Foot Screening and Education of the Patient with Diabetes.

Discipline of Podiatry

School of Health Sciences

NUI Galway

Aims & Objectives

- The aim of the education programme is to introduce primary care nurses to the Diabetes National Clinical Programme model of foot care management and the associated foot care decision making support tools, to enable nurses to use these tools to carry out:
  - Nursing management of the normal (low risk) foot in the person with diabetes in primary care settings
  - Assessment, identification and prompt referral of the “at risk” foot in the person with diabetes to the podiatry services/ foot protection team

Foot Complications in Diabetes- Some Facts

- Diabetic foot ulcers affect 12% to 25% of persons with diabetes mellitus throughout their lives (Singh, *et al* 2005).
- Foot ulceration is the precursor to non-traumatic lower extremity amputations in approximately 85% of cases (Frykberg, *et al* 2006).
- Up to 20% of those with ulceration will require inpatient treatment as part of their management (Reiber, 1996)
- Lower limb disease is the most common source of complications and hospitalization in the diabetic population (O'Loughlin et al 2010).
- In Ireland, the inpatient cost of treating a diabetic ulcer over 1 year was estimated at €23,500 per patient (Smith, *et al* 2004)

An Impending Epidemic…

- The Diabetes Expert Advisory Group entitled 'Making Diabetes Count' reported an estimate of 141,063 adults in the Republic of Ireland (4.7%) had diabetes at that time and predict this to rise to at least 193,944 or 5.6% of the population by 2015 (Balanda *et al*, 2005)
- The total number of people with diabetes worldwide is expected to rise from 171 million in 2000 (2.8% prevalence) to 366 million (4.4% prevalence) by 2030 (Wild *et al* 2004)

The Current Global Situation…

- **A limb is lost to diabetes every 30 seconds somewhere in the world (International Diabetes Federation, 2005).**
- This is despite the fact amputation risk can be decreased by between 49%-85% with the implementation of appropriate care strategies (International Diabetes Federation, 2005).

Prevalence of Diabetes / Diabetic Foot Disease in Ireland: 2005-2009

(Diabetes Federation of Ireland, 2010)

- 17207 admissions for foot ulcers, 5986 patients had diabetes (35%).
- 3435 admissions for foot ulcers (under 65), 1791 patients had diabetes (52%).
- 3237 lower limb amputations, 1579 patients had diabetes (49%).
- 1225 lower limb amputations (under 65), 592 patients had diabetes (48%).
- Estimated cost of preventable diabetic foot disease: **€239 million**.

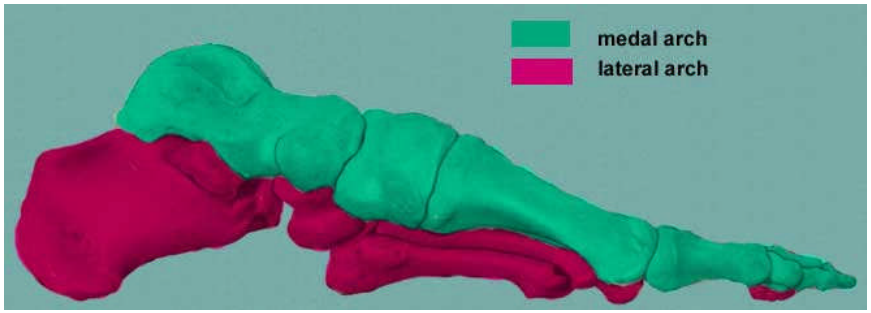
Inevitable or avoidable?

It has long been recognised that " 50% of ulcers may be prevented with suitable management" (Edmonds, et al 1986).

However many referrals are made too late….

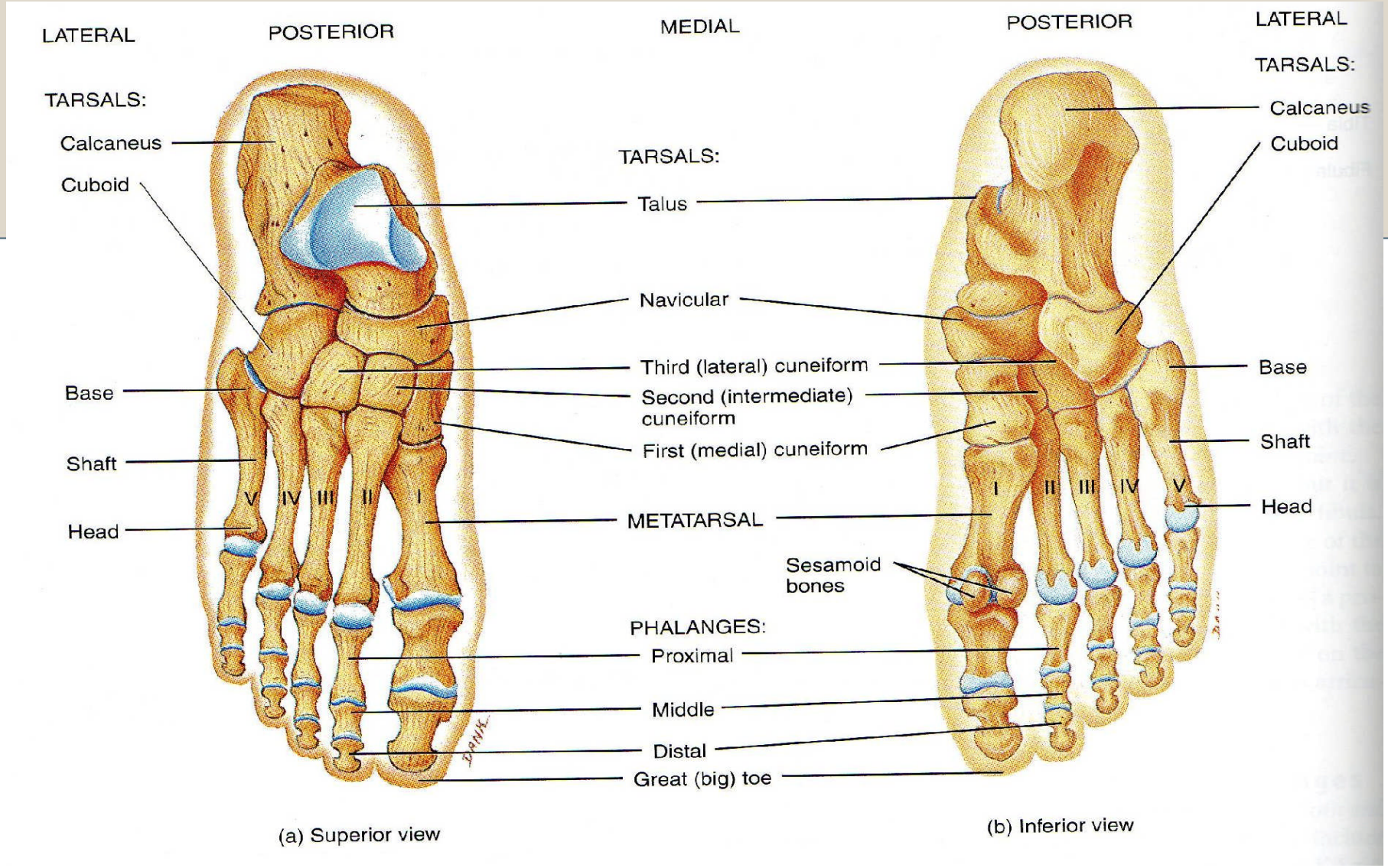
Early Identification of risk factors and prompt referral to the specialist multidisciplinary team is essential to save life and limb.

Part 1: Anatomy of the Foot



Anatomy of the Foot

- The foot is a highly complex structure that is made up 26 bones:
- The tarsus (ankle) is the proximal region of the foot and consists of **7 tarsal bones**.
- The metatarsus is the intermediate area of the foot and consists of **5 metatarsus bones.**
- The **Phalanges** comprise the distal component of the foot (toes).
- Each toe is numbered 1-5 (the big toe is number 1).



(Image reproduced from Tortora and Grabowski 1995)

Part 2:Assessment of the Diabetic Foot

Diabetic Foot Screening

- Medical History
  - Past foot history, duration and type of diabetes, complications of diabetes, drug history, family history, psychosocial history
- Identification of risk factors for ulceration
- Inspection of skin and nails
- Screening for sensory deficit
- Screening for vascular deficit
- Presence of structural foot deformity
- Risk categorisation
- Referral pathway

The non-ulcerated limb… prevention is the key

- Substantial evidence supports screening all patients with diabetes to identify those at risk of diabetic foot ulceration (DFU) (Singh, *et al* 2005).
- All patients with diabetes must have their feet/ lower limbs examined at least once a year.
- Prevention of DFU and amputation commences with identification of known risk factors for foot problems.

Risk Factors for DFU

- Peripheral polyneuropathy
- Vascular disease/ arterial insufficiency- CHD, PAD
- Structural Foot Deformity
- Inappropriate footwear
- Skin or nail pathologies on the foot
- Long diabetes duration
- Poor glycaemic control indicated by high HbA1c results
- Obesity
- History of previous ulceration or amputation
- Retinopathy/ Impaired Vision
- Nephropathy

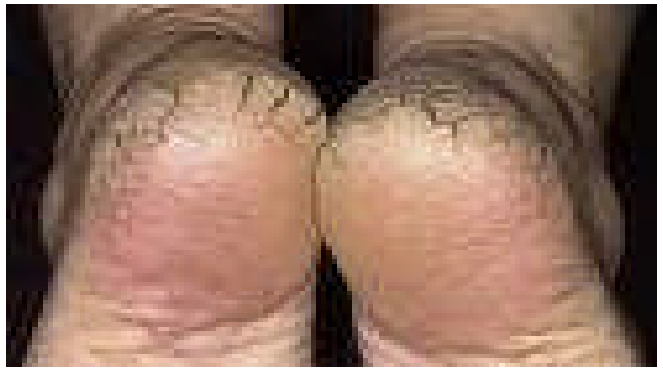
Peripheral Polyneuropathy

- Prolonged hyperglycaemia can give rise to peripheral poly-neuropathy affecting (O'Loughlin *et al* 2010):
  - Sensory pathways
  - Motor pathways
  - Autonomic pathways

- Symptoms of diabetic peripheral neuropathy are diverse from painless to painful affecting many pathways (motor, sensory and autonomic).

Diabetes Peripheral Neuropathy

- **Sensory**
  - insensate foot
- **Autonomic**
  - reduced sweat gland function
  - reduced inflammatory response
  - Vasomotor dysfunction
- **Motor**
  - structural foot deformity



Signs of Neuropathy

- Warm, dry foot with bounding pulses
- Pedal pulses palpable
- Characteristic change in shape with high arch and clawing of toes
- Lack of reflexes
- Ulcers usually on high plantar pressure areas, from neglected callus or previous injury i.e. a burn or cut
- Non-painful ulceration

Peripheral Sensory Neuropathy

- Sensory loss is a major contributory cause of DFU.
- Approximately 45-60% of all diabetic foot ulcers are purely neuropathic (Frykberg, et al 2006)
- Inadvertent trauma and repetitive stress in an insensate foot contribute to ulceration.

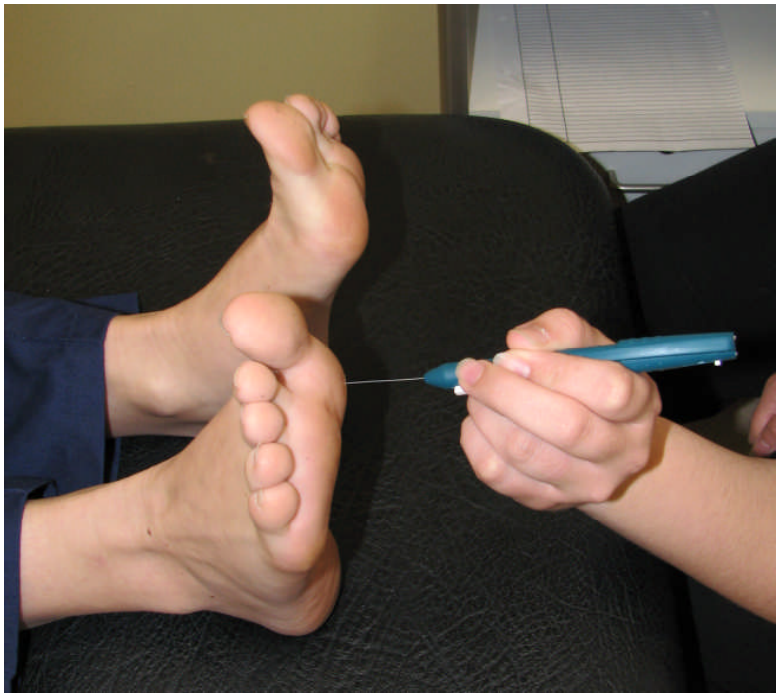
Neuropathic Foot Ulcers

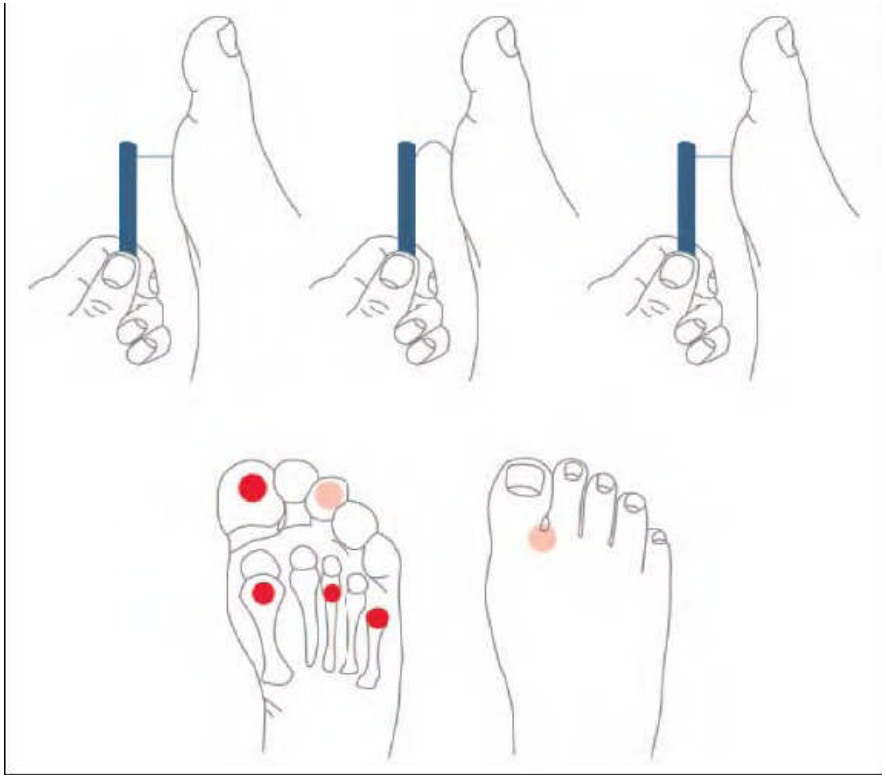
- Sensory loss is a major risk factor for ulceration.
- Neuropathic ulcers typically occur on weight bearing areas of the foot.
- The characteristic features of neuropathic ulceration include:
- Deep ulceration with hyperkeratosed edges
  - usually painless
  - highly exudative and sloughy,
  - irregular borders
  - surrounding skin may be macerated (Dawber, et al 2001)

Neurological Assessment

Sensory Assessment

- 10g monofilament (cutaneous pressure perception)





ADA, 2005

Neurological Assessment

Sensory Assessment

- 128 Hz Tuning Fork – vibration perception

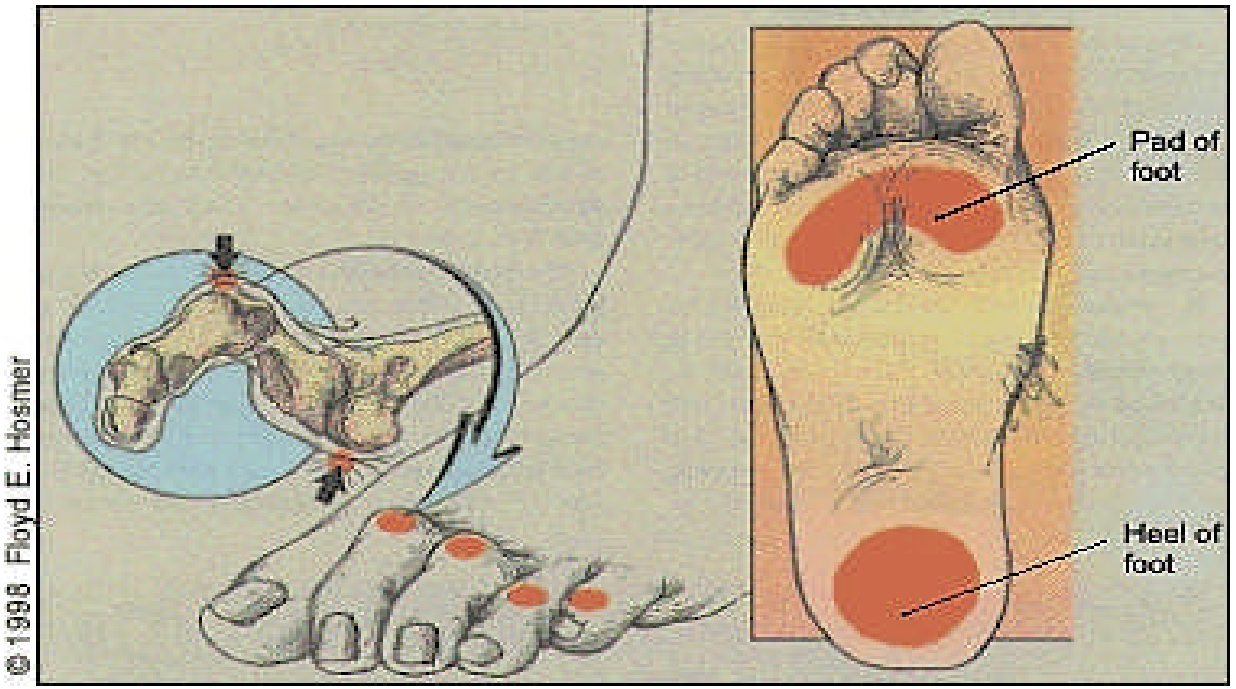
Peripheral Motor Neuropathy

Motor neuropathy can give rise to:

- Anterior crural muscle atrophy
- Ankle equinus
- Intrinsic muscle wasting
- Structural foot deformities
- Pes cavus/ pes planus
- Prominent metatarsal heads
- Toe deformities

Structural Foot Deformity

Extrinsic and intrinsic pressures



Autonomic Neuropathy

- Dry skin
- Fissures
- Callus
- Arteriovenous shunting
- Prominent dorsal veins

Neuropathic Pain

- Neuropathic pain affects between 8-26% of patients with diabetes
- Pain associated with diabetic neuropathy exerts a substantial impact on quality of life, particularly by causing considerable interference in sleep and enjoyment of life
- Despite this many patients receive no treatment for their neuropathic pain (Zeigler *et al* 2008)

Symptoms of Neuropathic Pain

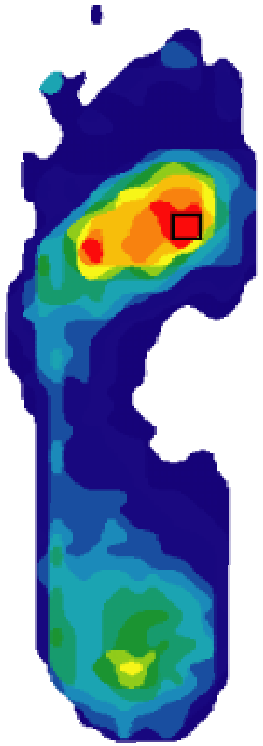
- Persistent or episodic pain that typically may worsen at night and improve during walking
- Pain is often described as a deep aching, but there may be lancinating stabs or burning
- Evoked pain such as allodynia (pain due to a stimulus that does not normally cause pain, e.g. stroking)
- Hyperalgesia (severe pain due to a stimulus that normally causes slight pain, e.g. pin-prick)
- Symptoms may be accompanied by sensory loss

Charcot's Neuroarthropathy

- Associated with a long duration of diabetes
- Due to autonomic peripheral neuropathy
- Foot is well perfused but there is loss of vasomotor control of bone perfusion
- Bone becomes fragile with active bone turnover (osteoporosis)
- Fractures occur spontaneously
- Rapidly progressive

Limited Joint Mobility

- Progressive stiffening of collagen containing tissue (cheiroarthropathy) can result in thickening of the skin and loss of joint mobility
- Restriction of joint mobility results in a rigid foot that loses its ability to adapt to the ground surface and absorb shock.
- The foot is subjected to high pressures, mainly in the forefoot, which are believed to contribute to ulceration



Footwear Assessment

- Inappropriate or ill-fitting footwear poses a significant risk factor for DFU
- Therapeutic footwear have been shown to have a beneficial effect in the primary and secondary prevention of DFU and to facilitate wound healing
- However clinical effectiveness is heavily dependent on acceptability and actual use of the therapeutic footwear

Peripheral Arterial Disease

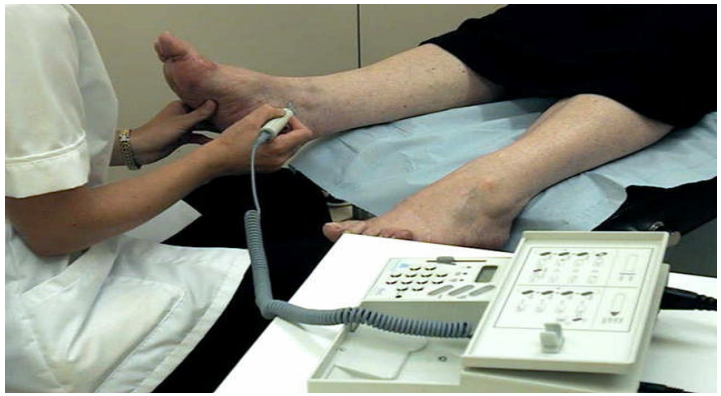
- PAD rarely leads to DFU but can significantly delay healing and increase amputation risk in established DFU.
- In the presence of PAD infection is difficult to treat as antibiotics are not delivered to the site.
- Anaerobic infections are common due to lack of oxygenation in the tissues.
- Early aggressive treatment of lower extremity ischaemia is therefore vital.

(Frykberg, *et al* 2006)

Vascular Assessment of the Lower Limb

Established tests to assess vascular status include:

- Palpation of foot pulses
- Doppler
- Ankle Brachial Pressure Index



Vascular Assessment: Pulse Palpation

Dorsalis Pedis

Posterior Tibial

Doppler Ultrasound

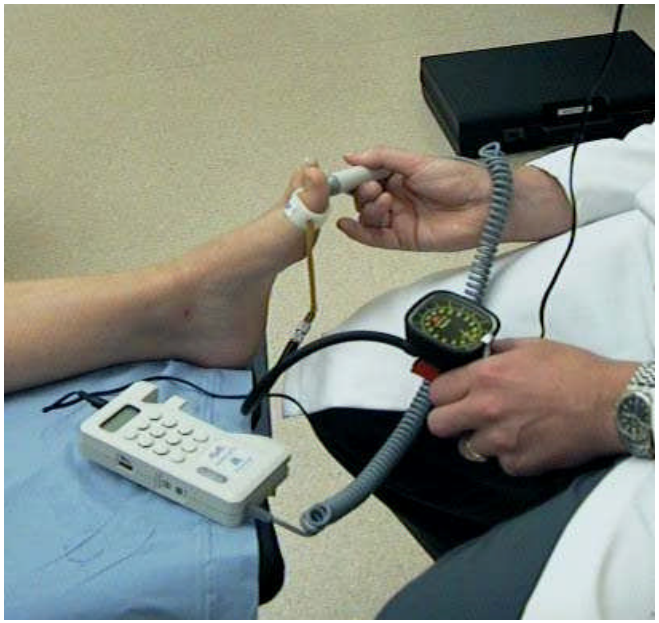
- As a tool for investigating PAD the Doppler is invaluable
- It allows quick identification of patients with significant PAD and those requiring further investigation
- Hold the probe at 45-60^{o} to the skin surface pointing towards the direction of blood flow
- Use sufficient gel

Ankle Brachial Pressure Index

- Normal: 0.9 – 1.3
- Ischaemia: < 0.9
- Critical Ischaemia:< 0.5
- Calcification: > 1.3

Arterial Calcification

Alternative vascular assessments- Toe Brachial Pressure Index and Transcutaneous Oxygen (TCPO2)



Indications for Vascular Consultation

- ABPI of less than 0.7

and/ or

- Toe Brachial Pressure Index- pressures less than 40 mmHg

and/ or

- Transcutaneous pressures less than 40 mmHg

and/ or

- If history and examination suggest ischaemia

and/ or

- If a non-healing ulcer is present

(Frykberg *et al* 2006)

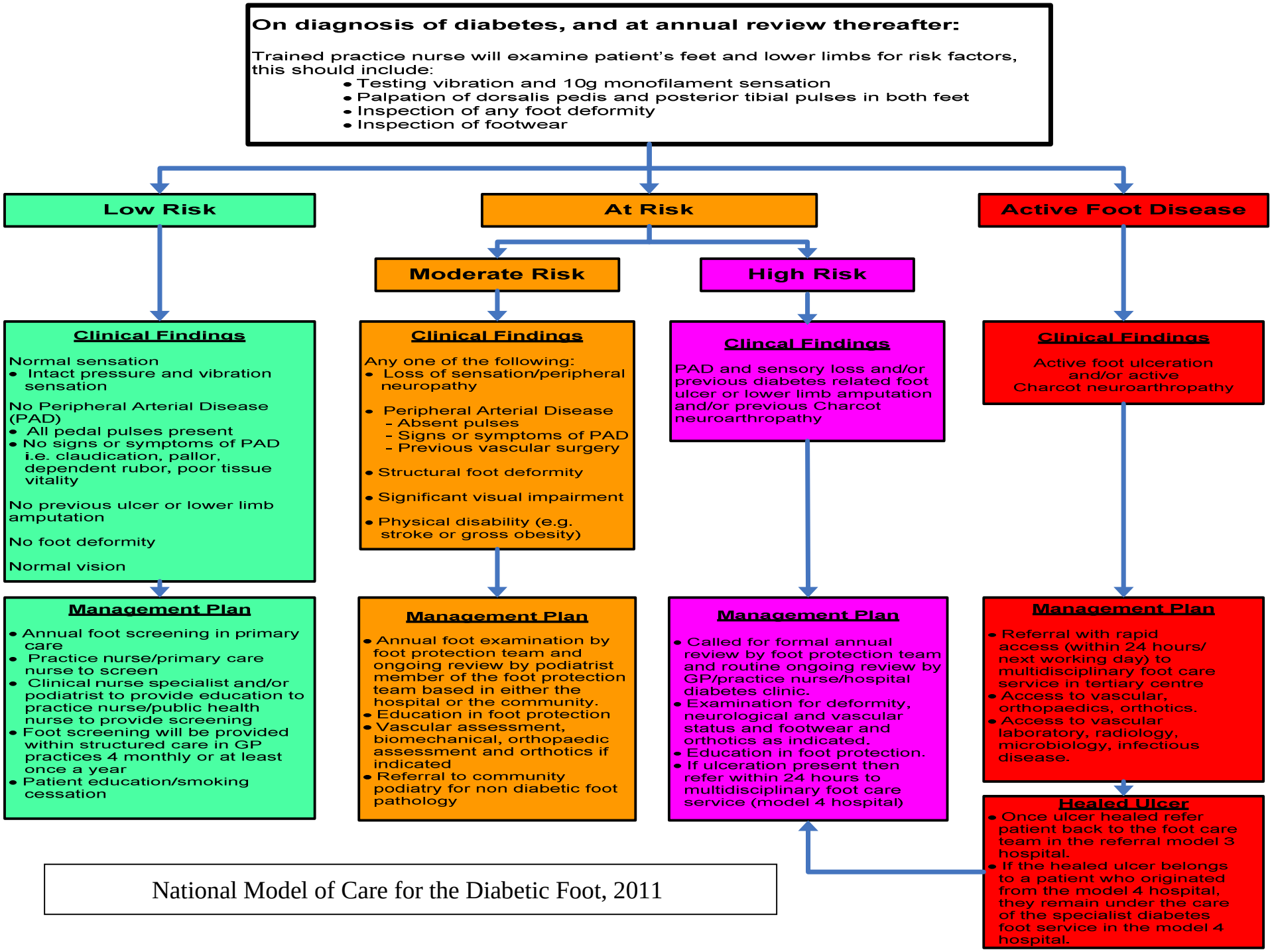
Ischaemic Foot

- Atrophic (thin) skin
- Anhydrotic (dry) skin
- Pale skin or in severe ischaemia an ischaemic rubor (red colour)
- Hair loss
- Cold/ Pulseless
- Thickened toenails (onychauxis) or fungal toenails (onychomycosis)
- Loss of fibrofatty padding on the plantar aspect (sole) of the foot
- Ulcers develop on borders of feet, tips of toes, under thickened toenails or around the heels.

Neuroischaemia

- Presence of neuropathy and ischaemia
- Foot is cold and pink may be painful depending on severity of neuropathy
- Pedal pulses not palpable
- This is a limb threatening state

Risk Group	Risk Category	Foot Examination Frequency	Examiner
Green	Low Risk	Annual	Primary care nurse
Amber	At Risk (Moderate Risk Category)	Annual or more frequently as required	GP/primary care nurse. Annual review by podiatrist either in community or hospital.
Pink	At Risk (High Risk Category)	Annual or more frequently as required	GP/primary care nurse or hospital diabetes clinic, **Plus scheduled annual** review or more frequent review as required **by member of foot protection team.**
Red	Active Foot Disease	At least once weekly or as required	Diabetes multidisciplinary foot care service



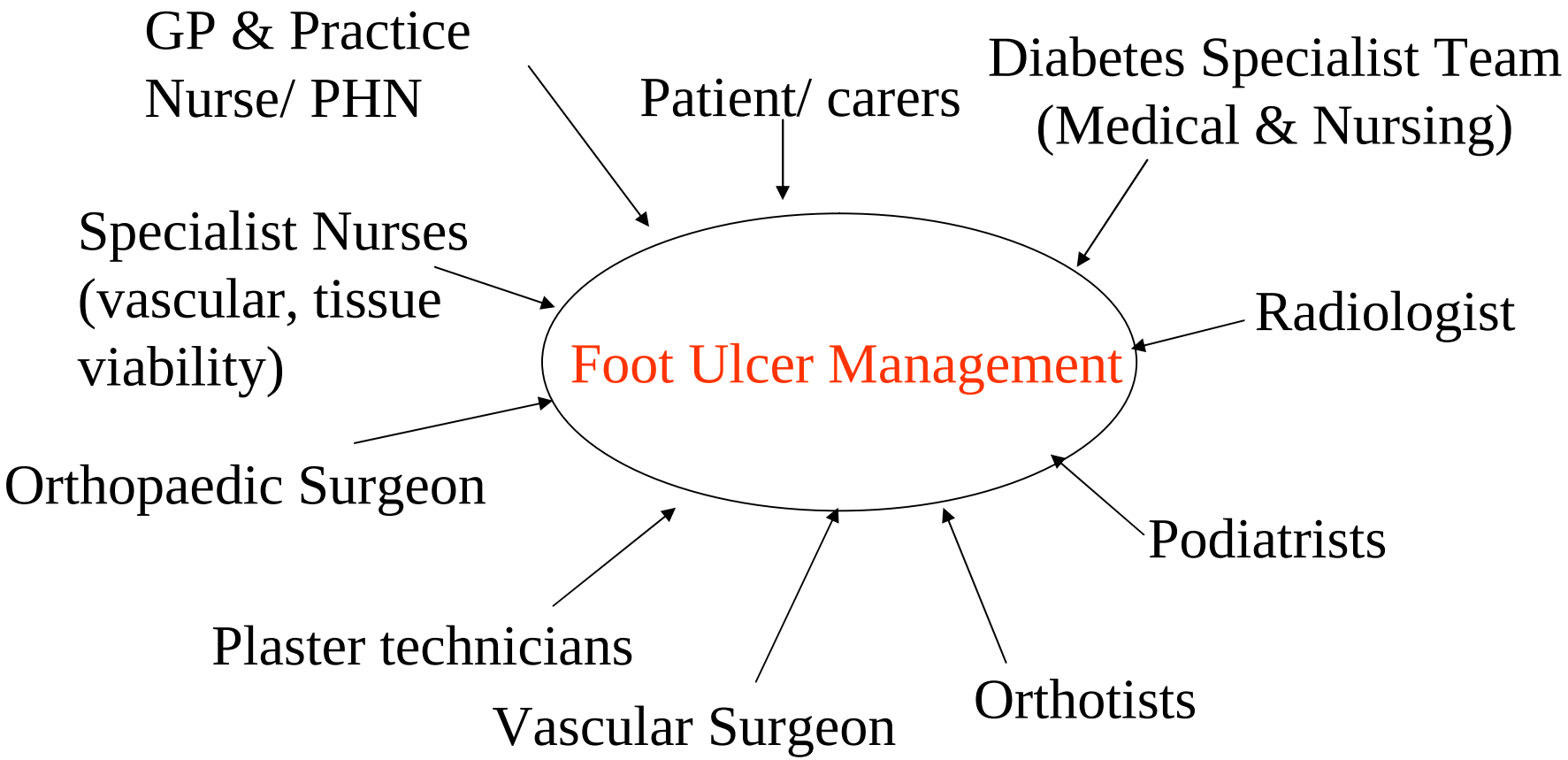
National Model of Care for the Diabetic Foot, 2011

Part 3:Management of the Diabetic Foot Ulceration

Multidisciplinary Management

- Multidisciplinary teams are essential for optimal management of diabetic foot disease
- No one person/ profession can manage the diabetic foot
- Successful management of the diabetic foot requires the expertise of the multidisciplinary team (Edmonds, *et al* 2008)

Multidisciplinary Management of DFU



Management of the Diabetic foot is based on the principles of:

- Mechanical Control
- Wound Control
- Microbiological Control
- Vascular Control
- Metabolic Control
- Educational Control

(Edmonds, *et al* 2008)

Mechanical Control

- The central goal of any treatment programme designed to prevent primary and secondary episodes of foot ulceration, and to heal active foot ulceration is effective reduction of pressure (offloading)
- Pressure on a wound can delay healing for a number of reasons:
  - Pressure causes a reduced perfusion to the wound, when the pressure is released reperfusion occurs causing an ischaemic-reperfusion injury
  - Hypoxia associated with ischaemia triggers a cascade of events which results in loss of cell membrane integrity and apoptosis
- There are numerous offloading modalities available

Total Contact Casts (TCCs)

- TCCs are considered by many specialists to be the gold-standard off-loading modality.
- Total contact casting employs a well-moulded, minimally padded cast that maintains contact with the entire plantar aspect of the foot and the lower leg.

Pneumatic Walkers

- Removable walking casts have been extensively used for lower extremity trauma for many years. These devices help to stabilize the traumatized foot, and have subsequently been modified to off-load diabetic foot ulcers.

Half Shoe

- Half-shoes are commercially available devices originally designed to decrease pressure on the forefoot after elective surgery.
- Half-shoes have increasing popularity to treat neuropathic foot ulcers because they are easy to use, inexpensive, and well accepted by patients.

Orthoses

Padding

- Felted foam is another frequently touted off-loading method.
- This approach is frequently used with anecdotal reports of success
- Despite much anecdotal evidence to support its use there is limited scientific evidence in the medical literature to support the use of felted foam on DFUs

Evidence-base

- A randomised controlled trial found that the total contact cast (TCC) healed a higher proportion of wounds in a shorter time than removable cast walkers and half-shoes; TCC's were found to reduce pressure at the site of ulceration by 84-92 % (Armstrong *et al* 2005)
- The TCC has therefore been suggested as the gold standard in pressure reduction.
- However in the presence of ischaemia and/or infection the TCC may be contra-indicated and an alternative strategy, such as a removable walker, allowing regular assessment of the wound should be considered.

Evidence-base

- A study exploring activity patterns of patients with diabetic foot ulceration goes someway to explain why the irremovable TCC is more effective than other offloading strategies (Armstrong, et al 2003).
- Findings of this study suggest that patients prescribed removable pressure relieving modalities only use these devices for a minority of steps taken each day!

Therapeutic Footwear

- **Range:**
  - Stock orthopaedic
  - Modular orthopaedic
  - Bespoke

- **Function**
  - Protection form injury and deformity
  - Prevention of ulceration
  - Facilitate Wound Healing
  - Prevent progression of deformity
  - Redistribution of plantar pressures
  - Improve mobility and quality of life

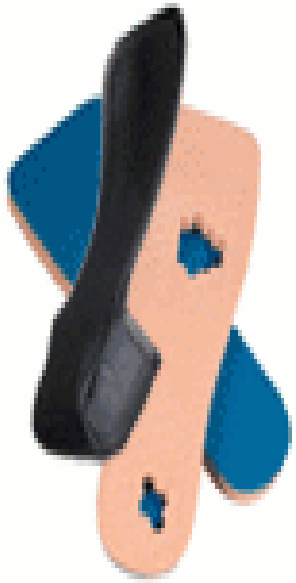
Med-Surg™ Shoe

Wound Care Shoe System

Gentle Step™ Shoe

Heelwedge™ Shoe

Orthowedge™ Shoe



Peg-Assist™ System

Wound Control

- The philosophy of **Wound bed preparation (WBP)** is widely accepted as a valuable strategy when implementing appropriate care planning for patients with complex wounds (Watret 2005)
- The "TIME" acronym has been suggested as a useful model which focuses on assessment and management of the wound bed

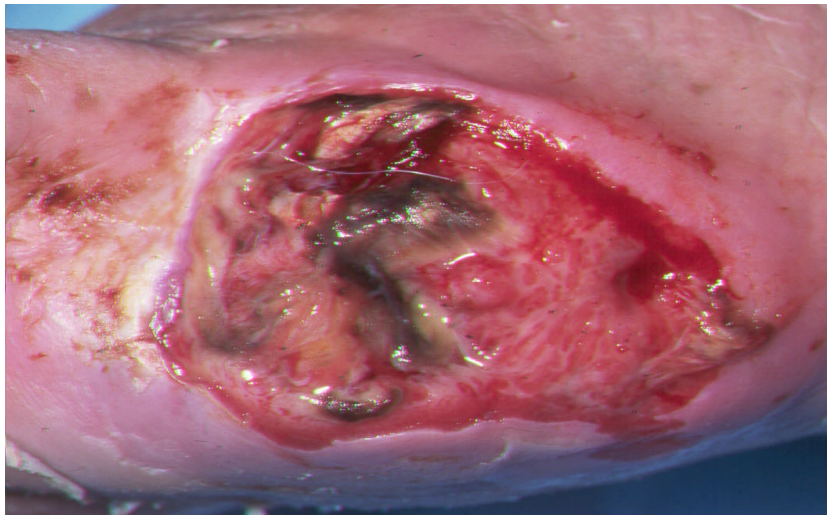
"TIME" to Heal

- Tissue Management : Assess the amount of viable and non-viable tissue. The presence of slough and necrotic tissue can delay healing.
- Infection/ inflammation: Prevention of infection is vital to prevent complications
- Moisture Balance: Assess wound exudate
- Edges of the wound: Closure of diabetic foot ulcers can be delayed due to necrotic tissue. Skilled sharp debridement is essential to promote healing

(Watret 2005)

Wound Control

- Assess the amount of viable and non-viable tissue
- Consider whether the wound is:
  - Necrotic
  - Sloughy
  - Granulating
  - Epithelialising



Wound Assessment

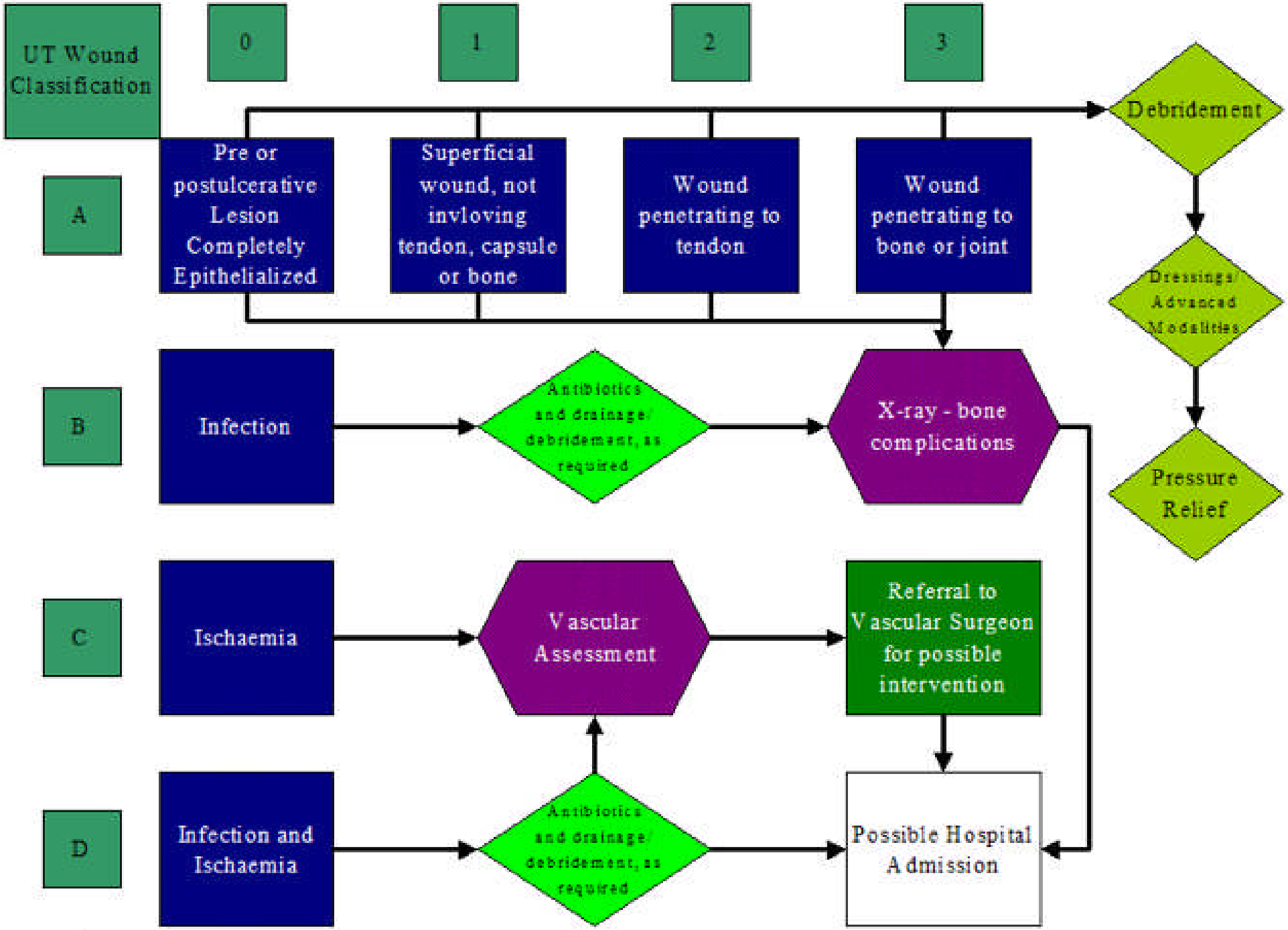
- Wound location
- Wound dimensions (height, width, surface area, depth)
- Nature of the wound bed (necrotic/ sloughy/ granulating/ epithelialising)
- Volume of wound exudate (low/ moderate/ high)
- Consistency of wound exudate (serous/ purulent)
- Wound margins (hyperkeratotic/ rolled edges/ undermined)
- Pain
- Presence of bony sequestrium or foreign bodies
- Presence of infection
- Condition of the peri-wound skin (e.g. macerated/ dermatitis)
- State of surrounding skin (e.g. erythema, inflammation)

(McIntosh & Newton, 2007)

Ulcers should be graded using the University of **Texas Classification system** which is a validated tool specifically for Diabetic Foot Ulcers

Stage	Grade			
	0	1	2	3
A	Pre- or post- lesion intact	Superficial wound	Penetrating to tendon or capsule	Penetrating to bone or joint
				
B	+ infection	+ infection	+ infection	+ infection
C	+ ischaemia	+ ischaemia	+ ischaemia	+ ischaemia
D	+ infection and ischaemia	+ infection and ischaemia	+ infection and ischaemia	+ infection and ischaemia

The University of Texas classification system (adapted from Armstrong et al**, 1998)**



Flowchart devised and constructed by Andrew Findlow ,Manchester Royal Infirmary, United Kingdom

Wound Debridement- Why Debride?

- Reduces dead/ devitalised tissue
- Promotes proliferation - granulation and epithelialisation
- Eliminates potential pathogens
- Allows exudate drainage
- Reveals true extent of ulceration
- Reduces pressure on subcutaneous tissue

The Importance of Wound Debridement

Initial Presentation

2 weeks post-debridement

Microbiological Control

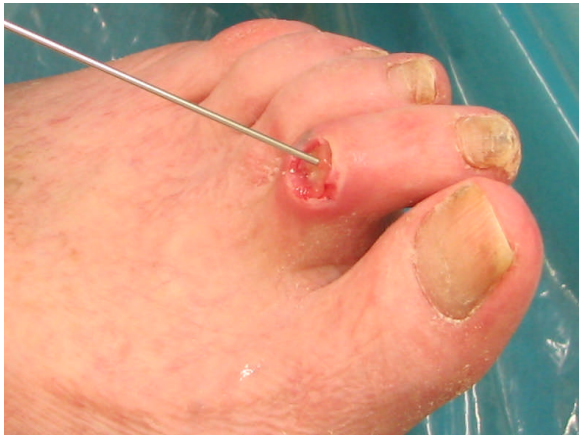
- Identification of infection in wounds can be challenging, particularly so in diabetic foot ulcers.
- Edmonds (2005) suggests that the classic signs of infection may not always be present in diabetic patients.
- Only half of infection episodes show signs of infection (Edmonds and Foster 2006).
- In the presence of neuropathy and ischaemia signs of infection can be diminished as the normal inflammatory response is impaired.
- It is important to remain extra vigilant when assessing the diabetic foot for signs of infection, if the wound is critically colonised or infection is present immediately refer the patient to the diabetic foot care team for management

Criteria for identifying infection in diabetic foot ulcers (Cutting *et al* 2005)

- Cellulitis
- Lymphangitis
- Phlegmon
- Purulent exudate
- Pus/Abscess
- Crepitus in the joint
- Erythema
- Increase in exudate volume
- Localised pain in a normally insensate (neuropathic) foot
- Malodour
- Probe to bone

Probe to Bone Test

- The diabetic patient presenting with a foot infection must be assessed promptly and managed aggressively.
- Cavanagh *et al* (2005) suggest initial treatment should include wound cleansing, debridement of non-viable tissue and probing, with a blunt sterile instrument, to ascertain depth and identify foreign bodies or exposed bone.
- If a sterile probe inserted into the wound reaches bone, osteomyelitis (bone infection) is indicated.
- If osteomyelitis is suspected plain x-rays can assist diagnosis, however initially reports may prove normal and evidence of osteomyelitis may not be apparent for 14 days (Edmonds, et al 2004)



Vascular Control

- Regular vascular assessment is imperative to identify patients with peripheral arterial disease so that they can be managed promptly.
- When vascular assessment indicates ischaemia a rapid referral should be made to the vascular team as revascularisation may be required for wound healing to occur.

Metabolic Control

- The United Kingdom Prospective Diabetes study (1998) demonstrated that lowering levels of HbA1c lowers the risk of vascular complications and suggests in practice patients should aim for near normal levels with HbA1c <7%.
- The International Diabetes Federation (IDF 2005) *Global guidelines for type 2 diabetes* recommend maintenance of haemoglobin A1C (HbA1c) below 6.5% to minimise the risk of developing complications.
- These values are corroborated by McIntosh *et al* (2001) who advocate target HbA1c should be set between 6.5-7.5% based on the patient's risk of macrovascular and microvascular complications.
- In general those at significant risk of macrovascular complications should be set a lower target HbA1c however in those at risk of iatrogenic hyperglycaemia higher targets may be necessary (McIntosh *et al* 2001).

Educational Control

- The National Service Framework for Diabetes recommends structured education to improve patients' knowledge and understanding of their condition enabling them to undertake more effective self-care (DoH 2005).
- Patients and their relatives/ carers should be instructed on the importance of maintaining foot health and safe self care to improve their knowledge and understanding of their condition enabling them to undertake more effective self-care (DoH 2005).

Educational Control

- A Cochrane review assessed the effectiveness of patient education on DFU prevention (Valk, et al 2001)- existing data suggests that patient education, particularly in high risk groups, improves foot care knowledge and positively influences patient behaviour in the short term which may reduce foot ulcerations and amputation.
- Practitioners therefore have a responsibility to provide structured education and training to all patients which should be revisited on a regular basis.

Conclusion

- Despite scientific evidence and clinical guidelines the prevention of DFU remains a significant challenge for practitioners.
- All individuals with diabetes should receive regular screening and structured education to empower them to maintain their own foot health
- Early identification of problems and rapid referral to the specialist multidisciplinary team can reduce the risk of DFU and unnecessary amputations.

References

- Armstrong DG. Lavery LA. Wu S et al (2005) Evaluation of Removable and Irremovable Cast Walkers in the Healing of Diabetic Foot Wounds Diabetes Care 28 (3) 551-554
- Armstrong DG. Lavery LA. Kimbriel HR (2003) Activity Patterns of Patients With Diabetic Foot Ulceration Diabetes Care 9 2595-2597
- Armstrong DG. Lavery LA. Harkless LB (1998) Validation of a Diabetic Wound Classification System Diabetes Care 21 5 855-859DoH (2005) Structured Patient Education in Diabetes; Report from the patient education working group, Department of Health
- Balanda K, Fahy L, Jordan A and McArdle E (2005). Making Diabetes Count. A systematic approach to estimating population prevalence on the island of Ireland. Institute of Public Health in Ireland. 39 – 43.
- Cavanagh PR. Lipsky BA. Bradbury AW et al (2005) Treatment for diabetic foot ulcers The Lancet 366 1725-1735
- Dawber R. Bristow I. Turner W (2001) Text Atlas of Podiatric Dermatology London Martin Dunitz Ltd
- Edmonds ME. Blundell MP, Morris ME (1986) Improved survival of the diabetic foot: the role of a specialized foot clinic Q J Med 60 (232): 763-71
- Edmonds, M. Foster AVM. Vowden P (2004) Wound Bed Preparation for diabetic foot ulcers In European Wound Management Association (EWMA) Position Document: Wound Bed Preparation in Practice. London: MEP Ltd.
- Edmonds ME. Foster AVM. Sanders LJ (2008) A practical Manual of Diabetic Foot Care 2nd Ed. Blackwell Publishing, Oxford
- Frykberg RG. Zgonis T. Armstrong DG et al (2006) Diabetic Foot Disorders: A Clinical Practice Guideline The Journal of Foot & Ankle Surgery 45 (5) (Supp) 1-65

References

- IDF Clinical Guidelines Task Force (2005) Global Guidance for Type 2 diabetes. Brussels: International Diabetes Federation
- McIntosh A. Hutchinson A. Home PD et al (2001) Clinical Guidelines and evidence review for type 2 diabetes: Management of blood glucose Sheffield ScHARR, University of Sheffield
- McIntosh, C. Newton, V (2007) Diabetic Foot Ulcers In Ousey, K. McIntosh, C (2007) Lower Extremity Wounds: A Problem-based Approach, Chichester, Wiley Blackwell
- O' Loughlin A. McIntosh, C. Dinneen SF. O'Brien T (2010) Basic Concepts to Novel Therapies: A Review of the Diabetic Foot International Journal of Lower Extremity Wounds 9(2):90-102
- Reiber GE. Vileikyte L. Boyko EJ et al (1999) Causal pathways for incident lower-extremity ulcers in patients with diabetes from two settings Diabetes Care 22 157-62
- Singh N. Armstrong DG. Lipsky BA (2005) Preventing foot ulcers in patients with diabetes JAMA 293 217-28
- Smith D, Cullen MJ, Nolan JJ (2004)The cost of managing diabetic foot ulceration in an Irish hospital. Ir J Med Sci Apr-Jun;173(2):89-92.
- Valk GD. Kriegsman DMW. Assendelft WJJ (2006) Patient education for preventing diabetic foot ulceration (review) The Cochrane Collaboration John Wiley & Sons
- Watret L (2005) Wound bed preparation and the diabetic foot The Diabetic Foot 8 (1) 18-26
- Wild S. Roglic G. Green A et al (2004) Global Prevalence of Diabetes Diabetes Care 27 1047-1053
- Ziegler D (2008)Painful Diabetic Neuropathy: treatment & future aspects Diabetes Metab Res Rev May-Jun;24 Suppl 1:S52-7.