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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 2007 (Resolution 20)*

ACR PRACTICE GUIDELINE FOR THE PERFORMANCE OF ADULT AND PEDIATRIC SKELETAL SCINTIGRAPHY (BONE SCAN)

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 has been developed to guide physicians performing skeletal scintigraphy in adult and pediatric patients. Skeletal scintigraphy involves the intravenous injection of a bone-seeking radiopharmaceutical and subsequent imaging with a gamma camera.

Properly performed, skeletal scintigraphy is a sensitive method for detecting numerous conditions involving the skeletal system. Although certain patterns are suggestive of individual disease entities, correlation of abnormal activity with clinical information, conventional radiographs, and other imaging techniques, including computed tomography, magnetic resonance imaging, and other radiopharmaceutical imaging studies, is frequently helpful for diagnosis.

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

(For pediatric consideration see sections V.A, V.C.1, 2, and VI.B.)

II. GOAL

The goal of skeletal scintigraphy is to enable the interpreting physician to detect anatomic and physiologic abnormalities of the bones by producing images of diagnostic quality.

III. INDICATIONS

Clinical indications for skeletal scintigraphy include, but are not limited to, detection, evaluation, and/or follow-up of:

1. Primary and metastatic bone neoplasms.
2. Disease progression or response to therapy.
3. Paget's disease of bone.
4. Stress and/or occult fractures.
5. Trauma – accidental and non-accidental.
6. Osteomyelitis.
7. Musculoskeletal inflammation or infection.
8. Bone viability (grafts, infarcts, osteonecrosis).
9. Metabolic bone disease.
10. Arthritides.
11. Prosthetic joint loosening and infection.
12. Pain of suspected musculoskeletal etiology.
13. Myositis ossificans.
14. Complex regional pain syndrome (CRPS 1). Reflex sympathetic dystrophy.
15. Abnormal radiographic or laboratory findings.
16. Distribution of osteoblastic activity prior to administration of therapeutic radiopharmaceuticals for treating bone pain.

For the pregnant or potentially pregnant patient, see the [ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation](#).

IV. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

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

V. SPECIFICATIONS AND PERFORMANCE OF THE EXAMINATION

The written or electronic request for skeletal 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. Radiopharmaceuticals

Technetium-99m methylene diphosphonate (MDP), technetium-99m hydroxymethylene diphosphonate (HDP), or a comparable agent is administered intravenously. The usual administered activity for adults is 15 to 30 millicuries (555 to 1,110 MBq). For very obese adult patients, administered activity of up to 40 millicuries (1,480 MBq) may be required (unless specifically prohibited by local or state regulations). For infants and children, the administered activity must be reduced according to a standard protocol, with a minimum administered activity of 2 millicuries (74 MBq)¹.

Examples of two protocols are:

200 microcuries (7.4 MBq) x body weight (kilograms)

or

20 millicuries (740 MBq) x $\frac{\text{body surface area (square meters)}}{1.73 \text{ square meters}}$

Adolescents may be given 15 to 20 millicuries (555 to 740 MBq), or an adult dose if they are physically mature.

Skeletal imaging radiopharmaceuticals are susceptible to generation of oxidation products. Care should be taken not to introduce air during either reconstitution of kits or drawing of dosages.

B. Patient Factors

The patient should be well hydrated. Ingestion of liquids should be encouraged between the time of radiopharmaceutical injection and imaging, unless the patient's clinical condition dictates otherwise.

The patient's bladder should be emptied immediately prior to imaging the pelvic area. The physician and technologist should be alert to the possibility of artifacts from urine contamination or from extravasation at the site of injection.

¹For more specific guidance on pediatric dosing, please refer to the *Pediatric Radiopharmaceutical Administered Doses: 2010 North American Consensus Guidelines* [2]

If the bladder obscures portions of the pelvis despite attempts to void, further evaluation may be necessary. If specific views or single-photon emission computed tomography (SPECT) imaging is not sufficient to clarify the area, then consideration may be given to catheterizing the bladder or obtaining a delayed scan.

C. Images

1. General: For routine skeletal scintigraphy, imaging should commence 2 to 4 hours after dosage. For infants and small children, the more rapid skeletal turnover may permit imaging to begin at 90 to 120 minutes. For patients in whom soft-tissue clearance is delayed, additional images at 6 to 24 hours may be needed. Images of the skeleton appropriate to the symptoms and condition should be obtained. For studies of the entire skeleton, multiple spot views or whole-body surveys may be performed. Anterior and posterior images of the axial and appendicular skeleton are standard. These may be supplemented by orthogonal views of the extremities, oblique views of the torso, and pinhole collimator or magnification views of specific regions of interest. If limited images of the skeleton are being acquired, carefully positioned comparison views of the contralateral side should be obtained. The nonaffected side should be acquired first and the affected side imaged for the same amount of time.
2. Three-phase imaging: For information regarding hyperemia or inflammation, initial blood flow (1 to 5 seconds per frame for 30 to 60 seconds), blood-pool imaging (up to 5 minutes), and delayed static imaging (2 to 4 hours) of a specific part of the skeleton may be useful in many evaluations. Indications may include, but are not limited to, trauma, neoplasm, infection, and reflex sympathetic dystrophy. Three-phase imaging may be combined with routine skeletal imaging.
3. SPECT: SPECT imaging can improve sensitivity, provide more precise localization of the radiopharmaceutical, and improve visualization of subtle abnormalities.

VI. EQUIPMENT SPECIFICATIONS

A. For standard-field-of-view cameras: At a minimum, a low-energy all-purpose (LEAP) collimator should be employed. A high-resolution collimator will provide better detail but at the expense of a longer imaging time. Although the information content of the images improves in proportion to the number of counts collected per image, a balance must be achieved among information density, patient comfort/motion, and practical time constraints.

Minimum suggested counts are:

1. Axial skeleton: 500,000 counts per image.
2. Appendicular skeleton: 100,000 to 300,000 counts per image.
3. Whole-body scan: 1,000,000 count each for both the anterior and posterior views.

B. For large-field-of-view cameras: Larger crystal size and improved electronics make greater count rates available for a given dosage. Although the same trade-off of improved image quality versus patient comfort/motion and practical imaging times exists as with standard-field-of-view cameras, the greater efficiency of large-field-of-view cameras permits better detail and higher information content through the use of a high-resolution collimator and increased counting statistics. Suggested counts are:

1. Axial skeleton: 600,000 counts per image.
2. Appendicular skeleton: 150,000 to 400,000 counts per image.
3. Whole-body scan: 1,500,000 to 2,000,000 counts each for both the anterior and posterior views. The suggested scan speed range for whole body imaging is 10 to 15 cm/minutes.

Delayed images, performed 6 to 24 hours after radiotracer injection, require prolonged imaging times that may be adjusted to patient tolerance.

When studying infants or small children who have received small radiopharmaceutical doses, case-by-case adjustment is advised to achieve the highest attainable count density with the fewest possible motion artifacts.

C. SPECT Imaging

1. Single head: For skeletal scintigraphy performed with SPECT, an all-purpose or high-resolution collimator should be used, keeping the patient as close to the detector as possible. No less than a 128 x 128 acquisition matrix should be used, and 120 to 128 steps for 15 to 30 seconds per camera stop with a 128 x 128 reconstruction matrix. With typical collimator or dosage combinations, average acquisitions should be for approximately 20 to 30 seconds per camera stop to obtain sufficient counts.
2. Multihead: A high-resolution collimator should be used, keeping the detectors as close to the patient as possible. A 128 x 128 matrix should be used with a 360 degree orbit and 120 to 128 total images obtained (dual-head cameras: 60 stops at 3 degree intervals; triple-head cameras: 40 stops at 3 degree intervals). Imaging times of 20 to 40 seconds per camera stop should be used, and reconstruction should be done on a 128 x 128

matrix. These parameters may be modified and imaging time shortened if the patient is unable to remain motionless for this duration of time.

VII. DOCUMENTATION

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

VIII. 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) or by state, and/or other regulatory agencies. Quantities of radiopharmaceuticals should be tailored to the individual patient by prescription or protocol.

IX. 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 Monitoring of Gamma Cameras](#).

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This guideline was revised according to the process described under the heading *The Process for Developing ACR Practice Guidelines and Technical Standards* on the ACR web page (<http://www.acr.org/guidelines>) by the Guidelines and Standards Committee of the Commission on Nuclear Medicine.

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