameras (250-300 mm) are preferred for planar imaging of small children and infants. Large-field-of-view gamma cameras ( $\geq 400$  mm) are preferred for adults. If a large-field-of-view gamma camera is used for planar imaging in an infant or small child, a converging collimator or use of acquisition zoom is recommended. For SPECT imaging in children, acquisition zoom may be helpful.

## X. RADIATION SAFETY IN IMAGING

Radiologists, radiologic 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 is the concept "As Low As Reasonably Achievable (ALARA)."

Facilities, in consultation with the medical physicist, should have in place and should adhere to policies and procedures, in accordance with ALARA, to vary

examination protocols to take into account patient body habitus, such as height and/or weight, body mass index or lateral width. The dose reduction devices that are available on imaging equipment should be active or manual techniques should be used to moderate the exposure while maintaining the necessary diagnostic image quality. Patient radiation doses should be periodically measured by a medical physicist in accordance with the appropriate ACR Technical Standard. 2006 (Res. 17)

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

Polices 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](#).

## **ACKNOWLEDGEMENTS**

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