Clinical Case Discussion

James J. Cappola, III,M.D., FACP

Chair and Associate Professor of Internal Medicine

CUSOM

April 10, 2025

CAMPBELL UNIVERSITY | Jerry M. Wallace School of Osteopathic Medicine

A 58-year-old man with a 20-year history of type 2 diabetes with neuropathy presents to the clinic with a nonhealing ulcer of the right foot. He first noticed a “sore” on sole of his foot about two weeks ago. The area has scant intermittent drainage.

He does tell you that his blood glucose levels have been more difficult to control over the last month . . .

Blood glucose readings in mg/dl

Day	Pre-Breakfast	Two hours after Breakfast	Prelunch	Two hours after lunch	Predinner	At Bedtime
Mon	160	220			180	
Tues	140		172	230		
Wed	132				205	190
Thurs	150	201	250			
Fri	130			181		193
Sat	160		170		199	
Sun	170	201	180			

His most recent HgbA1C is 9.1%

PMH:

- Obesity
- Type 2 diabetes x 20 years
- HTN
- TIA age 52
- CKD stage 2

PSH: none

Medications:

- Metformin 1000 mg po bid
- ASA 81 mg po daily
- Losartan 50 mg po daily
- Atorvastatin 80 mg po daily
- Dapagliflozin 10 mg po daily
- Insulin glargine 20 units SQ qhs

NKDA

Social history: The patient is single and lives alone. He works in construction. He smoked for 15 years but quit after his TIA. He drinks alcohol occasionally. There is no history of drug use.

Family hx:

- Mother age 75, HTN
- Father age 78, Type 2 diabetes
- Sister age 56, HTN
- No children

ROS: He has chronic numbness of both feet. He denies fever, chills, fatigue, weakness or changes in appetite or weight. He denies chest discomfort, difficulty breathing, nausea, vomiting, changes in bowel movements or urination.

On exam, he is in no distress
Vitals: bp 150/92 p 80 RR 14 afebrile. O2 sat 94% on room air
Weight 310 lbs

HEENT: PERRL; EOMI
Neck: full ROM ; no thyromegaly; supple; no masses; JVP 7 cm at 60 degrees; no carotid bruits
Car: R/R/R without r/m/g
Lungs: fair air movement bilaterally
OMM: L2 FRRSR
Abd: soft, nontender, nondistended, no organomegaly
Extr: No edema in legs; dp pulses trace bilaterally; capillary refill 5 seconds bilaterally

On exam, he is in no distress
Vitals: bp 150/92 p 80 RR 14 afebrile. O2 sat 94% on room air

Neuro: Absent vibratory and position sense over the entire foot
Minimal sensation to pain or temperature changes
Absent ankle reflexes

Carolinafootandankle.com

Diagnosis: Skin and soft tissue infection plantar aspect of R foot

What is the pretest probability of osteomyelitis in a patient with diabetes and a non-healing foot ulcer?

50%

Osteomyelitis of the Foot in Patients with Diabetes

- Vascular insufficiency is typically present
- Pretest probability of osteomyelitis among patients with nonhealing foot ulcer is 50%
- Symptoms and signs of inflammation are typically absent.
- Systemic signs of sepsis are typically late.

Osteomyelitis of the Foot in Patients with Diabetes

- Inflammatory markers

(C-reactive protein and ESR) may be normal.

- Blood cultures may be positive is 10 to 15% of patients.

Bedside diagnosis of foot osteomyelitis

Diagnosis of osteomyelitis in a patient with diabetes and a nonhealing foot ulcer:

Probing to Bone Test for osteomyelitis:
Use a stainless steel sterile blunt probe

Positive probe = rock hard gritty structure palpable at ulcer base

Researchgate.net

To detect osteomyelitis with positive probe

Sensitivity = 60%

Specificity = 91%

LR+ = Sensitivity/(1- Specificity) = 6.7

LR- = (1 – Sensitivity)/ Specificity = 0.45

So, if pretest probability of osteomyelitis is 50%

50% = 1:1 odds

Positive probe: 1:1 x 6.7 = 6.7: 1

Post test probability = 6.7/(6.7 +1) = 87% TREAT

Negative probe: 1:1 x 0.45 = 0.45 : 1

Post test probability = 0.45/(0.45+1)= 31% NEED MORE TESTING

Imaging Modalities for Foot Osteomyelitis

Operating Characteristics of Imaging Modalities in Osteomyelitis

Diagnostic modality	Total patients	Sensitivity (95% confidence interval)	Specificity (95% confidence interval)	Study
Probe-to-bone test or exposed bone	288	0.60 (0.46-0.73)	0.91 (0.86-0.94)	Dinh et al
Radiography LR+ 1.7 LR- 0.68	177	0.54 (0.44-0.63)	0.68 (0.53-0.80)	Dinh et al
Magnetic resonance imaging LR + 4.3 LR – 0.09	135 421	0.90 (0.82-0.95) 0.93 (0.82-0.97)	0.79 (0.62-0.91) 0.75 (0.63-0.84)	Dinh et al Lauri et al

Spritzer CE UpToDate 2024

MRI in Osteomyelitis

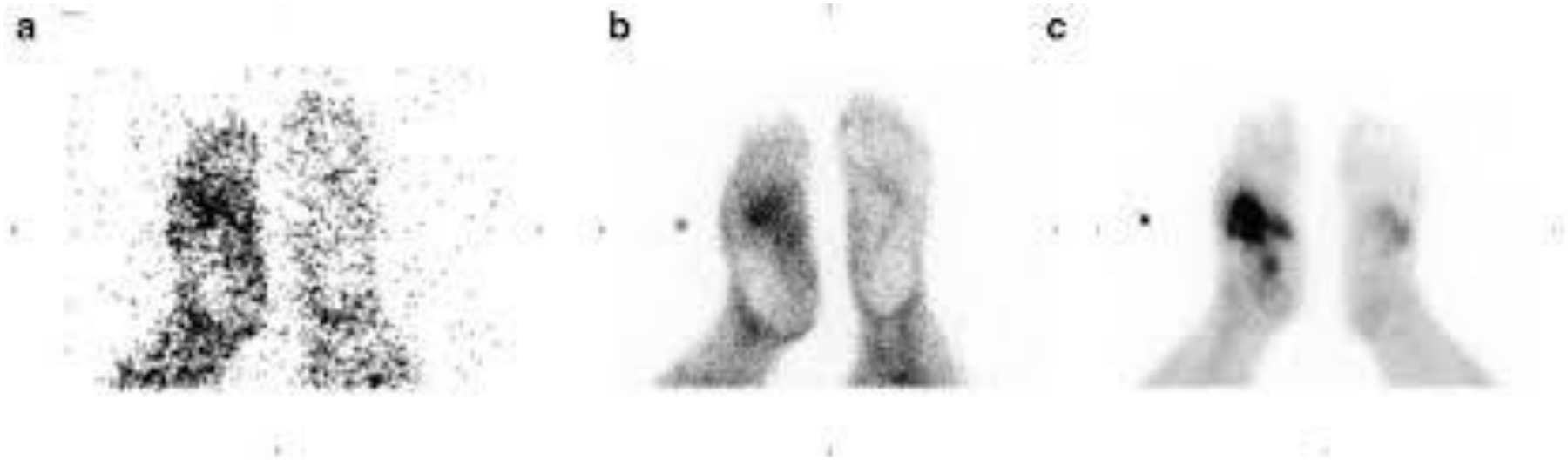
Semanticscholar.com

Operating Characteristics of Imaging Modalities in Osteomyelitis

Diagnostic modality	Total patients	Sensitivity (95% confidence interval)	Specificity (95% confidence interval)	Study
Bone scan LR + 1.1 LR – 0.68	185	0.81 (0.73-0.87)	0.28 (0.17-0.42)	Dinh et al
Tc-99m HMPAO WBC Ceretec scan LR + 11.4 LR – 0.10	406	0.91 (0.86-0.94)	0.92 (0.78-0.98)	Lauri et al

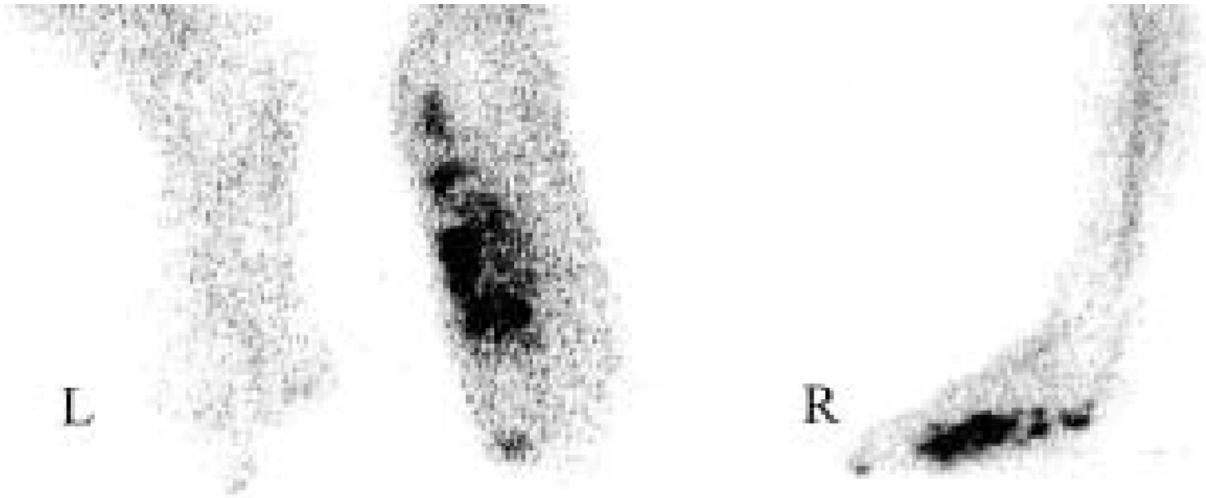
Spritzer CE UpToDate 2024

Bone scan in osteomyelitis



Musculoskeletalkey.com

Technecium-labeled white blood cell (Ceretec) Scan in Osteomyelitis



^{99m}Tc-HMPAO-Leu scan

Semanticscholar.com

Management of Osteomyelitis

Our patient is directly admitted to the hospital for further management . . .

Management of Foot Osteomyelitis

- Intravenous antibiotics
- Surgical debridement:
  - General surgery
  - Orthopedic surgery
  - Podiatry
- Tight glycemic control
- Assessment of arterial vascular supply and revascularization if indicated

Empiric Antibiotic Treatment for Osteomyelitis

Organisms to Cover	•Staphylococcus •Streptococcus •Pseudomonas •E. Coli •K. Pneumonia •Proteus sp.
Sample antibiotic Regimen (assumes normal renal and hepatic function)	Need polymicrobial coverage: Vancomycin IV dosed per load and trough levels Cefepime 2 grams IV q 8 hrs Duration generally six weeks

Tande AJ, UpToDate 2024

Your 2024 diabetes team

liver

METFORMIN
Reduces hepatic glucose production

gut

DIPEPTIDYL PEPTIDASE-4 INHIBITORS
("-gliptins")
Inhibits deactivation of glucagon–like peptide 1 (GLP-1)

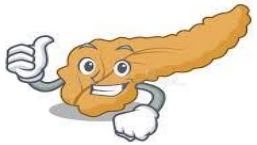
- Slows gastric emptying
- Induces satiety
- Reduces glucagon production during fasting

GLUCAGON-LIKE PEPTIDE RECEPTOR AGONIST
("-glutides")
Reduces glucagon secretion
Slows gastric emptying and improves satiety

peripheral tissues/muscle

THIAZOLIDINEDIONE
("-glitazones")
Stimulates transcription of multiple genes affecting carbohydrate and lipid metabolism.

pancreas



SULFONYLUREA
Stimulates pancreatic beta-cell insulin

INSULIN
Replaces endogenous insulin

DIET AND EXERCISE

kidney

SODIUM-GLUCOSE COTRANSPORTER 2 INHIBITORS (SGLT-2)
("-gliflozins")
Inhibit SGLTs membrane proteins in the proximal renal tubules which increases glucose excretion by 60 to 100 grams/day

CAMPBELL UNIVERSITY | Jerry M. Wallace School of Osteopathic Medicine

In the inpatient setting, stop all chronic diabetes medications EXCEPT insulin . . .

Blood glucose checks are ordered before meals, two hours after meals and at bedtime (ie. qac, qhs and 2 hrs pc) in the hospital with results as follows:

Breakfast: 7:30 AM
Lunch: 12:30 PM
Dinner: 5:30 PM

TIME	7 AM	10 AM	12 noon	2 PM	5 PM	9 PM	3 AM
Blood glucose (mg/dl)	210	205	190	230	220	320	176

Objective: Be able to start an intensive insulin regimen for an acutely ill patient in the hospital with type 2 diabetes and chronic poor control. Target blood sugars: 80 to 180 mg/dl while admitted.

Recommended regimen: Target blood glucose in the acute care setting is 80 to 180 mg /dl. The patient will need a combination of basal, correction, and prandial insulin to achieve target control.

Basal dose: Our patient weighs about 310 lbs or 140 kg. Insulin glargine for type 2 DM is recommended at doses starting either at 10 units SQ qhs or 0.1 to 0.2 units/kg actual body weight. Our patient is obese and acutely ill with more insulin resistance and likely needs 30 units SQ qhs.

Correction Dose: short-acting insulin dose which brings the glucose level down from the reading before meals to a selected target glucose level. Correction dose formulas have often replaced "sliding scales" and look like the following:

$$\textbf{Correction dose} = \frac{(\text{premeal blood glucose} - \text{target blood glucose})}{\text{Sensitivity factor}}$$

Target glucose is generally about 120 mg/dl

Sensitivity factors:

- 50 for patients who are older, weigh less or have poor kidney function
- **40** for patients of young or middle age, average weight and good kidney function
- 30 for patients who are obese and/or more insulin resistant
- 20 for patients who are very obese and/or very insulin resistant.

Correction dose for our patient: Humalog dose = (blood glucose – 120)/30

Note: Humalog pharmacokinetics:

- 60 minutes after SQ injection: 60% of Humalog is metabolized
- 120 minutes after SQ injection: 80% of Humalog is metabolized
- 180 minutes after SQ injection: nearly 100% of Humalog is metabolized

Prandial Dose : carbohydrate counting dose = short-acting insulin dose to be given before meals to cover carbohydrates to be eaten.

- Typical carbohydrate ratios:

  1 unit per 12 grams of CHO for patients who are more insulin sensitive
  1 unit per 10 grams of CHO for patients with average insulin sensitivity
  1 unit per 8 grams of CHO for patient who are more insulin resistant

- It is fine to making additional ratios like 1:15 or 1:6, etc depending on a patient's response

  For our patient, insulin to CHO ratio of 1:8 is prescribed

  If two-hour post prandial blood glucose is > 180 mg/dl, consider adding another correction dose of Humalog, for example (blood glucose – 120)/30.

Complete insulin orders for our patient:

Insulin glargine (Lantus) 30 units SQ qhs

Insulin lispro (Humalog) qac with dose = (blood glucose – 120)/30 + 1 unit per 8 grams of CHO to be eaten

Humalog 2 hours pc with dose = (blood glucose – 120/30

Assessment and Management of Arterial Insufficiency in the patient with foot osteomyelitis

CAMPBELL UNIVERSITY | Jerry M. Wallace School of Osteopathic Medicine

Key Points:
Peripheral Arterial Disease with Claudication

Diagnosis	Screen with Ankle-Brachial Index Investigate with: • Arterial doppler exam • MR angiogram • CT angiogram
Treatment	• RISK FACTOR MODIFICATION • Medically supervised exercise program • Antiplatelet therapy • Cilostazol therapy: phosphodiesterase inhibitor • Revascularization: percutaneous or surgical

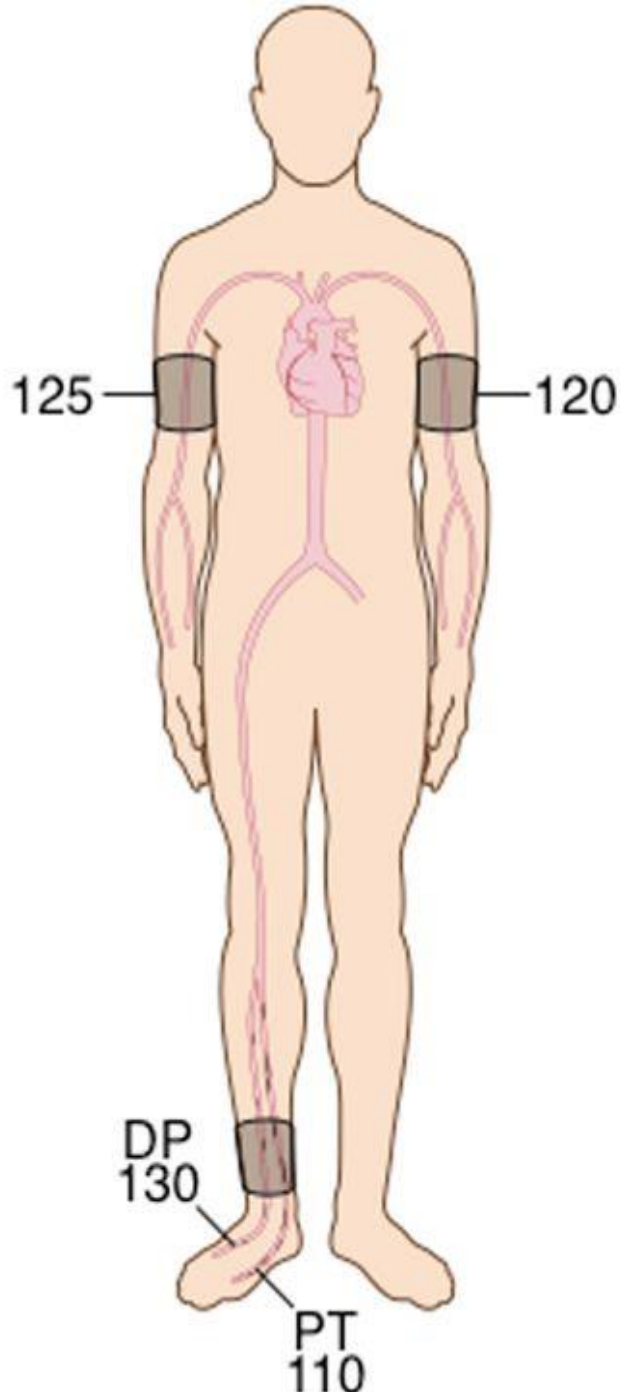
White, CJ, *Goldman-Cecil Medicine*, 25th edition, pp. 497-503

Ankle-brachial index

Traditional method	:	$\frac{\text{Higher ankle pressure}}{\text{Higher brachial pressure}}$
Alternative method	:	$\frac{\text{Lower ankle pressure}}{\text{Higher brachial pressure}}$

Traditional ABI : $\frac{130}{125}$ = 1.04

Alternative ABI : $\frac{110}{125}$ = 0.88



Brachial difference

BD : Higher brachial pressure – Lower brachial pressure

BD : 125 – 120 = 5

Interpreting the Ankle-Brachial Index (ABI)

ABI	**Interpretation**
>1.40	Noncompressible arteries
1.00 to 1.40	Normal
0.91 to 0.99	Borderline obstruction
0.71-0.90	Mild obstruction
0.41-0.70	Moderate obstruction
0.00-0.40	**Severe obstruction**

White, CJ, *Goldman-Cecil Medicine*, 25th edition pp. 497-503.

Consult either interventional cardiology or vascular surgery for revascularization . . .

Prevention of Foot Osteomyelitis in Patients with Diabetes

- Teach daily foot exam
- Proper foot wear
- Podiatry as necessary
- Skin care
- Bp, lipid and glycemic control
- Smoking cessation

Questions?

Thank you!