Imaging investigation of the Diabetic Foot

G. Arsos
3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
no conflict of interest to declare
Complications of DM

no diabetic brain

no diabetic eye

no diabetic ear

no diabetic heart

no diabetic kidney

no diabetic penis

...but, THE diabetic foot!
Definition of diabetic foot

(WHO & International Working Group on the Diabetic Foot, 1999)

The foot of diabetic patients with:

- Ulceration
- Infection
- Destruction of the deep tissues
- Neurological abnormalities
- Various degrees of peripheral vascular disease in the lower limb
● Mild - severe DM neuropathy  
\[ \approx 60-70\% \]

● Rate of amputation for people with DM : \( \times 10 \)
  (NHS : \( \times 15 \))

● 2\(^{nd}\) amputation within 3-5 yrs after the 1st : \( \geq 50\% \)
DFU., Diabetic foot ulcer

8 18 18 46 47 48 66 84 88 97

Prostate cancer  Breast cancer  Hodgkin's lymphoma  Neurotropic DFU  Amputation  Colon cancer  Ischaemic DFU  Peripheral arterial disease  Lung cancer  Pancreatic cancer

Relative 5-year mortality (%)


3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
“Every 30 seconds a lower limb is lost somewhere in the world as a consequence of diabetes.”

See Review page 1719
Number and rate of hospitalizations among adults aged ≥18 years with diagnosed diabetes for selected causes, United States, 2014

<table>
<thead>
<tr>
<th>Cause of hospitalization</th>
<th>No. in thousands</th>
<th>Crude rate per 1,000 persons with diabetes (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes as any listed diagnosis</td>
<td>7,155</td>
<td>327.2 (311.3–343.1)</td>
</tr>
<tr>
<td>Major cardiovascular disease</td>
<td>1,539</td>
<td>70.4 (66.8–73.9)</td>
</tr>
<tr>
<td>Ischemic heart disease</td>
<td>400</td>
<td>18.3 (17.3–19.3)</td>
</tr>
<tr>
<td>Stroke</td>
<td>251</td>
<td>11.5 (10.9–12.1)</td>
</tr>
<tr>
<td>Lower-extremity amputation</td>
<td>108</td>
<td>5.0 (4.7–5.2)</td>
</tr>
<tr>
<td>Diabetic ketoacidosis</td>
<td>168</td>
<td>7.7 (7.3–8.1)</td>
</tr>
</tbody>
</table>
The system of care for the diabetic foot: objectives, outcomes, and opportunities

Barshes NR et al, *Diabetic Foot & Ankle* 2013

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
The system of care for the diabetic foot: objectives, outcomes, and opportunities

Barshes NR et al, Diabetic Foot & Ankle 2013

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
Ulcerc-OM relationships in the DF

Pre-existing ulcer as the gate of infection:
> 90% of OM cases

Pre-existing ulcer:
85 % of amputations

The system of care for the diabetic foot: objectives, outcomes, and opportunities
Diabetic neuropathy

Charcot arthropathy

ULCER

Soft tissue infection

OSTEOMYELITIS

AMPUTATION

DM

angiopathy

difficult diagnosis

medical treatment

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
the diagnostic dilemas

OM

DFU, STI

aCA

treatment - duration

DFU, diabetic foot ulcer; STI, soft tissue infection
OM, osteomyelitis; aCA, acute Charcot Arthropathy

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
Treating Foot Infections in Diabetic Patients: A Randomized, Multicenter, Open-Label Trial of Linezolid versus Ampicillin-Sulbactam/Amoxicillin-Clavulanate

- Ulcer: 4
- Soft Tissue Infection: 3
- Osteomyelitis: 1

Linezolid
Ampic/Clav

Inf Ulc: 80
STI: 60
OM: 20

Lipsky BA, Clin Inf Dis 2004

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
<table>
<thead>
<tr>
<th>Severity / Extent</th>
<th>Route</th>
<th>Setting</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SOFT TISSUE ONLY</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>Topical- P.O.</td>
<td>Outp</td>
<td>1-2 w</td>
</tr>
<tr>
<td>Moderate</td>
<td>I.V. → P.O.</td>
<td>Outp (Inp)</td>
<td>1-3 w</td>
</tr>
<tr>
<td>Severe</td>
<td>I.V. → P.O.</td>
<td>Inp → Outp</td>
<td>2-4 w</td>
</tr>
<tr>
<td><strong>BONE or JOINT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No residual infected tissue</td>
<td>I.V. → P.O.</td>
<td>Inp → Outp</td>
<td>2-5 d</td>
</tr>
<tr>
<td>Residual infected soft tissue (not bone)</td>
<td>I.V. / P.O.</td>
<td>Inp → Outp</td>
<td>1-3 w</td>
</tr>
<tr>
<td>Residual infected (but viable) bone</td>
<td>I.V. → P.O.</td>
<td>Inp → Outp</td>
<td>4-6 wk</td>
</tr>
<tr>
<td>No surgery / residual dead bone postop.</td>
<td>I.V. → P.O.</td>
<td>Inp → Outp</td>
<td>≥3 mo</td>
</tr>
</tbody>
</table>

*Lipsky AB et al, ISDA Guidelines 2012*
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</tbody>
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Lipsky AB et al, ISDA Guidelines 2012

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
Comprehensive Foot Examination and Risk Assessment

A report of the Task Force of the Foot Care Interest Group of the American Diabetes Association, with endorsement by the American Association of Clinical Endocrinologists

“General inspection

A careful inspection of the feet in a well-lit room should always be carried out after the patient has removed shoes and socks.”

Boulton AJM et al, *Diabetes Care* 2008
Invited Review

Challenges in diagnosing infection in the diabetic foot

Table 1 Summary of potentially useful clinical findings in diagnosing diabetic foot infection

<table>
<thead>
<tr>
<th>A. History</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Long duration ( &gt; 4 weeks) of foot wound</td>
</tr>
<tr>
<td>2. Previous infection at the same or a nearby site</td>
</tr>
<tr>
<td>3. Presence of new pain in the wound (especially in a previously insensate foot)</td>
</tr>
<tr>
<td>4. Presence of immunosuppressive condition (beyond that related to diabetes)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Physical examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Large wound ( &gt; 2 cm²)</td>
</tr>
<tr>
<td>2. Deep wound ( &gt; 3 mm)</td>
</tr>
<tr>
<td>3. Classic signs of inflammation (tenderness, pain, redness, warmth, induration)</td>
</tr>
<tr>
<td>4. Secondary signs of infection (foul odour, friable or discoloured granulation tissue, rim undermining, purulent or non-purulent secretions)</td>
</tr>
</tbody>
</table>

Glaudemans AWM et al., Diab Med, 2015
“Ο βίος βραχύς, η δε τέχνη μακρή, ο δε καιρός οξύς, η δε πείρα σφαλερή, η δε κρίσις χαλεπή”

“Vita brevis, ars longa, occasio praeceps, experimentum periculosum, iudicium difficile”

41 foot ulcers (13 inflamed)

28 OM+ (68.3%)

9 C+

19 (68%) C-

C, clinical suspicion

Newman LG et al, JAMA 1991

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
Impact of OM likelihood on Probe-to-Bone test performance

% OM

% 0 20 40 60 80 100

PPV NPV

65.8 12.1 ALL 12.1 INF

76 Inf Ulcers 247 Ulcers - 199 Inf Ulcers
Se 66  Se 87
Sp 85  Sp 91

Grayson ML et al, JAMA 1995
Lavery LA et al., Diabetes Care 2007

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
The Performance of Serum Inflammatory Markers for the Diagnosis and Follow-up of Patients With Osteomyelitis

OM = 44.3%

Cutoff
CRP >14 mg/L
ESR >67 mm/h
WBC >14 × 10⁹/L
PCT >0.30 ng/mL

Sensitivity
Specificity

Michail M et al. *Int J Low Extrem Wounds* 2013

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
bone biopsy: sensitivity 88-100% (7 studies)*

- histology
- culture
- sensitivity?
- no significant sequelae
  15g trocar
  not contiguous to ulcer

- sampling error
- bone biopsy expertise
- significant peripheral vascular disease?

Mushlin AI at al., J Gen Int 1994
Needle Puncture vs Transcutaneous Bone Biopsy

31 patients

NEEDLE 13

BIOPSY 20

+50%

Senneville E et al., Clin Infect Dis 2009

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
RADIOLOGY

- Ro
- US
- CT
- MRI

NUCLEAR MEDICINE

- Bone scan: 99mTc-MDP
- Ga-67-citrate
- Tc-99m-IgG
- Tc-99m-ciprofloxacin
- In-111-WBC
- Tc-99m-HMPAO-WBC
- Tc-99m-Ab-WBC
- F-18-FDG (PET)

HYBRID TECHNIQUES: PET/CT, SPECT/CT

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
3 very good reasons for plain Rx in diabetic foot!

- Foreign body
- Gas
Plain Rx in diabetic foot

Early OM
- focal lucency
- loss of trabecular pattern
- cortical destruction

Late abnormalities
- periosteal reaction
- sclerosis
- new bone formation

Se ~ 60%   Sp ~ 80%

(-) Visibility: demineralization of > 30–50% / 2–4 weeks
   Suboptimal for detecting soft tissue infection
   D.D. infection from co-existing neuro-osteoarthropathy ??

(+) Serial radiographs /2 weeks
   changes characteristic of osteomyelitis over time
   likelihood of OM very high or low
   sufficient to confirm the clinical suspicion
Short Report: Complications

Diagnosing diabetic foot osteomyelitis: is the combination of probe-to-bone test and plain radiography sufficient for high-risk inpatients?

OM = 72.4%

<table>
<thead>
<tr>
<th>Test</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
<th>Negative predictive value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probe-to-bone test</td>
<td>0.95 (0.89–0.96)</td>
<td>0.93 (0.86–0.97)</td>
<td>0.97 (0.95–0.99)</td>
<td>0.83 (0.72–0.94)</td>
</tr>
<tr>
<td>Plain X-ray</td>
<td>0.82 (0.77–0.87)</td>
<td>0.93 (0.86–0.97)</td>
<td>0.97 (0.95–0.99)</td>
<td>0.65 (0.47–0.83)</td>
</tr>
<tr>
<td>Combined*</td>
<td>0.97 (0.95–0.99)</td>
<td>0.92 (0.84–0.96)</td>
<td>0.97 (0.95–0.99)</td>
<td>0.93 (0.88–0.98)</td>
</tr>
</tbody>
</table>

Aragon-Sanchez et al, Diabet Med 2011

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
MRI of the diabetic foot: differentiation of infection from neuropathic change

<table>
<thead>
<tr>
<th></th>
<th>MRI findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bone marrow signal change</td>
</tr>
<tr>
<td>2</td>
<td>Bone marrow oedema pattern</td>
</tr>
<tr>
<td>3</td>
<td>Distribution</td>
</tr>
<tr>
<td>4</td>
<td>Typical location</td>
</tr>
<tr>
<td>5</td>
<td>Deformity</td>
</tr>
<tr>
<td>6</td>
<td>Soft tissue changes</td>
</tr>
</tbody>
</table>

Tan PL, Br J Radiol 2007
<table>
<thead>
<tr>
<th></th>
<th>OM</th>
<th>CA</th>
</tr>
</thead>
</table>
| **BM signal change** | \( \downarrow T_1, \uparrow T_2, \text{STIR, Contr}^+ \) | Acute: \( \approx \text{OM} \)  
                      | Chronic: \( -, \downarrow T_1, T_2 \) |                           |
| **BM oedema pattern** | Single bone                      | Periarticular             |
|                      | Diffuse                          | Subchondral               |
| **Distribution**     | Focal                            | Several bones             |
| **Typical location** | • Toes                            | Midfoot                   |
|                      | • Metatarsal heads                |                           |
|                      | • Calcaneous                      |                           |
| **Deformity**        | NO                               | YES (+bone debris)        |
| **ST changes**       | • Ulcer                           | Skin intact               |
|                      | • Abcess                          | Oedematous                |
|                      | • Sinus tract                     |                           |
MRI OM findings
MRI : OM vs Bone Marrow Edema

13 DM patients
15 MR examinations before surgery

MR - histologic correlations in 57 bones
T2-weighted, STIR

18 bones with increased signal : edema of the marrow, not OM

Se = 90%, Sp = 71%

“Marrow edema cannot be reliably distinguished from osteomyelitis with MR imaging…….”

Craig JG et al. Radiology 1997

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
A) 3-phase bone scan: $^{99m}$Tc-MDP
Sensitive, not specific ( + in uninfected Charcot !)

B) Radionuclide labelled WBC scan

Labelled WBCs migrate to sites of infection (chemotaxy)
Not in sites of increased bone metabolism!
Specificity > bone scan

1) $^{111}$In-WBC
2) $^{99m}$Tc-HMPAO-WBC
3) $^{99m}$Tc-Antibodies-WBC
improved spatial resolution
lower radiation dose
complete in a single day
polyphosphate
Subramanian and McAfee, 1971
pyrophosphate
diphosphonate
Phosphatases resistance

17 studies

Sensitivity
Specificity

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ro</td>
<td>363</td>
<td>80</td>
</tr>
<tr>
<td>Bone</td>
<td>333</td>
<td>80</td>
</tr>
<tr>
<td>WBC</td>
<td>250</td>
<td>80</td>
</tr>
<tr>
<td>MRI</td>
<td>183</td>
<td>80</td>
</tr>
</tbody>
</table>

n = number of studies


3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
Σ. Γεώργα Διαφορική διάγνωση της οστεομυελίτιδας στους άκρους πόδες διαβητικών ασθενών με ραδιοϊσοτοπικές μεθόδους. Διδ. Διατριβή, Θεσσαλονίκη 2007

3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
Labeled leucocyte scan (LS)

- withdrawal of 30-50 ml blood
- isolation of wbc
- in vitro labelling with $^{99m}$Tc-HMPAO
- injection into the patient

- Planar images of the feet at 1 and 4 h p.i. (dorsal, plantar and lateral views)
- SPECT/CT scan at 4 h p.i.
2007 - 2018

1075 HMPAO-WBC scans

225 DF
Infected right foot plantar ulcer without OM

- 66-yr-old woman with NIDDM
- bilateral Charcot joints
- presented with a right midfoot deep plantar ulcer (Wagner 2)

Focal intense leucocyte uptake limited to the ulcer, incongruent with BS uptake

99mTc-MDP bone scan

99mTc-HMPAO-LS

Σ. Γέωργα, Εργ. Πυρηνικής Ιατρικής ΑΠΘ, ΓΝΘ Ιπποκράτειο
Σ. Γεώργα, Εργ. Πυρηνικής Ιατρικής ΑΠΘ, ΓΝΘ Ιπποκράτειο
clinical presentation of Charcot arthropathy

- warmth
- redness
- swelling
- pedal ulcer in 50%

also present in osteomyelitis

pain often absent

joint instability
foot deformity

Osteomyelitis may be clinically indistinguishable from an acute Charcot joint and both may occur simultaneously
69-yr-old woman
20-yr history of DM type2
Presentation: warm & swollen right foot, no pain

Rö: findings indicative of Charcot arthropathy
no findings of Osteomyelitis

MRI:
bone marrow edema,
compatible with Osteomyelitis

Σ. Γεώργα, Εργ. Πυρηνικής Ιατρικής ΑΠΘ, ΓΝΘ Ιπποκράτειο
**99mTc-MDP three-phase bone scan**

**Diagnosis:**
Acute Charcot arthropathy, without OM

**Outcome:**
Resolution of signs and symptoms after 4-months off-loading of the foot, without antibiotic treatment

Σ. Γεώργιος, Εργ. Πυρηνικής Ιατρικής ΑΠΘ, ΓΝΘ Ιπποκράτειο
FDG tumor model

Normal cell

- Glucose 6-phosphatase
- Glycolysis
- Hexokinase
- G6P
- FDG6P
- FDG

Tumour cell (inflammatory cells)

- Glucose 6-phosphatase
- Hexokinase
- Glycol.
- G6P
- FDG6P
- FDG
Keidar Z et al. The Diabetic Foot: Initial Experience with 18F-FDG PET/CT
J Nucl Med 2005
Diagnostic Performance of FDG-PET, MRI, and Plain Film Radiography (PFR) for the Diagnosis of Osteomyelitis in the Diabetic Foot

Asad Nawaz, Drew A. Torigan, Evan S. Siegelman, Sandip Basu, Timothy Chryssikos, Abass Alavi
Diagnostic Performance of FDG-PET, MRI, and Plain Film Radiography (PFR) for the Diagnosis of Osteomyelitis in the Diabetic Foot

Asad Nawaz, Drew A. Torigian, Evan S. Siegelman, Sandip Basu, Timothy Chryssikos, Abass Alavi

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<tr>
<th></th>
<th>Sensitivity (%)</th>
<th>Specificity (%)</th>
<th>PPV (%)</th>
<th>NPV (%)</th>
<th>Accuracy (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFR</td>
<td>63</td>
<td>87</td>
<td>60</td>
<td>88</td>
<td>81</td>
</tr>
<tr>
<td>FDG-PET</td>
<td>81</td>
<td>93</td>
<td>78</td>
<td>94</td>
<td>90</td>
</tr>
<tr>
<td>MRI</td>
<td>91</td>
<td>78</td>
<td>56</td>
<td>97</td>
<td>81</td>
</tr>
<tr>
<td>Clinical Condition:</td>
<td>Suspected Osteomyelitis of the Foot in Patients with Diabetes Mellitus</td>
<td>Variant 4:</td>
<td>Neuropathy without ulcer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>---------------------------------------------------------------------</td>
<td>------------</td>
<td>--------------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiologic Procedure</td>
<td>Rating</td>
<td>Comments</td>
<td>RRL*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray foot</td>
<td>9</td>
<td>Initial study. Radiographs and MRI are complementary. Both are indicated.</td>
<td>Min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI foot with contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary. Both are indicated. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI foot without contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary. Both are indicated.</td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT foot without contrast</td>
<td>5</td>
<td>For neuropathy or if MRI contraindicated.</td>
<td>Min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan foot</td>
<td>5</td>
<td>Useful for pre-radiographic findings of neuropathy. Also if MRI contraindicated.</td>
<td>Med</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan and In-111 WBC scan foot</td>
<td>2</td>
<td></td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In-111 WBC scan and Tc-99m sulfur colloid marrow scan foot</td>
<td>1</td>
<td></td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan and In-111 WBC scan and Tc-99m sulfur colloid marrow scan foot</td>
<td>1</td>
<td></td>
<td>High</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US foot</td>
<td>1</td>
<td></td>
<td>None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FDG-PET foot</td>
<td>1</td>
<td></td>
<td>High</td>
<td></td>
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</tbody>
</table>

**Rating Scale:** 1=Least appropriate, 9=Most appropriate

*Relative Radiation Level
ACR Appropriateness Criteria 2012: learning… but still inappropriate

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<td>Variant 2:</td>
<td>Soft-tissue swelling with neuropathic arthropathy without ulcer.</td>
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<th>Radiologic Procedure</th>
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<th>Comments</th>
<th>RRI*</th>
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<tbody>
<tr>
<td>X-ray foot</td>
<td>9</td>
<td>Initial study. Radiographs and MRI are complementary, and both are indicated. The results of initial x-ray examination do not preclude the necessity for additional studies.</td>
<td></td>
</tr>
<tr>
<td>MRI foot without and with contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary, and both are indicated. MRI is useful preoperatively to identify the extent of involvement and to map devitalized areas. See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td></td>
</tr>
<tr>
<td>MRI foot without contrast</td>
<td>9</td>
<td>Radiographs and MRI are complementary, and both are indicated.</td>
<td></td>
</tr>
<tr>
<td>CT foot without contrast</td>
<td>5</td>
<td>For neuropathy or if MRI contraindicated.</td>
<td></td>
</tr>
<tr>
<td>Labeled leukocyte scan foot (In-111 or Tc-99m)</td>
<td>3</td>
<td>May be appropriate in certain circumstances such as if MRI is contraindicated or unavailable.</td>
<td></td>
</tr>
<tr>
<td>Labeled leukocyte scan (In-111 or Tc-99m) and Tc-99m sulfur colloid marrow scan foot</td>
<td>3</td>
<td>May be appropriate in selected clinical circumstances.</td>
<td></td>
</tr>
<tr>
<td>CT foot without and with contrast</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT foot with contrast</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan foot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan and labeled leukocyte scan (In-111 or Tc-99m) foot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tc-99m 3-phase bone scan and labeled leukocyte scan (In-111 or Tc-99m) and Tc-99m sulfur colloid marrow scan foot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US foot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FDG-PET/CT foot</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

*Relative Radiation Level

Learning!

5, four yrs ago
DFI imaging recommendations

Ro : All with DFI

MRI : Abcess, OM uncertain

Radionuclide imaging : Alternative to MRI

DFI, Diabetic foot infection

Lipsky BA et al, Clin Inf Dis 2012
Radionucleotide Scans

Four radionucleotide studies are discussed here:

- technetium Tc-99m (\(^{99}\text{Tc}\))-labeled diphosphonate bone scanning;
- indium In-111 white blood cell (WBC);
- non-specific human immunoglobulin (HIG) labeled with Tc-99; and
- 18-flourodeoxyglucose positron emission tomography (18-FDG-PET).
Forest plots (of sensitivity and specificity) of all of the studies that used each test and pooled the diagnostic performance of the imaging techniques.

Detection of Osteomyelitis in the Diabetic Foot by Imaging Techniques: A Systematic Review and Meta-analysis Comparing MRI, White Blood Cell Scintigraphy, and FDG-PET

“The various modalities have similar sensitivity, but 18F-FDG-PET and 99mTc-HMPAO-labeled WBC scintigraphy offer the highest specificity”
3rd Dept. of Nuclear Medicine, AUTH School of Medicine, “Papageorgiou” Gen. Hospital
### Personal point of view

| Ro | ● initial imaging / serial  
    | ● all with DFI |
|----|----------------|
| MRI | ● forefoot  
   | ● wide soft tissue infection  
   | ● possible surgical intervention |
| Nuclear imaging | ● specific infection imaging  
                  | - $^{99m}$Tc-HMPAO-WBC (not Ab-labelled!)  
                  | - hybrid imaging (SPECT/CT)  
                  | ● mid-hidefoot : dif. aCA vs OM, > MRI  
                  | ● response : unique  
                  | ● bone scan : of limited value  
                  | ● 18F-FDG PET/CT : expensive  
                  | ● MRI alternative : on contraindications |
|    | Local expertise : indispensable |
thank you for your attention!