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ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF SCINTIGRAPHY FOR INFECTIONS AND INFLAMMATION

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. It should be recognized; therefore, 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 in performing scintigraphy for infections and inflammation. Properly performed imaging with radiopharmaceuticals that localize in inflamed or infected tissue is an effective means of detecting and evaluating many overt or occult infections. Correlation with clinical findings and other imaging modalities is imperative for maximum diagnostic yield. For this guideline, discussion is limited solely to agents that are not organ specific. The reader is referred to the guidelines covering scintigraphy of specific organs (e.g., the ACR Practice Guideline for the Performance of Adult and Pediatric Skeletal Scintigraphy for osteomyelitis and the ACR Practice Guideline for the Performance of Adult and Pediatric Hepatobiliary Scintigraphy for acute cholecystitis) for a discussion of those organs.

Application of this guideline should be in accordance with the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

II. GOAL

The goal of scintigraphy for infections and inflammation is to enable the interpreting physician to detect and evaluate foci of infected or inflamed tissue.

III. INDICATIONS

Clinical indications for scintigraphy of infections and inflammation include, but are not limited to:

1. Evaluation of fevers of unknown origin.
2. Detection of disk space and joint space infections.
3. Detection and evaluation of possible infections in immunocompromised patients.
4. Assessment of potential lymphocytic or granulocytic inflammatory processes (e.g., tuberculosis or sarcoidosis).
5. Evaluation of potential pulmonary inflammation from therapeutic or environmental agents.
6. Evaluation of postoperative fevers in the absence of localizing signs.
7. Assessment of inflammatory bowel disease.
8. Detection of osteomyelitis in the case of existing bone pathology.
9. Detection of osteomyelitis in diabetic patients.
10. Assessment of possible vascular infections (e.g., grafts, shunts, mycotic aneurysms).
11. Evaluation of a painful prosthesis.

IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

See the ACR Technical Standard for Diagnostic Procedures Using Radiopharmaceuticals.

V. SPECIFICATIONS OF THE EXAMINATION

A. Radiopharmaceuticals

1. Gallium-67 citrate

   Gallium-67 citrate in the carrier-free state, given intravenously, binds to plasma transferrin and is transported to inflamed and infected tissues, where it traverses the porous capillary endothelium. It may also accumulate in certain tumors (especially in lymphomas and lung carcinoma; see the ACR Practice Guideline for the Performance of Tumor Scintigraphy) and in traumatized tissue.

   Imaging is normally performed between 24 and 72 hours after administration of the agent; however, if appropriate, imaging may be performed as early as 4 hours or as late as 7 days after injection.

   Administered activities of 5.0-10.0 millicuries (185-370 MBq) may be given to adults. Administered activity for children is 0.04-0.07 millicurie/kg (1.5-2.6 MBq/kg), with a minimum of 0.25 millicurie (9 MBq). The pediatric administered activity should be as low as practically achievable for appropriate image quality.

2. Radiolabeled leukocytes (indium-111 or technetium-99m hexamethylpropylene amine oxime [HMPAO])

   In vitro labeling of leukocytes is an exacting process that requires isolation of the cells from the patient's blood (or from a donor in unusual circumstances in which the patient is leukopenic), separation of the cells from plasma, labeling of the cells with either indium-111 oxine or technetium-99m HMPAO, resuspension in plasma, and reinjection within 6 hours. Manipulation may impair the viability of the cells, and a quality control program is recommended.

   One must be absolutely certain that the labeled leukocytes (as with any blood product) are given only to the patient for whom they are intended. There must be a written policy for the handling of radiolabeled autologous blood products that will ensure that all samples are positively identified as to source and that reinjection of these agents occurs only into the correct patient.

   a. Indium-111 oxine-labeled leukocytes

      Imaging is normally performed at 18-24 hours after injection. However, the performance of an early (1-3 hours) study, especially when inflammatory bowel disease is suspected, may be appropriate. Additional imaging may be done at 48 hours.

      The usual adult administered activity is 500 microcuries (18.5 MBq). Administered activity for children should be reduced according to weight or body surface area. The administered activity for children is 0.0075-0.015 millicurie/kg, with a minimum of 0.050 millicurie (1.8 MBq). The pediatric administered activity should be as low as

practically achievable for appropriate image quality.

b. Technetium-99m HMPAO-labeled leukocytes

Images may be acquired as early as 0.5-3 hours after injection and as much as 24 hours later. The 6-hour physical half-life of technetium-99m precludes delayed imaging beyond 24 hours.

Unbound technetium-99m may accumulate in normal bowel on images obtained at more than 4 hours.

Administered activity of 10-20 millicuries (370-740 MBq) may be given to adults. The administered activity for children is 0.1-0.2 millicurie/kg (3.7-7.4 MBq/kg), with a minimum of 0.5 millicurie (18 MBq). The pediatric administered activity should be as low as practically achievable for appropriate image quality.

B. Patient-Related Issues

When gallium-67 citrate is used, bowel activity may obscure detail of the abdomen. Preparation of the colon using enemas and/or a mild laxative is frequently desirable. For this reason, gallium-67 citrate may not be optimal for patients whose disease is in the abdomen. In patients with diminished plasma transferrin, renal excretion may interfere with tissue deposition. Gallium-67 citrate is the agent of choice for evaluation of pulmonary conditions in immunosuppressed patients. In addition, it is often useful in suspected disk space infections, in pulmonary inflammation due to drug toxicity, and in evaluating fevers of unknown origin. In some situations, gallium-67 citrate may be superior to radiolabeled leukocytes for atypical bacterial, fungal, chronic, and spinal infections.

Both technetium-99m HMPAO-labeled and indium-111-labeled leukocytes perform well in detecting osteomyelitis and differentiating infection from other entities (such as prosthesis loosening), assessing potential vascular infections (shunts, grafts, and mycotic aneurysms), and evaluating postoperative fevers in the absence of localizing signs**.** Removal of dressings contaminated with wound drainage can eliminate a source of false positivity. Correlation of labeled leukocyte images with bone marrow images (performed with technetium-99m sulfur colloid) may help exclude false-positive studies due to leukocyte localization in bone marrow.

VI. EQUIPMENT SPECIFICATIONS

A gamma camera equipped with a medium-energy collimator is used for imaging gallium-67 and indium-111 leukocytes. A low-energy, all-purpose/general all-purpose (LEAP/GAP) collimator or a high-resolution collimator may be used with technetium-99m leukocytes. While a small-field-of-view (SFOV) camera (250-300 mm) can be used, the detector head must be shielded adequately if gallium-67 or indium-111 is used. A large-field-of-view (LFOV) (≥400 mm) camera head is preferable, especially if a large area of the body must be imaged.

For each of the three radiopharmaceuticals, the following techniques are suggested (assuming adult administered activity):

Radiopharmaceuticals	SFOV camera	LFOV camera
Gallium-67		
Spot images	50,000-300,000 counts	100,000-500,000 counts
Whole body		5 cm/min (40 min maximum)
Indium-111 leukocytes		
Spot images	30,000-60,000 counts	50,000-100,000 counts
Whole body		5 cm/min (40 min maximum)
Technetium-99m		
Spot image	50,000-300,000 counts	100,000-500,000 counts
Whole body		5 cm/min (40 min maximum)

Images may be obtained either as multiple spot views or as whole-body surveys. SPECT may be performed. If a single-head camera is used with gallium-67, a 6° sampling angle, 360° rotation, 64 x 64 matrix, and 20-25 seconds per stop (50,000-80,000 counts per stop) are suggested. If a multihead (two or more) system is used with gallium-67, one should use a 3° sampling angle, 64 x 64 matrix, and 20-25 seconds per stop (50,000-80,000 counts per stop). Because of the lower counting rates associated with indium-111 leukocytes and technetium-99m leukocytes, SPECT may be difficult.

VII. DOCUMENTATION

Reporting should be in accordance with the ACR Practice Guideline for Communication: Diagnostic Radiology.

VIII. 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.

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