Reducing amputations at a multidisciplinary diabetic foot clinic in London

Jonathan Valabhji

The St Mary's Hospital site of Imperial College Healthcare NHS Trust in West London is home to a multidisciplinary diabetic foot clinic. In this article, the clinic's Consultant reports some of the team's achievements, including a reduction in diabetes-related amputation and the establishment of a successful care pathway for the conservative management of neuropathic ulceration complicated by osteomyelitis. The difficulties (and some methods for overcoming them) of calculating diabetes-related amputation rates in the London population are described.

Article points

1. Establishment of the St Mary's Hospital multidisciplinary diabetic foot clinic has resulted in low rates of amputation.
2. Using magnetic resonance imaging to diagnose osteomyelitis and guide duration of antibiotics has resulted in long courses of antibiotics, low rates of amputation and low relapse rates.
3. A method for calculating amputation incidence in London that addresses the difficulties of matching a numerator with an appropriate denominator is described.

Keywords

- Amputation incidence
- Community partnership
- Osteomyelitis

We established our multidisciplinary diabetic foot clinic at St Mary's Hospital in West London in 2002. Over subsequent years, the clinic has evolved to include a team of three diabetes specialist podiatrists, a diabetologist lead, two vascular surgeons, an orthotist, a microbiologist, an orthopaedic surgeon who specialises in the correction of deformity resulting from Charcot neuroarthropathy, a neurologist whose special interest is peripheral neuropathy and a radiologist whose special interest is magnetic resonance imaging (MRI).

In 2007 St Mary's Hospital merged with Charing Cross and Hammersmith Hospitals to form Imperial College Healthcare NHS Trust (ICHT), and in the same year established a partnership between Westminster Primary Care Trust (PCT), the main commissioning PCT for St Mary's Hospital, and ICHT for the provision of diabetes care in a community setting and for the support of diabetes care in the primary care setting, called the Westminster Diabetes Partnership. The Partnership has facilitated the delivery of seamless care, including diabetic foot care, across primary, community and secondary care settings. Importantly for the delivery of effective diabetic foot care, the partnership has served to improve access to specialist services when required.

Managing osteomyelitis conservatively

For people presenting with neuropathic foot lesions, we perform MRI if osteomyelitis is suspected clinically (lesion present for more than 3 weeks, positive probe-to-bone test [Grayson et al, 1995; Shone et al, 2006; Lavery et al, 2007]; characteristic "sausage toe" appearance [Rajbhandari et al, 2000]; or characteristic changes of osteomyelitis on plain X-ray). Our MRI criteria for

Author details can be found on the last page of this article.

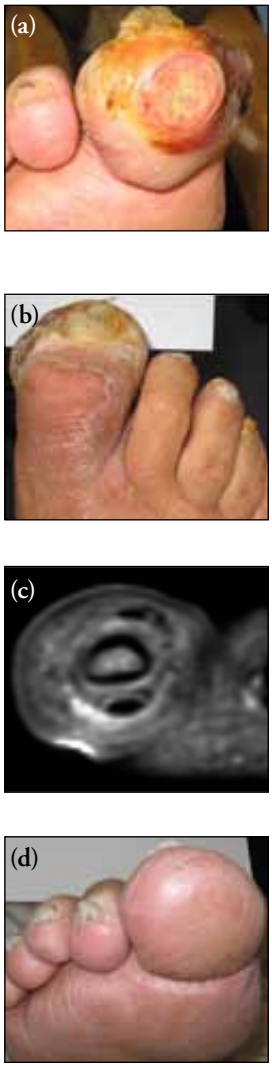

Figure 1. A neuropathic ulcer at the apex of the great toe treated by the multidisciplinary diabetic foot team at St Mary's Hospital, west London, according to the conservative management pathway detailed here. Note the (a–b) classic "sausage toe" appearance suggestive of underlying osteomyelitis; (c) corresponding coronal T2 weighted magnetic resonance imaging (MRI) in which the distal phalanx of the great toe returns hyperintense signal consistent with bone marrow oedema due to underlying osteomyelitis; and (d) the toe following 6 months of oral antibiotic therapy, during which both complete healing of the lesion and resolution of the underlying signal change on MRI were achieved.

diagnosing osteomyelitis associated with a neuropathic lesion require bone signal change to be in direct contiguity with signal change in soft tissue that is adjacent to the area of ulceration. We have found that remote areas of signal change on MRI, particularly involving mid- and hindfoot areas, are common and of unknown clinical significance (Thorning et al, 2010).

For those in whom osteomyelitis is confirmed, antibiotics are continued for a minimum 3-month period, with interval MRI performed at 3 months. All patients have optimum offloading of the neuropathic lesion using a variety of devices and regular outpatient podiatric debridement of callous, slough and necrotic tissue. All are screened for the presence of peripheral vascular disease: those with one or more foot pulse not palpable undergo duplex scanning to define potential target lesions for vascular surgical intervention, although only those whose neuropathic lesions are failing to improve or are deteriorating undergo intervention.

If the neuropathic lesion has healed at 3 months and the repeat MRI demonstrates resolution or significant improvement in underlying bone signal change, then the antibiotics are discontinued. If healing has not yet been achieved or if there is no change in the associated bone signal change on MRI, then antibiotics are continued for a further 3-month cycle with repeat MRI. If the lesion is clearly deteriorating clinically or radiologically, despite vascular surgical intervention if such intervention has been possible, then digital or more proximal amputation is undertaken.

We performed a retrospective cohort study to assess the effectiveness of this approach (Valabhji et al, 2009). We identified 53 episodes of neuropathic forefoot ulceration complicated by underlying osteomyelitis in 47 people with diabetes managed in the clinic between January 2003 and December 2008. We demonstrated healing without subsequent relapse in 40 episodes (75%), and avoidance of any form of amputation in 44 episodes (83%); eight episodes resulted in minor (15%) and one episode in major (2%) amputation. Median follow-up post-cessation of antibiotics was 15 months (range, 3–58 months). On treatment, improvement in the MRI bone signal change consistent with osteomyelitis is slow. Whether this is a true reflection of the time taken to achieve complete eradication of infection in bone, or whether the improvement in signal change lags behind clinical resolution of the osteomyelitis, is not known. For this reason, we do not repeat MRI any earlier than 3 months, necessitating the continuation of antibiotics for a minimum 3-month period. In fact, we found that the median duration of antibiotic therapy in our series using this treatment algorithm was 6 months (range, 3–12 months).

A concern of non-surgical approaches in this situation has been the potential for subsequent relapse. The relapse rate over the entire follow-up period using MRI to guide the duration of antibiotics was between 7% and 13%. Other reports describing conservative management of osteomyelitis that demonstrated similarly high rates of avoidance of amputation (Game and Jeffcoate, 2008; Senneville et al, 2008) used significantly shorter courses of antibiotics (2 and 3 months, respectively). However, the relapse rates in these other studies at 12 months were 31% and 32%, respectively, compared with 2% at 12 months in our series using MRI to guide the duration of antibiotics. It is therefore possible that the slow resolution of bone signal change on MRI more closely reflects the time taken to achieve eradication of infection in bone with antibiotics.

Demonstrating low amputation incidence at the population level

In order to derive amputation incidence, it is necessary to match a numerator with an appropriate denominator. This is particularly difficult in London. We have recently described a method that attempts to overcome many of the difficulties, and have demonstrated particularly low amputation incidence associated with the activity of our multidisciplinary diabetic foot clinic (Valabhji et al, 2010).

Page points

1. To derive the most accurate amputation incidence possible, it is necessary to match a numerator with an appropriate denominator. This is particularly difficult in London.
2. The difficulties of establishing a denominator in a London population include accounting for the lack of a one-to-one relationship between any acute trust or hospital and its main commissioning primary care trust.
3. The difficulties in establishing a numerator include the fact that not all acute trusts have multidisciplinary foot clinics and access to vascular surgery can differ; referrals from more distant primary care trusts often constitute more difficult cases that are therefore more likely to result in amputation.

The difficulties of establishing a denominator in a London population are:

- There is a lack of a one-to-one relationship between any acute trust/hospital and its main commissioning PCT in London. As distances between hospitals are short and transport links good, any central London PCT refers patients to several different acute trusts, and any central London acute trust will see patients from many different PCTs. The diversity of referrals has been encouraged through patient choice and the system of Choose and Book (Parmar et al, 2009). Hence, although the main commissioning PCT for St Mary's Hospital is Westminster PCT, only between 62% and 84% of people with diabetes in Westminster receive their inpatient care at St Mary's Hospital, and between 20% and 54% of the amputations performed at St Mary's Hospital involve Westminster PCT patients, with significant year-on-year variation for both parameters.
- In central London the turnover of the local population is high: in Westminster PCT up to 10% per annum (approximately 10% inflow, 7% outflow and 3% increase in population).
- Under-ascertainment of numbers of people with diabetes is significant. In Westminster PCT, Quality and Outcomes Framework (QOF) data for financial year 2004/2005 suggested that 6211 people had diabetes. The estimate, based on the Yorkshire and Humber Public Health Observatory diabetes prevalence model for 2005, was 9415 (Yorkshire and Humber Public Health Laboratory, 2005).
- Earlier diagnosis through increased awareness and recent requirements for PCTs to screen cardiovascular risk, often including a glucose parameter, in those aged 40–75 years increases the denominator with people of shorter diabetes duration and without complications, resulting in apparent lower amputation incidence. Amputation incidence in the Netherlands fell 34% (55 to 36 per 10000 people with diabetes), yet amputation numbers remained relatively unchanged because the population with diabetes had increased 50% (van Houtum et al, 1996). Many studies therefore report amputation incidence per 100000 of the general population (Calle-Pascual et al, 1997; Global Lower Extremity Amputation Study Group, 2000; Krishnan et al, 2008).

The difficulties of establishing a numerator in a London population are:

- Not all acute trusts have multidisciplinary foot clinics and access to vascular surgery can differ; for clinics incorporating a vascular surgeon, referrals come from more distant PCTs that often constitute more difficult cases more likely to result in amputation.
- Inaccuracy of hospital coded data, compounded by recent improvements in coding due to financial incentives for acute trusts to correctly code secondary diagnoses such as diabetes, has resulted in an apparent increase in amputations in those with diabetes.
- Retrospective methods assessing amputation number fail to identify all of those identified by prospective surveys, although collection of amputation data prospectively requires additional resource (Rayman et al, 2004).

We had not collected amputation data prospectively. We examined hospital coded inpatient data to establish the numerator: the number of inpatient episodes each financial year in which a primary or secondary diagnosis of diabetes, based on International Classification of Diseases (ICD-10) codes, was recorded in a person who underwent a non-traumatic amputation, based on Operating and Coding Procedures (OPCS-4) codes and where the PCT commissioner code was Westminster. Referrals from other PCTs, which may have represented more difficult cases, were not included. A minor amputation was defined as any lower extremity amputation distal to the ankle joint; a major amputation was defined as any lower extremity amputation through or proximal to the ankle joint. When a revision occurred within 3 months, only the later procedure was recorded.

Page points

1. The mean annual incidence of minor, major and total amputations over the 5 financial years was 14.7, 4.2 and 18.9 per 10 000 people with diabetes, respectively, and 3.9, 1.1 and 5.0 per 100 000 of the general population, respectively.
2. Our major amputation incidence of 1.1 per 100 000 of the general population is lower than the previously lowest published incidence.
3. While it has been demonstrated previously that the establishment of a London hospital multidisciplinary diabetic foot clinic can reduce rates of diabetes-related amputation, we are the first to demonstrate that establishing such a clinic in London can be associated with low amputation incidence at the population level.

We examined Westminster PCT QOF datasets to establish two denominators for each financial year: per 10 000 people with diabetes and per 100 000 people in the general population. As not all people with diabetes in Westminster PCT receive inpatient care at St Mary's Hospital, we corrected both denominators for the hospital's percentage market share for the provision of inpatient diabetes care for Westminster PCT each financial year, derived from the Dr Foster database (Dr Foster Intelligence, 2008; Dr Foster Health and Medical Guides, 2010). We calculated mean annual incidence for minor, major and total amputations in people with diabetes from Westminster PCT who received treatment at St Mary's Hospital. The mean annual incidence of minor, major and total amputations over the 5 financial years (April 2004 – April 2009) was 14.7, 4.2 and 18.9 per 10 000 people with diabetes, respectively, and 3.9, 1.1 and 5.0 per 100 000 of the general population, respectively.

Our major amputation incidence of 1.1 per 100 000 of the general population is lower than the previously lowest published incidence of 2.2 per 100 000 from Madrid (Calle-Pascual et al, 1997) and is lower than the major amputation incidence from other United Kingdom centres: Leeds, Leicester, Middlesborough, and Newcastle report 15.4, 5.8, 18.0, and 14.9, respectively (Global Lower Extremity Amputation Study Group, 2000), and Ipswich (Krishnan et al, 2008) 2.8 per 100 000. Our total amputation incidence expressed per 10 000 people with diabetes similarly compares favourably with other groups (Canavan et al, 2008; Krishnan et al, 2008; Johannesson et al, 2009; Schofield et al, 2009). At 4.2 per 10 000 people with diabetes, our major amputation incidence compares favourably with that for people with diabetes in England as a whole – we have recently demonstrated this to be 10.2 per 10 000 (Vamos et al, 2010).

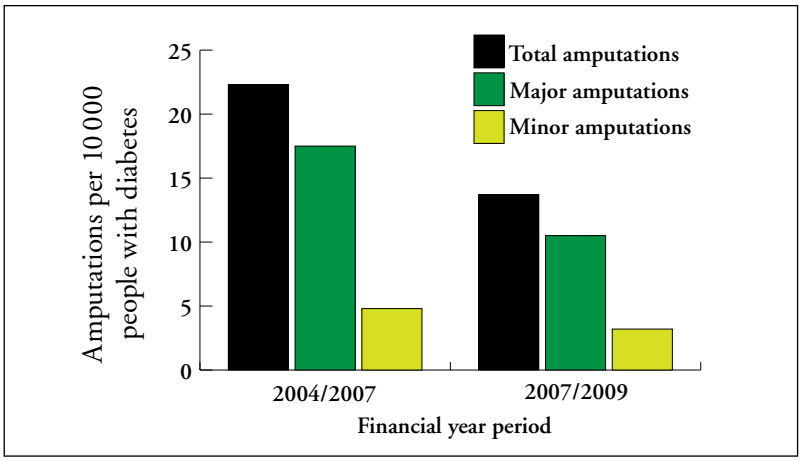

Figure 2. Amputation incidence per 10 000 people with diabetes in the 3 financial years (2004–2007) prior to establishment of the Westminster Diabetes compared with the 2 financial years (2007–2009) following its establishment.

A partnership to drive down amputation incidence

The 5-year period for which we established mean annual amputation incidence corresponded to 3 years prior to, and 2 years following, establishment of the Westminster Diabetes Partnership. We were, therefore, able to compare annual amputation incidence prior to and following establishment of the partnership. Annual incidence of minor, major and total amputations per 10 000 people with diabetes in the 3 financial years prior to the establishment of the partnership compared with the subsequent 2 years decreased by 40%, 34% and 39%, respectively (*Figure 2*). Annual incidence of minor, major and total amputations per 100 000 of the general population decreased by 35%, 28% and 33%, respectively. The achieved annual incidence of minor, major and total amputations was 10.5, 3.2 and 13.7 per 10 000 people with diabetes, and was 3.0, 0.9 and 3.8 per 100 000 of the general population, respectively.

Conclusion

While it has been demonstrated previously that the establishment of a London hospital multidisciplinary diabetic foot clinic can reduce rates of diabetes-related amputation (Edmonds et al, 1986), we are the first to demonstrate that establishing such a clinic in London can be associated with low amputation incidence at the population level. Our method for deriving amputation incidence has attempted to overcome many of the difficulties matching a numerator with an appropriate denominator

"We have shown that an effective network for foot care across primary, community and secondary care settings, through an acute–primary care trust partnership, can be associated with further reductions in amputation incidence at the population level."

in London. Accepting the limitations of the method used, our published lower limb major amputation incidence is the lowest ever reported.

For the management of neuropathic forefoot lesions complicated by underlying osteomyelitis, our rates of minor, major and total amputation of 15%, 2% and 17%, respectively, compare well with rates reported in other series describing conservative management of osteomyelitis (5–38%, 0–29% and 7–47%, respectively; Game and Jeffcoate 2008; Senneville et al, 2008; others reviewed in Jeffcoate and Lipsky, 2004). We also demonstrated particularly low relapse rates associated with our management pathway.

A recent study demonstrated a significant reduction in amputation incidence associated with the establishment of a dedicated diabetic foot care team that incorporated a community-based podiatry service (Canavan et al, 2008). We have shown that an effective network for foot care across primary, community and secondary care settings, through an acute–primary care trust partnership, can be associated with further reductions in amputation incidence at the population level. ■

Author

Jonathan Valabhji is Consultant Physician and Lead Clinician for Diabetes, Imperial College Healthcare NHS Trust and Honorary Clinical Senior Lecturer, Imperial College London, London.

Calle-Pascual AL, Redondo MJ, Ballesteros M et al (1997) Nontraumatic lower extremity amputations in diabetic and non-diabetic subjects in Madrid, Spain. *Diabetes Metab* **23**: 519–23

Canavan RJ, Unwin NC, Kelly WF, Connolly VM (2008) Diabetes- and nondiabetes-related lower extremity amputation incidence before and after the introduction of better organized diabetes foot care: continuous longitudinal monitoring using a standard method. *Diabetes Care* **31**: 459–63

Dr Foster Health and Medical Guides (2010) Hospital guide. Available at: http://bit.ly/k3xdrq (accessed 03.04.10)

Dr Foster Intelligence (2008) About Us. Available at: http://bit.ly/mQRf9i (accessed 03.04.10)

Edmonds ME, Blundell MP, Morris ME et al (1986) Improved survival of the diabetic foot: the role of a specialized foot clinic. *Q J Med* **60**: 763–71

Game FL, Jeffcoate WJ (2008) Primarily non-surgical management of osteomyelitis of the foot in diabetes. *Diabetologia* **51**: 962–7

Global Lower Extremity Amputation Study Group (2000) Epidemiology of lower extremity amputation in centres in Europe, North America and East Asia. The Global Lower Extremity Amputation Study Group. *Br J Surg* **87**: 328–37

Grayson ML, Gibbons GW, Balogh K et al (1995) Probing to bone in infected pedal ulcers. A clinical sign of underlying osteomyelitis in diabetic patients. *JAMA* **273**: 721–3

Jeffcoate WJ, Lipsky BA (2004) Controversies in diagnosing and managing osteomyelitis of the foot in diabetes. *Clin Infect Dis* **39**(Suppl 2): S115–22

Johannesson A, Larsson GU, Ramstrand N et al (2009) Incidence of lower-limb amputation in the diabetic and nondiabetic general population: a 10-year population-based cohort study of initial unilateral and contralateral amputations and reamputations. *Diabetes Care* **32**: 275–80

Krishnan S, Nash F, Baker N et al (2008) Reduction in diabetic amputations over 11 years in a defined U.K. population: benefits of multidisciplinary team work and continuous prospective audit. *Diabetes Care* **31**: 99–101

Lavery LA, Armstrong DG, Peters EJ, Lipsky BA (2007) Probe-to-bone test for diagnosing diabetic foot osteomyelitis: reliable or relic? *Diabetes Care* **30**: 270–4

Parmar V, Large A, Madden C, Das V (2009) The online outpatient booking system 'Choose and Book' improves attendance rates at an audiology clinic: a comparative audit. *Inform Prim Care* **17**: 183–6

Rajbhandari SM, Sutton M, Davies C et al (2000) 'Sausage toe': a reliable sign of underlying osteomyelitis. *Diabet Med* **17**: 74–7

Rayman G, Krishnan ST, Baker NR et al (2004) Are we underestimating diabetes-related lower-extremity amputation rates? Results and benefits of the first prospective study. *Diabetes Care* **27**: 1892–6

Schofield CJ, Yu N, Jain AS, Leese GP (2009) Decreasing amputation rates in patients with diabetes-a population-based study. *Diabet Med* **26**: 773–7

Senneville E, Lombart A, Beltrand E et al (2008) Outcome of diabetic foot osteomyelitis treated nonsurgically: a retrospective cohort study. *Diabetes Care* **31**: 637–42

Shone A, Burnside J, Chipchase S et al (2006) Probing the validity of the probe-to-bone test in the diagnosis of osteomyelitis of the foot in diabetes. *Diabetes Care* **29**: 945

Thorning C, Gedroyc WM, Tyler PA et al (2010) Midfoot and hindfoot bone marrow edema identified by magnetic resonance imaging in feet of subjects with diabetes and neuropathic ulceration is common but of unknown clinical significance. *Diabetes Care* **33**: 1602–3

Valabhji J, Oliver N, Samarasinghe D et al (2009) Conservative management of diabetic forefoot ulceration complicated by underlying osteomyelitis: the benefits of magnetic resonance imaging. *Diabet Med* **26**: 1127–34

Valabhji J, Gibbs RG, Bloomfield L et al (2010) Matching the numerator with an appropriate denominator to demonstrate low amputation incidence associated with a London hospital multidisciplinary diabetic foot clinic. *Diabet Med* **27**: 1304–7

Vamos EP, Bottle A, Majeed A, Millett C (2010) Trends in lower extremity amputations in people with and without diabetes in England, 1996-2005. *Diabetes Res Clin Pract* **87**: 275–82

van Houtum WH, Lavery LA, Harkless LB (1996) The impact of diabetes-related lower-extremity amputations in The Netherlands. *J Diabetes Complications* **10**: 325–30

Yorkshire and Humber Public Health Laboratory (2005) *PBS Diabetes Population Prevalence Model – Phase 3* (password protected). YHPHL, York. Available at: http://bit.ly/ktuPPC (accessed 03.04.10)