American College of Radiology
ACR Appropriateness Criteria®
Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus

Variant 1: **Suspected osteomyelitis of the foot in patients with diabetes mellitus. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Radiography foot	Usually Appropriate	☢
CT foot with IV contrast	Usually Not Appropriate	☢
CT foot without and with IV contrast	Usually Not Appropriate	☢
CT foot without IV contrast	Usually Not Appropriate	☢
FDG-PET/CT whole body	Usually Not Appropriate	☢☢☢☢
WBC scan and sulfur colloid scan foot	Usually Not Appropriate	☢☢☢☢
WBC scan foot	Usually Not Appropriate	☢☢☢☢
MRI foot without and with IV contrast	Usually Not Appropriate	O
MRI foot without IV contrast	Usually Not Appropriate	O
3-phase bone scan and WBC scan and sulfur colloid scan foot	Usually Not Appropriate	☢☢☢☢
3-phase bone scan and WBC scan foot	Usually Not Appropriate	☢☢☢☢
3-phase bone scan and WBC scan with SPECT or SPECT/CT foot	Usually Not Appropriate	☢☢☢☢
3-phase bone scan foot	Usually Not Appropriate	☢☢☢
US foot	Usually Not Appropriate	O

Variant 2: **Soft-tissue swelling without ulcer. Suspected osteomyelitis or early neuropathic arthropathy changes of the foot in patients with diabetes mellitus. Additional imaging following radiographs.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI foot without and with IV contrast	Usually Appropriate	O
MRI foot without IV contrast	Usually Appropriate	O
CT foot with IV contrast	May Be Appropriate	☢
CT foot without IV contrast	May Be Appropriate	☢
3-phase bone scan and WBC scan with SPECT or SPECT/CT foot	May Be Appropriate	☢☢☢☢
FDG-PET/CT whole body	May Be Appropriate	☢☢☢☢
WBC scan foot	May Be Appropriate	☢☢☢☢
3-phase bone scan and WBC scan foot	May Be Appropriate	☢☢☢☢
WBC scan and sulfur colloid scan foot	Usually Not Appropriate	☢☢☢☢
3-phase bone scan and WBC scan and sulfur colloid scan foot	Usually Not Appropriate	☢☢☢☢
CT foot without and with IV contrast	Usually Not Appropriate	☢
3-phase bone scan foot	Usually Not Appropriate	☢☢☢
US foot	Usually Not Appropriate	O

Variant 3: **Soft-tissue swelling with ulcer. Suspected osteomyelitis of the foot in patients with diabetes mellitus with or without neuropathic arthropathy. Additional imaging following radiographs.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI foot without and with IV contrast	Usually Appropriate	O
MRI foot without IV contrast	Usually Appropriate	O
CT foot with IV contrast	May Be Appropriate	☢
CT foot without IV contrast	May Be Appropriate	☢
3-phase bone scan and WBC scan foot	May Be Appropriate	☢☢☢☢
3-phase bone scan and WBC scan with SPECT or SPECT/CT foot	May Be Appropriate	☢☢☢☢
3-phase bone scan foot	May Be Appropriate (Disagreement)	☢☢☢
FDG-PET/CT whole body	May Be Appropriate	☢☢☢☢
WBC scan foot	May Be Appropriate	☢☢☢☢
WBC scan and sulfur colloid scan foot	Usually Not Appropriate	☢☢☢☢
3-phase bone scan and WBC scan and sulfur colloid scan foot	Usually Not Appropriate	☢☢☢☢
CT foot without and with IV contrast	Usually Not Appropriate	☢
US foot	Usually Not Appropriate	O

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Summary of Literature Review

Introduction/Background

The Centers for Disease Control and Prevention National Diabetes Statistics Report of 2017 states that 30.3 million people in the United States have diabetes (9.4% of the population) [1]. Diabetes-related foot complications, such as soft-tissue infection, osteomyelitis, and neuropathic osteoarthropathy, account for up to 20% of all diabetic-related North American hospital admissions, with up to $1.5 billion spent annually in the United States on diabetic foot ulcer care [2].

Neuropathic changes in the foot are present in about 1% of diabetics [3]. Neuropathic osteoarthropathy is a progressive process affecting the bones, joints, and soft tissue of the foot and ankle. Delay in the diagnosis may lead to derangement of the bony architecture of the foot, deformity, recurrent foot ulcerations, cellulitis, osteomyelitis, and amputation [4].

Imaging findings should not be interpreted in isolation. Clinical features that suggest osteomyelitis include an ulcer area >2 cm^2, an elevated erythrocyte sedimentation rate level of >70 mm/hour, positive probe-to-bone test, a nonhealing ulcer for 6 months, erythema, fever, and elevated white blood cell (WBC) count [2,5,6]. A negative probe-to-bone test may exclude the diagnosis of osteomyelitis with a high negative predictive value [7]. The Infectious Diseases Society of American recommends performing the probe-to-bone test on any diabetic foot infection with an open wound [8]. Deep wound cultures correlate well with osseous cultures and provide a sensitive method in assessing and targeting likely pathogens that cause osseous infections [9].

For the diabetic foot with a clinical examination suggesting crepitus where soft-tissue gas associated with wet gangrene is suspected, please see the ACR Appropriateness Criteria® topic on Suspected Osteomyelitis, Septic Arthritis, or Soft Tissue Infection (Excluding Spine and Diabetic Foot) for appropriate guidance [10].

Discussion of Procedures by Variant

Variant 1: Suspected osteomyelitis of the foot in patients with diabetes mellitus. Initial imaging.

Radiography Foot

Radiographs are useful as the initial screening examination. They evaluate anatomic detail and previous surgeries and are useful to evaluate for other causes of pain, such as radiopaque foreign body, soft-tissue gas, fracture, degenerative changes, neuropathic arthropathy, or tumor. Radiographs are insensitive in the detection of early stages of acute osteomyelitis [11]. Soft-tissue swelling and obscuration of the fat planes will precede osseous changes [12]. Osseous changes may take 10 to 12 days to develop in adults [13]. Early bony changes of osseous infection include periosteal reaction, lytic bone destruction, endosteal scalloping, osteopenia, loss of trabecular architecture, and new bone apposition [13].

CT Foot

There is no relevant literature to support the use of CT with or without intravenous (IV) contrast as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

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MRI Foot
There is no relevant literature to support the use of MRI with or without IV contrast as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

FDG-PET/CT Whole Body
There is no relevant literature to support the use of fluorine-18-2-fluoro-2-deoxy-D-glucose (FDG)-PET/CT as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

WBC Scan and Sulfur Colloid Scan Foot
There is no relevant literature to support the use of a dual isotope WBC with sulfur colloid scan as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

WBC Scan Foot
There is no relevant literature to support the use of In-111 WBC scan as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

3-phase Bone Scan and WBC Scan and Sulfur Colloid Scan Foot
There is no relevant literature to support the use of combined imaging with 3-phase bone scan and In-111 WBC scan and Tc-99m sulfur colloid scan as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

3-phase Bone Scan and WBC Scan Foot
There is no relevant literature to support the use of a 3-phase bone scan with In-111 WBC as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

3-phase Bone Scan Foot
There is no relevant literature to support the use of a 3-phase bone scan as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

US Foot
There is no relevant literature to support the use of ultrasound (US) as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

3-phase Bone Scan and WBC Scan with SPECT or SPECT/CT foot
There is no relevant literature to support the use of single-photon emission computed tomography (SPECT/CT) as the initial screening examination in diabetic patients with suspected osteomyelitis of the foot.

Variant 2: Soft-tissue swelling without ulcer. Suspected osteomyelitis or early neuropathic arthropathy changes of the foot in patients with diabetes mellitus. Additional imaging following radiographs.

The likelihood of developing osteomyelitis without an associated wound or ulceration is extremely low. Almost all osteomyelitis and soft-tissue abscesses of the diabetic foot represent areas of contiguous infection from adjacent skin ulcerations and not hematogenous seeding [14]. Any imaging modality performed for this variant should be able to identify soft-tissue infections, tumors and abscesses, early neuropathic arthropathy, or subtle fractures not revealed on initial radiographs. Diabetic foot osteomyelitis and neuroarthropathy can be difficult to differentiate clinically. The early diagnosis of neuropathic disease prior to the development of radiographic change is important, as these patients will be treated with altered footwear and orthotics to prevent the progression to deformity.

US Foot
US is of limited benefit in the detection of adult osteomyelitis because of its inability to penetrate the cortex of the bone. The role of US in the diabetic foot includes detection of subperiosteal and soft-tissue abscesses, tenosynovitis, joint effusions, and radiolucent foreign bodies. US is insensitive to the marrow edema and trabecular microfractures present in neuropathic foot.

CT Foot
CT is able to image large anatomic regions rapidly with multiplanar reconstruction capability. CT with or without IV contrast demonstrates the features of acute osteomyelitis, such as periosteal reaction, endosteal scalloping, and lytic bone destruction, more clearly and in more detail than on radiographs but is less sensitive than MRI and nuclear medicine studies for detecting early intramedullary changes of acute osteomyelitis [15]. Features of chronic osteomyelitis (sequestra, involucrum, cloaca, sinus tracts) are well depicted on CT with or without IV contrast. CT with or without IV contrast may be superior to MRI for the findings of sequestra, foreign bodies, and

soft-tissue gas [16]. CT with or without IV contrast is more sensitive than radiographs to osseous changes allowing earlier detection of neuropathic arthropathy changes of debris, fragmentation, disruption, and dislocation [3,17]. When metal is present in or near the area of interest, there is significant loss of image resolution that is due to a beam-hardening artifact [13]. Dual-energy CT may be useful for metal artifact reduction if available. With high-resolution multiplanar imaging, CT is able to delineate the anatomic extent of soft-tissue infections. Contrast is preferred for the evaluation of soft-tissue infection and delineation of fluid collections [16].

MRI Foot

MRI with or without enhancement demonstrates excellent soft-tissue contrast and sensitivity to marrow abnormalities [18,19] with high-resolution detail in multiple anatomic planes. The likelihood of osteomyelitis without an associated wound or ulceration is extremely low. MRI with or without enhancement is a good modality to identify other potential sources of pain in this variant, such as soft-tissue infections, tumors and abscesses, early neuropathic arthropathy, or subtle fractures. Normal marrow signal reliably excludes osteomyelitis [20]. Positive cases of osteomyelitis demonstrate decreased T1-weighted bone marrow signal and increased signal on fluid-sensitive sequences [21,22]. Some authors suggest increased T2-weighted bone marrow signal may represent early osteomyelitis or be a predictor of later development of osteomyelitis, even in the setting of a normal T1-weighted signal [2]. MRI with or without enhancement is often the modality of choice in this variant because of its high sensitivity for osteomyelitis [23-25]. MRI with or without IV contrast can detect the earliest findings of neuropathic arthropathy, such as marrow edema and trabecular microfractures [17,26]. A negative MRI indicates that acute neuropathic arthropathy is unlikely [27]. MRI may be limited by artifact secondary to orthopedic hardware.

Perhaps as important as detecting osteomyelitis, the structural definition and high spatial resolution multiplanar images are important for evaluating the extent of osseous involvement and the location and size of drainable fluid collections for surgical planning [28]. The use of gadolinium contrast is useful to determine fluid collection/abscesses, sinus tracts, and devitalized regions. The “ghost sign” on postcontrast images may reveal osteomyelitis superimposed on neuropathic arthropathy. The ghost sign is noted when bones appear to be ‘‘dissolved’’ on T1-weighted images but become more regular morphologically on T2-weighted or contrast-enhanced imaging [29]. MRI with IV contrast demonstrates greater sensitivity in detecting inflammation as well as associated fasciitis, myositis, fluid collections, and areas of necrosis [29].

3-phase Bone Scan Foot

The 3-phase bone scan is sensitive but not specific in differentiating osteomyelitis from a neuropathic foot since both processes cause increased osteoblastic activity [30]. Pathologies with high bone turnover, such as fracture, neuroarthropathy, malignancy, or recent surgery, may result in a positive scan in the absence of infection. A negative bone scan excludes infection with a high degree of certainty [31]. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

3-phase Bone Scan and WBC Scan Foot

The combined bone scan and labeled leukocyte scan (In-111 or Tc-99m) markedly improves specificity in the nonmarrow-containing skeleton when there has been previous surgery, radiographs are abnormal, or when any other cause for bone remodeling is present [32]. It can be useful for distinguishing true WBC accumulation secondary to osteomyelitis from nonspecific WBC uptake that is seen in neuropathic joint [32,33]. Planar scintigraphic imaging modalities alone have relatively low spatial resolution and lack anatomic specificity. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

WBC Scan Foot

Labeled leukocyte imaging is advantageous for imaging acute infection in immunocompetent patients with intact chemotaxis. The modality is most useful for identifying neutrophil-mediated inflammatory processes, such as bacterial infections, because the majority of leukocytes labeled are neutrophils, and it is less useful in illnesses in which the predominant cellular response is other than neutrophilic, such as tuberculosis. Chronicity of infection and nonspecific inflammation may lead to inconsistent results, and a recent onset neuropathic joint may yield false-positive results [34,35]. Planar scintigraphic imaging modalities have relatively low spatial resolution and lack of anatomic specificity. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

WBC Scan and Sulfur Colloid Scan Foot
Combined labeled leukocyte and sulfur colloid bone marrow imaging is most useful when increased labeled leukocyte activity is secondary to altered bone marrow distribution, such as around joint prosthesis [36]. Labeled leukocytes and sulfur colloid normally accumulate in bone marrow, and discordant labeled white cell activity without corresponding sulfur colloid uptake indicates infection [37]. Planar scintigraphy imaging modalities alone have relatively low spatial resolution and lack anatomic specificity. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

3-phase Bone Scan and WBC Scan and Sulfur Colloid Scan Foot
Combined labeled leukocyte and sulfur colloid bone marrow imaging is most useful when increased labeled leukocyte activity is secondary to altered bone marrow distribution, such as around joint prostheses [36]. In evaluating arthroplasties, positive bone scan and WBC uptake with no uptake on the bone marrow scan is considered positive for infection [38]. This modality may be helpful when significant metal hardware is present that would impair MRI or CT imaging. Planar scintigraphic imaging modalities have relatively low spatial resolution and lack anatomic specificity. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

FDG-PET/CT Whole Body
FDG-PET/CT has potentially an important role in diagnosing deep soft-tissue infection and osteomyelitis and in differentiating neuropathic arthropathy [39,40]. The high resolution of FDG-PET/CT offers an advantage over single-photon emitting tracers, particularly when evaluating precise localization of radiotracer accumulation in bones of the distal forefoot, where the majority of diabetic foot infections occur [41]. Fused FDG-PET/CT allows correct differentiation between osteomyelitis and soft-tissue infection [42,43]. FDG-PET/CT can be used in the evaluation of patients with metal implants that would compromise the accuracy of MRI or CT [40]. Prior studies have demonstrated high accuracy in the detection of osteomyelitis in cases complicated by prior surgery, trauma, and the presence of orthopedic hardware [44-46].

3-phase Bone Scan and WBC Scan with SPECT or SPECT/CT Foot
Planar scintigraphic imaging modalities have relatively low spatial resolution and lack anatomic specificity. SPECT/CT fused imaging improves the diagnostic accuracy mainly because of accurate anatomic localization [47-50]. Dual isotope SPECT/CT is reported to be more accurate than bone scan SPECT/CT or WBC-SPECT/CT alone [51].

Variant 3: Soft-tissue swelling with ulcer. Suspected osteomyelitis of the foot in patients with diabetes mellitus with or without neuropathic arthropathy. Additional imaging following radiographs.

Imaging plays a central role in characterizing soft-tissue and osseous infections in the diabetic foot by identifying the location, evaluating the extent of involvement, and detecting complications, such as soft-tissue abscesses or sinus tracts. The infected ulcer may progress to soft-tissue abscess, sinus tract, infected tendon sheath, osteomyelitis, or septic arthritis [29]. If an ulcer with a positive probe-to-bone test is present, the risk of osteomyelitis is 12% to 66% [52-54]. The role of any imaging modality in these patients is to confirm the presence of soft-tissue or osseous infection and determine the anatomic extent for treatment planning.

US Foot
US demonstrates limited benefit in the detection of adult osteomyelitis because of its inability to penetrate the cortex of the bone. The role of US in the diabetic foot includes detecting subperiosteal and soft-tissue abscesses, tenosynovitis, joint effusions, and radiolucent foreign bodies. US is insensitive to the marrow edema and trabecular microfractures present in neuropathic foot.

CT Foot
CT is able to image large anatomic regions rapidly with multiplanar capability. CT with or without IV contrast demonstrates the features of acute osteomyelitis, such as periosteal reaction, endosteal scalloping, and lytic bone destruction, more clearly and in more detail than on radiographs, but is less sensitive than MRI and nuclear medicine studies for detecting early intramedullary changes of acute osteomyelitis [15]. Features of chronic osteomyelitis (sequestra, involucrum, cloaca, sinus tracts) are well depicted on CT with or without IV contrast. CT with or without IV contrast may be superior to MRI for the findings of sequestra, foreign bodies, and soft-tissue gas [16]. CT with or without IV contrast is more sensitive than radiographs to osseous changes, allowing

earlier detection of neuropathic arthropathy changes of debris, fragmentation, disruption, and dislocation [3,17]. When metal is present in or near the area of interest, there is significant loss of image resolution that is due to a beam-hardening artifact [13]. Dual-energy CT may be useful for metal artifact reduction if available. With high-resolution multiplanar imaging, CT is able to delineate the anatomic extent of soft-tissue infections. Contrast is preferred for the evaluation of soft-tissue infection and delineation of fluid collections [16].

MRI Foot

MRI with or without enhancement is the favored modality in this variant and has demonstrated high sensitivity (90%) and specificity (83%) for early osteomyelitis in a large meta-analysis [23]. MRI with or without enhancement demonstrates excellent soft-tissue contrast and sensitivity to marrow abnormalities [18,19] with high-resolution detail in multiple anatomic planes. Normal marrow signal reliably excludes osteomyelitis [20]. Positive cases of osteomyelitis demonstrate decreased T1-weighted bone marrow signal and increased signal on fluid-sensitive sequences [21,22]. Some authors suggest increased T2-weighted bone marrow signal may represent early osteomyelitis or be a predictor of later development of osteomyelitis, even in the setting of a normal T1-weighted signal [2]. The high resolution can delineate the anatomic extent of osteomyelitis and assist in surgical planning [29]. MRI with or without IV contrast can detect the earliest findings of neuropathic arthropathy, such as marrow edema and trabecular microfractures [17,26]. A negative MRI indicates that acute neuropathic arthropathy is unlikely [27]. MRI may be limited by artifact secondary to orthopedic hardware.

Perhaps as important as detecting osteomyelitis, the structural definition and high spatial resolution multiplanar images are important for evaluating the extent of osseous involvement and the location and size of drainable fluid collections for surgical planning [28]. The use of gadolinium contrast is useful to determine fluid collection/abscesses, sinus tracts, and devitalized regions. The “ghost sign” on postcontrast images may reveal osteomyelitis superimposed on neuropathic arthropathy [29]. MRI with IV contrast demonstrates greater sensitivity in detecting inflammation as well as associated fasciitis, myositis, fluid collections, and areas of necrosis [29].

3-phase Bone Scan Foot

The 3-phase bone scan is sensitive but not specific in differentiating osteomyelitis from a neuropathic foot since both processes cause increased osteoblastic activity [30]. Pathologies with high bone turnover, such as fracture, neuroarthropathy, malignancy, or recent surgery, may result in a positive scan in the absence of infection. A negative bone scan excludes infection with a high degree of certainty [31]. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery. In the setting of deep soft-tissue ulceration, positive uptake in the adjacent bone is highly suggestive of osteomyelitis.

3-phase Bone Scan and WBC Scan Foot

The combined bone scan and labeled leukocyte scan (In-111 or Tc-99m) markedly improves specificity in the nonmarrow-containing skeleton when there has been previous surgery, radiographs are abnormal, or when any other cause for bone remodeling is present [32]. It can be useful for distinguishing true WBC accumulation secondary to osteomyelitis from nonspecific WBC uptake that is seen in neuropathic joint [32,33]. Planar scintigraphic imaging modalities alone have relatively low spatial resolution and lack anatomic specificity. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

WBC Scan Foot

Labeled leukocyte imaging is advantageous for imaging acute infection in immunocompetent patients with intact chemotaxis. The modality is most useful for identifying neutrophil-mediated inflammatory processes, such as bacterial infections, because the majority of leukocytes labeled are neutrophils, and it is less useful in illnesses in which the predominant cellular response is other than neutrophilic, such as tuberculosis. Chronicity of infection and nonspecific inflammation may lead to inconsistent results, and a recent onset neuropathic joint may yield false-positive results [34,35]. Planar scintigraphic imaging modalities have relatively low spatial resolution and lack of anatomic specificity. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

WBC Scan and Sulfur Colloid Scan Foot

Combined labeled leukocyte and sulfur colloid bone marrow imaging is most useful when increased labeled leukocyte activity is secondary to altered bone marrow distribution, such as around joint prosthesis [36]. Labeled

leukocytes and sulfur colloid normally accumulate in bone marrow, and discordant labeled white cell activity without corresponding sulfur colloid uptake indicates infection image [37]. Planar scintigraphic imaging modalities alone have relatively low spatial resolution and lack anatomic specificity. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

3-phase Bone Scan and WBC Scan and Sulfur Colloid Scan Foot

Combined labeled leukocyte and sulfur colloid bone marrow imaging is most useful when increased labeled leukocyte activity is secondary to altered bone marrow distribution, such as around joint prostheses [36]. In evaluating arthroplasties, positive bone scan and WBC uptake with no uptake on the bone marrow scan is considered positive for infection [38]. This modality may be helpful when significant metal hardware is present that would impair MRI or CT imaging. Planar scintigraphic imaging modalities have relatively low spatial resolution and lack anatomic specificity. Nuclear medicine modalities are useful in cases where infection is multifocal or when the infection is associated with orthopedic hardware or chronic bone alterations from trauma or surgery.

FDG-PET/CT Whole Body

FDG-PET/CT has potentially an important role in diagnosing deep soft-tissue infection and osteomyelitis and differentiating neuropathic arthropathy [39,40]. The high resolution of FDG-PET/CT offers an advantage over single-photon emitting tracers, particularly when evaluating precise localization of radiotracer accumulation in bones of the distal forefoot, where the majority of diabetic foot infections occur [41]. Fused FDG-PET/CT allows correct differentiation between osteomyelitis and soft-tissue infection [42,43]. FDG-PET/CT can be used in the evaluation of patients with metal implants that would compromise the accuracy of MRI or CT [40]. Previous studies have demonstrated high accuracy in the detection of osteomyelitis in cases complicated by prior surgery, trauma, and the presence of orthopedic hardware [44-46].

3-phase Bone Scan and WBC Scan with SPECT or SPECT/CT Foot

Planar scintigraphic imaging modalities have relatively low spatial resolution and lack anatomic specificity. SPECT/CT fused imaging improves the diagnostic accuracy mainly because of accurate anatomic localization [47-50]. Dual isotope SPECT/CT is reported to be more accurate than bone scan SPECT/CT or WBC-SPECT/CT alone [51].

Summary of Recommendations

- **Variant 1**: Radiography of the foot is usually appropriate as the initial imaging examination in diabetic patients with suspected osteomyelitis of the foot.
- **Variant 2**: MRI without IV contrast or MRI without and with IV contrast is usually appropriate as additional imaging following radiographs in diabetic patients with foot swelling without ulceration when osteomyelitis or early neuropathic arthropathy is suspected. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 3**: MRI without IV contrast or MRI without and with IV contrast is usually appropriate as additional imaging following radiographs of the foot, in diabetic patients with or without neuropathic arthropathy when foot swelling and ulceration is present and osteomyelitis is suspected. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care). The panel did not agree on recommending a Tc-99m 3-phase bone scan foot in this clinical scenario. There is insufficient medical literature to conclude whether or not a Tc-99m 3-phase bone scan would be of benefit. A Tc-99m 3-phase bone scan in this patient population is controversial but may be appropriate.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [55].

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

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