

Identifying nocturia as a contributor to diabetic foot ulcer healing delays

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Article points

1. A high prevalence of people in this study group had nocturia.
2. People with diabetes and a plantar diabetes foot ulcer may not have optimal offloading for their nocturnal activities, including nocturia.
3. Diabetes foot ulcer healing is delayed by unprotected weight-bearing at night.
4. This study supports the premise of non-removable offloading, especially for people with nocturia.

Key words

- Diabetes
- Foot ulcer
- Nocturia
- Nocturnal activity
- Offloading

Authors

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Identifying risk factors that contribute to the development and progression of a diabetic foot ulcer is critical to preventing lower extremity amputation. Nocturia is a common cause of night waking. Multiple factors contribute to nocturia, which may result in barefoot walking and potential complications for the diabetic foot. Ulcer healing may be delayed and new wounds may develop during the course of nocturnal activity.

The lifetime risk of a person with diabetes developing a foot ulcer may be as high as 25% (Boulton et al, 2008). The causal pathway primarily involves peripheral sensorimotor neuropathy, skin trauma and deformity, often due to altered foot biomechanics (Reiber et al, 1999; Leymarie et al, 2004; Bus, 2012). Successful management of the person with a plantar diabetic foot ulcer (DFU) requires a multidisciplinary team and a holistic approach. Particular attention should be paid to effective offloading to redistribute pressure (Armstrong et al, 2004; Boulton et al, 2008). Offloading devices are necessary for healing a DFU, as well as maintaining the foot in a healed state when worn (Cavanagh and Bus, 2011). Armstrong et al (2003) demonstrated that offloading devices are often not worn as prescribed.

Barefoot ambulation occurs during showering and may occur during nocturia and nocturnal activity, which may leave the foot unprotected and exposed to weight-bearing forces and trauma. A search of the medical literature identified no studies that examined the relationship between nocturia or nocturnal weight-bearing activity and healing of DFUs. Current clinical practice in managing and preventing DFUs should consider these aspects. Nocturia and nocturnal activity offloading may be inadequate or the devices not worn, delaying progress to timely healing or prompting a recurrence of DFUs.

Aim

The aim of the study was to establish the prevalence of nocturia in people with a DFU, and determine the offloading method used during these events, and its effect on healing.

Methods

Patients ($n=95$) presenting at the Austin Health Diabetes Foot Ulcer and Charcot's Clinic with a plantar DFU between December 2009 and February 2012 were recruited for the study. Informed consent was obtained and a structured survey (*Box 1*) was conducted. In the absence of any published or peer-reviewed questionnaires on this topic, a tool was developed for this study based on information sourced from the Continence Foundation of Australia and the Australian National Health and Medical Research Council. This study received approval from the Austin Health Human Research Ethics Committee.

Results

Table 1 provides a summary of participant demographics and assessment parameters. The mean age of participants was 62.8 years (age range, 21–84 years). The mean HbA_{1c} was 8.41% (68.4 mmol/mol). Seventy (73%) participants were male. Seventy-nine (83%) had diabetes of >10 years' duration. Seventy-seven (81%) had type 2 diabetes. Peripheral arterial disease was present in 61 participants (64%) and loss of protective sensation was present in 94 (98%).

Nocturia was experienced by 75% of the study group. There was a mean number of toilet visits of 2.09 (range, 1–7 toilet visits) per night. Nearly 48% of these individuals walked greater than 22 steps per nocturia episode (Table 2). This has a potential for 250m of weight bearing on a DFU per night. Very few participants consumed caffeine or alcohol prior to going to bed. Small numbers of participants experienced prostate problems or urinary tract infections.

Of the 75% who experienced nocturia, each had an average of 4.1 risk factors known to cause nocturia (Box 2). Some 95.8% of participants reported using nocturnal offloading. This is reflected in the 65% of people with DFUs whose ulcers reduced by ≥50% in 4 weeks. Of the 75%

Box 1. Structured survey content.

- How many times do you get up at night to go to the toilet?
- How many steps is it from your bed to the toilet?
- Are you currently taking fluid tablets?
- Do you have swollen ankles?
- Do you have high blood pressure?
- Do you have kidney problems and take medications for this?
- Do you drink caffeine before going to bed?
- Do you drink more than 10 cups (1 cup = 250 mL) of fluid a day?
- Do you have trouble sleeping at night?
- Do you have a known prostate problem?
- Do you have a known urinary tract infection?
- Do you wake at night and get out bed for other reasons?
- Do you have heart of disease?
- When you get out bed, what do you put on your feet?
- How many standard alcoholic drinks do you drink before going to bed?†
 - Light beer (0.8 standard drink)
 - Medium beer (1 standard drink)
 - Regular beer (1.5 standard drinks)
 - 100mL wine (9–13% alcohol by volume; 1 standard drink)
 - 30mL nip of spirits (1 standard drink)
 - Can spirits (5% alcohol by volume; 1.5–2.5 standard drinks)

†Australian Government National Health and Medical Research Council Alcohol Guidelines (2015), Continence Foundation of Australia (2010)

Table 1. Participant demographic and clinical data.

Variable	
Participants (n)	95
Male (%)	71
Age (years)	63.2±12.42
Type 2 diabetes (%)	76.8
Duration >10 years (%)	80
Loss of protective sensation† (%)	95.7
HbA _{1c} (%)	8.33 ± 2.31
Lives alone (%)	30.5
Smoker (%)	12.6
Depression (%)	20.5
English as a second language (%)	9.4
BMI >25 kg/m ² (%)	80
eGFR >90 mL/min/1.73m ² (%)	23.1
Peripheral arterial disease‡ (%)	61
Diabetic retinopathy (%)	48.4
Cardiac disease (%)	50.5
Diabetes management (%)	
Diet and exercise only	5.2
Oral antidiabetes agent(s)	18.9
Insulin	47.3
Previous diabetic foot pathology (%)	
Digit, foot or limb amputation	49.3
Charcot’s neuroarthropathy	14.7
Structural foot deformity	68.4

†Insensitivity to 10-g monofilament; ‡ankle–biracial pressure index <0.8mmHg and >1.2mmHg

who experienced nocturia, 65.2% achieved a 50% reduction of their ulcer dimensions in 1 month (Sheehan et al, 2003) with adhesive felt offloading or foot orthotics in shoes/slippers.

Table 2. Nocturia events and number of nocturnal steps.

	N	%
Nocturia episodes per night		
≤2	50	69.5
3	14	19.4
4	5	6.9
5	1	1.3
6	1	1.3
≥7	1	1.3
Number of nocturnal weight-bearing steps		
≤10	61	84.7
≥11	34	47.2
Other nocturnal activities		
	7/95	0.07

Discussion

Nocturia is a need to empty the bladder frequently, often with only short times between toilet visits, during the night. The Continence Foundation of Australia (2010) states that a normal bladder may wake a person up once at night to pass urine and twice if that person is >65 years of age. Nocturia affects men and women equally and occurs more frequently with age (Weiss et al, 1998).

Multiple factors may result in nocturia (Box 2), including cardiovascular disease, diabetes mellitus, lower urinary tract disorders, anxiety or primary sleep disorders and behavioural and environmental factors (Weiss and Blaivas 2000; Fitzgerald et al, 2007). Interestingly, fluid intake at bedtime correlates poorly with nocturia episodes (Fitzgerald et al, 2007; Tikkinen et al, 2009).

People with a DFU and nocturia sharing a bedroom may not use lighting to prevent partner disturbance, risking foot trauma. Adequate lighting and clear access to the toilet should be discussed with the patient by diabetic foot health providers.

The American Diabetes Association (2010) reported that, in people with diabetes, polyuria is associated with hyperglycaemia. A study by Yerkes (2009) identified that urinary tract infections and incontinence are associated

with autonomic neuropathy in people with diabetes. Yerkes concluded that people with these conditions are more likely to have nocturia episodes. In a Chinese study by Zhang et al (2011), it was found that hypertension was a significant risk factor for nocturia, and diabetes a possible risk factor for nocturia. A Finnish population study by Tikkinen et al (2006) identified nocturia in 12.5% of men and 12.9% of women. This study found that nocturia was associated with urgency, snoring, restless legs syndrome and obesity in both sexes, with benign prostate hyperplasia, antidepressant use and prostate cancer for men and overweight, diabetes and coronary artery disease for women (Tikkinen et al, 2009).

Recommendations

Counselling people on the use of footwear is part of evidence-based holistic DFU management, but nocturnal use is likely to be overlooked until nocturia is identified. In our experience, Crocs™ (Crocs Inc.) enable quick and easy donning, minimise trauma events and offer foot protection for nocturia and showering. They are a light and durable shoe and resistant to bacteria and fungi. However, they should only be used for nocturia and showering. Simple modifications to accommodate deformities can be achieved to the sole of this preferred style of Crocs (Figure 1). Charcot's or other plantar deformities can be accommodated by creating a cavity in the thickened sole of this Crosslite™ (Crocs Inc.) material. This is heat adjustable to accommodate any foot volume.

People with PFUs should be questioned regarding nocturia. Those using removable

Box 2. Nocturia summary.

Nocturia is associated with:

- Disrupted sleep
- Impaired mental and somatic health
- Reduced quality of life
- Increased mortality.

Nocturia is attributed to:

- Ageing
- Pregnancy and childbirth
- Benign prostatic hyperplasia
- Nocturnal polyuria
- Diminished nocturnal bladder capacity.

Nocturia is related to:

- Overactive bladder syndrome
- Obstructive sleep apnoea
- Use of diuretics, caffeine or alcohol.

(Weiss and Blaivas, 2000; Tikkinen et al, 2009; 2010)



Figure 1. The authors' preferred style of Croc™ for modification and use as a protective shoe during night-time walking and showering by people with diabetic plantar neuropathic ulcers.

offloading devices may need alternative night footwear. Footwear, such as Crocs for nocturia and showering after healing, may prevent ulcer recurrence. Opportunities for further research may include analysis of prescribed nocturnal footwear and its impact on ulcer healing.

Conclusion

One difficulty in achieving healing of DFUs is patient concordance with offloading devices. This study reported conflicting vignettes from patients and the reality of their compliance with prescribed management. The study participants were identified as having a high prevalence of nocturia, during which — without effective offloading — healing delays can occur. This study supports the need for non-removable offloading devices for patients with plantar neuropathic ulcers, especially in people who have nocturia. ■

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