Diagnostic Imaging Pathways - Osteomyelitis (Suspected Acute)

Population Covered By The Guidance

This pathway provides guidance on the imaging investigation of adult patients with suspected acute osteomyelitis.

Date reviewed: August 2013

Date of next review: 2017/2018

Published: August 2013

Quick User Guide

Move the mouse cursor over the PINK text boxes inside the flow chart to bring up a pop up box with salient points.
Clicking on the PINK text box will bring up the full text.
The relative radiation level (RRL) of each imaging investigation is displayed in the pop up box.

SYMBOL	RRL	EFFECTIVE DOSE RANGE
	None	0
	Minimal	< 1 millisieverts
	Low	1-5 mSv
	Medium	5-10 mSv
	High	>10 mSv

Pathway Diagram

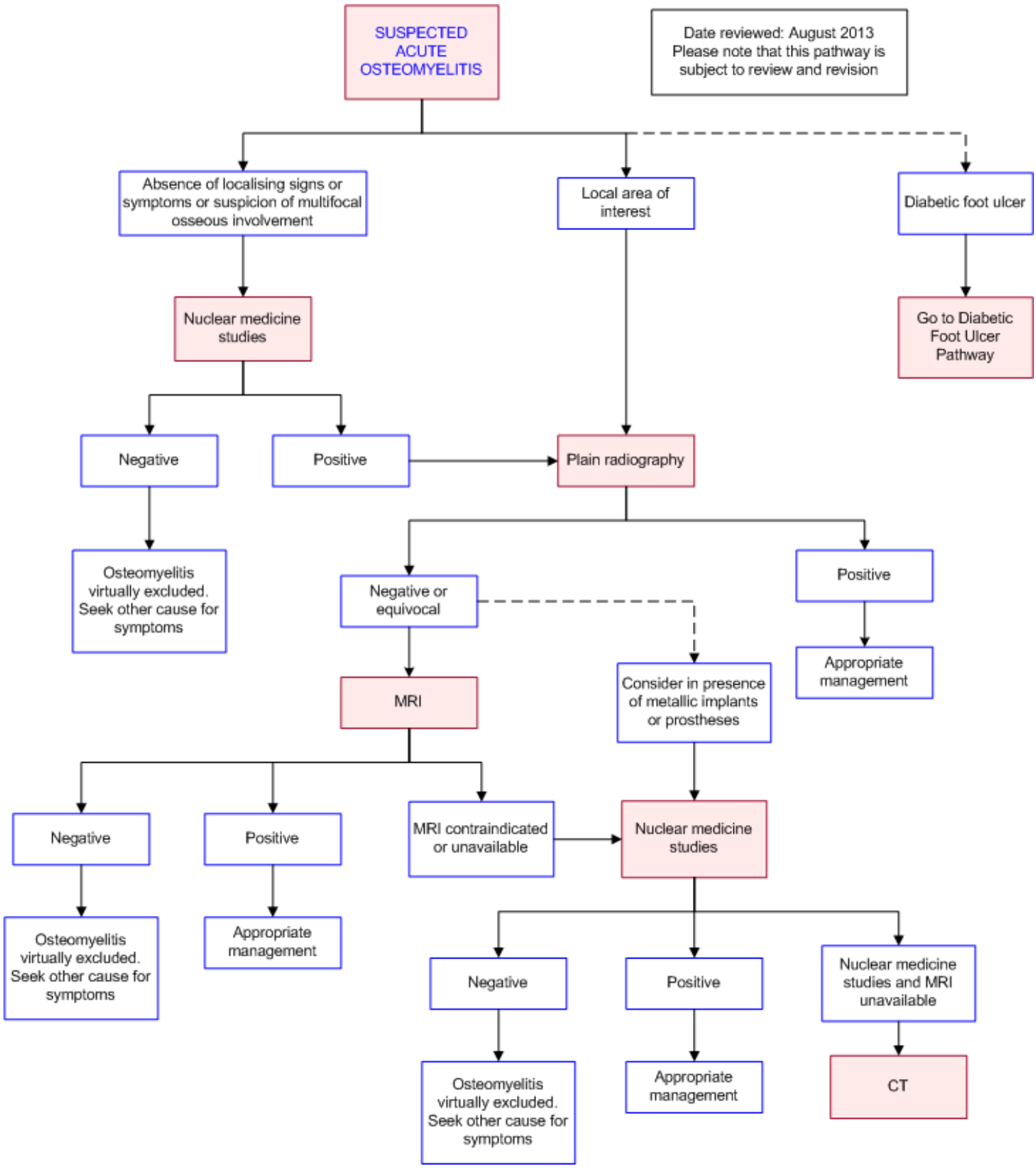


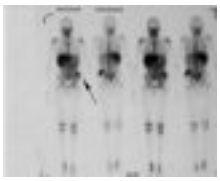
Image Gallery

Note: These images open in a new page

1 

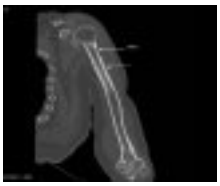
Osteomyelitis

Image 1 (Plain Radiograph): Osteomyelitis of the left distal radius (arrow).

2 

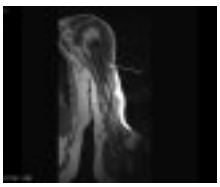
Osteomyelitis

Image 2 (Bone Scan): Focal area of increased uptake representing osteomyelitis in the region of the left iliac crest (arrow).

3 

Osteomyelitis

Image 3 (Computed Tomography): Coronal image of chronic osteomyelitis showing cortical thickening of proximal humerus (arrow).

4 

Osteomyelitis

Image 4 (Magnetic Resonance Imaging): Coronal T1 image showing chronic osteomyelitis of proximal humerus (arrow).

Teaching Points

- Plain radiography is the initial imaging modality of choice, but may be normal in the early stages of disease. ‘Normal’ plain radiographs do not exclude osteomyelitis
- MRI is considered the optimal imaging modality in the evaluation of osteomyelitis and associated soft tissue abnormalities
- Nuclear medicine studies are an alternative to MRI when there are no localising signs or symptoms in suspected osteomyelitis, when MRI is contraindicated or unavailable or in cases of suspected peri-prosthetic infection. They can also monitor response to treatment

Suspected Acute Osteomyelitis

- Diagnosis of osteomyelitis is based on a high index of clinical suspicion, confirmed by isolation of the organism by direct bone biopsy with histologic findings of inflammation and osteonecrosis, or blood culture in the case of haematogenous osteomyelitis
- Adjunctive imaging modalities include radiography, MRI and nuclear medicine studies
- No single test has 100% specificity and sensitivity for every case of musculoskeletal infection. Depending on the age of the patient, presence of orthopaedic hardware, location of infection, and systemic conditions, the choice of imaging modalities must be tailored to the patient's condition

Plain Radiography

- Initial modality for investigation of suspected osteomyelitis
- Typically does not show abnormalities caused by osteomyelitis until about 2 weeks after initial infection, when nearly 50% of the bone mineral content has been lost 1

- An abnormal plain radiograph doubles the odds of osteomyelitis based on a limited systematic review 2
- Pooled sensitivity of 54% and specificity of 68% for detection of osteomyelitis underlying diabetic foot ulcers on recent meta-analysis 3
- Normal plain radiographs do not exclude osteomyelitis

Magnetic Resonance Imaging (MRI)

- Highly sensitive for detecting osteomyelitis as early as 3-5 days after onset of infection with reported figures ranging from 82 to 100%. The specificity ranges from 75 to 96% 4,5
    - Two meta-analyses reported pooled sensitivities of 90% and specificities of 79-82.5% in the diagnosis of foot osteomyelitis, outperforming plain radiography, 99-Tc bone scanning and leucocyte scintigraphy 3,6
- Advantages 7
    - No ionising radiation
    - Optimal visualisation of soft tissue structures, including detection of sinus tracts, deep tissue necrosis, abscesses and other inflammatory changes 2,3,6,8-11
    - High sensitivity in early stages - reveals bony oedema useful for early detection of infection
- Limitations
    - Metallic implants may produce local artefacts and decrease image quality
    - Contraindicated in the presence of a ferromagnetic substance, e.g. pacemaker, aneurysm clip, cochlear implant, ocular foreign body, spinal cord stimulator and some stent materials

Nuclear Medicine Scans

- Nuclear medicine studies allow the localisation of disease based on functional and metabolic status
- Advantages 1
    - Sensitive
    - Allows whole body survey, important in localising infection in patients with fever of unknown origin and identifying multifocal osseous involvement
    - Can image patients who have prostheses without interference from artefact
- Disadvantages
    - Often non-specific (particularly bone scintigraphy)
    - Associated with radiation
- False positives can occur particularly where there are co-existing conditions, such as degenerative joint disease, non-infectious inflammatory bone disease, bone tumour, recent surgery, diabetic arthropathy, gout and trauma 1,12-16
- Bone scintigraphy is sensitive but relatively nonspecific
- Labelled leucocyte scintigraphy with either indium-111 (^{111}In) or technetium-99 (^{99m}Tc), improves specificity (to 74 and 85% respectively) for diagnosing acute infections, but remains less sensitive in chronic osteomyelitis and vertebral osteomyelitis 14,17,18
- A combined dual study of three-phase bone and labelled leucocyte scintigraphy may improve sensitivity and specificity. 15,19-21 This is recommended and usually required for accurate localisation 15,20
- Gallium scintigraphy is an alternative if MRI or leucocyte scintigraphy is unavailable. 1 It is also preferred over leucocyte scintigraphy in imaging suspected vertebral osteomyelitis, e.g. Secondary spondylodiscitis, especially in post-surgical forms where MRI may be less useful 21
- While not widely available or routinely used, FDG-PET with or without CT has emerged as helpful

adjunct in the diagnosis of osteomyelitis. On metaanalyses, FDG-PET generally has superior specificity and diagnostic accuracy compared to other imaging methods, particularly in the setting of prosthetic joint implants, Charcot's neuroarthropathy, vertebral osteomyelitis (specifically secondary spondylodiscitis) and chronic osteomyelitis, although it does not differ significantly from leucocyte scintigraphy in the peripheral skeleton. 19,21-23 One observational study found FDG-PET less effective than MRI in foot-ulcer associated chronic osteomyelitis 24

- Where MRI is unavailable or contraindicated, a radionuclide bone scan and a labelled white blood cell scan is recommended as the best alternative to rule out osteomyelitis 1,25
- Normal nuclear medicine scans largely rule out osteomyelitis

Computed Tomography (CT)

- Useful for guiding needle during biopsy and identifying sequestra (necrotic bone) 1

References

Date of literature search: April 2013

The search methodology is available on request. Email

References are graded from Level I to V according to the Oxford Centre for Evidence-Based Medicine, Levels of Evidence. Download the document

1. Pineda C, Espinosa R, Pena A. **Radiographic imaging in osteomyelitis: the role of plain radiography, computed tomography, ultrasonography, magnetic resonance imaging, and scintigraphy.** Semin Plastic Surg. 2009;23(2):80-9. (Review article)
2. Butalia S, Palda VA, Sargeant RJ, Detsky AS, Mourad O. **Does this patient with diabetes have osteomyelitis of the lower extremity?** JAMA. 2008;299(7):806-13. (Level II evidence)
3. Dinh MT, Abad CL, Safdar N. **Diagnostic accuracy of the physical examination and imaging tests for osteomyelitis underlying diabetic foot ulcers: meta-analysis.** Clin Infect Dis. 2008;47(4):519-27. (Level I evidence)
4. Pineda C, Vargas A, Rodríguez AV. **Imaging of osteomyelitis: current concepts.** Infect Dis Clin North Am. 2006;20(4):789-825. (Review article)
5. Modic MT, Feiglin DH, Piraino DW, Boumphrey F, Weinstein MA, Duchesneau PM, et al. **Vertebral osteomyelitis: assessment using MR.** Radiology. 1985;157(1):157-66. (Level III evidence)
6. Kapoor A, Page S, LaValley M, Gale D. R, Felson D. T. **Magnetic resonance imaging for diagnosing foot osteomyelitis: A meta-analysis.** Arch Intern Med. 2007;167(2):125-32. (Level II evidence)
7. Tehranzadeh J, Wong E, Wang F, Sadighpour M. **Imaging of osteomyelitis in the mature skeleton.** Radiol Clin North Am. 2001;39(2):223-50. (Review article)
8. Ledermann H, Morrison W, Schweitzer M. **Pedal abscesses in patients suspected of having pedal osteomyelitis: analysis with MR imaging.** Radiology. 2002;224(3):649-55. (Level III evidence)
9. Ledermann H, Schweitzer M, Morrison W. **Nonenhancing tissue on MR imaging of pedal infection: characterization of necrotic tissue and associated limitations for diagnosis of osteomyelitis and abscess.** AJR Am J Roentgenol. 2002;178(1):215-22. (Level III evidence)
10. Hopkins KL, Li KC, Bergman G. **Gadolinium-DTPA-enhanced magnetic resonance imaging of musculoskeletal infectious processes.** Skeletal Radiol. 1995;24(5):325-30. (Level III evidence)
11. Rahmouni A, Chosidow O, Mathieu D, Gueorguieva E, Jazaerli N, Radier C, et al. **MR imaging in**

acute infectious cellulitis. Radiology, 1994;192(2):493-96. (Level III evidence)
12. Esterhai JL, Goll SR, McCarthy KE, Velchik M, Alavi A, Brighton CT, et al. **Indium-111 leukocyte scintigraphic detection of subclinical osteomyelitis complicating delayed and nonunion long bone fractures: a prospective study.** J Orthop Res. 1987;5(1):1-6. (Level II evidence)
13. Magnuson JE, Brown ML, Hauser MF, Berquist TH, Fitzgerald RH, Klee GG. **In-111-labeled leukocyte scintigraphy in suspected orthopedic prosthesis infection: comparison with other imaging modalities.** Radiology. 1988;168(1):235-9. (Level III evidence)
14. Schauwecker DS, Park HM, Mock BH, Burt RW, Kernick CB, Ruoff AC, et al. **Evaluation of complicating osteomyelitis with Tc-99m MDP, In-111 granulocytes, and Ga-67 citrate.** J Nucl Med 1984;25(8):849-53. (Level III evidence)
15. Kolindou A, Liu Y, Ozker K, Krasnow AZ, Isitman AT, Hellman RS, et al. **In-111 WBC imaging of osteomyelitis in patients with underlying bone scan abnormalities.** Clin Nucl Med. 1996;21(3):183-91. (Level II/III evidence)
16. McCarthy K, Velchik MG, Alavi A, Mandell GA, Esterhai JL, Goll S. **Indium-111-labeled white blood cells in the detection of osteomyelitis complicated by a pre-existing condition.** J Nucl Med. 1988;29(6):1015-21. (Level II/III evidence)
17. Capriotti G, Chianelli M, Signore A. **Nuclear medicine imaging of diabetic foot infection: results of meta-analysis.** Nucl Med Commun. 2006;27(10):757-64. (Level II evidence)
18. Whalen JL, Brown ML, McLeod R, Fitzgerald RH. **Limitations of indium leukocyte imaging for the diagnosis of spine infections.** Spine (Phila Pa. 1976). 1991;16(2):193-7. (Level II evidence)
19. Termaat MF, Raijmakers PGHM, Scholten HJ, Bakker FC, Patka P, Haarman HJTM. **The accuracy of diagnostic imaging for the assessment of chronic osteomyelitis: a systematic review and meta-analysis.** J Bone Joint Surg Am. 2005;87(11):2464-71. (Level I/II evidence)
20. Seabold JE, Nepola JV, Conrad GR, Marsh JL, Montgomery WJ, Bricker JA, et al. **Detection of osteomyelitis at fracture nonunion sites: comparison of two scintigraphic methods**. AJR Am J Roentgenol 1989;152(5):1021-1027. (Level II/III evidence)
21. Prandini N, Lazzeri E, Rossi B, Erba P, Parisella M, Signore A. **Nuclear medicine imaging of bone infections.** Nucl Med Commun. 2006;27(8):633-44. (Level II evidence)
22. Wang G-l, Zhao K, Liu Z-f, Dong M-j, Yang S-y. **A meta-analysis of fluorodeoxyglucose-positron emission tomography versus scintigraphy in the evaluation of suspected osteomyelitis.** Nucl Med Commun. 2011;32(12):1134-42. (Level I/II evidence)
23. Basu S, Chryssikos T, Houseni M, Scot Malay D, Shah J, Zhuang H, et al. **Potential role of FDG PET in the setting of diabetic neuro-osteoarthropathy: can it differentiate uncomplicated Charcot's neuroarthropathy from osteomyelitis and soft-tissue infection?** Nucl Med Commun. 2007;28(6):465-72. (Level II evidence)
24. Schwegler B, Stumpe KDM, Weishaupt D, Strobel K, Spinas GA, von Schulthess GK, et al. **Unsuspected osteomyelitis is frequent in persistent diabetic foot ulcer and better diagnosed by MRI than by 18F-FDG PET or 99mTc-MOAB.** J Intern Med. 2008;263(1):99-106. (Level II evidence)
25. Lipsky BA, Berendt AR, Cornia PB, Pile JC, Peters EJ, Armstrong DG, et al. **2012 Infectious Diseases Society of America clinical practice guideline for the diagnosis and treatment of diabetic foot infections.** Clin Infect Dis. 2012;54(12):e132-73. (Evidence based guideline)

Information for Consumers

Information from this website	Information from the Royal Australian and New Zealand College of Radiologists' website

Consent to Procedure or Treatment Radiation Risks of X-rays and Scans Bone Scan Computed Tomography (CT) Magnetic Resonance Imaging (MRI) Plain Radiography (X-ray)	Computed Tomography (CT) Contrast Medium (Gadolinium versus Iodine) Gadolinium Contrast Medium Iodine-Containing Contrast Medium Magnetic Resonance Imaging (MRI) Plain Radiography/X-rays Radiation Risk of Medical Imaging During Pregnancy Radiation Risk of Medical Imaging for Adults and Children Nuclear Medicine Nuclear Medicine Bone Scan PET Scan

File Formats

Some documents for download on this website are in a Portable Document Format (PDF). To read these files you might need to download Adobe Acrobat Reader.