Case Based Discussions - Diabetic Foot

Mr David Russell

Associate Professor in Vascular Surgery, Leeds

Vascular Lead, Leeds Diabetes Limb Salvage Service

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Diabetes Related Amputation in England

BBC NEWS

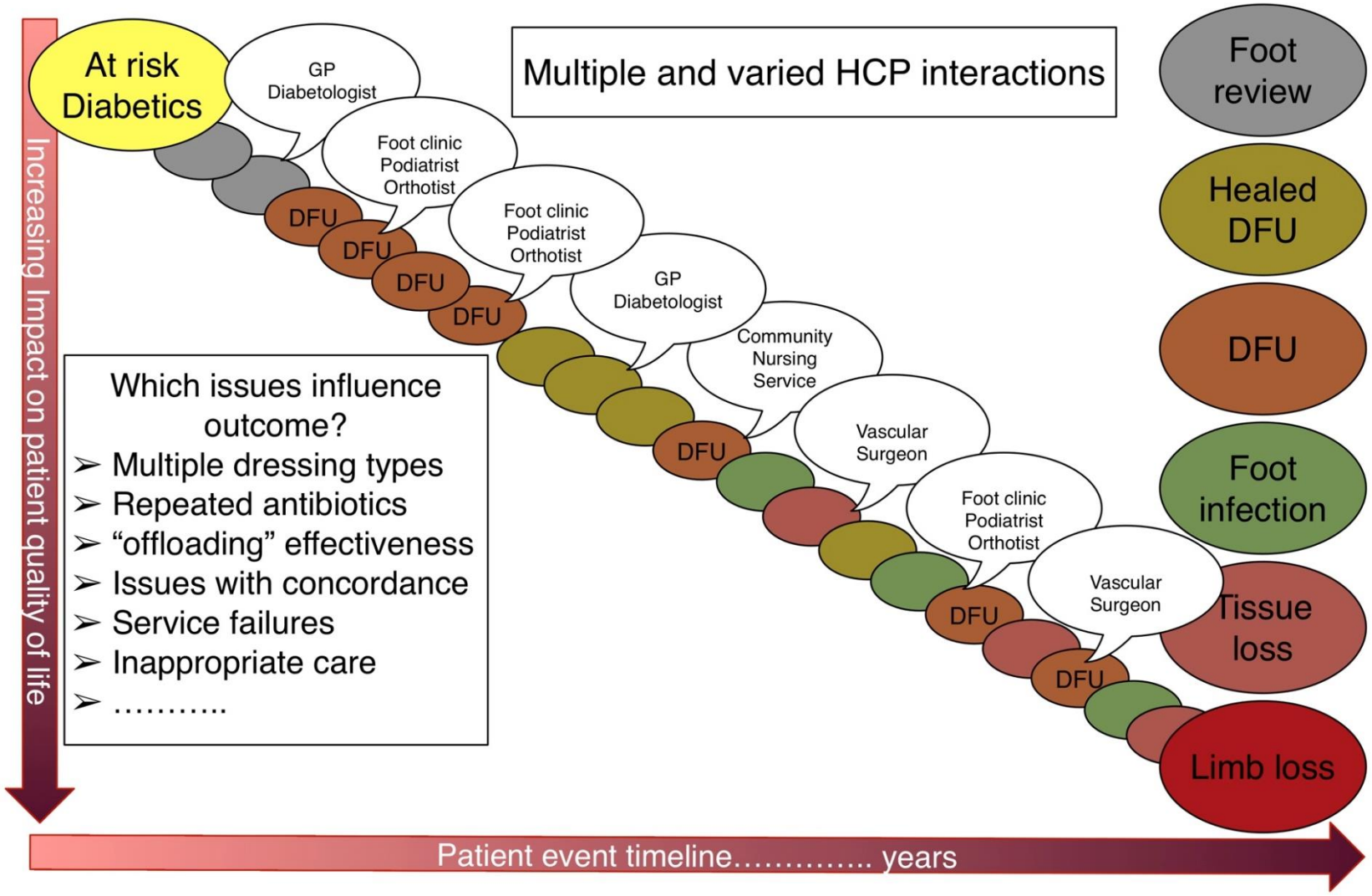
Home UK World Business Politics Te

Fear over high rates of diabetes foot amputations

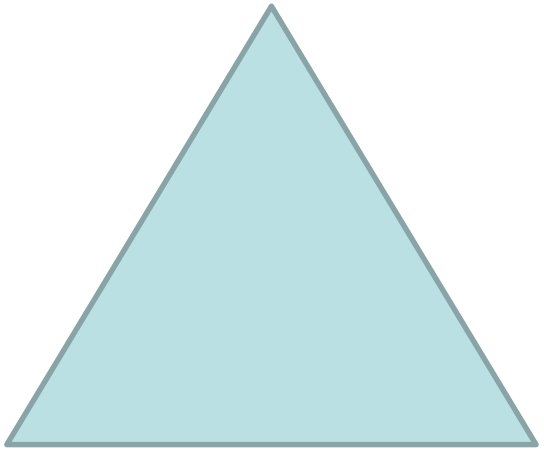
27 April 2022

Major differences in the rate of foot amputations for people with diabetes in England are incredibly concerning, patient groups say.

One patient's foot pathway

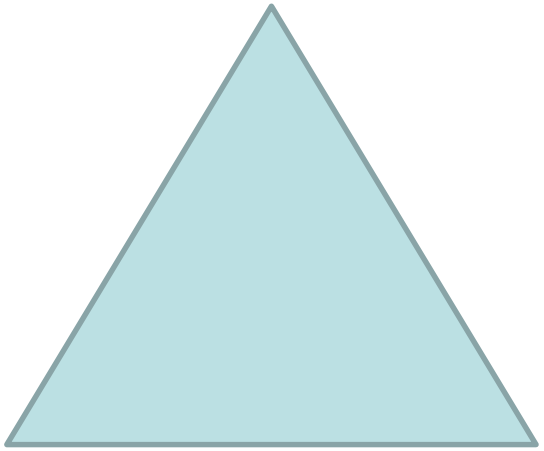


The Diabetic Foot



The Diabetic Foot

Neuropathy



Infection

Ischaemia

Learning Objectives

- Understand the aetiology of diabetic foot problems
- Be aware of the strategies to prevent and manage diabetic foot complications
  - Risk stratification
  - Offloading
  - Management of infection
  - Assessment and management of ischaemia

Case History

- 56 year old gentleman
- New diagnosis Type 2 diabetes

- What foot care should be put in place?

Assessment of the Intact Diabetic Foot (NG19)

Assessment in the Community (Trained Individual)

Low Risk:
No risk factors except callus alone

Annual inspection:
Inspect for deformity
Test sensation
- 10g monofilament
- vibration

Palpate foot pulses
Inspect footwear

Patient Education

Increased Risk:
Deformity or Neuropathy or Non-critical ischaemia
3-6 monthly review by foot protection team:

Patient Education
Evaluate biomechanics and footwear
Re-assess vascular status
Liaise to optimise diabetes and risk factors

High Risk:
Previous ulcer/amputation or RRT or Neuropathy+limb ischaemia or Neuropathy+callus/deformity or Ischaemia+callus/deformity
1-2 monthly review:
Intensified patient education
Specialist footwear
Re-assess vascular status
Skin and nail care
Risk factor management

Case History

- Same 56yr gentleman
- Has foot check, no palpable pulses but good signal on HHD so defined as low risk. No foot care education.
- Develops plantar 5th MT head ulcer
  - Managed by GP for 3 months
  - 2 short courses antibiotics (flucloxacillin 250mg qds for 7 days)
  - Progressing so sent in to Limb Salvage MDT clinic

Case History

- What is the initial assessment and management in clinic?

Case History

- What is the initial assessment and management in clinic?

History and risk factors

Lifestyle and social factors

Neuropathy

Vascular assessment

Wound assessment

Vascular Assessment

- Neuropathy is associated with medial calcinosis and abnormal autonomic responses which affects all recognised bedside tests
  - ABPI inaccurate in 40%
  - TBI inaccurate / not measurable in 30%

Assessment of Ischaemia

	Sensitivity	Specificity	Positive predictive value	Negative predictive value	Positive likelihood ratio	Negative likelihood ratio
Either pedal pulse	0.55 (0.33–0.77)	0.60 (0.45–0.75)	0.41 (0.22–0.59)	0.73 (0.58–0.88)	1.38 (0.79–2.38)	0.75 (0.43–1.30)
Hair loss	0.8 (0.62–0.98)	0.44 (0.28–0.59)	0.42 (0.26–0.58)	0.81 (0.64–0.98)	1.42 (1.00–2.02)	0.46 (0.18–1.18)
Atrophy	0.5 (0.28–0.72)	0.87 (0.77–0.98)	0.67 (0.43–0.91)	0.77 (0.65–0.90)	3.9 (1.54–9.87)	0.57 (0.36–0.90)
Dependent rubor	0	1	Not discriminatory*	0.66 (0.54–0.78)	Not discriminatory*	1
Cool skin	0.3 (0.10–0.50)	0.90 (0.80–0.99)	0.6 (0.30–0.90)	0.71 (0.59–0.84)	2.93 (0.93–9.19)	0.78 (0.57–1.06)
Blue/purple skin	0	0.92 (0.84–1.01)	0	0.64 (0.51–0.76)	0	1.09 (0.99–1.19)
Capillary refill	0.42 (0.20–0.64)	0.63 (0.48–0.78)	0.36 (0.16–0.56)	0.69 (0.53–0.84)	1.14 (0.58–2.24)	0.92 (0.58–1.44)
Venous filling	0	1	Not discriminatory†	0.65 (0.51–0.79)	Not discriminatory†	1
Ankle pressure	0.47 (0.25–0.70)	0.79 (0.66–0.92)	0.55 (0.29–0.77)	0.75 (0.62–0.88)	2.25 (1.05–4.96)	0.67 (0.42–1.05)
Toe pressure	0.45 (0.23–0.67)	0.97 (0.92–1.00)	0.90 (0.71–1.00)	0.78 (0.66–0.89)	17.55 (2.39–128.96)	0.56 (0.38–0.84)
Toe brachial pressure index	0.89 (0.76–1.00)	0.45 (0.29–0.61)	0.45 (0.29–061)	0.89 (0.76–1.00)	1.62 (1.17–2.2)	0.24 (0.06–0.91)
Ankle brachial pressure 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)
Pole test at ankle	0.28 (0.07–0.48)	0.97 (0.92–1.00)	0.83 (0.54–1.00)	0.73 (0.61–0.86)	10.29 (1.29–81.60)	0.74 (0.55–0.99)
$TcPo_2$	0.28 (0.07–0.48)	0.66 (0.51–0.81)	0.28 (0.07–0.48)	0.66 (0.51–0.81)	0.81 (0.34–1.93)	1.10 (0.76–1.58)
Waveform analysis	0.85 (0.69–1.00)	1‡	1‡	0.93 (0.85–1.00)	Diagnoses PAD‡	0.15 (0.05–0.43)

Values in parentheses are 95% CI.
*Not discriminatory because dependent rubor was not elicited in any patient.
†Not discriminatory because impairment of venous filling was not elicited in any patient.
‡The gold standard definition of peripheral arterial disease (PAD) used included monophasic (damped) waveforms in any vessel, therefore the specificity and positive predictive value ratios are 1 and, positive likelihood is effectively infinite and diagnoses PAD.

Vriens B et al. Diabet. Med. 2018; 35: 895–902

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Wound Assessment

- TIME
- Tissue
  - Debridement of non-viable material
    - Surgical/hydrosurgical
    - Enzymatic
    - Hydrolytic
- Infection/Inflammation
- Moisture imbalance
- Edge of wound

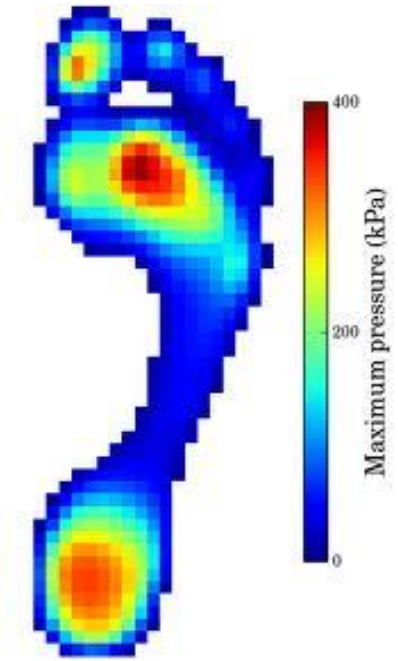
Wound Assessment

- Classification systems
  - Texas
  - WIfI
  - SINBAD

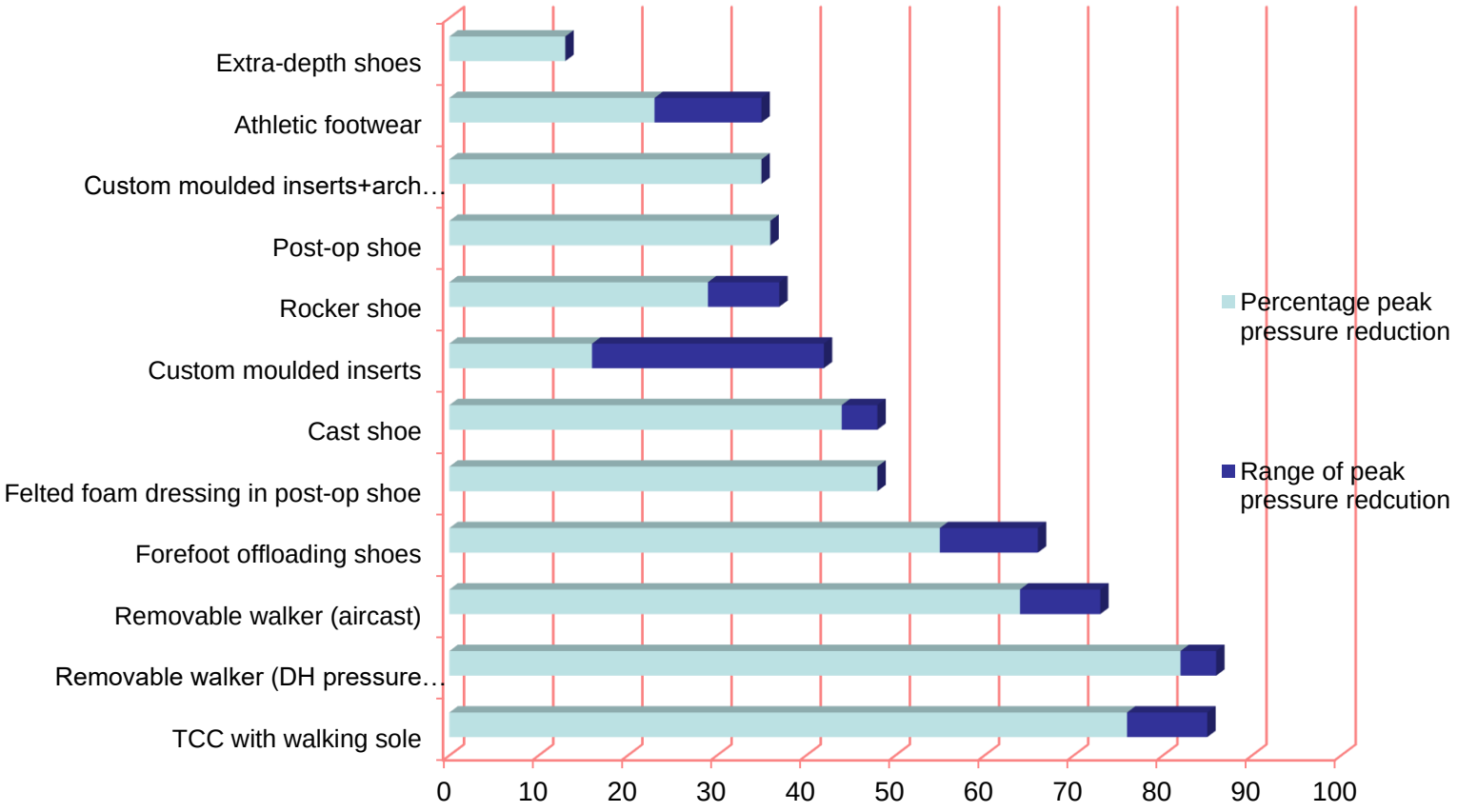
Category	Definition	SINBAD
Site	Forefoot	0
	Midfoot and hindfoot	1
Ischemia	Pedal blood flow intact: at least one pulse palpable	0
	Clinical evidence of reduced pedal blood flow	1
Neuropathy	Protective sensation intact	0
	Protective sensation lost	1
Bacterial infection	None	0
	Present	1
Area	Ulcer $<1 cm^2$	0
	Ulcer $\geq 1 cm^2$	1
Depth	Ulcer confined to skin and subcutaneous tissue	0
	Ulcer reaching muscle, tendon or deeper	1
Total possible score		6

Off-loading the diabetic foot

- Peak pressures up to 1000kPa
- Repetitive pressure insult, with shear forces, leads to ulceration
- Misnomer – all strategies aim to redistribute pressure

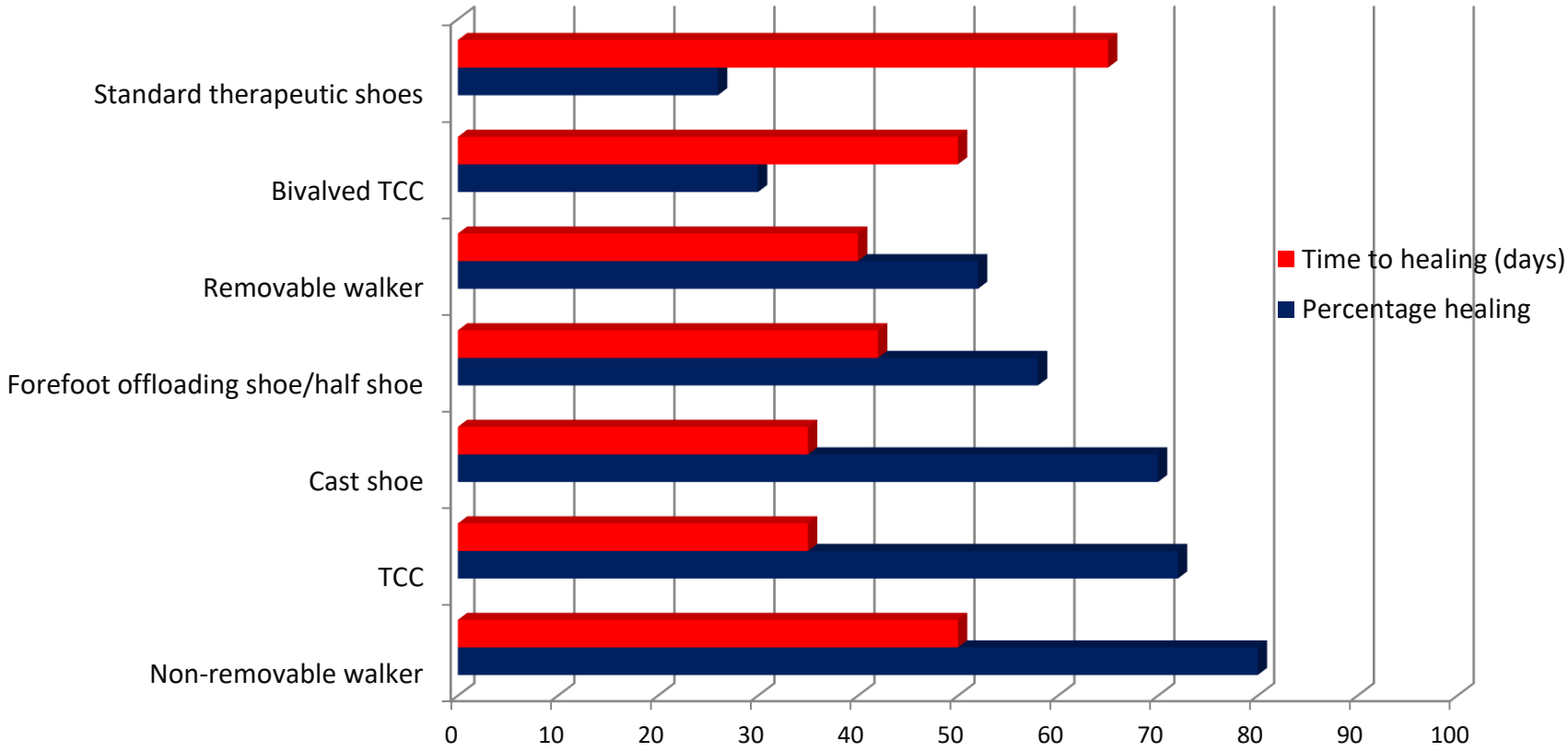


Off-loading footwear – pressure reduction



Modified from Cavanagh PR et al. JVS 2010; 52(12S): 37S-43S

Off-loading footwear – healing



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Off-loading footwear - problems

- Both NICE and IWGDF recommend TCC
  - Contra-indicated in infection and significant ischaemia
  - Long application time
  - Only offered as routine footwear in 2% US centres[2]
- Compliance is poor with removable devices[1]
- iTCC quicker to apply, equally effective[3]

1. Armstrong DG et al. Diabetes Care 2003; 26: 2595-7
2. Wu SC et al. Diabetes Care 2008; 31(11): 2118-9
3. Armstrong DG et al. Diabetes Care 2005; 28(3): 551-4

Off-loading – surgical options

- Consider implications of debridement and minor amputation decisions
- Study of 90 hallux or 1st ray amputees
  - 60% 1 further amputation
  - 21% 2 further amputations
  - 7% 3 further amputations

Murdoch DP et al. Journal Foot and Ankle Surgery 1997; 36(3): 204-8

Off-loading – surgical options

- Percutaneous Achilles tendon lengthening
  - Reduces forefoot pressures and helps healing and minimises recurrent of plantar forefoot ulceration[1]
  - Reduces recurrent ulceration following transmetatarsal amputation

1. Frykberg RG et al. Surgical off-loading of the diabetic foot JVS 2010; 52(12S): 44S-58S

Off-loading – surgical options

- Digital ulcers
  - Tenotomy
  - Arthroplasty
- Charcot foot
  - Exostectomy
  - Midfoot, hindfoot and ankle arthrodesis
- Plantar forefoot ulcers
  - Metatarsal osteotomy
  - Metatarsal head excision

Case History

- Despite off-loading and best wound care, has now developed cellulitis around ulcer, dorsal 5th MT head and tracking to midfoot.
  - Systemically well
  - CBG 15mmol/mol
  - Ulcer probes to bone

- What is your management plan?

Diagnosis- Soft tissue infection

Clinical Manifestation of Infection	PEDIS Grade	IDSA Infection Severity
No symptoms or signs of infection	1	Uninfected
Infection present, as defined by the presence of at least 2 of the following items: • Local swelling or induration • Erythema • Local tenderness or pain • Local warmth • Purulent discharge (thick, opaque to white or sanguineous secretion)		
Local infection involving only the skin and the subcutaneous tissue (without involvement of deeper tissues and without systemic signs as described below). If erythema, must be >0.5 cm to ≤2 cm around the ulcer. Exclude other causes of an inflammatory response of the skin (eg, trauma, gout, acute Charcot neuro-osteoarthropathy, fracture, thrombosis, venous stasis).	2	Mild
Local infection (as described above) with erythema > 2 cm, or involving structures deeper than skin and subcutaneous tissues (eg, abscess, osteomyelitis, septic arthritis, fasciitis), **and** No systemic inflammatory response signs (as described below)	3	Moderate
Local infection (as described above) with the signs of SIRS, as manifested by ≥2 of the following: • Temperature >38°C or <36°C • Heart rate >90 beats/min • Respiratory rate >20 breaths/min or $PaCO_2$ <32 mm Hg • White blood cell count >12 000 or <4000 cells/μL or ≥10% immature (band) forms	4	Severe[a]

Abbreviations: IDSA, Infectious Diseases Society of America; $PaCO_2$, partial pressure of arterial carbon dioxide; PEDIS, perfusion, extent/size, depth/tissue loss, infection, and sensation; SIRS, systemic inflammatory response syndrome.

[a] Ischemia may increase the severity of any infection, and the presence of critical ischemia often makes the infection severe. Systemic infection may sometimes manifest with other clinical findings, such as hypotension, confusion, vomiting, or evidence of metabolic disturbances, such as acidosis, severe hyperglycemia, and new-onset azotemia [29, 43, 44].

IDSA (Lipsky *et. al.* 2012)

Diagnosis- Osteomyelitis

- Clinical
  - "Sausage toe"
  - Depth and size of ulcer
    - Not sensitive or specific when used alone (Dinh 2008; Butalia 2008)
  - Probe to Bone Test (PTB)
    - PPV= 0.57; NPV= 0.98 [~20% prev.] (Lavery 2007)
    - PPV= 0.95; NPV= 0.91 [~80% prev.] (Lozano 2010)

Diagnosis- Osteomyelitis

- Bone Biopsy Histology:
  - Used as reference standard
  - *Meyr et. al.* 2011- Complete agreement in 1/3 of specimens only
  - *Weiner et. al.* 2011- as likely to find a false negative with histology as with microbiology
- Bone Biopsy Culture:
  - Sensitivity 75% (NPV 39%) (*Weiner* 2011)
  - Contamination if taken through base of wound
  - High False Neg rate (ABx exposure, small sample volume etc.)
- Combined Histo/Micro Bone Bx
  - Sensitivity improves to 84% (*Weiner 2011; White 1995*)

Diagnosis- Osteomyelitis

- Radiology
  - Plain XR:
    - Sensitivity 0.54 (CI 0.44–0.63)

    (timing of test/pop. prevalence)

    - Specificity 0.91 (CI 0.86–0.94)
  - MRI:
    - Sensitivity 0.90 (CI 0.82–0.95)
    - Specificity 0.79 (CI 0.62–0.91)

(*Dinh 2008*)

Diagnosis- Osteomyelitis

- Less useful Investigations:
  - Bone Scan (Sens. 81% / Spec. 28%)
  - Labelled WBC scan (Sens. 74% / Spec. 68%)
  - Needle aspiration: 23-46% correlation to bone culture
  - Sinus Tract swabs: 44% correlation to bone culture but possibly better with consecutive cultures

Sampling- Osteomyelitis

- Why?
  - Improved outcomes (Senneville *et. al.* 2008)
  - Reduced resistance
- Open or Percutaneous Bone Biopsy
  - Pros
    - Clean contamination free specimen
  - Cons
    - Difficult to obtain in timely fashion
    - Technically difficult from distal bones
    - Creates further breech in skin integrity
    - Small volume specimens

Antibiotics vs Surgical Management

- Significant biomechanical sequelae to minor amputation / bone excision
- Meta-analysis of 435 hallux amputations[1]
  - 19.8% re-amputation at 26 month follow-up
    - Additional digit 37.2%
    - TMA 32.6%
    - BKA 29.1%
- 82% 12 month remission rate in patients treated primarily with 6 weeks of targeted antibiotic therapy[2]
- RCT showed no difference in primary healing surg vs ABs[3]

1. Borkosky SL et al Diabetic Foot and Ankle 2012; 3: 12169
2. Game FL et al Diabetologia 2008; 51(6): 962-967
3. Lazaro-Martınez JL et al. Diabetes Care 2014;37:789–795

Antibiotic Treatment- Principles

- DFI is different to other soft tissue infections
- Antibiotic Resistance
    - Be sure of the diagnosis (to avoid over-prescribing)
    - Good Sampling: Empiric → Targeted regimen
- Site/Depth of infection
- IV vs. Oral
- Duration

Antibiotic Treatment- Duration

Site of Infection, by Severity or Extent	Route of Administration	Setting	Duration of Therapy
Soft-tissue only			
Mild	Topical or oral	Outpatient	1–2 wk; may extend up to 4 wk if slow to resolve
Moderate	Oral (or initial parenteral)	Outpatient/ inpatient	1–3 wk
Severe	Initial parenteral, switch to oral when possible	Inpatient, then outpatient	2–4 wk
Bone or joint			
No residual infected tissue (eg, postamputation)	Parenteral or oral	…	2–5 d
Residual infected soft tissue (but not bone)	Parenteral or oral	…	1–3 wk
Residual infected (but viable) bone	Initial parenteral, then consider oral switch	…	4–6 wk
No surgery, or residual dead bone postoperatively	Initial parenteral, then consider oral switch	…	≥3 mo

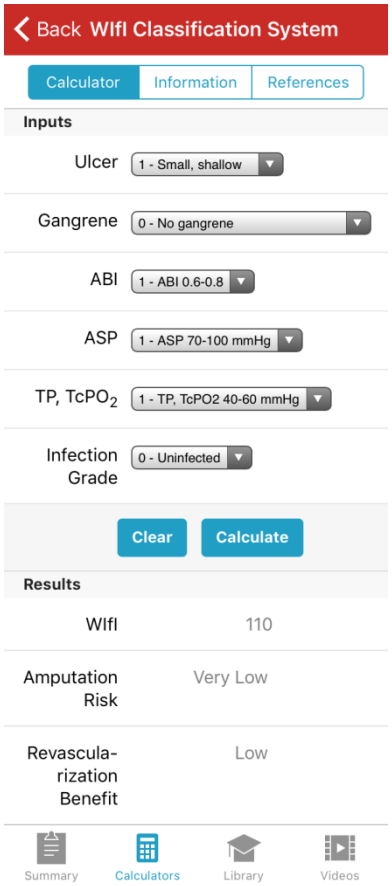
Revascularisation

- No good test to determine need for revascularisation:
  - ABPI <0.5
  - Ankle systolic pressure <50 or <70mmHg
  - Toe pressure <30mmHg
  - $TcPO_2$ <30mmHg
- Be more aggressive with infection and large soft tissue defects
- Good quality imaging including the foot
- BEST-CLI vs BASIL-2

WIfI

- Validated scoring system
  - Wound extent
  - Degree of ischaemia
    - ABPI
    - Ankle systolic pressure
    - TBI/$TcPO_2$
  - Foot infection
- App available for smartphone
- Real time decision making

WIfI


Back WIfI Classification System
Calculator
Information
References
Inputs
Ulcer
1 - Small, shallow
Gangrene
0 - No gangrene
ABI
1 - ABI 0.6-0.8
ASP
1 - ASP 70-100 mmHg
TP, TcPO2
1 - TP, TcPO2 40-60 mmHg
Infection Grade
0 - Uninfected
Clear
Calculate
Results
WIfI
110
Amputation Risk
Very Low
Revascula-rization Benefit
Low
Summary
Calculators
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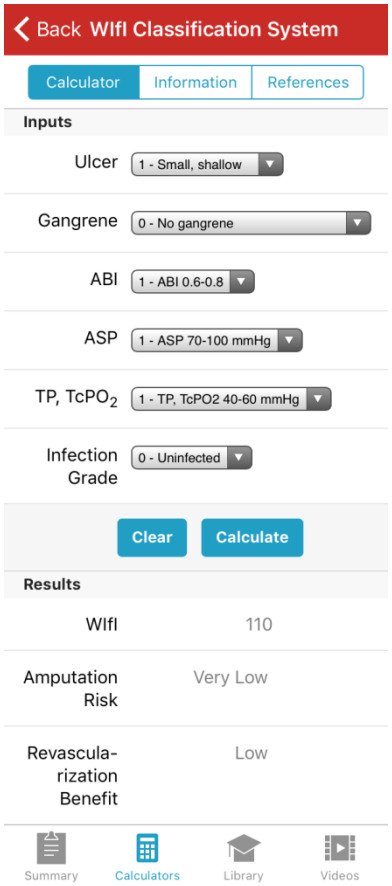
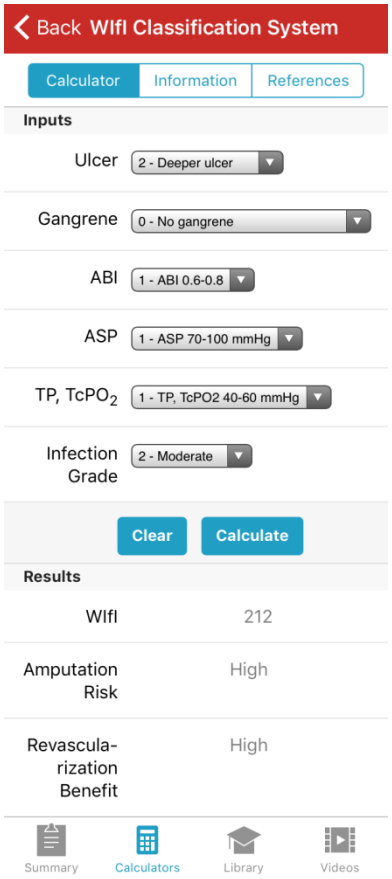
Videos

WIfI


Back WIfI Classification System
Calculator
Information
References
Inputs
Ulcer
1 - Small, shallow
Gangrene
0 - No gangrene
ABI
1 - ABI 0.6-0.8
ASP
1 - ASP 70-100 mmHg
TP, TcPO2
1 - TP, TcPO2 40-60 mmHg
Infection Grade
0 - Uninfected
Clear
Calculate
Results
WIfI
110
Amputation Risk
Very Low
Revascula-rization Benefit
Low
Summary
Calculators
Library
Videos


Back WIfI Classification System
Calculator
Information
References
Inputs
Ulcer
2 - Deeper ulcer
Gangrene
0 - No gangrene
ABI
1 - ABI 0.6-0.8
ASP
1 - ASP 70-100 mmHg
TP, TcPO2
1 - TP, TcPO2 40-60 mmHg
Infection Grade
2 - Moderate
Clear
Calculate
Results
WIfI
212
Amputation Risk
High
Revascula-rization Benefit
High
Summary
Calculators
Library
Videos

Case History

- 63 year old Type 2 diabetic
- Flu like symptoms for 3 days
- CBG 29mmol/mol
- Noticed some swelling and pain in left foot over last 48 hours
- Management plan?

Drainage of Sepsis - When I do it

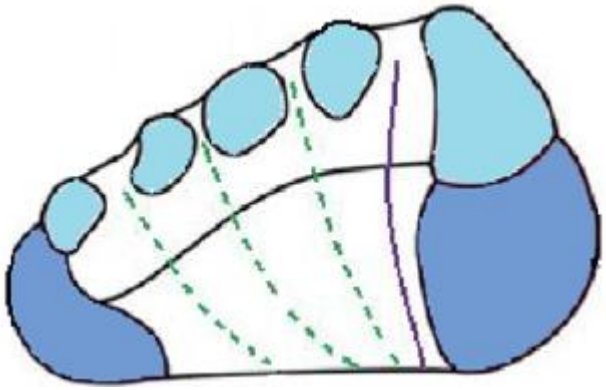
- Considerations:
  - Infection vs ischaemia
  - Debridement vs definitive management
  - Residual biomechanics
- Pus needs urgent drainage and debridement
  - Fluctuance
  - Deep plantar tenderness (especially with dorsal erythema)
  - Pus following debridement of unhealthy tissue
  - Remote sinuses
  - Soft tissue gas on plain Xray
- “Time is tissue”

Drainage of Sepsis - How I do it

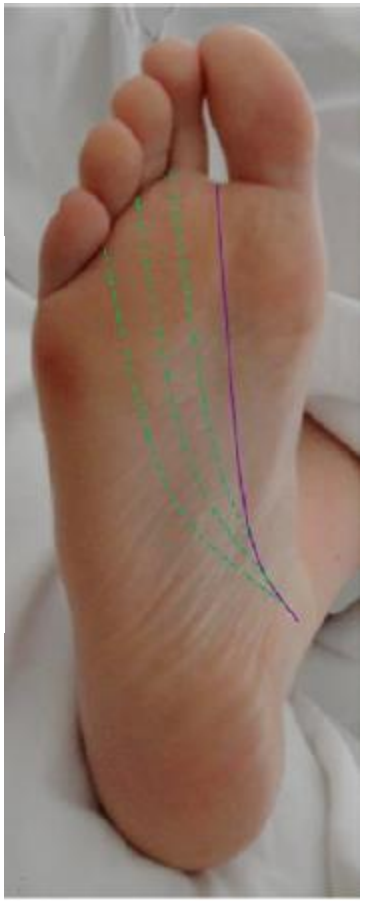
- MDT approach
- Fluid resuscitation as required
- Pus/deep tissue sample antibiotic naive
- Early antibiotic therapy (broad spectrum as per local policy)

Drainage of Sepsis - How I do it

- Loeffler-Ballard incision
- Debridement to healthy tissue
  - White
  - Yellow
  - Pink
  - Healthy vessels
  - Bleeding skin edges



- Clean tissue for microbiology and histology
- Preserve healthy tissue for reconstruction



Drainage of Sepsis - How I do it

- Negative pressure therapy post-op
- May need serial debridements
- Urgent vascular imaging and revascularisation (open)
- Antibiotics
  - Based on clean tissue and bone specimens
  - 2 weeks for soft tissue
  - 6 weeks for bone
- ?role for local antibiotics

Examples

Examples

Use of Available Tissue

- Reconstructive options:
  - Need to consider at time of first debridement
  - MDT discussion
  - Use available soft tissue for local flaps
  - Split skin graft
  - Free flaps
  - Dermal substitutes

- May need tendon transfer for ongoing stability

Use of Available Tissue











Dermal Substitutes

Dermal Substitutes

Dermal Substitutes

Free Flaps

Free Flaps

Prostheses

Prostheses

Prostheses

Sepsis Management Conclusions

- Diabetic foot collections require urgent drainage
- All infected, unhealthy, ischaemic tissue must be removed
- Loeffler-Ballard incision allows access to all plantar compartments whilst preserving skeleton and healthy soft tissue for future reconstruction
- Clean tissue and bone samples will help to guide antibiotic therapy
- All cases must be managed within a multidisciplinary team

Learning Objectives Recap

- Understand the aetiology of diabetic foot problems
- Be aware of the strategies to prevent and manage diabetic foot complications
  - Risk stratification
  - Offloading
  - Management of infection
  - Assessment and management of ischaemia