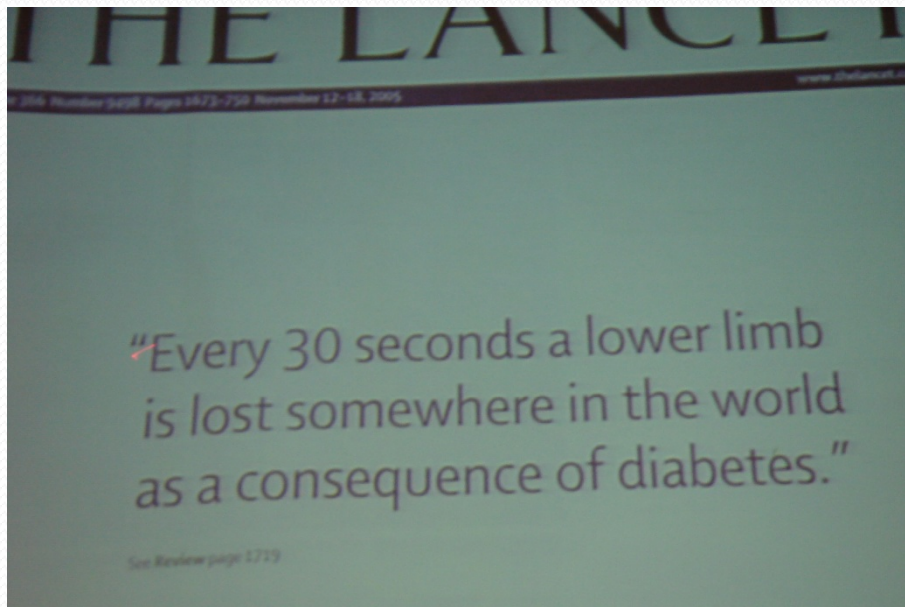


제 23차 대한당뇨병학회 춘계학술대회 May 6-8. 2010

Pathophysiology and Diagnosis of Diabetic Foot



전북대학교 의학전문대학원
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박태선



Lancet 2005; 366 Nov 12 :1673-1750

Review

1719 **The global burden of diabetic foot disease**

Andrew JM Boulton, Loretta Vileikyte, Gunnel Ragnarson-Tennvall, Jan Apelqvist

[Preview](#) | [Summary](#) | [Full Text](#)
| [PDF](#)

1725 **Treatment for diabetic foot ulcers**

Peter R Cavanagh, Benjamin A Lipsky, Andrew W Bradbury, Georgeanne Botek

[Preview](#) | [Summary](#) | [Full Text](#)
| [PDF](#)

1736 **Wound healing and its impairment in the diabetic foot**

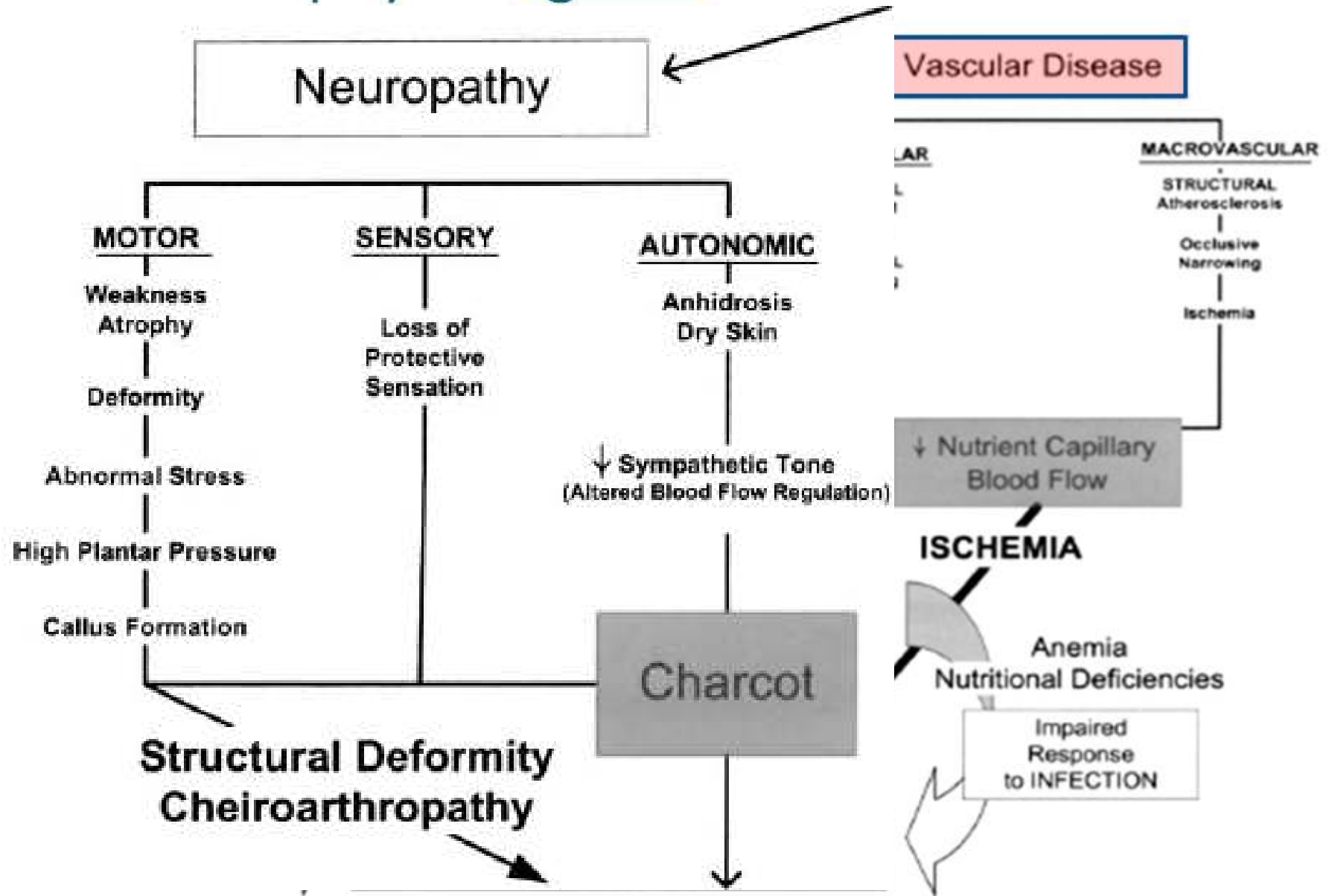
Vincent Falanga

[Preview](#) | [Summary](#) | [Full Text](#)
| [PDF](#)

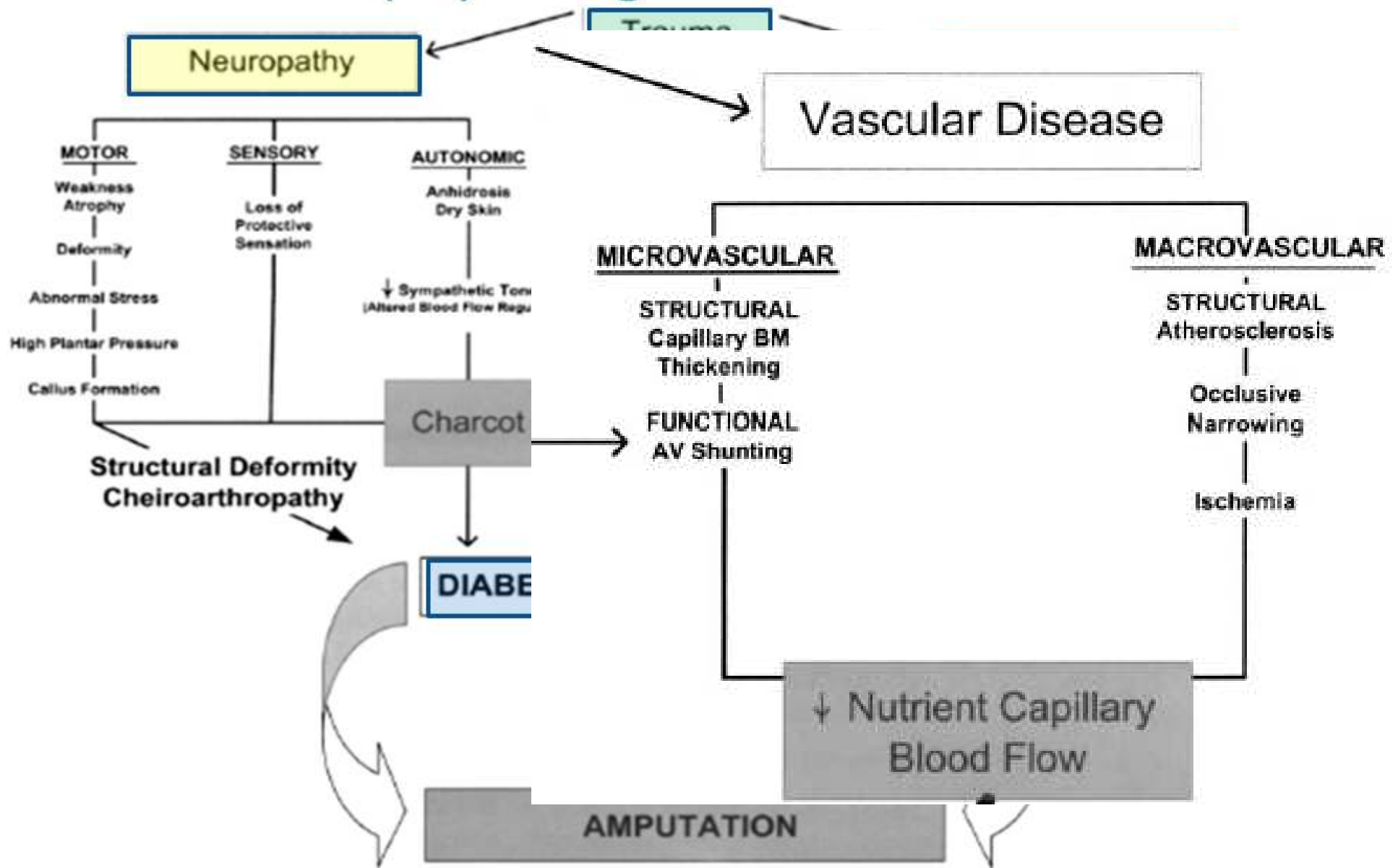
Pathophysiology of Diabetic foot



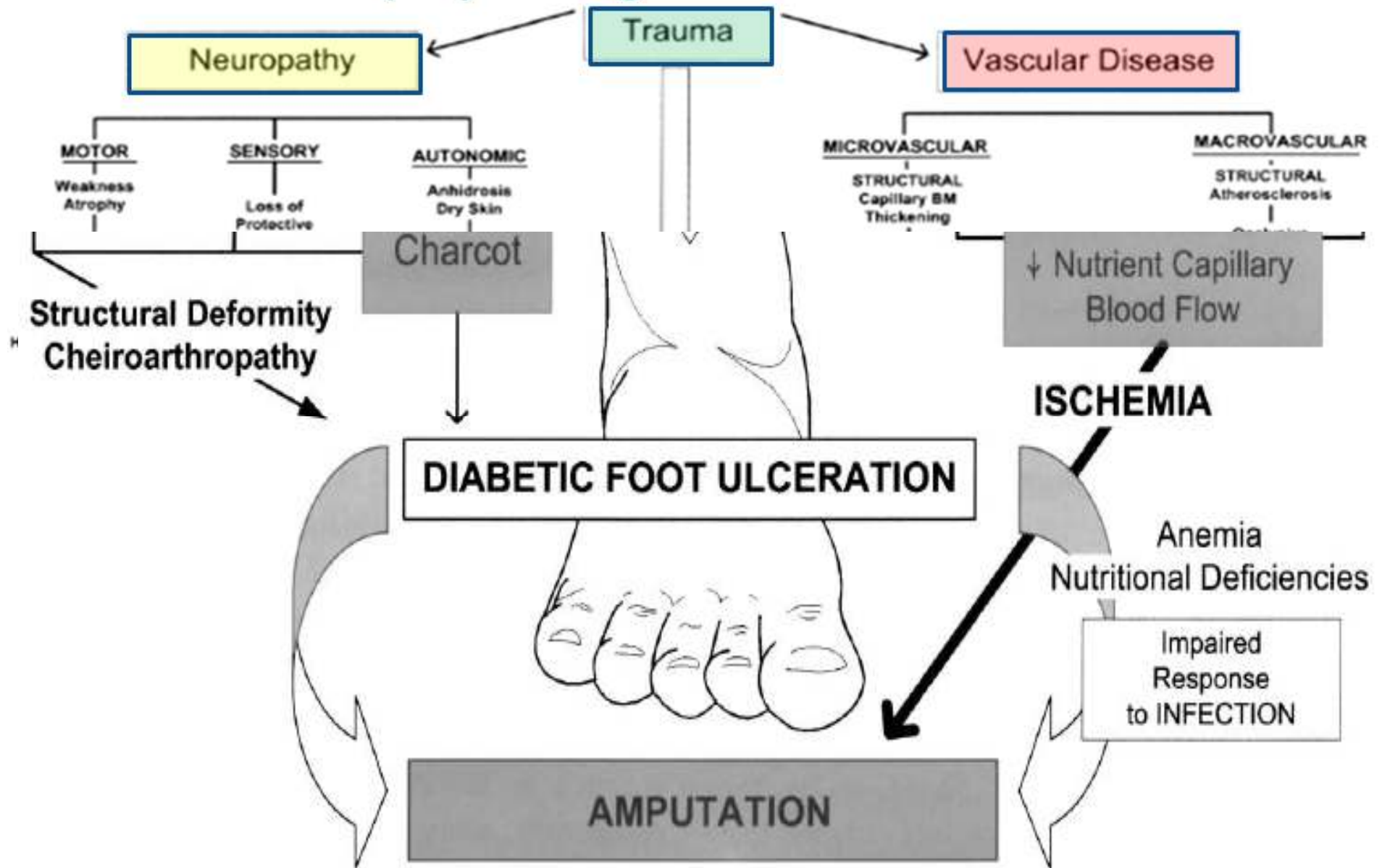
Pathophysiologies of diabetic foot



Pathophysiologies of diabetic foot



Pathophysiologies of diabetic foot

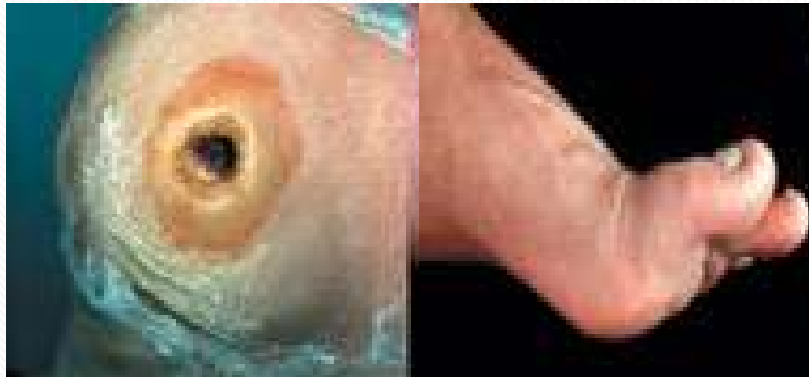


Diagnosis of Diabetic Foot



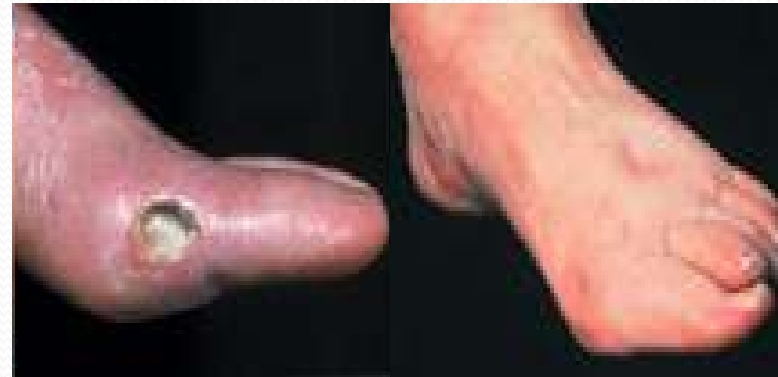
Neuropathic foot

- Plantar aspect of the foot under the metatarsal heads or on the plantar aspects of the toes



Ischemic foot

- Medial aspect of first MTP joint of foot
- pitting edema, hallux valgus and erythema from pressure from tight shoe on medial aspect of first MTP joint

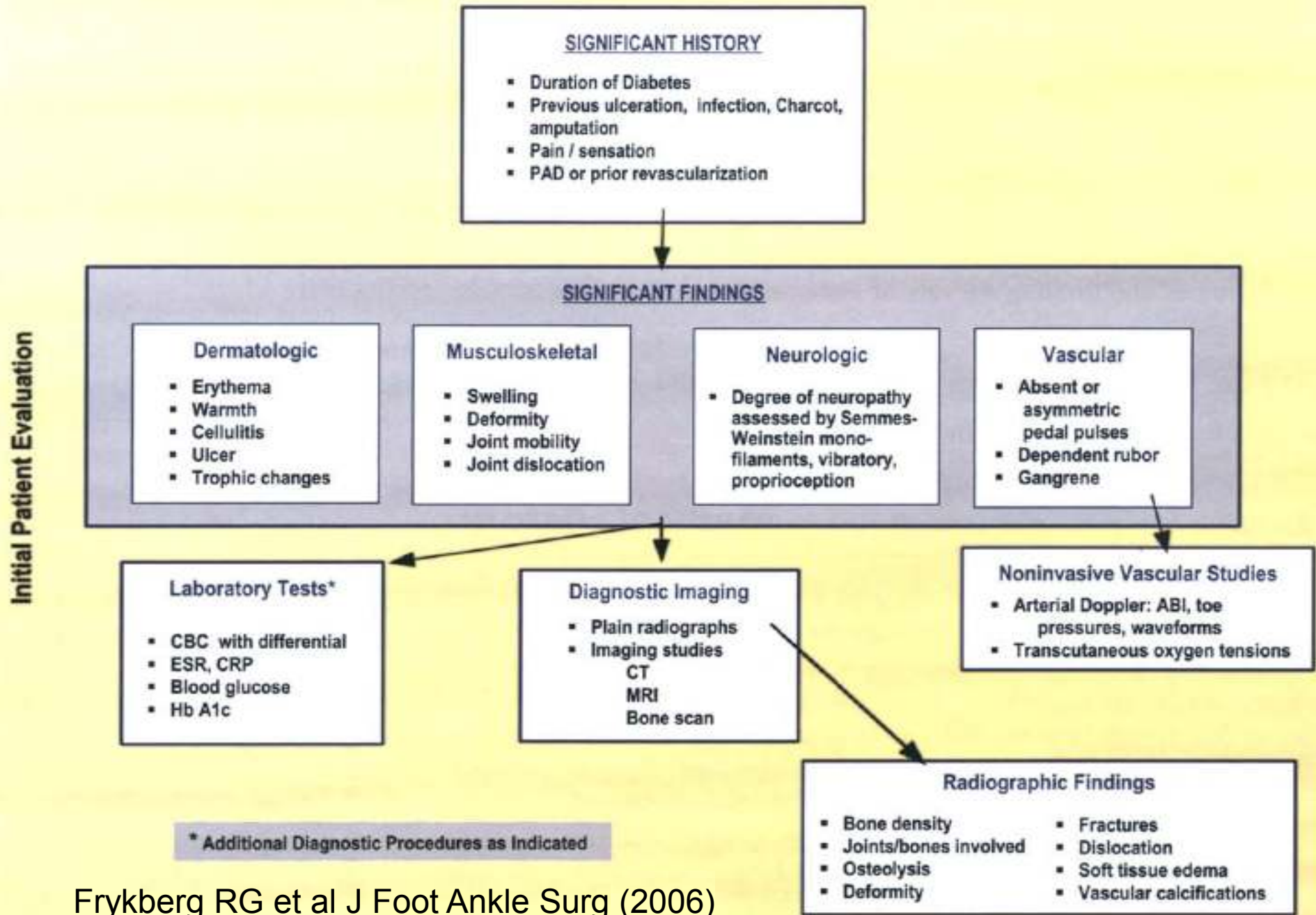


General Evaluation for Diabetic Foot

- General condition
- Glycemic control
- Occupational history
- Medical photography
- Six concerns
 - vascular testing, sensory testing, ROM of joint, contracture of tendon, bony prominence, skin and nail condition



Diabetic Foot Disorders



Frykberg RG et al J Foot Ankle Surg (2006)

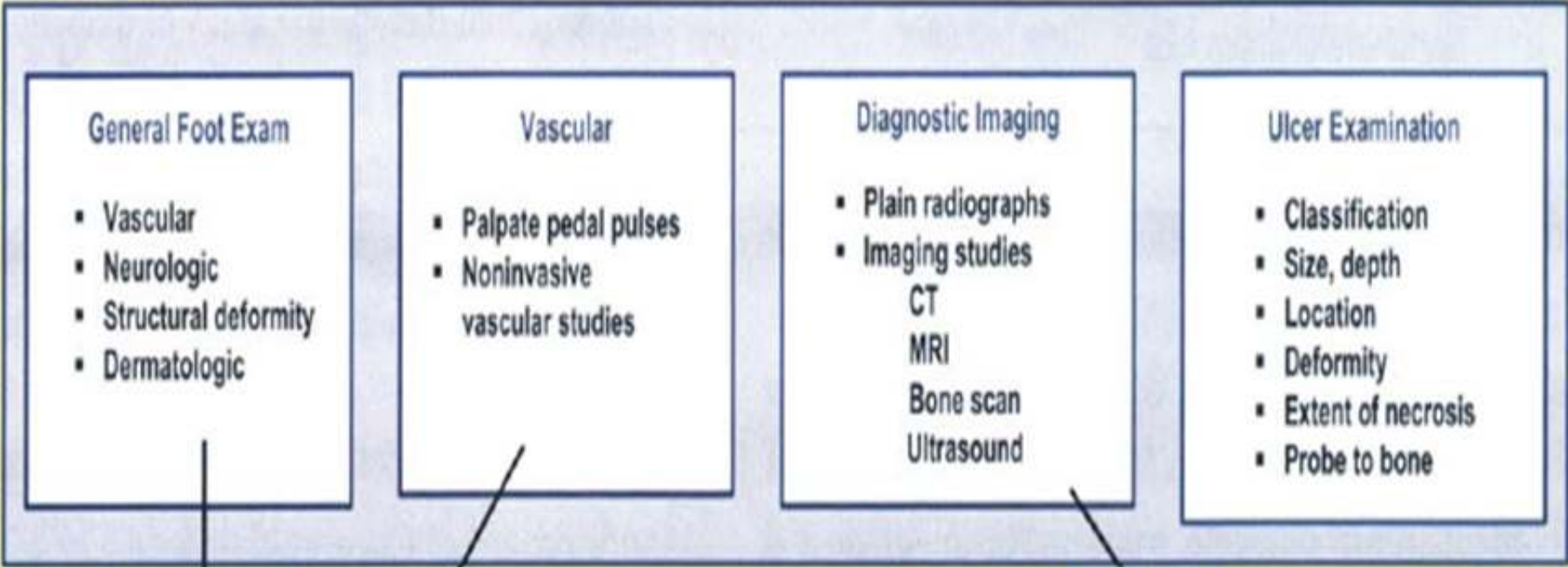
Diabetic Foot Ulceration

Refer to Pathway #1

SIGNIFICANT HISTORY

- Duration of ulcer
- Previous ulceration
- Pain / sensation
- Vascular history

* Additional Diagnostic Procedures as Indicated



General Foot Exam

- Vascular
- Neurologic
- Structural deformity
- Dermatologic

Vascular

- Palpate pedal pulses
- Noninvasive vascular studies

Diagnostic Imaging

- Plain radiographs
- Imaging studies
 - CT
 - MRI
 - Bone scan
 - Ultrasound

Ulcer Examination

- Classification
- Size, depth
- Location
- Deformity
- Extent of necrosis
- Probe to bone

Presence of
GANGRENE

PAD

INFECTION

Assessment of Diabetic foot ulcers



Skin / Ulcer

- description, depth, location, classification

Infection

- gram stain, cultures, radiographs, scans

Vascular

- pulses, color, skin temperatures, Doppler, TcPO₂

Neuropathy

- sensory disturbances, monofilament, VPT, DTRs



Deformity

- deformity, joint mobility, contractures

Etiology

- mechanical, thermal, chemical

Wagner ulcer classification*

Grade	Description
0	No ulcer, but high risk foot (bony prominences, callus, claw toes, etc)
1	Superficial full thickness ulcer
2	Deep ulcer, may involve tendons. No bone involvement
3	Deep ulcer with bone involvement: osteomyelitis
4	Localized gangrene, e.g., toes
5	Gangrene of whole foot

* Not specific for diabetes and not consider other factors (e.g., infection, neuropathy)



G1

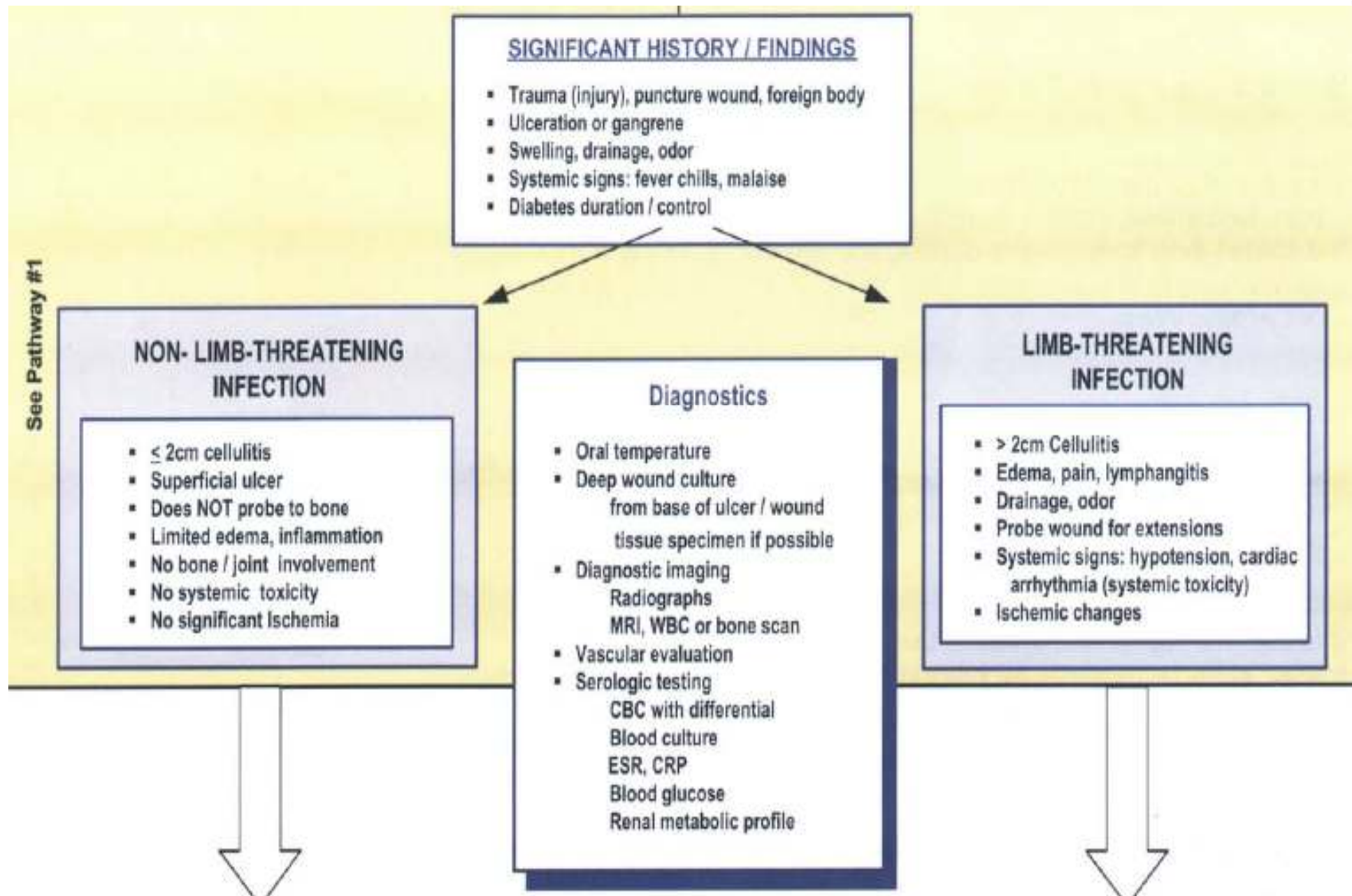


G2



G3

Diabetic Foot Infection

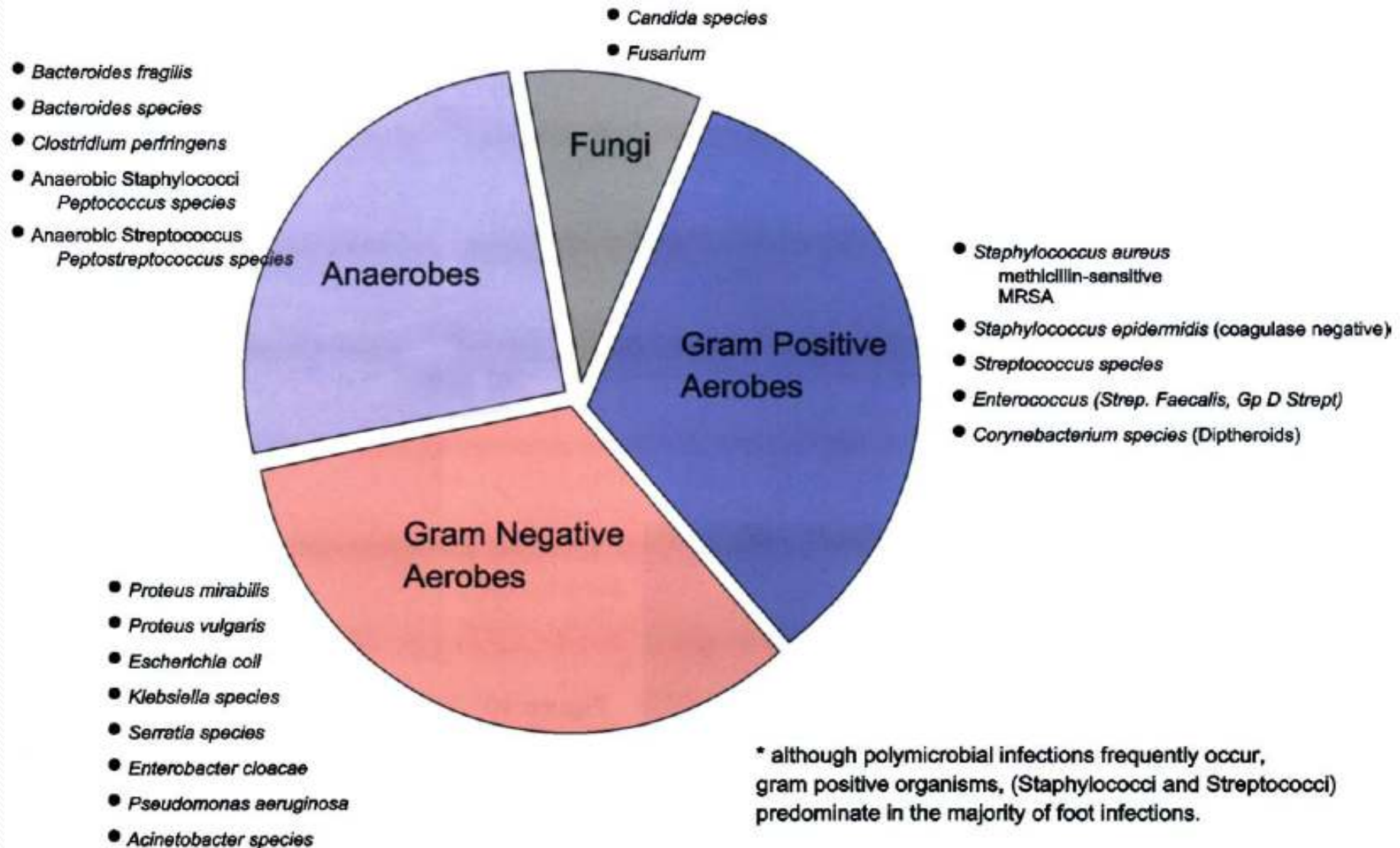


Infection in Diabetic Foot

- Absence fever or leukocytosis
- Organism; polymicrobial; G⁺ cocci, G⁻ rods (Pseudomonas), anaerobes
- Foul smelling ; suspicious anaerobic or enterococcal infection
- Culture study; swab to bone
- Gas(+) on X-ray; aerobic G⁺ cocci or G⁻rod

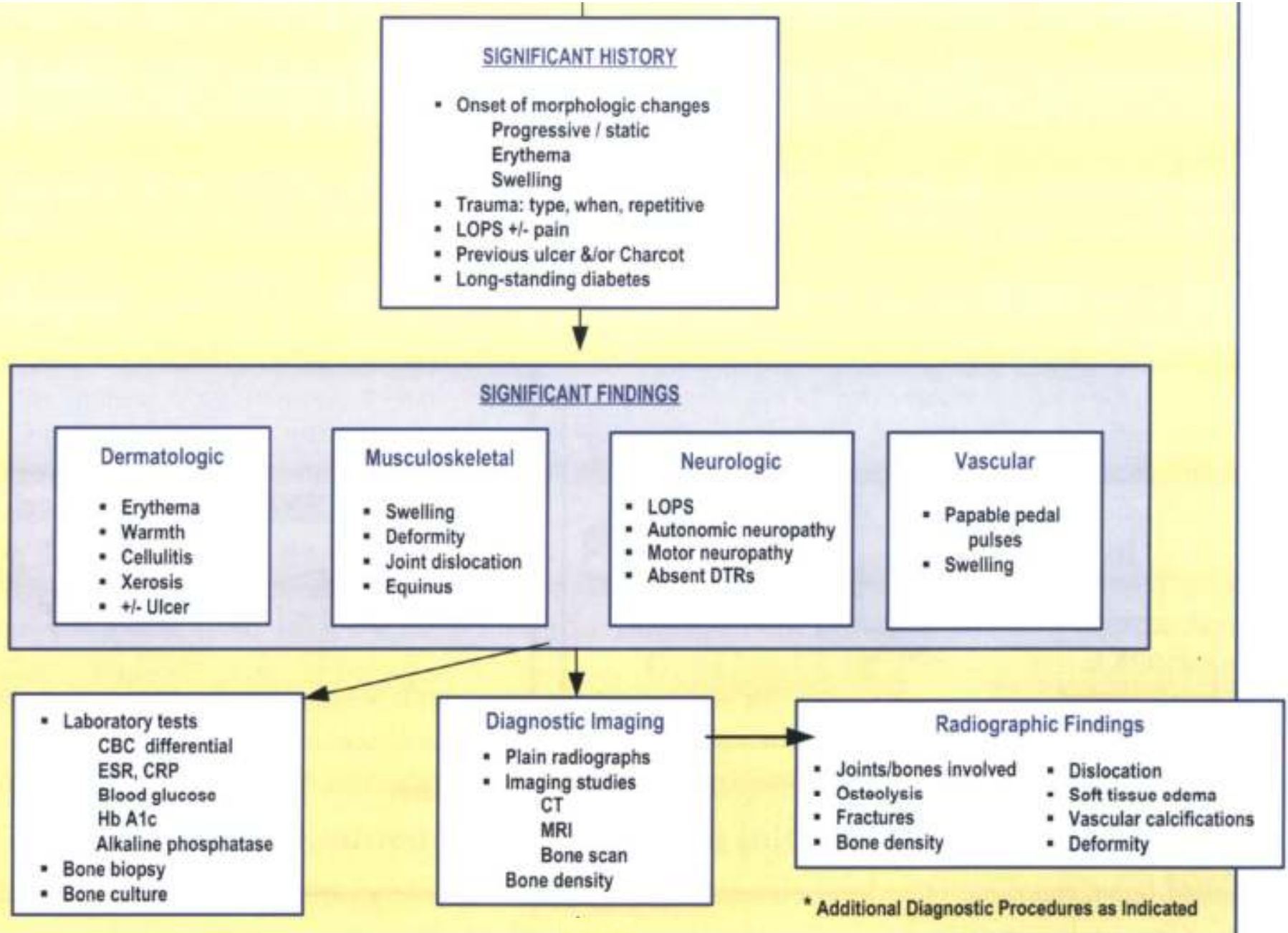


Polymicrobial Diabetic Foot Infections



Charcot Foot

Refer to Pathway #1

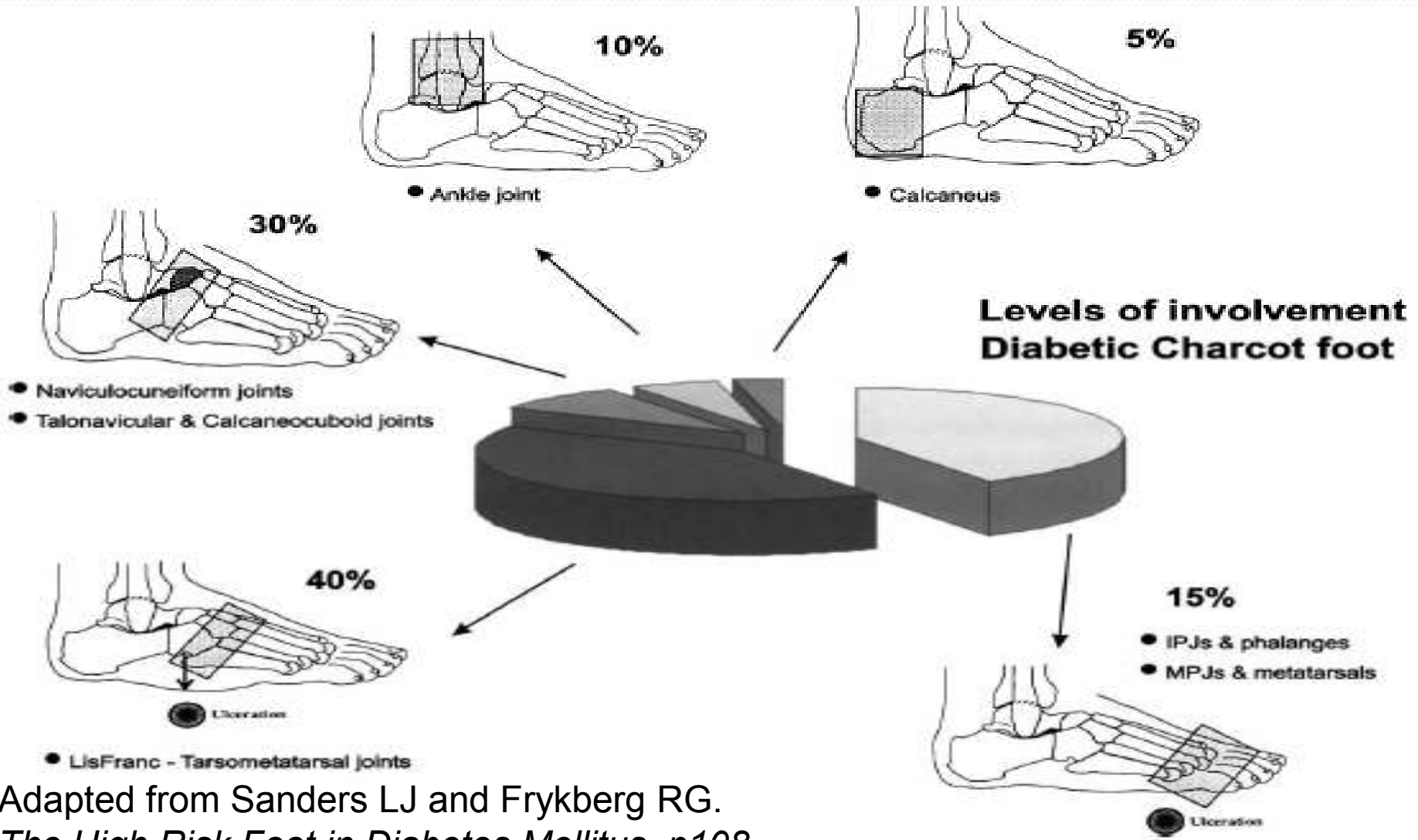


* Additional Diagnostic Procedures as Indicated

Neuropathic Ulcer: Charcot foot deformity.
Large painless ulcer on bottom of foot. Lateral x-ray demonstrates marked soft tissue swelling as well as bony destruction caused by underlying osteomyelitis



Charcot foot (Diabetic Neuroarthropathy)



Adapted from Sanders LJ and Frykberg RG.
The High Risk Foot in Diabetes Mellitus p108

Diabetic PAD

SIGNIFICANT HISTORY

- Rest Pain
- Previous ulceration or infection
- Claudication
- Smoker
- Metabolic syndrome



SIGNIFICANT FINDINGS

Examination

- Dermatologic: trophic changes, ulcer, gangrene
- Vascular: Poor or non-palpable pedal pulses

Clinical Maneuvers

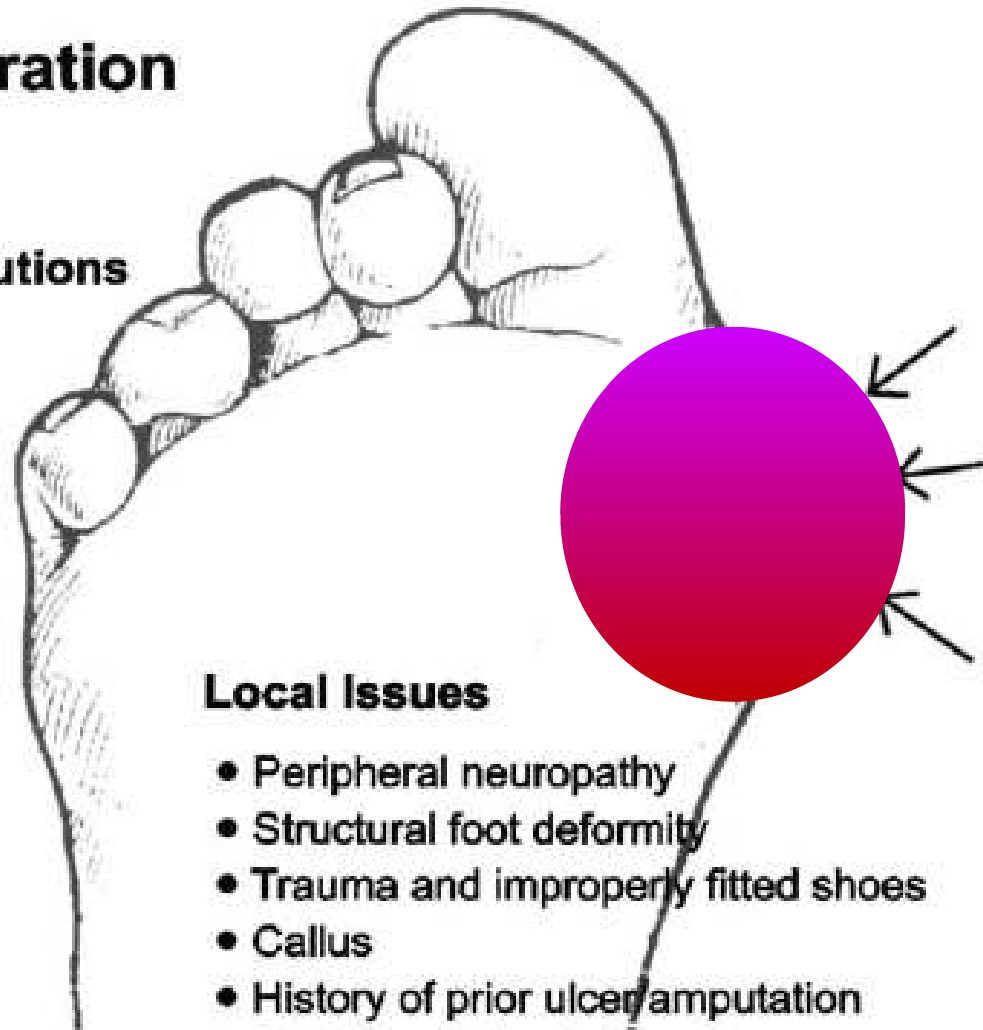
- Elevation pallor
- Dependent rubor



Risk Factors for Ulceration

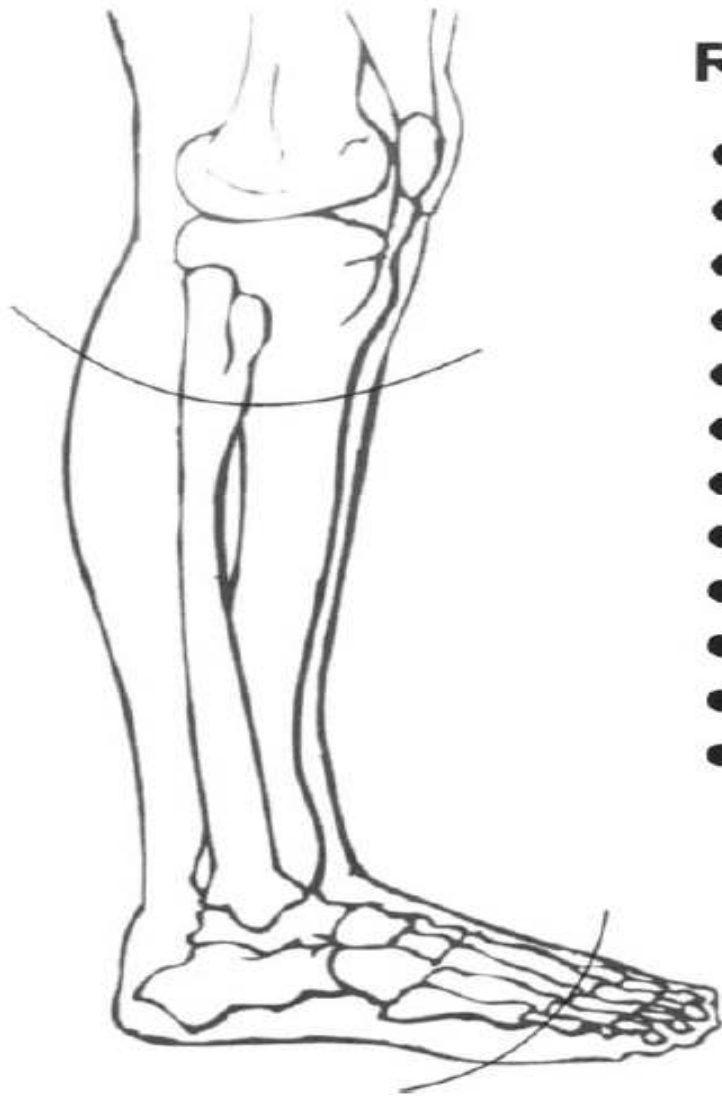
General or Systemic Contributions

- Uncontrolled hyperglycemia
- Duration of diabetes
- Peripheral vascular disease
- Blindness or visual loss
- Chronic renal disease
- Older age



Local Issues

- Peripheral neuropathy
- Structural foot deformity
- Trauma and improperly fitted shoes
- Callus
- History of prior ulcer/amputation
- Prolonged elevated pressures
- Limited joint mobility



Risk Factors for Amputation

- Neuropathy LOPS
- Peripheral arterial disease (PAD)
- Infection
- History of prior foot ulcer or amputation
- Structural foot deformity
- Trauma
- Charcot foot
- Impaired vision
- Poor glycemic control
- Older age
- Male Sex
- Ethnicity (greatest rates in blacks & Hispanics)

Frykberg RG et al. J Foot Ankle Surg. (2006)

Risk Categorization System

Category	Risk Profile	Evaluation Frequency
0	Normal	Annual
1	Peripheral neuropathy(LOPS)	Semi-annual
2	Neuropathy, deformity and/or PAD	Quarterly
3	Previous ulcer or amputation	Monthly to quarterly

Precipitating causes of foot ulcer and infection

- Friction in ill fitting or new shoes
- Untreated, self treated callus
- Foot injuries (eg, unnoticed trauma in shoes or when walking barefoot)
- Burns(eg, hot bath, water bottle, radiator , sand)
- Corn plaster
- Nail infections (paronychia)
- Heel friction in patients confined to bed
- Foot deformities



Clinical Manifestation

- Symptoms: neuralgia, swelling, discharge, ulceration, gangrene.
- Neuropathy
 - burning, searing, tingling sensation
 - 화끈거린다, 저리다, 시리다, 조인다, 이불이 스치면 괴로워 발을 내놓고 잔다.
 - worse at night
 - bilateral and symmetric
 - around ankle and foot

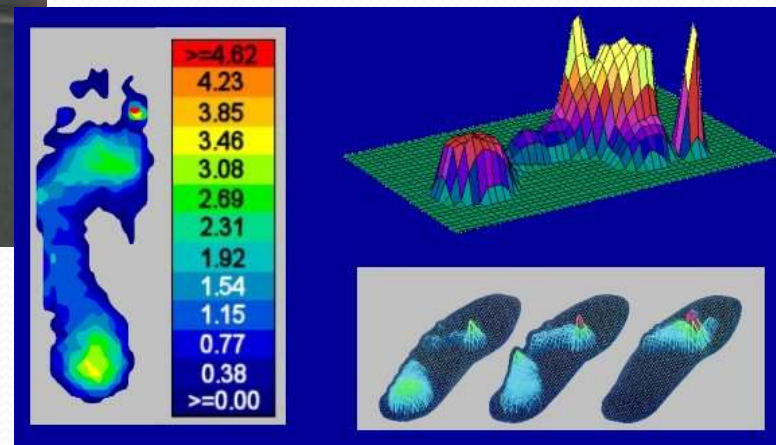


Physical Examination

- Evaluation of both feet
- Gait pattern and shoes
- ROM: ankle, toe, knee
- Shape of foot, foot arch
- Swelling, redness, warmth
- Deformity: bunion, claw toe, hind foot deformity
- Skin and nail condition
- Web condition



Pressure mat



Factors suggesting hospitalization

- Severe infection
- Metabolic instability
- IV therapy needed (and not available as outpatient)
- Diagnostic tests needed (not available as outpatient)
- Critical foot ischemia
- Surgical procedures required
- Compliance with treatment unlikely
- Complex dressing changes needed

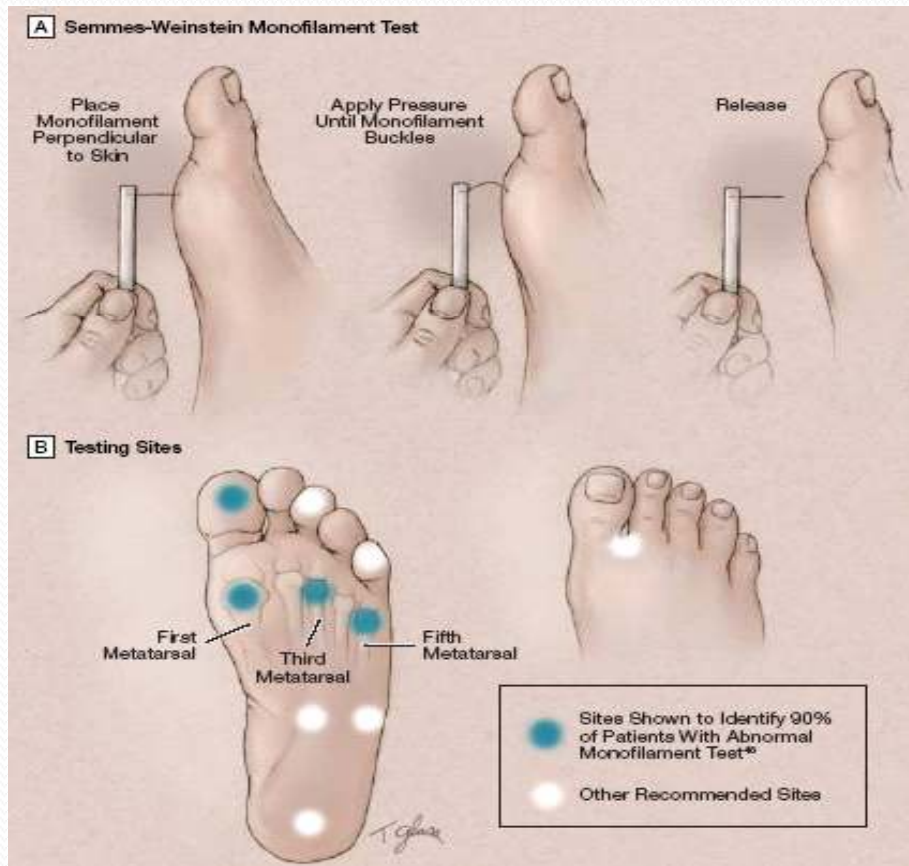


Neurologic Test

- Skin condition ; dry, flaking, crackled skin
- Sensory: Semmes-Weinstein monofilaments (5.07)
- D/Dx with other neurologic abnormality
 - Tinel sign for tarsal tunnel syndrome
 - DTR
 - EMG & NCV



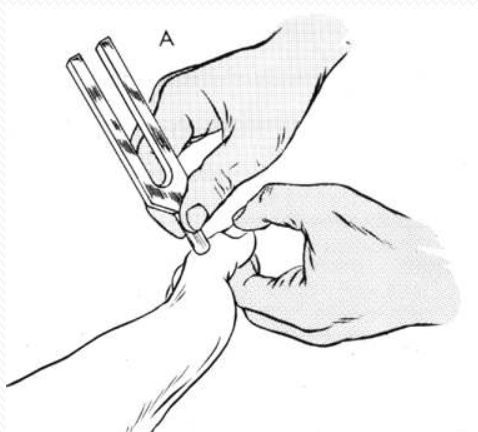
Use of Monofilament



JAMA. 2005;293:217-228



Vibration threshold measure machine



Quantitative Sensory Test machine



Vascular Studies

- P/E ; pulse, capillary filling, warmth, skin condition
- Ankle-Brachial arterial Index (ABI)
- Ankle pressure > 70mmHg,
Toe pressure > 40mmHg
- Doppler U/S and Pulse-Volume Recordings (PVRs)
- Oxymetry, TcPO₂
- Angiography

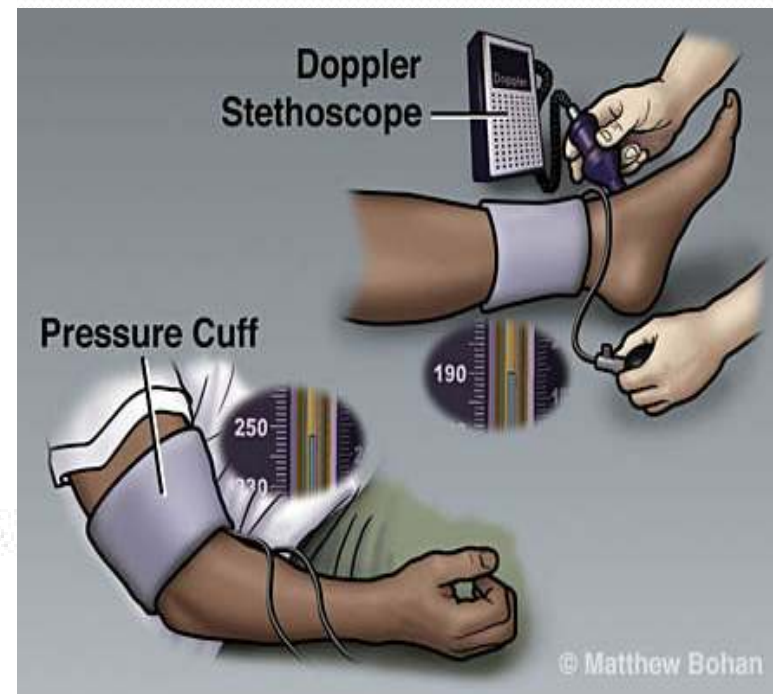
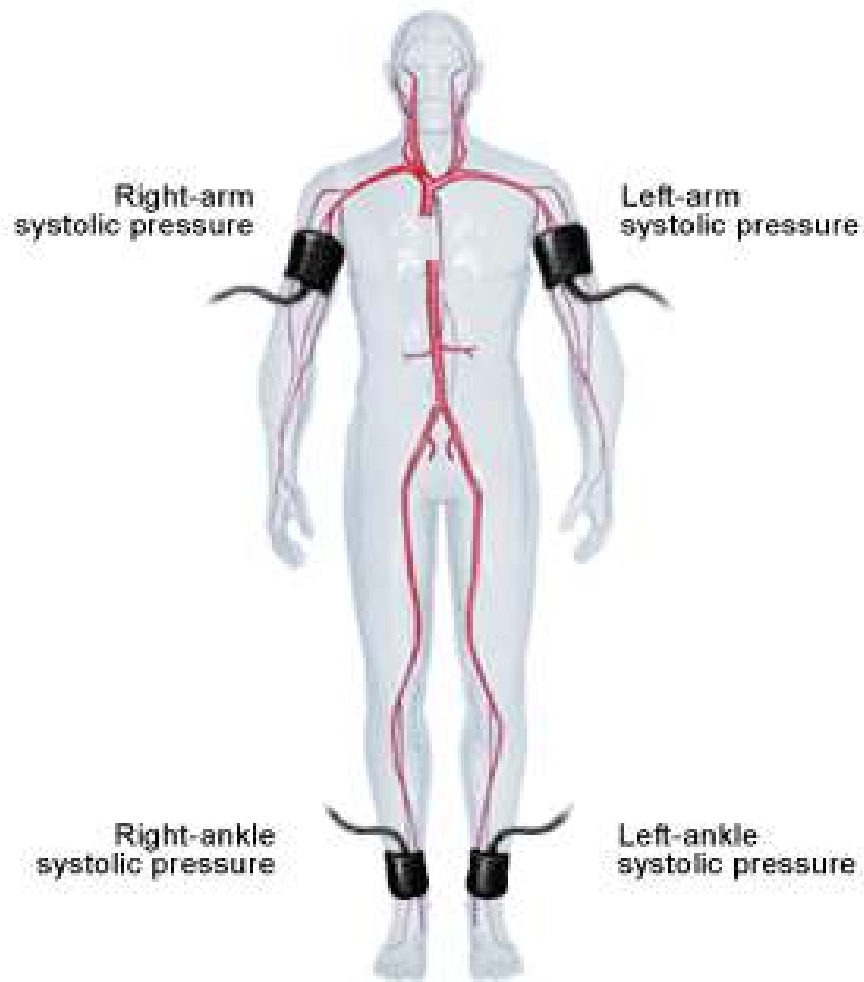


ABI -a sensitive parameter to confirm PAD

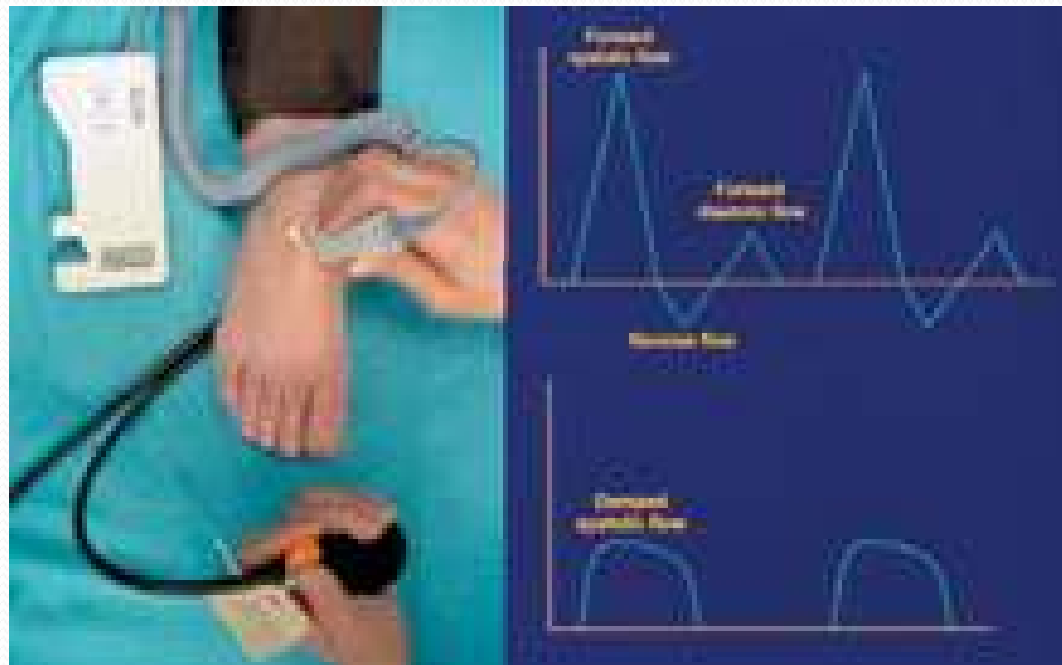
- Procedure:
 - Measure the systolic blood pressure by Doppler probe in the brachial and dorsalis pedis arteries of each sides use the highest of the brachial pressure (left or right)
 - use the highest ankle pressure (dorsalis pedis or posterior tibial) for each leg
 - calculate the ABI: divide the ankle pressure by the highest brachial pressure.
- Interpretation:
 - $ABI \geq 1.0$: normal
 - $ABI 0.8 - 1.0$: mild arterial occlusive disease
 - $ABI 0.5 - 0.8$: moderate arterial occlusive disease
 - $ABI \leq 0.5$: severe arterial occlusive disease



Ankle Brachial Index



Hand held Doppler Ultrasound



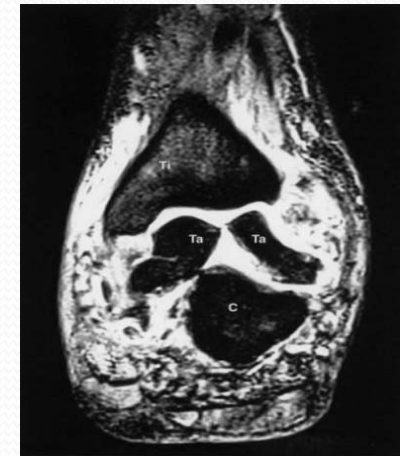
Laboratory Study

- Blood glucose (FBS, pp2)
- CBS and total lymphocyte
- ESR/CRP
- Protein, Alb
- Smear culture
- Measurement of foot pressure
- Foot printing



Imaging Study

- Simple X-ray:
 - Foot standing lateral, AP, oblique view
- MRI
- Bone Scan
- Gallium scan, Indium scan



Screening Methods for Diabetic Foot

	Monofilament (Light Touch Sensation)	Biothesiometer (Vibratory Sensation)	Tuning Fork (Vibratory sensation)	Pressure mat or Platform (Plantar pressure)
선별검사 양성 기준	≥ 1 Insensate site	Vibration perception threshold >25V	Patient loses vibration while examiner still perceives it	Cutoffs: ≥59 N/cm² ;≥70 N/cm² ;≥87.5 N/cm²;
민감도 %	66-91	83-86	55-61	57;70;64
특이도 %	34-86	57-63	59-72	70;65;46
Comment	Inexpensive, quick, widely available, validated; number of test sites needed unclear	Accuracy similar to monofilament, but more expensive and not as widely available	Inexpensive, quick, widely available, less predictive than monofilament	Numerical value of plantar pressure is device-specific; optimal cutoff unknown



Multidisciplinary Team Approach

- Endocrinology
- Orthopedic surgery
- Vascular surgery
- Plastic surgery
- Neurology
- Orthosis or Shoe
- Rehabilitation
- Physical medicine



Conclusion

- Diabetic foot problems result in major medical, social, and economic consequences for patients, their families, and society
- Neuropathy is the major contributory factor in the pathogenesis of diabetic foot ulcers
- All patients with diabetes should have a thorough foot examination at least annually



Thank you for your attention for
your patients foot!!

