THE DIABETIC FOOT
IN 2010

Nepal, November 2010

Andrew J M Boulton, MD, DSc, FRCP
Universities of Manchester, UK
and Miami, FL, USA
Vice-President and Director of
International Postgraduate Education, EASD
Amputation – most feared complication of diabetes
Foot Ulcers and mortality

• 10 yr population-based prospective study of 65,000 persons in Norway: 1339 with DM, 155 with DM + Fu history
• Mean age 49y no DM, 65y DM, 67 DM+FU
• 10 yr mortality: 11% noDM, vs 35% vs 49%
• After adjustment for co-morbidities, DM+FU 2.29 increased risk of mortality

Iversen et al, Diabetes Care, 2009;31:2193
What is the cost of Diabetic foot care?

1. Developed country

- 25% of diabetic patients develop a foot problem in their lifetime
- 2008: estimated 20.8 million with DM in USA
- Total of $19bn spent on diabetic foot ulcers
- $11bn spent on amputation
- Up to $21bn could be saved annually with practical and effective preventative foot-care education

Rogers et al, JAPMA, 2008;98:166
What is the cost of Diabetic foot care?

2. Developing country

- 2010: estimated 51 million with DM in India
- Population-based study from Chennai
- Cost of illness study: 4677 subjects screened: 1050 with DM, 718 agreed to take part
- Median direct cost for DM $526, indirect $103
- Costs increased according to complications
- Extrapolated to all India – annual cost of Diabetes in India – US$32bn.

Tharkar et al, DRCP 2010;89:334
Who is at risk of Foot Ulceration?

- Neuropathy
- Peripheral Vascular Disease
- Past history of foot ulceration
- Microvascular Complications (especially nephropathy)
- Elderly, living alone
- Foot deformity
- Amputation
Impact of Diabetic Peripheral Neuropathy (DPN)

- Most common peripheral neuropathy in developed nations
- Accounts for more hospitalizations than all other diabetic complications combined
- Contributes to 50%-70% of all nontraumatic amputations in the US
- There are 85,000 amputations in the US each year, 1 every 10 minutes, 87% due to neuropathy, cost $37B

Boulton et al. *Diabetes Care* 2004;27:1458-1486
Does Neuropathy Lead to Ulceration? A Prospective Study

- 469 diabetic patients screened in 1988
- Vibration perception assessed by biothesiometry
- All foot ulcers recorded

Young et al, Diabetes Care 1994;17:557
Biothesiometer
# Prospective Foot Ulcer Study

## Results — Foot Ulcers

<table>
<thead>
<tr>
<th></th>
<th>VPT&lt;15</th>
<th>VPT 16-24</th>
<th>VPT&gt;25</th>
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<tbody>
<tr>
<td>Total ulcers 1988-92</td>
<td>6</td>
<td>2</td>
<td>41</td>
</tr>
<tr>
<td>Risk per patient</td>
<td>2.9%</td>
<td>3.4%</td>
<td>19.6%</td>
</tr>
<tr>
<td>Risk/patient/year</td>
<td>0.7%</td>
<td>0.9%</td>
<td>4.9%</td>
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Paul Brand CBE, MD, FRCS
1914-2003

• The Gift of Pain
• Pain: the Gift nobody wants

• Surgeon and missionary: worked in leprosy and diabetes
• He took the foot from art to science
Diabetic Neuropathy

‘PAIN – God’s greatest gift to mankind’

Paul Brand
PAIN

‘I shall never be free until I can feel pain’

Leprosy patient in Madras: cited by Dr Paul Brand
‘If I were to choose between pain and nothing ..... I would choose pain’

William Faulkner
Loss of proprioception
FOOTWEAR

• Controlled evidence for reduction of recurrent ulceration
• Evidence for footwear as part of multidisciplinary approach

Uccioli et al, D.Care 1995; 18: 1376
Dargis et al, D. Care 1999; 22: 1428
Faglia et al, D. Care 2001; 245: 78
A Case of PUO?

- Temp 38.3°C. Tachycardia, normotensive
- CVS/RS nad
- Abdomen – no tenderness – exit site slight discharge.
- Legs – moderate oedema – bandage over R hallux
- CNS ‘grossly inact’
A Case of PUO?

- Hb 10.9g%, wbc 15.5 platelets normal
- Urea 34, Creat 766, K 5.0
- Blood cultures negative
- CXR, ECG - unremarkable
- PD fluid culture negative
- Exit site culture ’skin commensals’
- U/S and CT abdomen - unremarkable
A Case of PUO?

- Started on broad spectrum antibiotics
- No improvement after holiday weekend
- Diabetes team referral Tuesday
- Feet examined, dressing removed
- ........
A Case of PUO: Motto of story

In diabetes, ALWAYS examine the feet: lack of symptoms ≠ lack of Neuropathy
Other Associations with Foot Ulceration
End-stage Renal Disease

- Association between start of dialysis and incidence of foot ulceration
- Up to 40% of dialysis patients have past or current ulceration
- ? Related to lack of diabetes follow-up
- ? Ethnic protection lost

Game et al 2005, 2010; Ndip et al 2010
Dialysis and Foot Ulceration

• Dialysis is an independent risk factor for foot ulceration
• When compared to ESRD patients not on dialysis, 4.2x increased risk of foot ulceration
• Mortality after amputation - 290% increase in hazard for those on dialysis
• Need for foot care on dialysis units

Ndip A et al, Diabetes Care 2010;33: 878-880 and 33;1811-1816
CDFE
Report of a Task force of the ADA
Meeting, Chicago, January 2008

Co-Chairs:
AJM Boulton and DG Armstrong

Members: S Albert, R Frykberg, R Hellman, Sue Kirkman, L Lavery, J LeMaster, J Mills, M Mueller, P Sheehan, D Wukich.
Comprehensive Diabetic Foot Exam (CDFE)

AIMS

To review the recent literature and recommend key constituents of the CDFE for adult persons with diabetes
Recommendations

1. History and general exam

- Peripheral Vascular Disease
- Past foot ulceration or amputation
- Renal status
- Footwear assessment
- Dermatological
- Foot deformity
Recommendations
2. Neuropathy Assessment

• 10 g monofilaments tested at 4 sites (MTH 1,3 & 5 and hallux plantar)
AND ONE OTHER OF

• 128 Hz tuning fork vibration - hallux
• Pinprick sensation – dorsal hallux
• Ankle reflexes
• VPT – biothesiometer/VPT meter
Recommendations
3. Vascular Assessment

- Foot pulse assessment – dichotomous
  IF ANY PULSE ABSENT or Hx of PVD, then
- Ankle Brachial Index if possible.
Recommendations
4. REFERRAL/FOLLOW-UP

• Risk Category (RC) 0 – annual review
• RC 1 (LOPS ± Deformity): 3-6 monthly
• RC 2 (PAD ± LOPS): 2-3 monthly and consider vascular referral
• RC 3 (ph ulcer or amputation): every 1-2 months by specialist

Boulton, Armstrong et al. Diabetes Care 2008;31:1679
Can the introduction of a multidisciplinary foot team reduce foot problems?

- 11 yr prospective study of hospital admissions for DF problems in Ipswich
- 62% fall in major amputations
- Total amputations down by 70%
- These improvements followed the introduction of a multidisciplinary foot service

Krishnan et al, Diabetes Care, 2008;31:99
A diabetic foot ulcer should heal if:

• There is adequate arterial inflow
• Any infection is appropriately managed
• Pressure is removed from the wound and its margins
Factors That Enhance Wound Healing

Correct underlying condition

- Control infection
- Vascular reconstruction for patients with severely compromised peripheral circulation
- Adequate glycaemic control for patients with diabetes
- Off-load pressure
- Maintain moist wound healing environment
Factors That Enhance Wound Healing *(continued)*

Adequate debridement

– Removes infected and non-viable tissue
– May stimulate release of endogenous growth factors
Common Methods to “Off-Load” the Foot

- Bed Rest
- Wheel Chair
- Crutch Assisted Gait
- Total Contact Casts
- Felted Foam
- “Half Shoes”
- Therapeutic Shoes
- Custom Splints
- Removable Cast Walkers
Offloading the DM Wound

Cumulative Survival

Week of therapy

Device
- TCC
- Half Shoe
- Aircast

Armstrong, et al, Diabetes Care, 2001
‘Instant Total-Contact Cast’ vs TCC: controlled trial

• Randomized controlled trial: 38 plantar neuropathic ulcer patients randomized to instant or regular TCC
• No differences in healing times observed
• Instant TCC quicker to apply and cheaper for the duration of treatment
• Any center can apply instant TCC without casting experience
• This treatment could revolutionize the management of plantar neuropathic ulcers

Katz et al, Diabetes Care 2005;28:555
Methods
Standard Total Contact Cast
Methods
“Instant Total Contact Cast”
NPWT in the Diabetic Foot

A non-pharmacological tool that can influence wound healing
NPWT after partial foot amputations: a randomized trial

- Multi-centre trial in USA
- 162 patients randomized to NPWT or standard treatment: 16 week observation period
- After 16 weeks: NPWT 56% healed, control 39% healed (p=0.04)
- Rate of healing (p=0.005) and rate of granulation (p=0.001) faster in NPWT group
- Trend towards fewer amputations in the NPWT group (p=0.06)

Lavery, APMA, 2005
Armstrong & Lavery, Lancet 2005;366:1704
NPWT in the treatment of diabetic foot ulcers: a randomized trial

- Multi-centre trial in USA
- 342 patients randomized to NPWT or standard treatment: 16 week observation period
- After 16 weeks: NPWT 43% healed, control 30% healed (p=0.007)
- No safety concerns in NPWT or standard moist wound healing control group
- Fewer secondary amputations in the NPWT group (p=0.035)

Blume PA et al, Diabetes Care 2008;31:631
NPWT in the Diabetic Foot

Conclusions

NPWT is a useful non-invasive therapy that, when used appropriately, can accelerate wound healing in the diabetic foot.
Diabetic Foot Wounds in 2010
How much stagnation?

- Dressings
- Topicals
- Infection management
- Amputation Reduction
- Patient Education
- Charcot
Dressings: what do we know?

- ‘For an obstinate ulcer, sweet wine and a lot of patience should be enough’
  
  Hippocrates

- Virtually NO EVIDENCE to support the use of any particular dressing
  
  - Normal dressing qualities: absorption and retention
  - Remember the words of Brand: ‘Dressings deceive both doctor and patient into thinking that by covering the wound they were curing it’
  - Large RCT 3 dressings: none was superior

Knowles EA, The foot in diabetes, 4th edn 2006
RCT of 3 dressings in chronic diabetic foot ulcers

- RCT of 317 patients randomize to one of 3 dressings: N-A, Inadine or Aquacell
- FU for >6 weeks, no osteomyelitis
- Primary endpoint: ulcers healed at 24 weeks
- No differences in healing or recurrence rates observed
- Costs: £15 VS £17 VS £44
- No indication to use more expensive dressings

Jeffcoate et al. Health Technol Assess 2009 Nov;13:1
The Diabetic Foot

• INFECTION
Diabetic Foot Infections

• How to diagnose infection in the diabetic foot? Only 3 studies identified as suitable in a review
• Probably should take deep cultures
• Antimicrobial intervention: systematic review
• Only 23 studies identified, 5 on oral agents: evidence too weak to recommend any particular agent

O'Meara et al. Diabetic Med 2006;23:341
Diabetic Foot Infections

- Tissue from wound base most useful for culture
- Which ulcers should we treat with antibiotics? Very sparse data
- Which antibiotics should be used?
- No indication to treat with antibiotics clinically non-infected neuropathic ulcers
- International guidelines on diagnosing and treating the infected diabetic foot and osteomyelitis now published

Lipsky et al, Clin Infect Dis 2004;38:17
Attack of the Superbugs

Infections. First, they last only days, or at most weeks, limiting sales. And the better the drug, the more likely doctors and hospitals are to keep it on the shelf as a last resort. Most hospitals require that doctors get special approval to prescribe the best new antibiotics. In that regard, what’s good for public health isn’t necessarily good for antibiotic development.

Capricious regulation is another problem, adding to uncertainty and, in turn, the cost of development. For drugs targeted to many common bacterial ailments, the FDA historically required so-called non-inferiority trials. This meant a new antibiotic needed to prove it was generally no worse than existing treatments in order to win regulatory approval. Otherwise, conducting trials to prove a new antibiotic was better than a sugar-pill placebo—or superior to existing drugs—would require huge trials and, in some cases, was simply unethical if it meant asking pa-
Culture of hands for MRSA

Before handwashing

After handwashing
Larvae and MRSA?

- Prospective longitudinal study
  - 13 subjects culture positive MRSA contaminated wounds
- Larvae applied x3-5 applications q4-5 days
  - 12/13 cultures revealed eradication of MRSA

Bowling, et al, Diabetes Care, 2007
Larval Therapy (LT) and Infection?

• Prospective longitudinal study
• 91 patients with infected ulcers treated with LT: impact on bacteriology assessed after 4 days
• LT – significant impact on most bacteria including Staph and MRSA
• No effect on Pseudomonas
• Antimicrobial peptide Lucifensin isolated from maggots

Multidisciplinary team

- Diabetologists
- Interventional Radiologists
- Nurses
- Orthotist
- Patient
- Podiatrist
- Surgeons

No conflicting advice
For one mistake made for not knowing, ten mistakes are made for not looking.
上医医未病之病
中医医将病之病
下医医已病之病

～黄帝内经～

Superior doctors prevent the disease.
Mediocre doctors treat the disease before evident.
Inferior doctors treat the full-blown disease.
— Huang Dee

Nai-Ching (2600 BC, First Chinese Medical Text)