

Comprehensive Management of Osteomyelitis in the Diabetic Foot

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I have no disclosures.

Case

- 74 yo male with the following PMHx
 - DM2, well controlled on insulin and an SGLT2i (A1C 7.2%)
 - DFUs necessitating a hallux amputation 6 weeks prior
 - Retinopathy
 - Hand contractures and OA
 - CKD stage 3A (baseline Cr ~1.3-1.4)
 - CHF (on asa, statin, ARB)
 - HTN
 - Hyperlipidemia
 - Quit smoking in the 60's

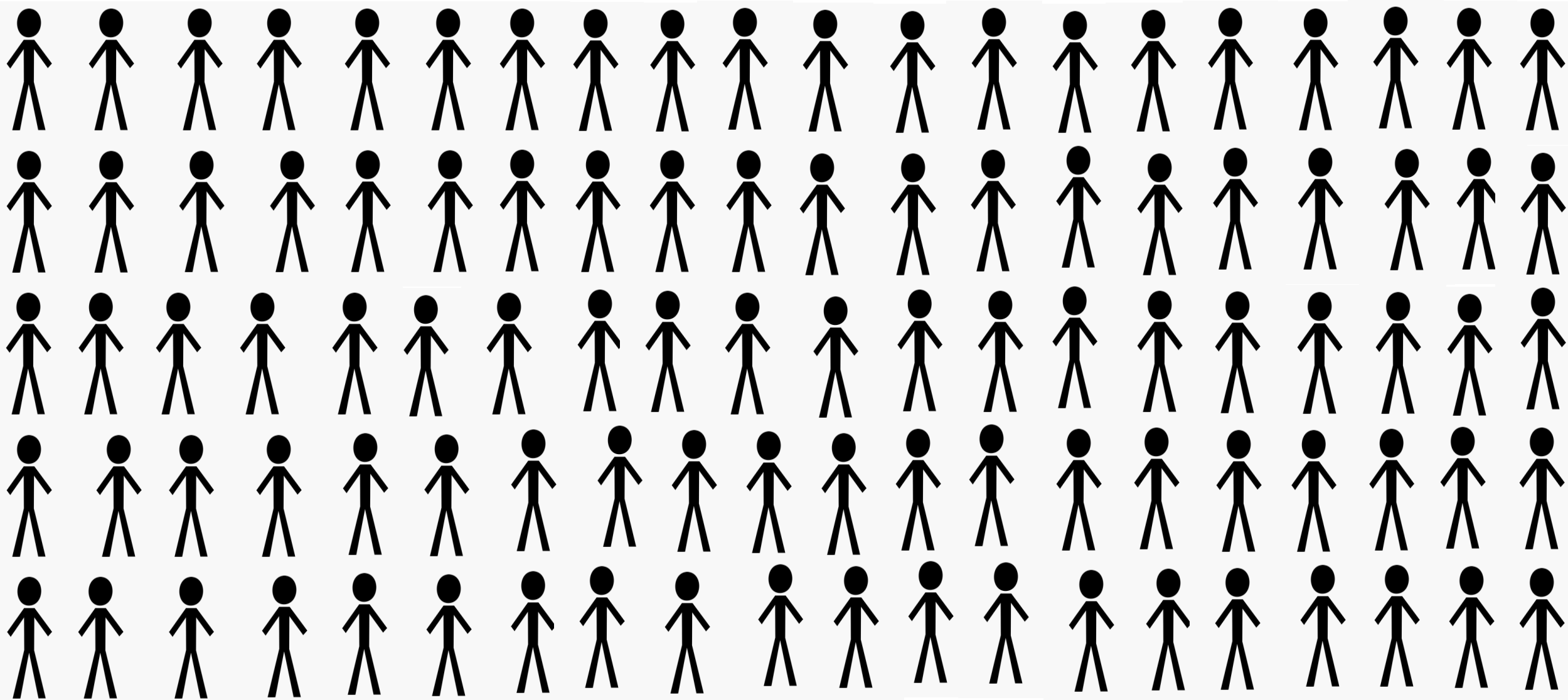
HPI

- Undergone hallux amp 6 weeks prior
- Discharged home to do his own wound care
- Trouble following up in pod clinic post-op
- Called in the day prior to presentation complaining that his foot was red and he developed a blister
- Podiatry worked with social work to get a ride

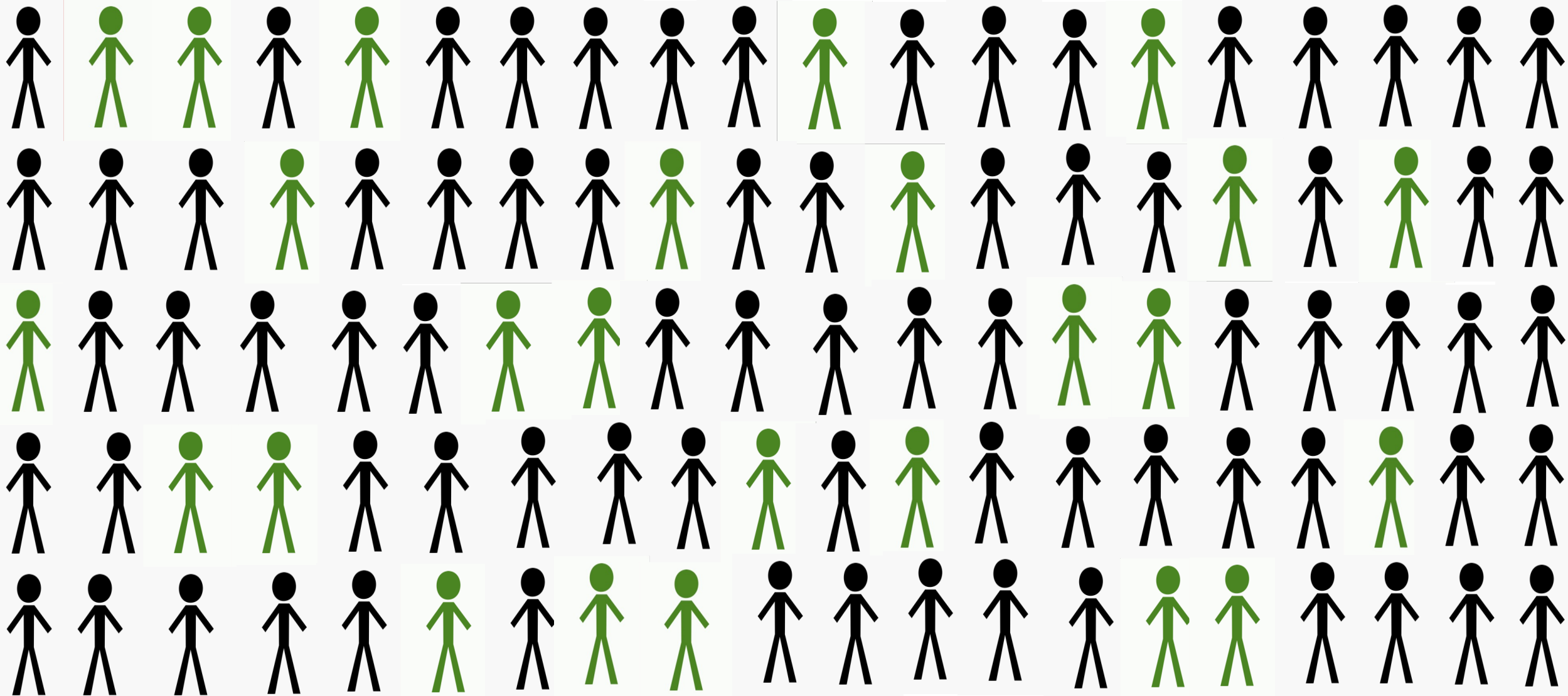


Physical exam

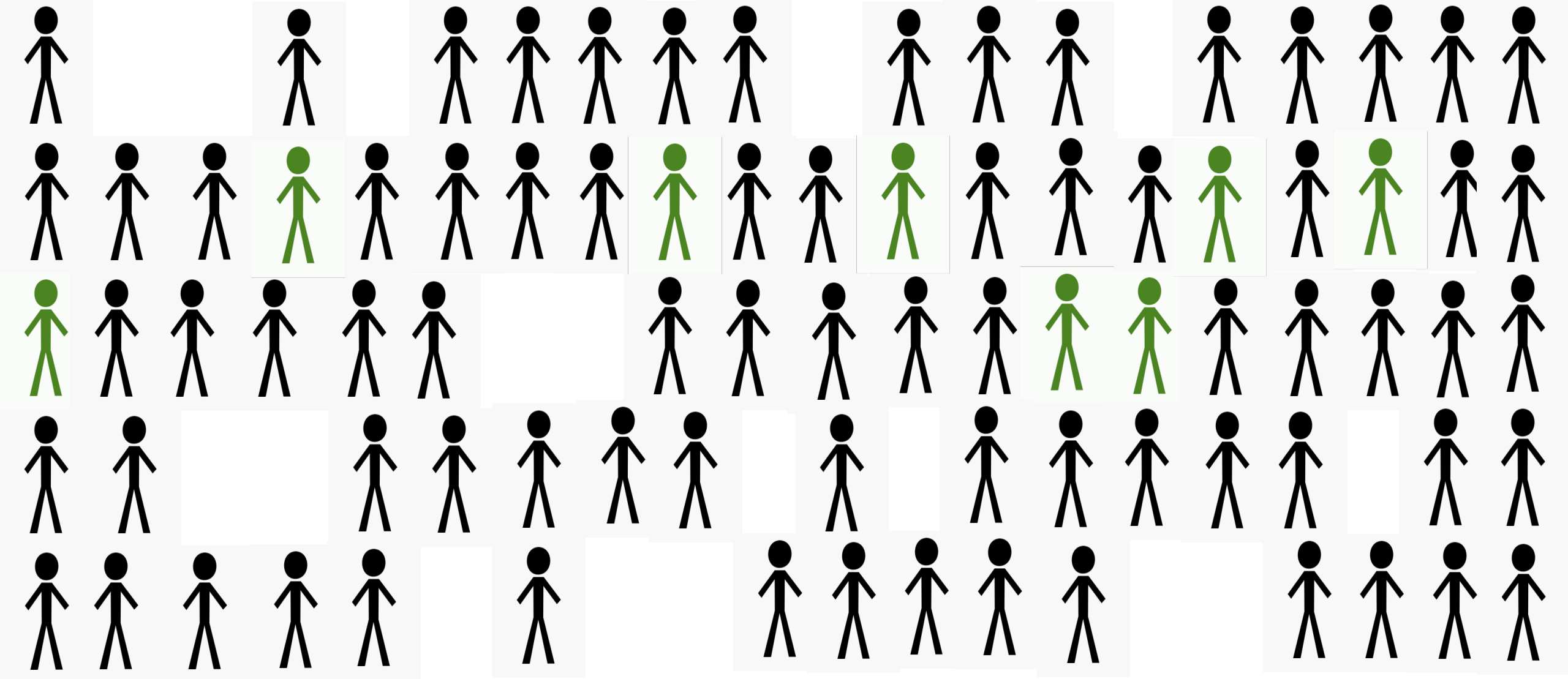




>37 million Americans have diabetes



25% will develop a diabetic foot ulcer



≥70% will die or undergo amputation

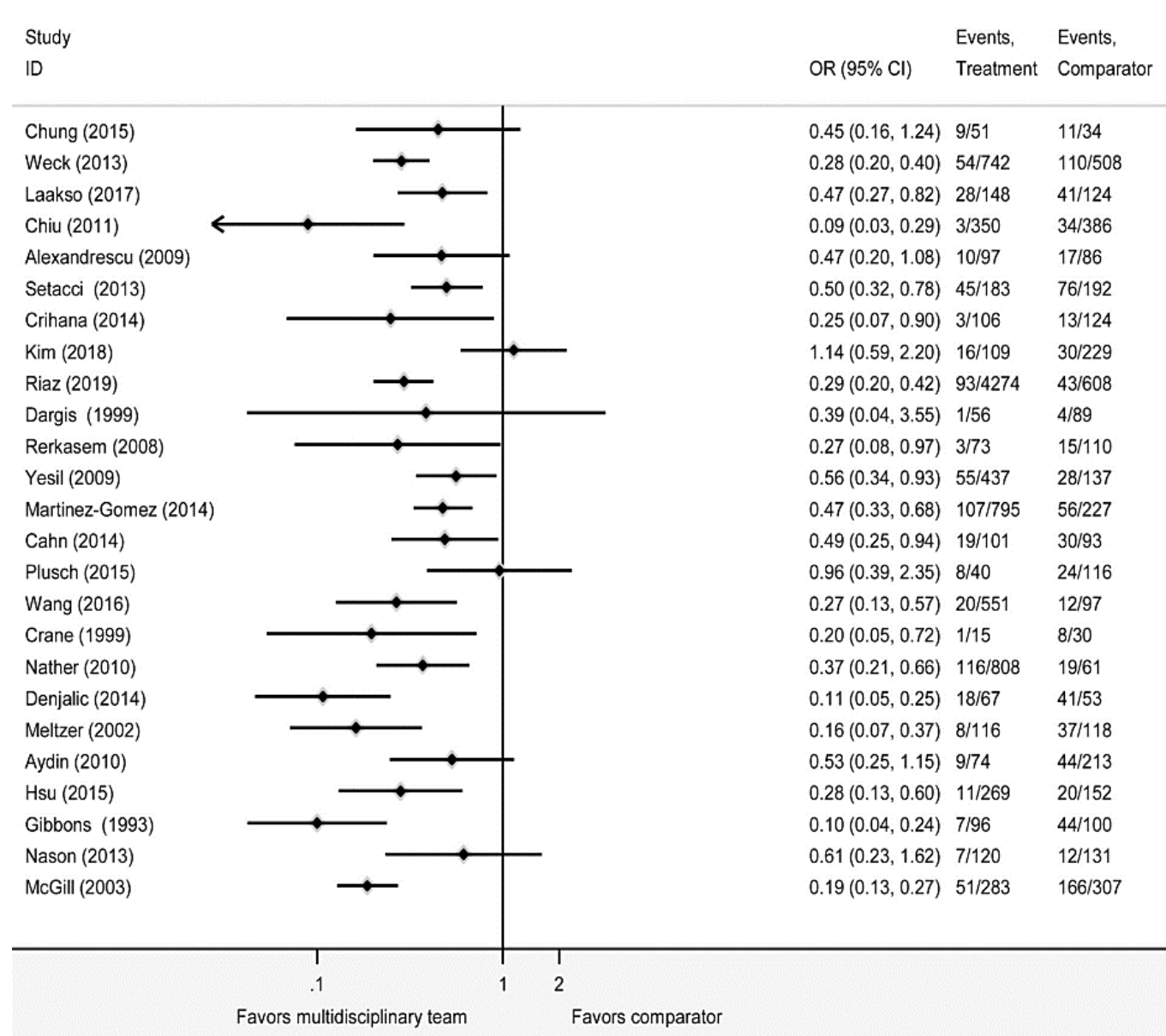
Learning Objective

Develop a 4-pronged approach to caring for patients with diabetic foot osteomyelitis.

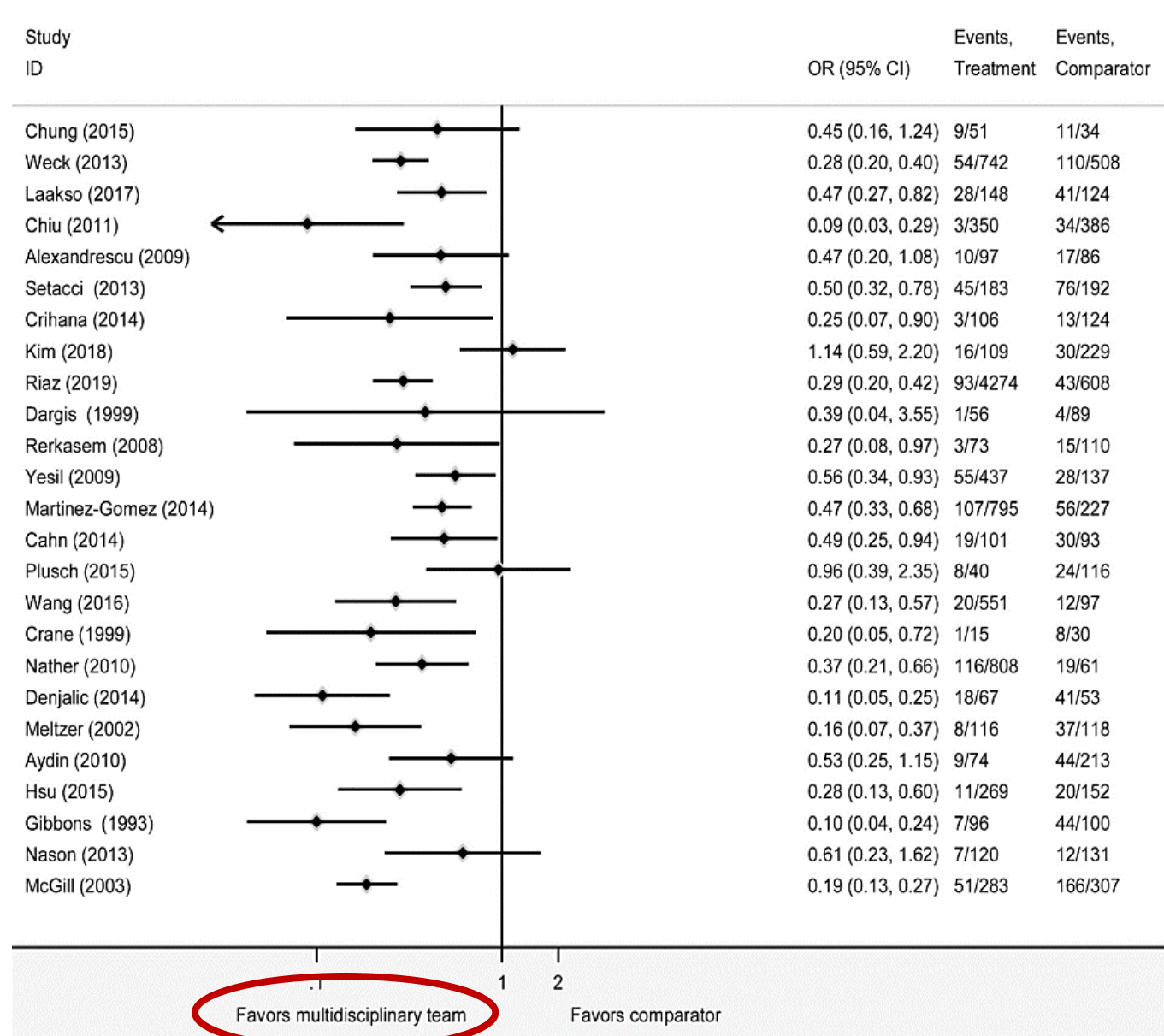
Outline

1. Evidence behind comprehensive care
2. Glycemic control
3. Vascular disease
4. Mechanical complications
5. Infection

Comprehensive Care Teams Are Associated with a Reduced Risk of Amputation



Comprehensive Care Teams Are Associated with a Reduced Risk of Amputation



**Glycemic
Control**



**Addressing
Infection**

**Management
of Vascular
Disease**

Biomechanics

7.5%

Foot Ankle Spec. 2018 Feb;11(1):17-21. doi: 10.1177/1938640017694722. Epub 2017 Feb 1.

Patients With Diabetic Foot Disease Fear Major Lower-Extremity Amputation More Than Death.

Wukich DK^{1,2,3}, Raspovic KM^{1,2,3}, Suder NC^{1,2,3}.

SGLT2 Inhibitors

- Loss of glucose through the urine leads to reductions in:
 - Weight
 - Volume
 - Blood pressure
- Decreased cardiovascular events
- Improved control of heart failure
- Reductions in end-stage renal disease

Neal B et al. *NEJM*. 2017;377(7):644-57

Zannad F et al. *Lancet*. 2020;396(10254):819-29

Heerspink HJL et al. *Am J Kidney Dis*. 2022;79(2):244-56

CANVAS: HR_{amp} 1.97
(95% CI 1.41-2.75)

2017

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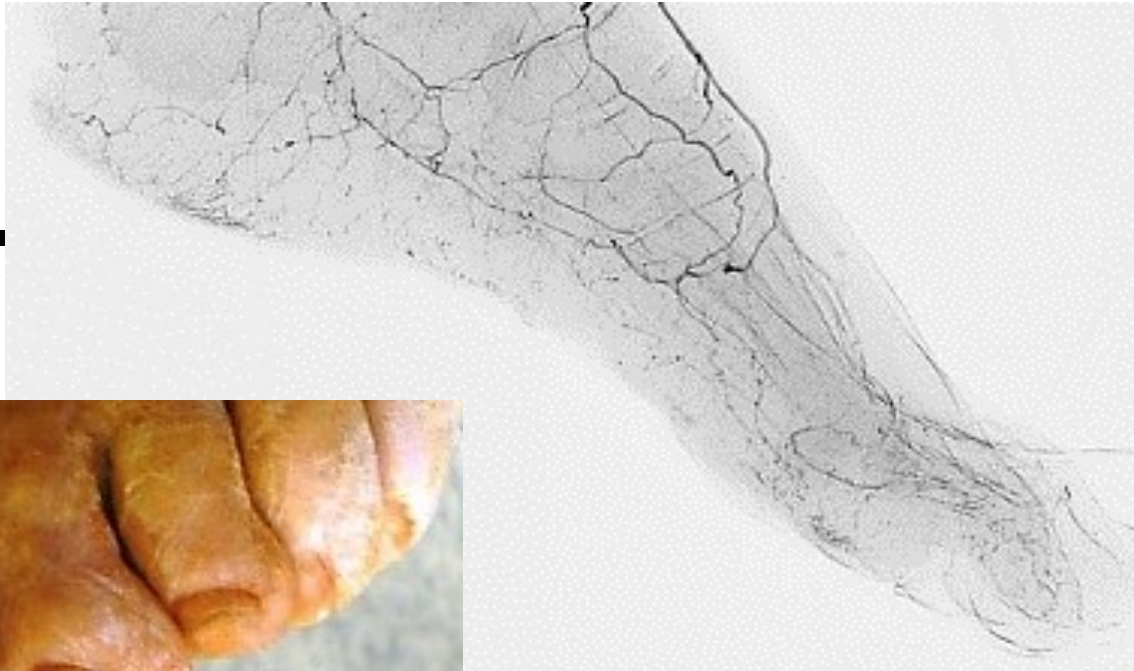
FDA Black Box Warning

2017

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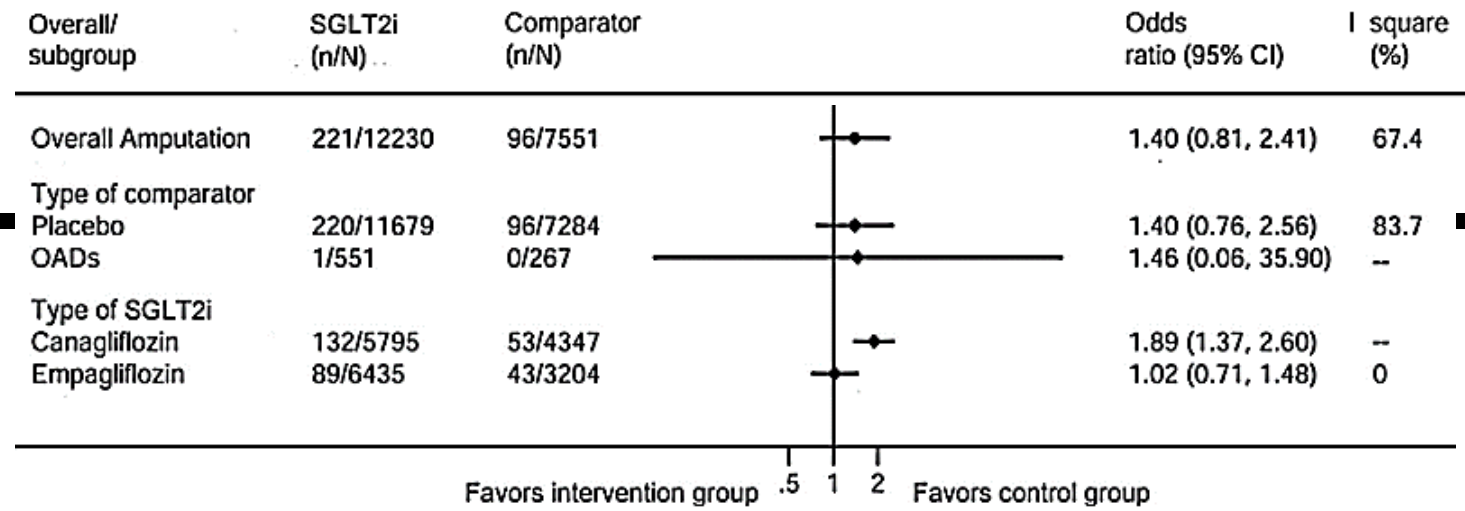
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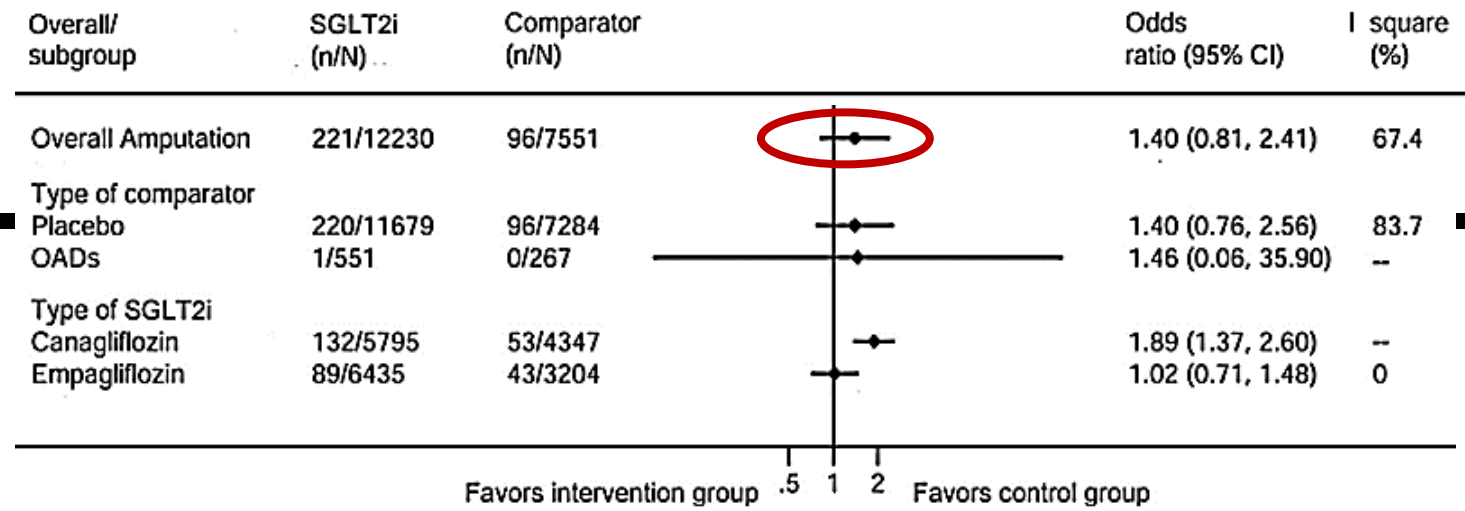
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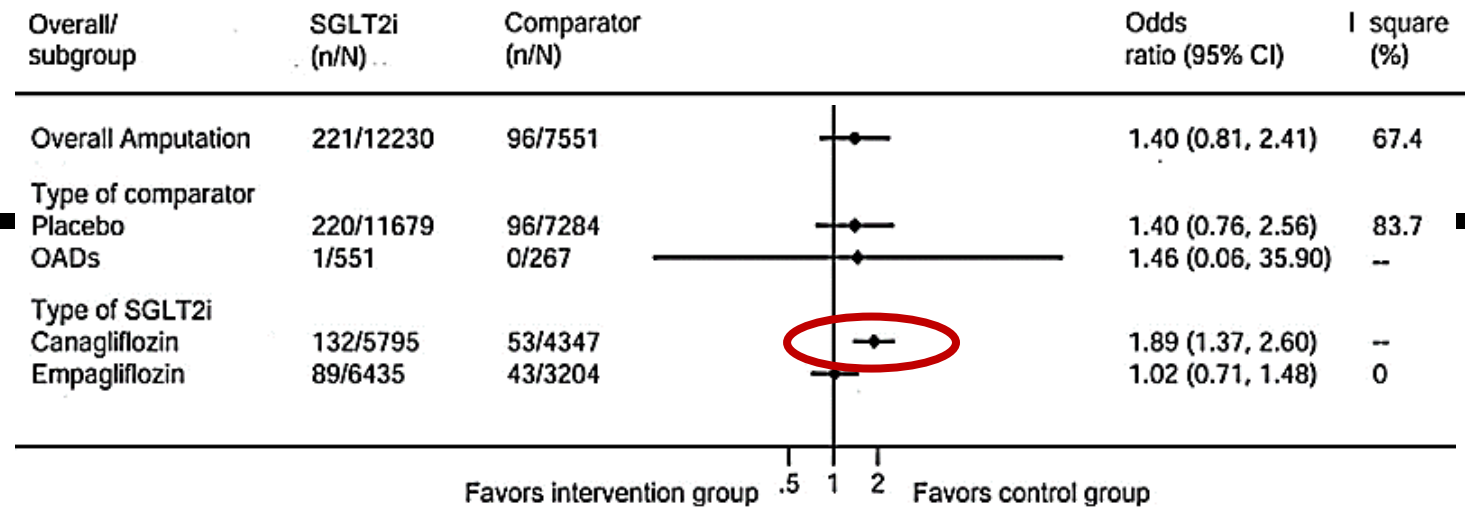
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FDA Black Box Warning

2017

2020

FDA Removes Black Box Warning
DM practice flux

Case

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**Glycemic
Control**



**Addressing
Infection**

**Management
of Vascular
Disease**

Biomechanics

ODDS OF MAJOR AMPUTATION

Vascular Disease

		+	-
Infection	+	3.0	1.0
	-	1.7	Ref



25%

TBIs & ABIs

Test	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value	Positive Likelihood Ratio	Negative Likelihood Ratio
Toe Brachial Index	0.89 (0.76-1.00)	0.45 (0.29-0.61)	0.45 (0.29-0.61)	0.89 (0.76-1.00)	1.62 (1.17-2.20)	0.24 (0.06-0.91)
Ankle Brachial Index	0.68 (0.48-0.89)	0.59 (0.44-0.75)	0.46 (0.28-0.65)	0.79 (0.63-0.94)	1.69 (1.03-2.77)	0.53 (0.26-1.08)

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Mean Arterial Calcification (MAC)

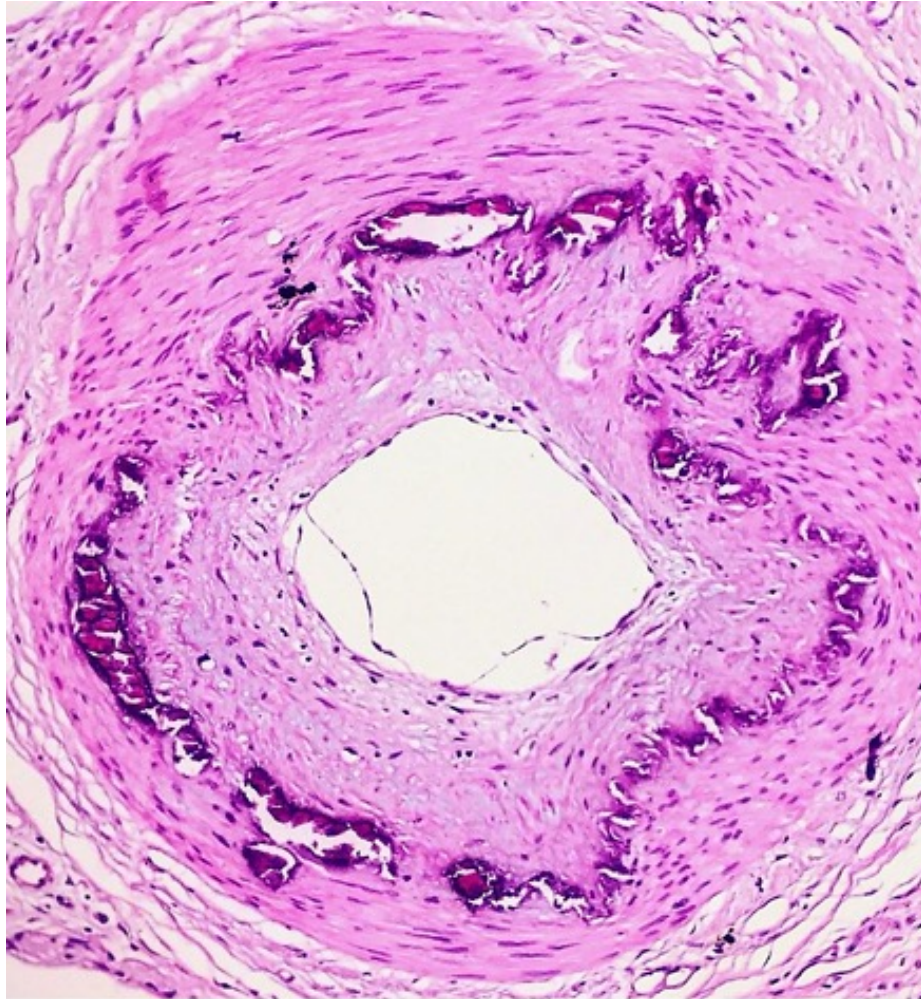
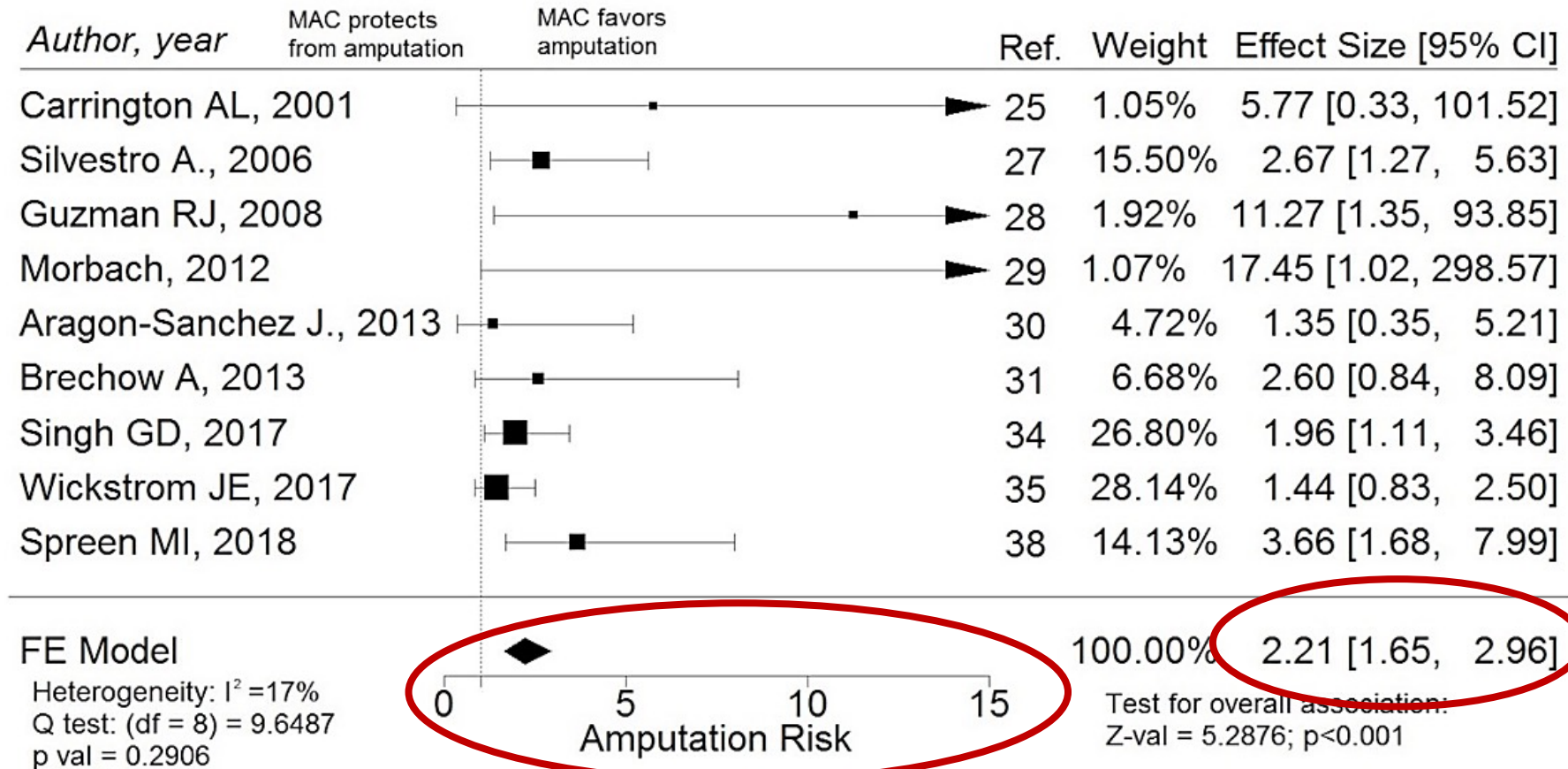


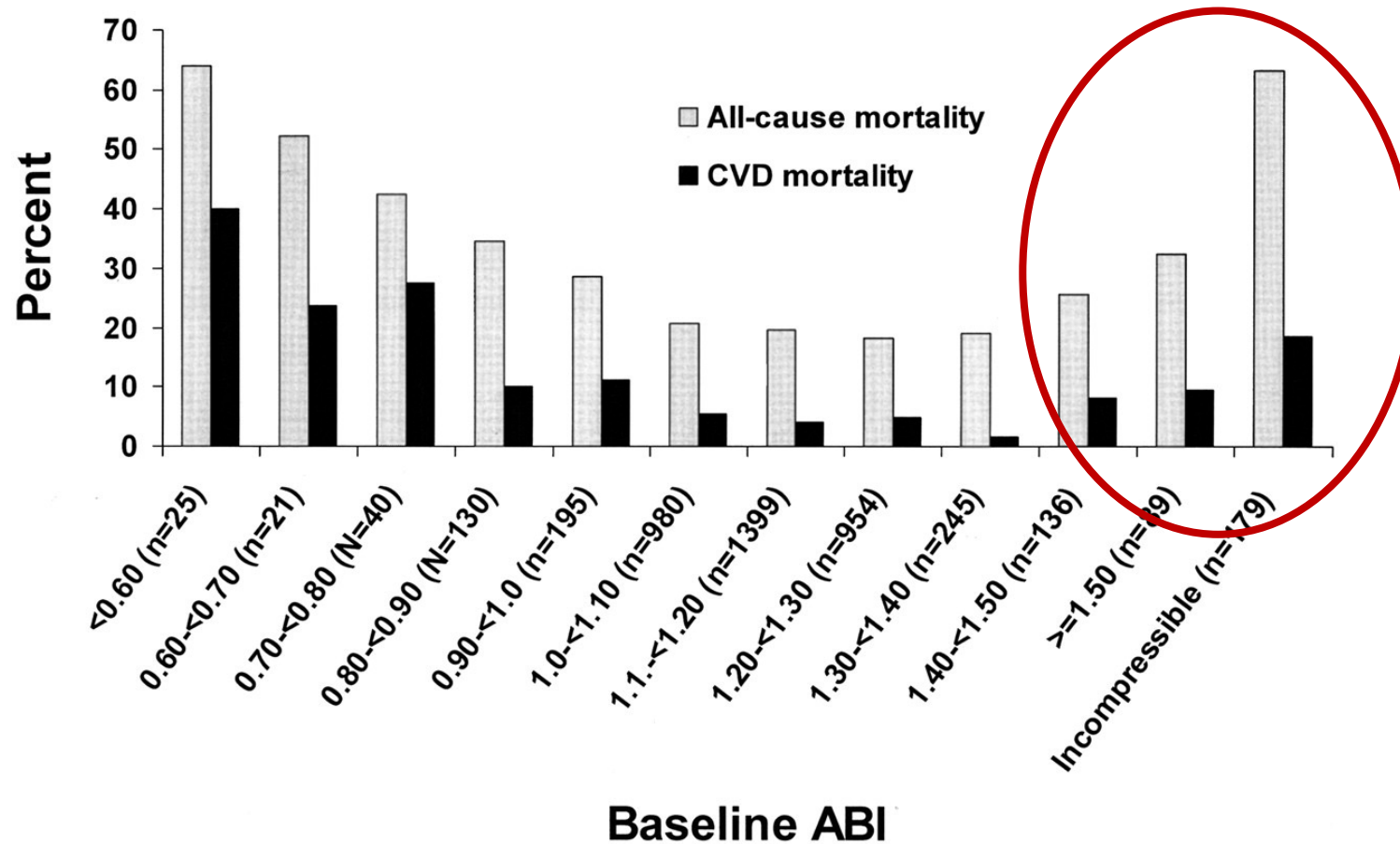
Photo courtesy of Dr. Peta Tehan

- Occurs in 21% of patients with diabetes
- PAD equivalent
- Marker of small vessel disease

MAC is Associated with an Increased Risk in Major Amputation



MAC is Associated with Increased Mortality



When to Refer for possible revascularization (my opinion)

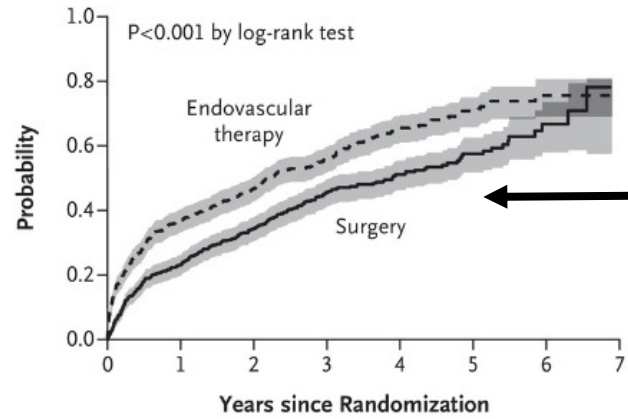
- Monophasic waveforms
- $ABI \leq 0.7$
- High ABI (falsely?) but low TBI



Primary Outcome

- Major amputation
- Re-intervention
- Death

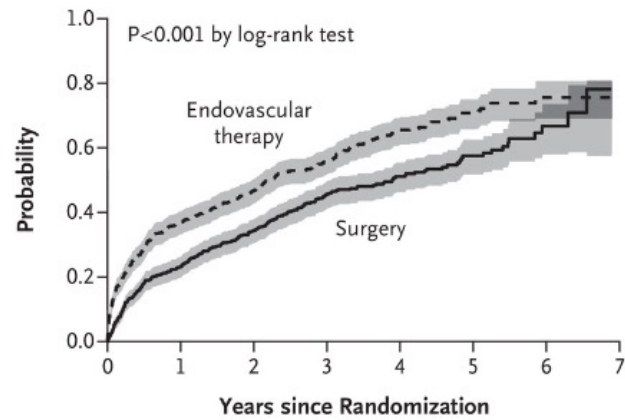
A Major Adverse Limb Events or Death



No. at Risk	0	1	2	3	4	5	6	7
Endovascular therapy	716	404	304	175	102	46	14	0
Surgery	718	463	349	204	117	52	12	0

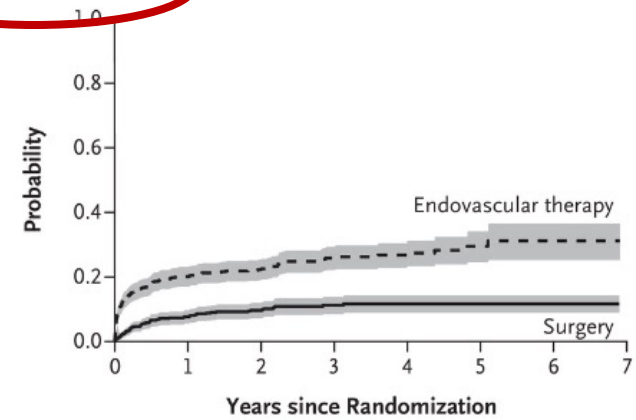
Patients who underwent surgery had fewer major adverse limb events or death compared to patients who underwent endovascular revascularization.

A Major Adverse Limb Events or Death



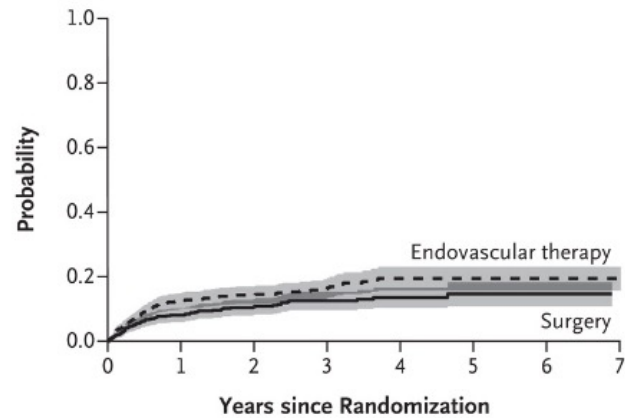
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B Major Reintervention



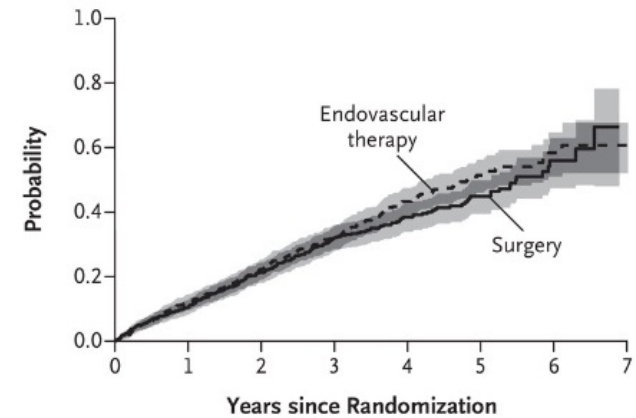
No. at Risk		0	1	2	3	4	5	6	7
Endovascular therapy	716	444	331	192	111	48	14	0	
Surgery	718	500	385	227	128	58	13	0	

C Above-Ankle Amputation



No. at Risk		0	1	2	3	4	5	6	7
Endovascular therapy	716	501	387	239	142	64	17	1	
Surgery	718	502	387	229	131	58	15	0	

D Death



No. at Risk		0	1	2	3	4	5	6	7
Endovascular therapy	716	586	462	298	182	85	23	1	
Surgery	718	577	457	282	168	80	20	0	

Case

- ABI 1.35 with triphasic waveforms
- Toe pressure was 75 mmHg
- Medical management:
 - Aspirin
 - Statin
 - ARB
- Non-smoker

Hyperglycemia

**Secondary
Infection**



**Vascular
Disease**

Biomechanics

Wagner grade 0: no ulcer

Wagner grade 1: partial or full thickness ulcer

Wagner grade 2: exposed tendon/deeper structures

Wagner grade 3: abscess or osteomyelitis

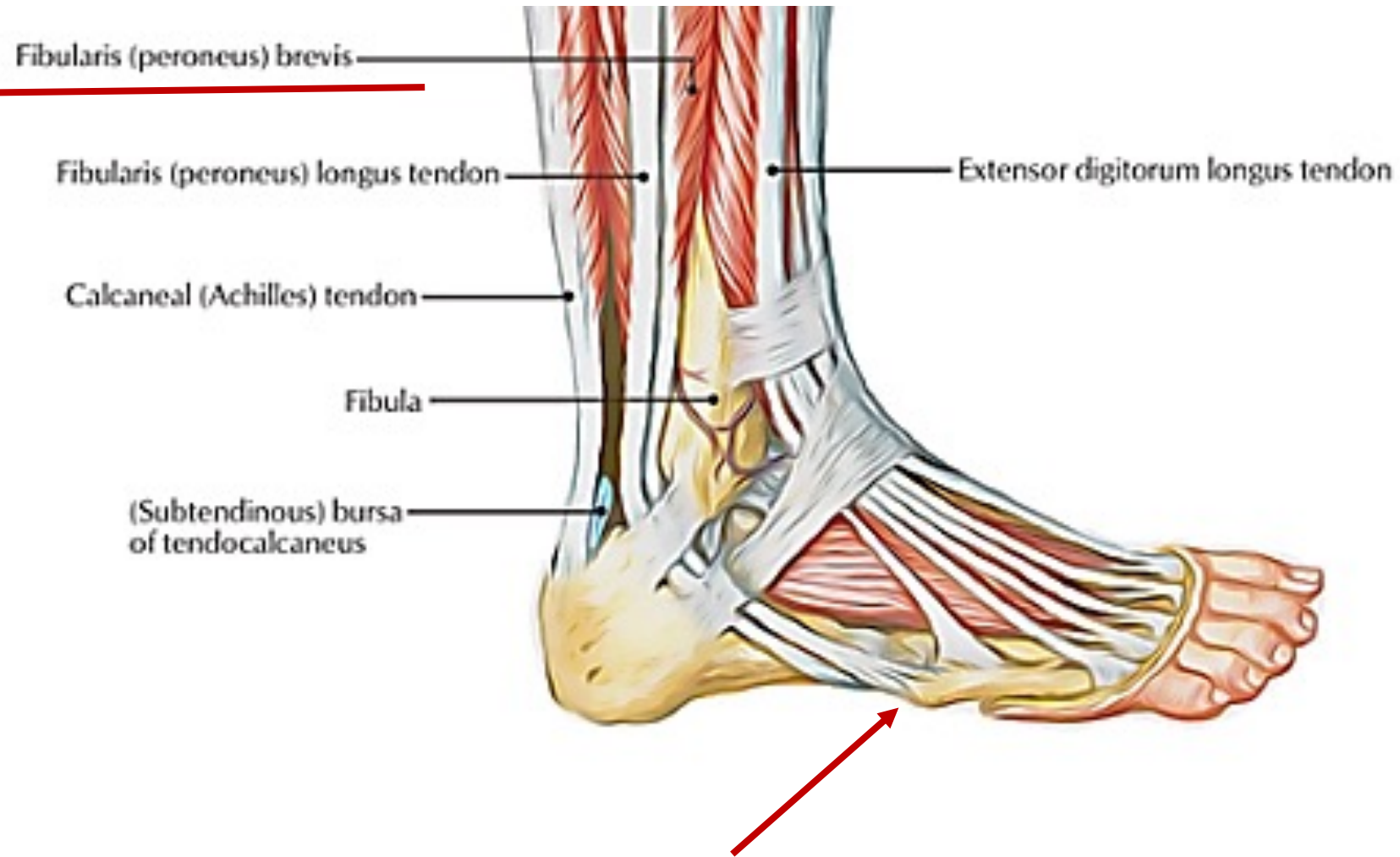
Wagner grade 4: partial foot gangrene

Wagner grade 5: whole foot gangrene

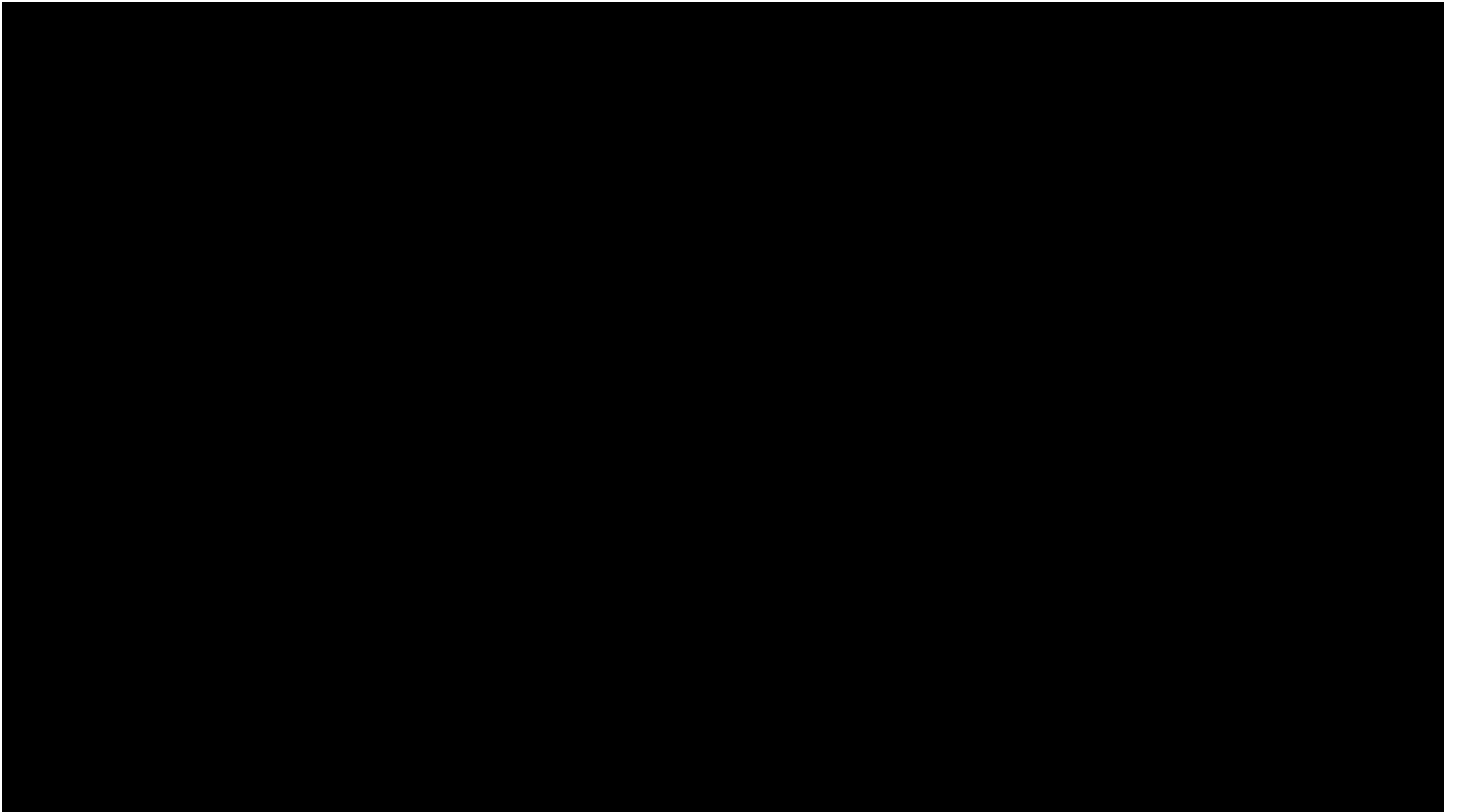
Most important sites

- calcaneal
- base 5th metatarsal





Peroneus brevis inserts into the base of the 5th metatarsal



Case



Wagner grade 3 – pretty clearly a deep space abscess and the wound probed to bone

Case



Hyperglycemia

**Secondary
Infection**



**Vascular
Disease**

Biomechanics

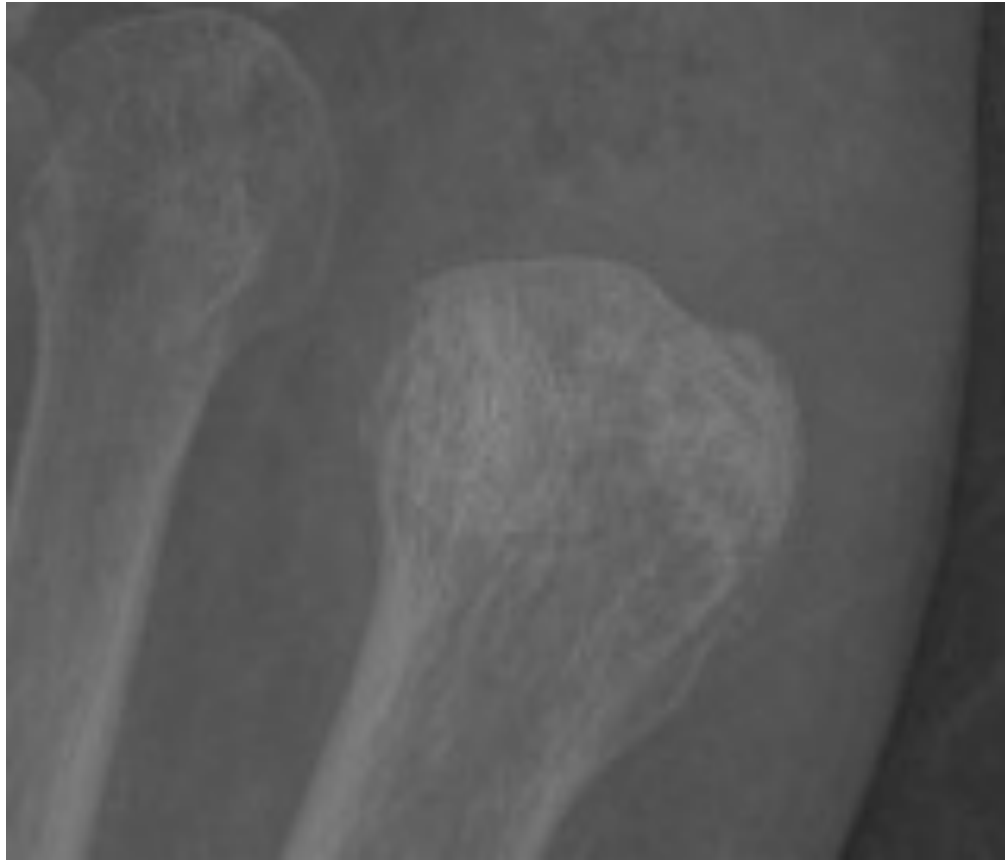
Diagnostic Tests for Osteomyelitis in Diabetic Foot Ulcers

Test	Sensitivity	Specificity	+ Likelihood Ratio	- Likelihood Ratio
X-ray	62%	78%	2.8	0.5
MRI	93-96%	75-84%	3.7-6.0	0.05-0.09
WBC scan	91-92%	75-92%	3.6-11.5	0.09-0.1
PET	84%	93%	12.0	0.2

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WBC scan	91-92%	75-92%	3.6-11.5	0.09-0.1
PET	84%	93%	12.0	0.2
Probe-to-Bone	87%	83%	5.1	0.2

Case

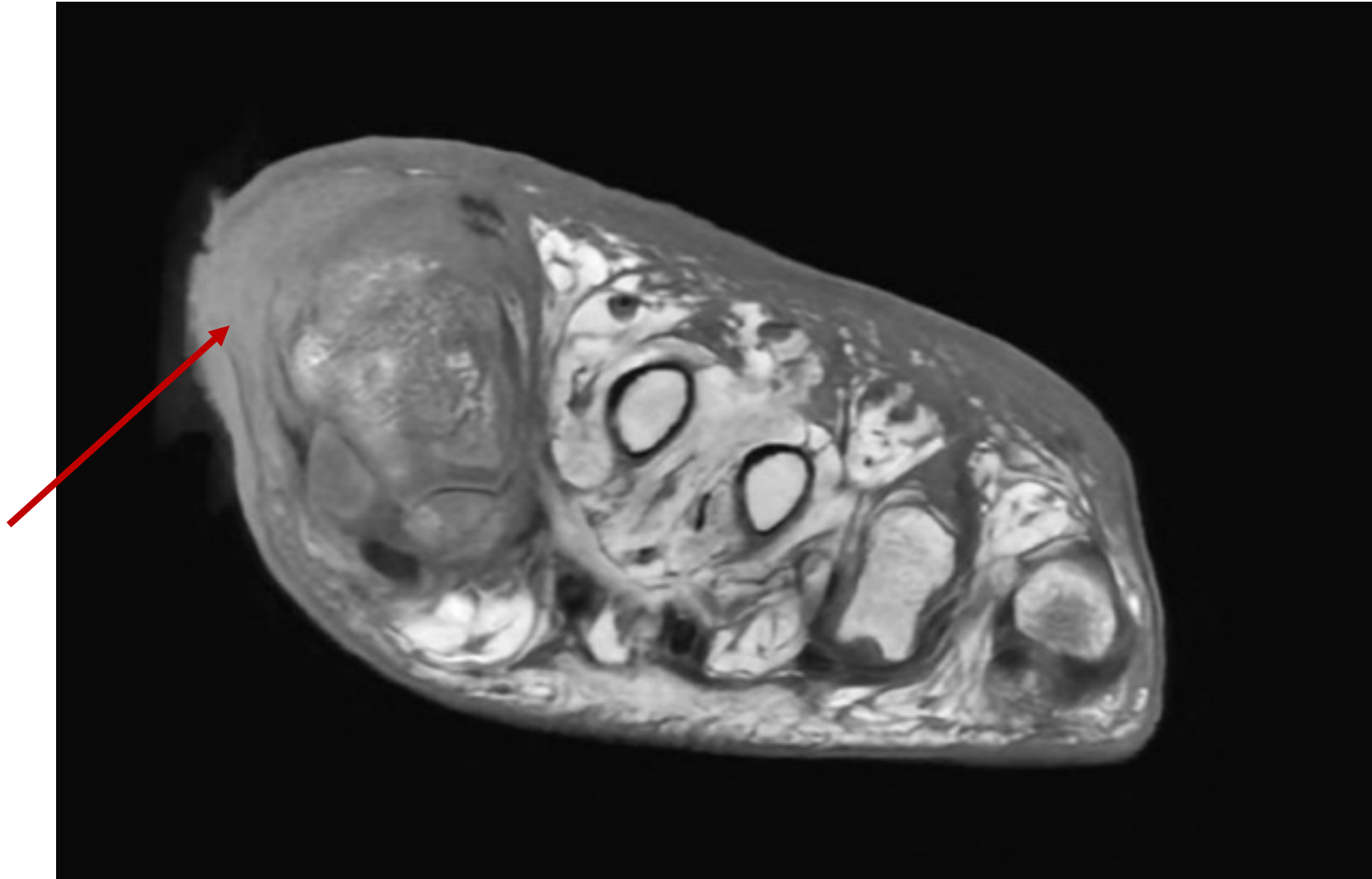


6 weeks ago

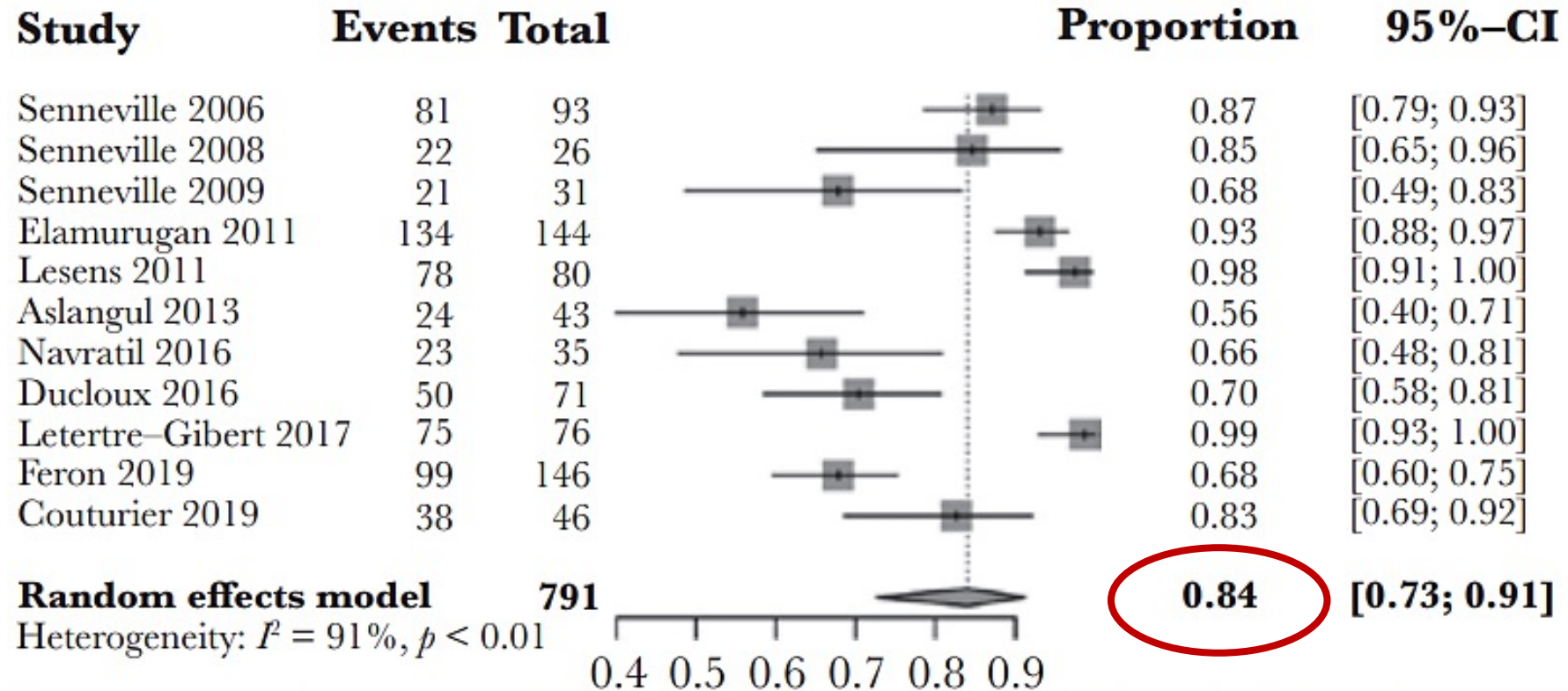


now

Case

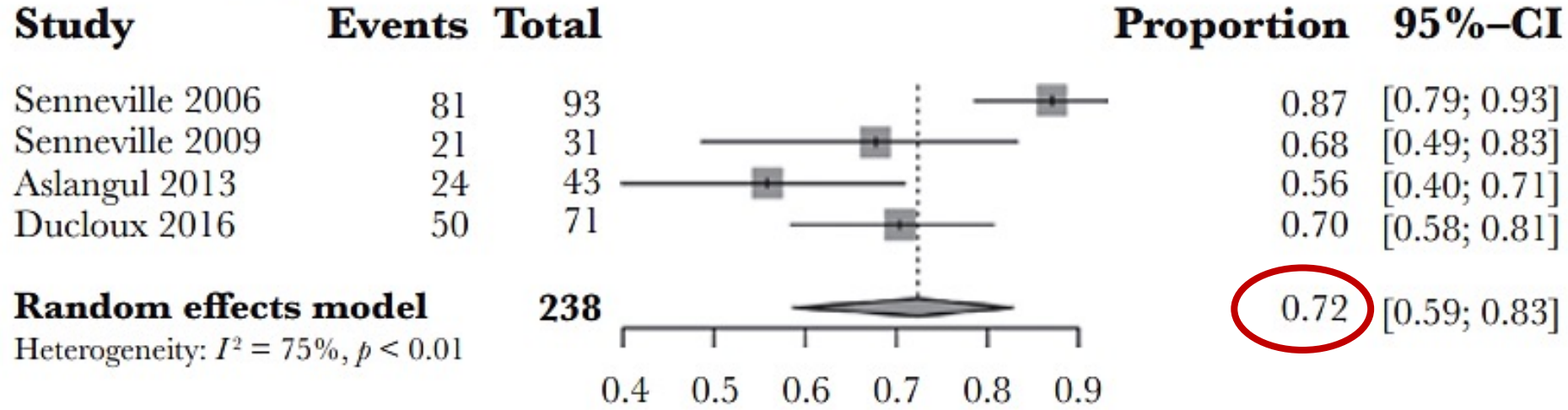


84% of Percutaneous Bone Biopsies Have a Positive Microbiologic Culture

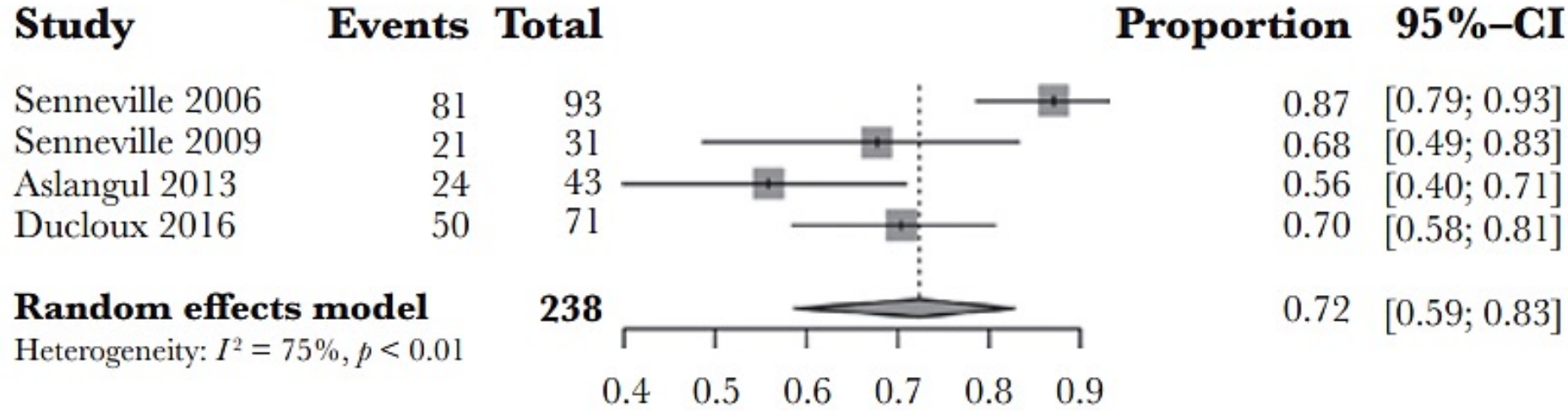


Events, number of positive percutaneous bone biopsies; Total, number percutaneous bone biopsies

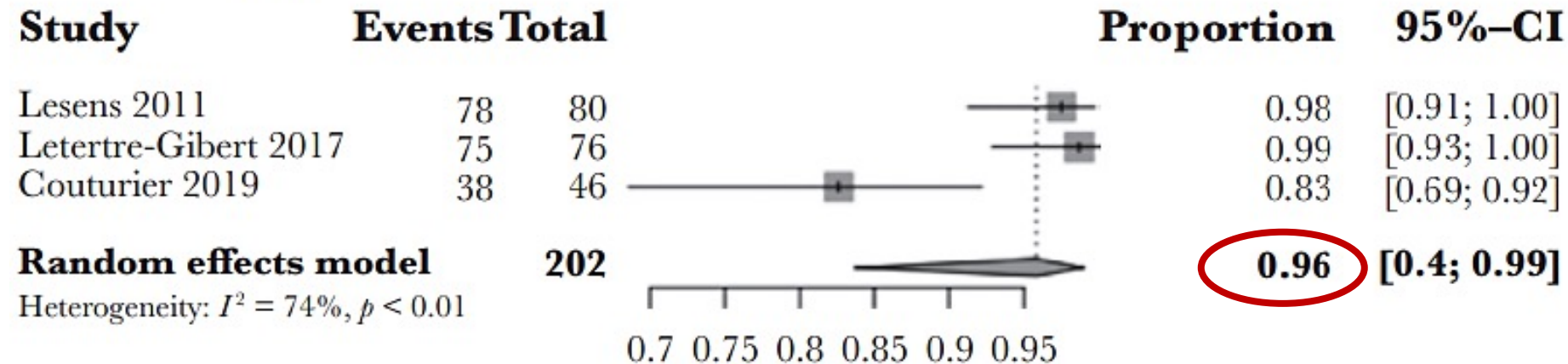
Excluded patients that received antibiotics ≤ 2 weeks prior to the biopsy



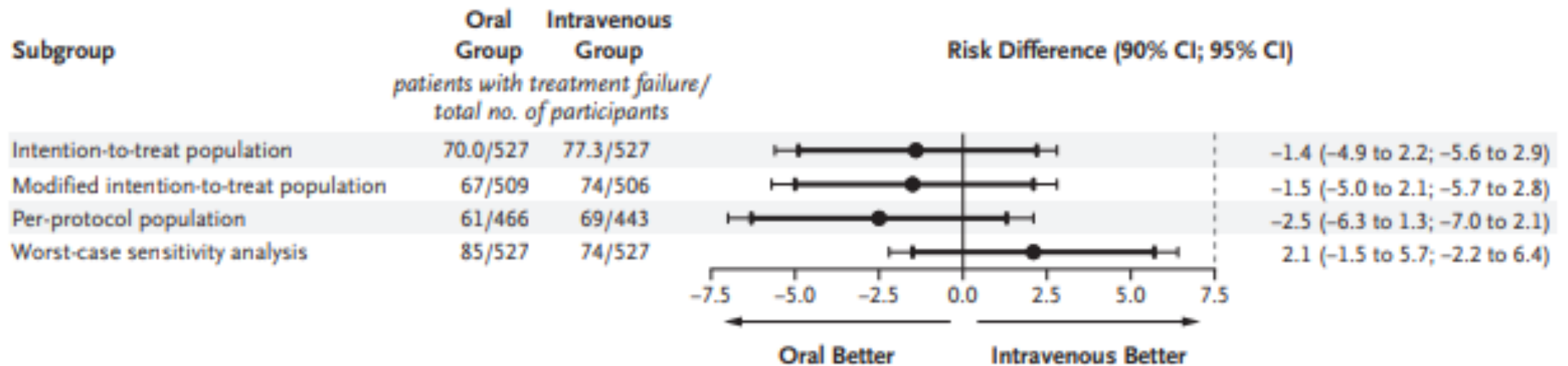
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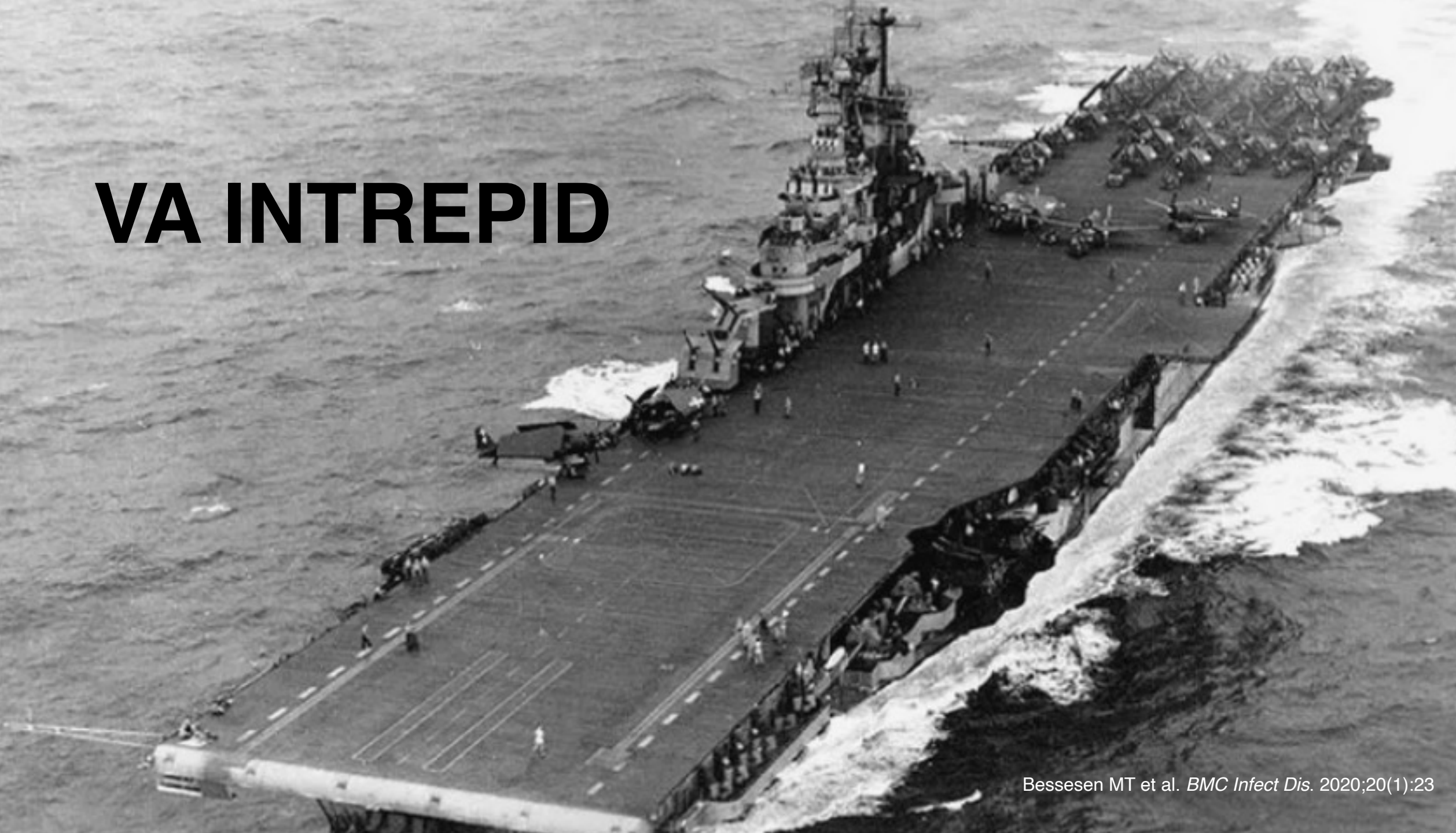
“Oral antibiotic therapy was noninferior to IV antibiotic therapy when used within the 1st 6 weeks for complex orthopedic infections.”



Oral Antibiotics That Wouldn't Be Unreasonable

Antibiotic	
Ciprofloxacin	
Moxifloxacin	
Linezolid	→ Marrow suppression
TMP-sulfa	
Metronidazole	→ Neuropathy
Rifampin	
Doxycycline	
Clindamycin	

VA INTREPID



Case

- Blood cultures negative
- Pus expressed pre-op: Gram stain with moderate GPCs pairs, culture MSSA and Strep pyogenes
- Distal bone culture: MSSA, Group G Strep, Corynebacterium striatum, Anaerococcus, Campylobacter ureolyticus
- Proximal bone culture: MSSA, Strep agalactiae, Corynebacterium striatum, Anaerococcus, Campylobacter ureolyticus
- ESR 69 → 60
- CRP 7.26 → 1.44

**Do we go
back in or
trust
antibiotics?**



Treatment

- Empiric vancomycin and piperacillin-tazobactam
- Dropped piperacillin-tazobactam 3 days post-op
- Anaerobic GNR isolated on bone culture → added metronidazole to vancomycin
 - Had to stop metro due to nausea
 - AKI on vanco → dapto
 - Pulmonary toxicity on dapto → linezolid

**Glycemic
Control**

**Addressing
Infection**



**Management
of Vascular
Disease**

Biomechanics