

High-risk foot and the effect of deteriorating renal function and dialysis in people with diabetes

Sue Foster

Citation: Foster S (2017) High-risk foot and the effect of deteriorating renal function and dialysis in people with diabetes. *Journal of Diabetes Nursing* 21: 10–15

Article points

1. Diabetic neuropathy and nephropathy are closely linked, and people with moderate-to-severe renal disease have an increased risk of foot ulceration.
2. People with diabetes and end-stage renal disease need regular screening and follow-up, and deteriorating renal function should be an indication that the feet are at increased risk.
3. Targeted education of both renal patients and dialysis staff can help improve outcomes in this vulnerable group.

Key words

- Diabetic foot
- Diabetic nephropathy
- Haemodialysis

Authors

Sue Foster is Community Diabetes Specialist Nurse, Buckinghamshire Healthcare NHS Trust.

As microvascular complications, diabetic neuropathy and nephropathy are closely linked. People with advanced renal dysfunction are at increased risk of foot ulceration and mortality, and people with both renal failure and foot complications have a higher risk of death than those with renal failure alone. In this article, the author reviews the risk factors for developing foot complications in relation to renal failure, as illustrated by a case report, and makes recommendations to improve care and outcomes in the high-risk group of people with diabetes and comorbid renal disease.

Diabetic nephropathy, the main cause of end-stage renal disease, is associated with other microvascular complications, including neuropathy. It is also correlated with foot ulceration and amputation (Ndip et al, 2010a; Bennett et al, 2015), and there is a significantly higher mortality rate for people who have foot complications and renal failure compared to those with renal failure alone (Ndip et al, 2012; Game et al, 2013).

The NICE NG19 guideline classifies people with diabetes who are receiving renal replacement therapy as being at high risk of developing a foot problem (NICE, 2015). This is due to a number of factors, including the presence of peripheral artery disease (Ndip et al, 2010b; Al-Thani et al, 2014). However, it is possible that people are at increased risk even with moderate reductions in estimated glomerular filtration rate (eGFR; Wolf et al, 2009; Valabhji, 2012). Could there also be other factors that require consideration, such as inflammatory markers?

In this review of the literature, the significance of renal impairment and the high risk of foot disease will be argued and related to a case study of a patient receiving haemodialysis. The risk factors

for developing foot complications will be analysed in relation to renal failure. The role of screening and health education in the prevention of foot disease in the author's area will be evaluated and recommendations for change to improve clinical outcomes discussed.

Case study

John (a pseudonym) is 64 years old, Caucasian, single, unemployed (a former builder) and he lives alone in a council property. He was diagnosed with type 2 diabetes 11 years ago. His BMI at diagnosis was 31 kg/m² and he was started on metformin and gliclazide. Simvastatin, aspirin and ramipril were also prescribed.

John had microalbuminuria, hypertension and hyperlipidaemia. His HbA_{1c} had slowly been increasing and deteriorated when the metformin was stopped owing to a decline in eGFR. John was also given replacement erythropoietin for anaemia and alfacalcidol for bone mineral disorder. Recently, his HbA_{1c} had reached 96 mmol/mol (10.9%) and he was referred to the community diabetes nurse to discuss starting insulin. His renal function was slowly declining and 18 months ago he had been started on haemodialysis at a satellite

Page points

1. Longer diabetes duration, poor glycaemic control, smoking and being tall all increase the risk of peripheral neuropathy, which in turn increases the risk of ulceration.
2. Poor glycaemic control is the common factor predisposing to both diabetic neuropathy and nephropathy.
3. End-stage renal disease and haemodialysis are also risk factors for foot ulceration.

centre at the local hospital three times a week due to diabetic nephropathy.

When John's feet were examined by the practice nurse at the surgery over 18 months ago, the pulses were detected and sensation using the 10 g monofilament test had also been present in both feet. There was no evidence of previous ulceration, calluses or deformity in the notes at the surgery.

John struggled with the diagnosis of diabetes and, although he had diabetes complications, he found it difficult to stop smoking and adhere to a healthy diet. Socially, he did not leave the house as he had no transport and very little money. Previously he had attended the GP surgery for his yearly diabetes reviews, but since starting the dialysis he no longer went out. A family member visited to do the shopping once week and a neighbour also bought him food, but he insisted on having various foods that were high in sugar and fat. His personal hygiene was poor and he had a bath once per week. He wore the same clothes, including socks, for several days at a time.

District nurses were involved with giving his insulin daily. John did not check his own feet as he was unable to see properly and he did not know why it was important. He wore plastic shoes (Crocs) all the time. A more recent 10 g monofilament test indicated reduced sensation in both feet. In arterial assessment, the posterior tibial and dorsalis pedis pulses were difficult to detect by palpation. The skin was pale, flaky and dry but foot temperature did not vary significantly. John was referred to podiatry as a high risk for developing foot complications and further vascular tests were requested. The haemodialysis unit was contacted but, unfortunately, they said that they did not check feet, although they were happy for the podiatrist to visit the unit.

Diabetic foot ulcer risk factors

John had many risk factors that could lead to ulcers, amputation and increased mortality risk. Longer duration of diabetes is associated with increased foot risk (Behary et al, 2012). Poor glycaemic control, smoking and being tall (John was 1.91 metres in height) all predispose to peripheral neuropathy, which can increase the risk of ulceration by two- to five-fold (Young, 2014). In addition, the dry skin that is also common in this

condition, an effect of autonomic neuropathy that reduces sweating, can increase the risk if the skin is not kept moist (Baker and Kenny, 2016).

Hyperglycaemia

The common factor predisposing to both peripheral neuropathy and renal dysfunction is poor glucose control ($HbA_{1c} >48$ mmol/mol [6.5%]; Hill et al, 2014). In the 10-year follow-up of the UKPDS (UK Prospective Diabetes Study), previous intensive glucose control in people with type 2 diabetes reduced the risk of microvascular disease affecting the kidneys, eyes and feet (Holman et al, 2008). In the case described, John had poor vision (retinopathy) which increased the risk of walking on an object without noticing, and this would be compounded by the reduced sensation from his peripheral neuropathy, so that he might not feel the object and remove his foot. John had received treatment for the retinopathy but was not compliant with it. Poor sight and the inability to check the feet increase the risk of foot complications (Valabhji, 2012).

The long-acting insulin glargine was given to John to control his blood glucose levels, as it has been shown to reduce the risk of hypoglycaemia (important given John's living situation) compared to NPH insulin (Lee et al, 2012). Interestingly, Kostev et al (2012) proposed that patients receiving this insulin were significantly less likely to develop foot ulceration. It could be argued that less hypoglycaemia prevents glucose instability, which can reduce endothelial dysfunction and inflammation, both of which have been correlated with diabetes complications (Ceriello and Kilpatrick, 2013).

Haemodialysis

In addition to the above factors, it could be argued that haemodialysis is a predisposing factor for foot ulceration when eGFR falls below 12 mL/min and uraemic neuropathy develops, which can affect all three of the nervous systems: central, peripheral and autonomic (Ndip et al, 2010b). Indeed, vasculitides caused by end-stage renal disease can cause peripheral neuropathy (Valabhji, 2012).

Interestingly, it is possible that neuropathy can even occur in earlier-stage renal disease, at stages 3a and 3b. In a retrospective, observational

study, Margolis et al (2008) suggested that people with diabetes who had a moderate reduction in kidney function (eGFR <60 mL/min/1.73 m²) had a significantly increased risk of foot ulcers and amputation. Furthermore, Wolf et al (2009) suggested there was a significant correlation between albuminuria, deteriorating eGFR and diabetic foot syndrome.

Haemodialysis increases the risk of foot disease in people with diabetes via several mechanisms, including poor perfusion to the feet during dialysis (Beckert et al, 2009; Kay et al, 2011), arterial calcification (Al-Qaisi et al, 2009), and anaemia and the consequent reductions in tissue oxygenation and wound healing (Valabhji, 2012). Anaemia in renal failure is related to erythropoietin deficiency and can begin to deteriorate at stage 3a renal disease (Bennett and Aditya, 2015).

In John's case, he did not attend his diabetes clinic appointments, where he would have had his feet checked, and the dialysis unit did not perform foot checks. People who receive dialysis do not necessarily attend podiatry appointments and may not appreciate the importance of correct foot management (Ndip et al, 2010c). Educating staff and patients of the dialysis units to perform foot checks may help to reduce the risk of diabetic foot complications (Reda et al, 2012; Pollard et al, 2015). Having one or more "champions" in the hospitals to ensure that foot checks and standards are maintained can help with this and is recommended by Diabetes UK (Joule, 2016).

Psychosocial factors

Patients need to take responsibility for taking care of their feet, but this can be challenging if there is poor motivation or if they have false illness beliefs (Bruun et al, 2014; Vedhara et al, 2014). Moreover, depression in people with end-stage renal disease has been suggested to increase mortality (Young et al, 2010). These factors highlight that, in John's case, psychosocial and patient-centred care to support self-management may have been more important than education alone (Dorresteijn et al, 2014).

Motivational interviewing has been proposed for improving self-management of the feet (Gabbay et al, 2011). Interestingly, in the NICE

(2011) Quality Standard for diabetes in adults, it is implied that carers can also attend structured education. Spouses and carers can play an important role in supporting people with diabetes to look after their feet. In the author's area, this is actively encouraged, and anecdotal evidence would suggest that it is beneficial. Indeed, Cerrone et al (2015) suggest that people who had good support from their spouses had a significantly lower risk of foot complications, albeit in a small study that did not assess ethnic groups.

Recommendations to improve patient care and clinical outcomes

In the last three years, the author has run a community diabetes renal clinic for people with deteriorating renal function (stage 3–4; Foster, 2014). This clinic has provided care closer to patients' homes, regular follow-up and an integrated multidisciplinary team approach. A joint renal diabetes clinic in Ireland showed similar benefits (Thabit et al, 2012). Feet are checked in the author's clinic and a risk assessment made according to the NICE (2015) guideline on diabetic foot problems. This involves checking the circulation and assessing for peripheral neuropathy and any previous ulceration or amputations at each visit. It could also be argued that proteinuria and deteriorating renal function should be added to the risk check (Margolis et al, 2008; Wolf et al, 2009).

One of the advantages of the renal diabetes clinic in the author's area is that timely referral to podiatry services, using the Diabetes UK (2016) footcare pathway, means treatment can be instigated early. Game et al (2013) proposed that the onset of foot ulcers occurred just prior to dialysis, suggesting that the inflammation that is contributing to the ulcer may also affect the kidney deterioration. It could, therefore, be argued that blood tests should be taken to detect these inflammatory markers at an earlier stage of renal deterioration (Weigelt et al, 2009; Khanbhai et al, 2012), allowing targeted education of patients and increased screening of foot health and renal function.

The NICE (2015) guideline proposes that people who are admitted to hospital with a diabetic foot problem or who have a problem identified whilst admitted should receive attention

Page points

1. It is possible that moderate renal disease also increases the risk of foot ulceration.
2. Low motivation and false illness beliefs can be barriers to good foot self-management; in such patients, psychosocial and patient-centred care may be more important than education alone.
3. Motivational interviewing and involving family and carers can have important roles in foot self-care.
4. Running joint diabetes and renal clinics can improve foot screening rates and outcomes in renal patients.

Page points

1. People with diabetes undergoing dialysis, who attend for the day and are not acutely unwell, may be less likely to receive foot checks at clinics.
2. Education of staff in dialysis units, using a foot care guide and, possibly, including the nephrologists as part of the multidisciplinary team may improve outcomes.

within 24 hours. However, people with diabetes undergoing dialysis, who attend for the day and are not acutely unwell, may be less likely to receive the same surveillance and, therefore, may have an ulcer that goes undetected, despite their high level of risk. A multidisciplinary team approach that provides access to the vascular team may improve the prognosis if interventions such as percutaneous transluminal angioplasty are considered (Matsuzaki et al, 2012).

One of the changes to the service that could be suggested is a foot care education programme given to staff and patients in the dialysis units (Meaney, 2012; Reda et al, 2012; Wilson and Lawrence, 2013). The author has met with the lead podiatrist and suggested a joint education session with the renal staff regarding diabetes and the foot, with a view to implementing a similar foot care guide.

An audit of “putting feet first” was undertaken over four months in the author’s hospital by the podiatrists. There were a total of 490 patients assessed. People from poorer social backgrounds, people with learning difficulties and single men comprised approximately 70% of foot pathology cases. This information supports findings from other areas around the country that social deprivation increases the risk of foot disease (Leese et al, 2013). John was an example of this. His non-attendance at the surgery for diabetes reviews meant that changes to the peripheral circulation and nerves were not detected. A foot register for people with diabetes could perhaps be kept at the GP surgery to identify those who are receiving dialysis, in order to follow up any non-attenders. Notably, in the author’s hospital audit, 17% of people at high risk were unknown to podiatry.

Interestingly, in the National Diabetes Footcare Audit (Health and Social Care Information Centre, 2016), no reference was made to people who are receiving dialysis and have foot problems. Capturing such data would provide more information about the scale of the problem and on possible interventions to increase screening and prevention of ulceration, and it may even enable funding for renal specialist podiatrists (Pollard et al, 2015).

Devising new ways of educating people on managing their diabetes and understanding the

importance of checking their feet may also be a priority. Recently, a survey of people with type 2 diabetes suggested that 42% were not confident in managing their condition (Diabetes UK, 2015). Care planning may help to improve this with a more patient-centred approach (Foot et al, 2014), and motivational interviewing may also be helpful (Gabbay et al, 2011).

Conclusion

Uraemic neuropathy and vasculitides caused by end-stage renal failure, poor perfusion to the feet during dialysis and anaemia are some of the mechanisms by which the risk of foot disease is increased in people with renal failure. Foot education and updates, given by podiatrists to both primary care staff and patients, play an important part in preventing foot ulcers. However, patients’ health beliefs about caring for their feet, psychosocial factors and living alone all have an effect on their self-management.

People with end-stage renal disease need regular screening and follow-up to prevent them being lost in the system. Deteriorating renal function should be an indication that the feet are at increased risk. The use of specialist renal diabetes clinics and working with the multidisciplinary team are both preventative measures.

Education of staff in dialysis units, using a foot care guide and, possibly, including the nephrologists as part of the multidisciplinary team may lead to a reduction in foot ulceration, amputation and mortality in this high-risk group of people. ■

Al-Qaisi M, Nott DM, King DH, Kaddoura S (2009) Ankle brachial pressure index (ABPI): an update for practitioners. *Vasc Health Risk Manag* **5**: 833–41

Al-Thani H, El-Menyar A, Koshy V et al (2014) Implications of foot ulceration in hemodialysis patients: a 5-year observational study. *J Diabetes Res* **2014**: 945075

Baker N, Kenny C (2016) Prevention, screening and referral of the diabetic foot in primary care. *Diabetes & Primary Care* **18**: 234–42

Beckert S, Sundermann K, Wolf S et al (2009) Haemodialysis is associated with changes in cutaneous microcirculation in diabetes mellitus. *Diabet Med* **26**: 89–92

Behary P, Tai FW, Najam O et al (2012) An audit of the multidisciplinary diabetic follow-up of patients with end-stage diabetic nephropathy attending the dialysis centre at Ealing Hospital in West London. *Diabet Med* **29**(Suppl 1): 150 (abstract P394)

Bennett K, Aditya BS (2015) An overview of diabetic nephropathy: epidemiology, pathophysiology and treatment. *Journal of Diabetes Nursing* **18**: 61–7

- Bruun C, Guassora AD, Nielsen AB et al (2014) Motivation, effort and life circumstances as predictors of foot ulcers and amputations in people with type 2 diabetes mellitus. *Diabet Med* **31**: 1468–76
- Ceriello A, Kilpatrick ES (2013) Glycemic variability: both sides of the story. *Diabetes Care* **36**(Suppl 2): 272–5
- Cerrone E, Creagh FM, Strong S et al (2015) Marriage: it's good for your feet! *Diabet Med* **32**(Suppl 1): 153 (abstract P403)
- Diabetes UK (2015) *42% of people with Type 2 diabetes "not confident managing their condition"*. DUK, London. Available at: <http://bit.ly/1GJPMpl> (accessed 20.12.16)
- Diabetes UK (2016) *Putting Feet First: Integrated footcare pathway*. DUK, London. Available at: <http://bit.ly/2h6odok> (accessed 20.12.16)
- Dorresteijn JA, Kriegsman DM, Assendelft WJ, Valk GD (2014) Patient education for preventing diabetic foot ulceration. *Cochrane Database Syst Rev* **2014**: CD001488
- Foot C, Gilbert H, Dunn P et al (2014) *People in control of their own health and care: the state of involvement*. The King's Fund, London. Available at: <http://bit.ly/2hQTX1A> (accessed 20.12.16)
- Foster S (2014) Can community-based clinics be used to reduce the progression of diabetic nephropathy? *Diabetes & Primary Care* **16**: 242–5
- Gabbay RA, Kaul S, Ulbrecht J (2011) Motivational interviewing by podiatric physicians: a method for improving patient self-care of the diabetic foot. *J Am Podiatr Med Assoc* **101**: 78–84
- Game FL, Selby NM, McIntyre CW (2013) Chronic kidney disease and the foot in diabetes – is inflammation the missing link? *Nephron Clin Pract* **123**: 36–40
- Health and Social Care Information Centre (2016) *National Diabetes Foot Care Audit Report: 2014–2015. England and Wales*. HSCIC, Leeds. Available at: <http://bit.ly/2g85MOd> (accessed 20.12.16)
- Hill CJ, Cardwell CR, Patterson CC et al (2014) Chronic kidney disease and diabetes in the national health service: a cross-sectional survey of the U.K. national diabetes audit. *Diabet Med* **31**: 448–54
- Holman RR, Paul SK, Bethel MA et al (2008) 10-year follow-up of intensive glucose control in type 2 diabetes. *N Engl J Med* **359**: 1577–89
- Joule N (2016) Improving diabetes: inpatient footcare. *Diabetes Update* **2016**: 26–7
- Kay DB, Ray S, Haller NA, Hewitt M (2011) Perfusion pressures and distal oxygenation in individuals with diabetes undergoing chronic hemodialysis. *Foot Ankle Int* **32**: 700–3
- Khanbhai M, Loukogeorgakis S, Wright J (2012) Anaemia, inflammation, renal function, and the diabetic foot: what are the relationships? *The Diabetic Foot Journal* **15**: 150–8
- Kostev K, Dippel FW, Rockel T, Siegmund T (2012) Risk of diabetic foot ulceration during treatment with insulin glargine and NPH insulin. *J Wound Care* **21**: 483–9
- Lee P, Chang A, Blaum C et al (2012) Comparison of safety and efficacy of insulin glargine and neutral protamine hagedorn insulin in older adults with type 2 diabetes mellitus: results from a pooled analysis. *J Am Geriatr Soc* **60**: 51–9
- Leese GP, Feng Z, Leese RM et al (2013) Impact of health-care accessibility and social deprivation on diabetes related foot disease. *Diabet Med* **30**: 484–90
- Margolis DJ, Hofstad O, Feldman HI (2008) Association between renal failure and foot ulcer or lower-extremity amputation in patients with diabetes. *Diabetes Care* **31**: 1331–6
- Matsuzaki K, Miyamoto A, Hakamata N et al (2012) Diabetic foot wounds in haemodialysis patients: 2-year outcome after percutaneous transluminal angioplasty and minor amputation. *Int Wound J* **9**: 693–700
- Meaney B (2012) Diabetic foot care: prevention is better than cure. *J Ren Care* **38**(Suppl 1): 90–8
- Ndip A, Rutter MK, Vileikyte L (2010a) Dialysis treatment is an independent risk factor for foot ulceration in patients with diabetes and stage 4 or 5 chronic kidney disease. *Diabetes Care* **33**: 1811–6
- Ndip A, Lavery LA, Boulton AJ (2010b) Diabetic foot disease in people with advanced nephropathy and those on renal dialysis. *Curr Diab Rep* **10**: 283–90
- Ndip A, Lavery LA, Lafontaine J et al (2010c) High levels of foot ulceration and amputation risk in a multiracial cohort of diabetic patients on dialysis therapy. *Diabetes Care* **33**: 878–80
- Ndip A, Vardhan A, Breislin K, Boulton AJ (2012) High mortality rates from foot complications in diabetic patients on dialysis. *Diabetes* **61**(Suppl 1): A32 (abstract 120-OR)
- NICE (2011) *Diabetes in adults* (QS6). NICE, London. Available at: www.nice.org.uk/guidance/qs6 (accessed 20.12.16)
- NICE (2015) *Diabetic foot problems: prevention and management* (NG19). NICE, London. Available at: www.nice.org.uk/guidance/ng19 (accessed 20.12.16)
- Pollard H, Rajbhandari S, Solomon L (2015) A renal specialist podiatrist accessing patients with diabetes in a tertiary care haemodialysis unit can improve concordance and reduce the risk of amputation. *Diabet Med* **32**(Suppl 1): 152–3 (abstract P401)
- Reda A, Hurton S, Embil JM et al (2012) Effect of a preventive foot care program on lower extremity complications in diabetic patients with end-stage renal disease. *Foot Ankle Surg* **18**: 283–6
- Thabit H, Besharatian B, Conlon PJ, Smith D (2012) Complications and characteristics of patients referred to a joint diabetes renal clinic in Ireland. *Ir J Med Sci* **181**: 549–53
- Valabhji J (2012) Foot problems in patients with diabetes and chronic kidney disease. *J Ren Care* **38**(Suppl 1): 99–108
- Vedhara K, Dawe K, Wetherell MA et al (2014) Illness beliefs predict self-care behaviours in patients with diabetic foot ulcers: a prospective study. *Diabetes Res Clin Pract* **106**: 67–72
- Weigelt C, Rose B, Poschen U et al (2009) Immune mediators in patients with acute diabetic foot syndrome. *Diabetes Care* **32**: 1491–6
- Wilson B, Lawrence J (2013) Implementation of a foot assessment program in a regional satellite hemodialysis setting. *CANN J* **23**: 41–7
- Wolf G, Müller N, Busch M et al (2009) Diabetic foot syndrome and renal function in type 1 and 2 diabetes mellitus show close association. *Nephrol Dial Transplant* **24**: 1896–901
- Young BA, Von Korff M, Heckbert SR et al (2010) Association of major depression and mortality in stage 5 diabetic chronic kidney disease. *Gen Hosp Psychiatry* **32**: 119–24
- Young M (2014) The diabetic foot: an overview for diabetes nurses. *Journal of Diabetes Nursing* **18**: 218–26

“People with end-stage renal disease need regular screening and follow-up to prevent them being lost in the system. Deteriorating renal function should be an indication that the feet are at increased risk.”