

Improved foot management of people with diabetes by primary healthcare nurses in Auckland, New Zealand

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ABSTRACT

AIMS: Evaluate trends in foot examinations for people with diabetes by primary healthcare nurses between 2006–2008 and 2016 in Auckland, New Zealand.

METHODS: All primary care nurses in 2006–2008 and 2016 were identified and 26% and 24% were randomly sampled and surveyed, respectively. Nurse participants completed a self-administered questionnaire and telephone interview about the care provided for people with diabetes.

RESULTS: Significantly more patients consulted by practice nurses received foot examinations in 2016 (58%) compared with 2006–2008 (36%), and foot-care education (66% versus 26%). Of the 43% of patients who had no foot examination in 2016, 23% had no previous examination documented. Significantly more nurses in 2016 than in 2006–2008 self-reported routinely examining patients' feet (45% versus 31%) and giving foot-care education (28% versus 13%). These practices were associated with nurses undertaking >5 hours of diabetes education within the past five years.

CONCLUSIONS: Practice nurses have significantly expanded their role in managing people with diabetes over the last decade by increasing the number of foot examinations and providing recommended foot-care education. Improved management was associated with nurses attending diabetes education in the past five years. Gaps were identified in conducting the recommended number of foot examinations, categorising patients' risk of foot disease and recording previous examinations.

Foot disease is a common complication of diabetes with a lifetime risk of up to 15% to 25%,¹ and it is the leading cause of lower-limb amputation.² Peripheral neuropathy, peripheral arterial disease (PAD) and infection are the most common pathological conditions that underpin diabetes-related foot ulceration or disease.^{2,3} Foot ulceration takes on average three months to heal and impairs an individual's productivity⁴ and quality of life.³ The probability of a further foot ulceration within 12 months after the onset of foot disease is 40%,² and mortality within this period is 14%,⁵ which increases to over 70% by five years.²

There are few reports on diabetic foot disease in New Zealand. One study of 2,192 people with diabetes who attended eye screening in a semi-rural region classified 13% of patients as high risk of developing foot disease.⁶ A survey of 53 Māori primary care patients in Auckland with long-term diabetes found 53% had developed pre-ulcerative foot lesions and 8% had current lesions, despite over 85% having a good knowledge of foot care.⁷ A cohort study linking primary health and hospital records identified additional risk factors for lower-limb amputation as male gender, Māori ethnicity, economic deprivation, elevated HbA1c

and dyslipidaemia.⁸ A national cohort study that followed most people diagnosed with diabetes in New Zealand (n=217, 207) between 2010 and 2013 reported that 0.92% had at least one lower-limb amputation.⁹ Similar risk factors were identified as in the previous studies, plus comorbidities and a previous amputation.⁹

Despite the high prevalence of diabetes in New Zealand's non-European populations,¹⁰ a review of 12 European and Australasian countries reported that New Zealand had one of the lowest annual rates of minor and major amputations in people with PAD (55% of whom have diabetes), reporting 9.3 and 7.2 per 100,000 people, respectively.¹¹ This may reflect a lower proportion of active smokers (14%), younger Māori and Pacific populations with diabetes¹⁰ and mostly free treatment for lower-leg ulceration and disease compared with the other countries surveyed.¹¹ Despite this, there are regional differences in lower-limb amputations for people with diabetes with higher rates in the Waikato and Hutt Valley regions.¹² Lower rates of diabetes-related foot disease have been reported for Asian populations in New Zealand⁸ and the UK, which is attributed to lower rates of neuropathy compared with the European population.¹³

Although the incidence of lower-limb amputation has decreased in many developed countries, including New Zealand,^{3,11,14} the prevalence of diabetes-related foot disease will continue to rise due to the increasing number of people developing type 2 diabetes¹⁵ and the increased survival rate.¹⁶ This will increase the future costs of managing diabetes, as the estimated cost per wound episode is \$30,000 in New Zealand,¹⁷ while in the US, over half the total diabetes budget is spent on peripheral vascular and neurologic complications (mostly related to lower-limb ulceration).¹⁸

Nurses providing community-based care are ideally placed to reduce the risk of people with diabetes developing foot disease. Comprehensive foot examinations are essential for identifying patients with reduced sensation, peripheral vascular disease and early skin changes,¹⁹ and to arrange appropriate follow-up referral to reduce the risk of amputations.¹⁹ Nurses are also able to identify and intensify interventions for patients with risk factors for foot

disease—elevated HbA1c, hypertension, dyslipidaemia,^{7,19} tobacco use, obesity and lack of physical activity.^{6,7,20}

Given the increasing importance of diabetes foot disease, the aims of this report are to determine (1) whether there have been changes in foot examinations and education for people with diabetes by primary healthcare (PHC) nurses between an initial survey carried out in 2006–2008²¹ and a similar survey in 2016, and (2) whether the diabetes education of nurses is related to their management of foot disease in people with diabetes.

Methods

Study design and population

Two cross-sectional surveys of PHC nurses were carried out in 2006–2008 and in 2016 in Auckland, New Zealand. The same methodology was used for both surveys and has been described.^{22,23} All practice nurses (PNs) based in the Auckland region were identified by updating and utilising a list of all general practitioners and PNs held in the Department of General Practice and Primary Health Care at the University of Auckland in 2006. In 2016, all PNs were identified by lists provided by all seven PHOs. For both time periods, lists of all district nurses (DNs) and specialist nurses (SNs) were provided by the three district health boards (DHBs) in Auckland. Of the total number of nurses, 287 (26%) in 2006 and 336 (24%) in 2016 were randomly selected and participated. Response rates were 86% and 73% for each survey, respectively. Figure 1 outlines the sampling frame for the numbers of PNs, DNs and SNs, including 19 and 25 diabetes nurse specialists, respectively, in each survey. Nurses completed a self-administered questionnaire providing biographical and work-related information and a telephone interview to ascertain information about the care provided for people with diabetes. A total of 308 people with diabetes were consulted in 2006–2008 and 447 in 2016 by the nurse participants on a randomly selected day each nurse had worked in the week prior to the telephone interview. Nurses were able to provide information for 265 (86% of the total) patients in 2006–2008. In 2016, because of the larger number of people with diabetes that were consulted, information was collected from 166 (37%)

randomly selected patients, depending on the time each nurse had available for the interview.

People with diabetes consulted

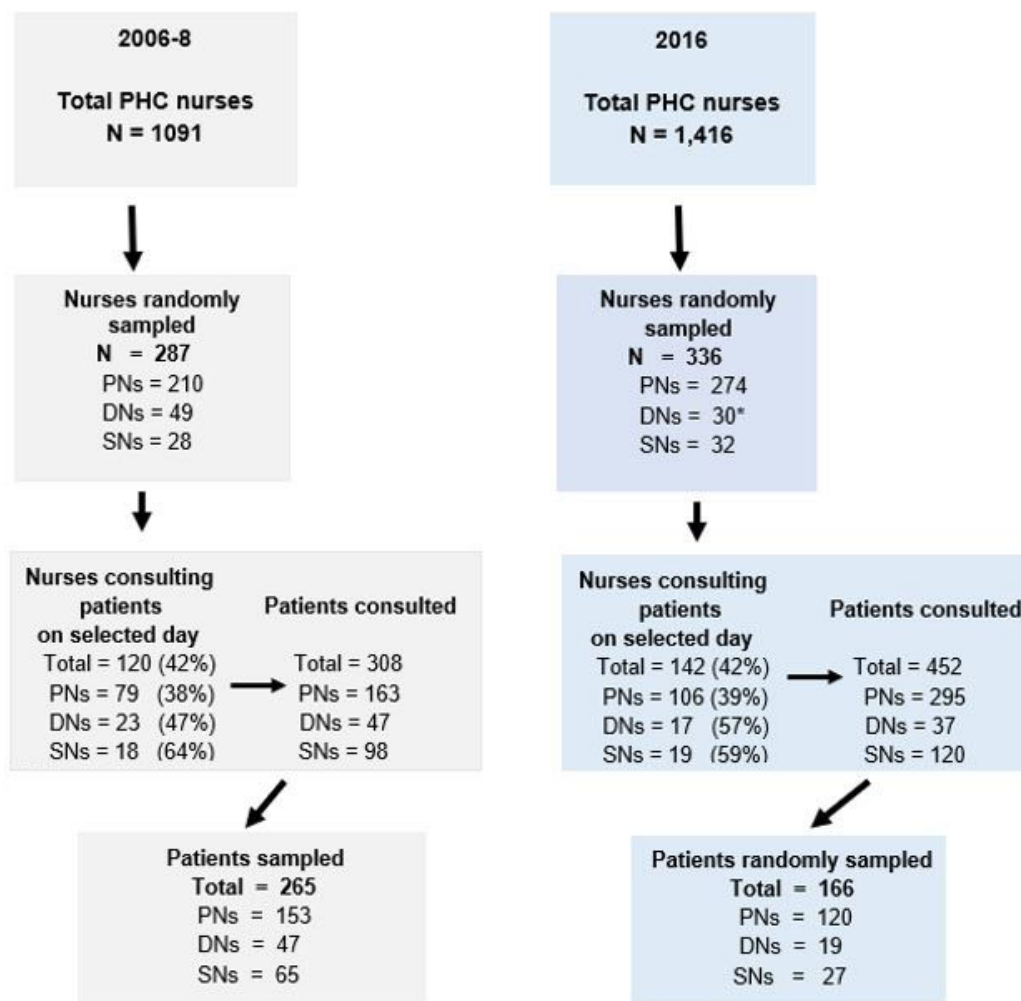
For both surveys, all nurses were asked during the telephone interview, and without prompting, what activities and assessments they routinely perform during a diabetes consultation. Nurses who had consulted at least one person with diabetes on the randomly selected day were also asked about the actual assessments and care provided for each patient. Specifically, nurses were asked whether they had checked each patient’s feet. Nurses who responded positively were asked to state

what they had checked without prompting. An additional question in the 2016 survey asked nurses who had not examined patients’ feet for the “date of the patient’s last foot exam”. Ethical approvals were granted by the University of Auckland Human Participants Ethics Committee (014713) and Northern Regional Ethics Committee (NTX/05/10/128) for the 2016 and 2006–2008 surveys, respectively.

Statistical analysis

All patient analyses were weighted by the proportion of people with diabetes consulted by all nurse groups on any given day in Auckland during the survey period, along with weighting for the sampling of nurses.

Figure 1: Sampling frame for the total number of primary healthcare (PHC) nurses surveyed and the number of people with diabetes consulted by practice nurses (PNs), district nurses (DNs) and specialist nurses (SNs) on a randomly selected day.



*From two out of three district health boards.

SUDAAN (version 11.0 Research Triangle Institute, 2012) was used to correct standard errors for any design effects from clustering (for nurses who consulted and provided information for more than one patient) and the Mantel-Haenszel method was used to adjust for confounding variables.

Analyses of the nurse data were weighted for the proportion of nurses sampled by nurse group, to reflect all nurses providing community-based care at the time of the surveys, using SAS 9.4 (version SAS Institute, Cary, NC, 2013). Multivariate prevalence ratios from log binomial regression models using SAS (GENMOD) were used to examine any associations that provision of self-reported routine foot and wound care had with attendance of specific diabetes education over the past five years and years since graduation (as a proxy for age and experience).

Results

Numbers of nurses and patient details

Between surveys there was an 45% increase in the total number of PNs (813 to 1,181), a 46% decrease for SNs (98 to 53) and DNs remained similar (180 and 182). The proportion of PNs and SNs who consulted people with diabetes on the randomly selected day remained the same and was not significantly changed ($p > 0.05$) for DNs (Figure 1). The proportions of patients consulted by the nurses in 2016 were: 56% male, 71% aged over 50 years, 72% non-European New Zealanders and 95% had type 2 diabetes; and were similar to the patients surveyed in 2006–2008.

Foot examinations and education in 2016

Fifty-seven percent of all patients consulted by 142 nurses in 2016 had their feet examined, and DNs were more likely to do this than PNs and SNs (Table 1). However, PNs were significantly more likely than DNs and SNs to test sensation ($p = 0.0005$). Of the 43% of patients who did not have their feet examined during the consultation, 43% and 72% had had a foot examination within the previous 3 and 12 months, respectively. Overall, 15% of the total patient cohort had no previous record of a foot examination. Foot-care education was received by 65% of

all patients consulted by the nurses, mostly relating to suitable footwear (43%), self-examination (41%) and moisturising feet and heels (24%). Twelve percent of patients received advice regarding toe and nail care, foot-related complications (including calluses), using orthotics and sensory awareness (Table 1).

Comparison of the two surveys

Table 2 compares the proportion of all patients between the two surveys who received foot examinations, foot-care education and wound care during the nurse consultation. Overall, there was a substantial (but not significant) increase in the proportion of patients who had foot examinations in 2016 (57%) compared with 45% in 2006–2008. For patients consulted by PNs, significantly more had foot examinations in 2016 (58%) compared with 2006–2008 (36%, p -value=0.03). In contrast, patients consulted by SNs had fewer foot examinations in 2016 (26%) compared with 2006–2008 (46%), although this comparison was not significant, because of the small number of patients in 2016. Overall, there was also a large increase in the proportion of patients who received foot-care education in 2016 (65%) compared with 2006–2008 (26%). In contrast, significantly fewer patients in 2016 received wound care or ‘other’ additional care, such as medication management, compared with patients in 2006–2008 (Table 2).

Self-reported routine foot care by nurses

Table 3 shows significantly more nurses in 2016 self-reported routinely conducting foot examinations (45%) and providing foot-care education (28%) during diabetes consultations compared with nurses in the 2006–2008 survey, who reported 31% and 13%, respectively. There was no difference in the proportion of nurses between surveys who reported routinely providing wound care.

Table 4 shows that nurses who had attended over 20 hours of diabetes education in the past five years were significantly more likely to self-report routinely examining patients’ feet and providing foot-care education during consultations, but less likely to provide wound care, compared with nurses who had attended

Table 1: People with diabetes (n=166) who received foot examinations, foot-care education and wound care by 142 nurses by nurse group, after weighting for the proportion of nurses (weighted) and patients sampled (weighted=1,291) in 2016.

Variable and level	Total surveyed N=166 N	Weighted by total sampling probability				Wald P-value ^b
		Total sample weighted N=1,291 ^a %	Total patients by nurse group			
			Practice nurses n=120 %	District nurses n=19 %	Specialist nurses n=27 %	
Feet examined	87	57	58	79	26	0.03
Characteristic examined						
Colour	87	57	58	79	26	0.03
Skin integrity	87	57	58	79	26	0.03
Nails	86	57	58	72	26	0.06
Oedema	81	55	55	78	26	0.04
Pedal pulses	62	45	48	25	26	0.20
Sensation	66	48	55	8	26	0.005
Microfilament	29	25	30	0	6	0.06
If no foot exam, when was last exam	79	100	(55)	(3)	(21)	0.19
<3 months	27	43	45	86	16	
4–6 months	9	12	12	0	14	
7–12 months	12	17	20	0	6	
>12 months	6	5	4	0	13	
Not known	25	23	19	14	51	
Foot care education	96	65	66	75	43	0.21
Specific education given						
Suitable footwear	58	43	45	42	25	0.34
Self-examination	59	41	44	22	30	0.30
Moisturising feet and heels	27	24	26	9	19	0.43
Consult podiatrist	13	6	5	3	16	0.36
Other (n=20)	20	12	8	51	7	0.14
Received wound care	28 ^c	14	5	91	2	0.002

^aThe total weighted sample is used to estimate the total number of people with diabetes consulted by all nurses in Auckland during the study period.

^bP-value showing the significance of variation in percentages in subgroups, from the Wald chi-square value.

^cn=165 patients.

Table 2: Comparison between surveys of foot examinations and foot-care education received by people with diabetes and consulted by nurses on the randomly selected day, after weighting for the proportions of nurses and patients sampled in each survey and adjusting for sex, age, ethnicity and nurse group.

Variable	Survey 2006–2008	Survey 2016	Wald P-value ^a
Total patients sampled	265	166	
Categorical variables	Weighted % (number sampled)	Weighted % (number sampled)	
Foot examinations	45 (119)	57 (86) ^b	0.13
Nurse groups			
Practice	36 (55)	58 (64)	0.03
District	74 (34)	79 (16)	0.72
Specialist	46 (30)	26 (6)	0.21
Specific foot assessments			
Colour	45 (119)	57 (86) ^b	0.13
Skin integrity	45 (119)	57 (86)	0.13
Nails	44 (117)	57 (85)	0.13
Pedal pulses	31 (82)	44 (61)	0.13
Oedema/swelling	32 (84)	55 (80)	0.007
Sensation	30 (78)	48 (65)	0.04
Microfilament test	24 (64)	25 (28)	0.97
Ipswich (touch test) ^c	(0)	(0)	-
Other foot assessments ^d	19 (51)	2 (5)	<0.0001
Foot-care education	26 (68)	65 (94) ^b	<0.0001
Nurse groups			
Practice	26 (41)	66 (71)	<0.0001
District	30 (14)	75 (12)	0.006
Specialist	20 (13)	43 (11)	0.14
Patient to self-examine feet	8 (23)	39 (56) ^b	0.0006
Suitable footwear	7 (18)	43 (57)	<0.0001
Moisturise feet and heels	5 (13)	24 (27)	0.04
Consult podiatrist	3 (7)	5 (12) ^b	0.21
Other foot-care education ^e	3 (7)	12 (19) ^b	0.009
Follow-up podiatrist	8 (21)	13 (24)	0.15
Wound care	29 (78)	14 (28)	0.006
Nurse groups			
Practice	17 (26)	5 (10)	0.005
District	94 (43)	91 (17)	0.75
Specialist	14 (9)	2 (1)	0.08
Other care provided	50 (133)	16 (30)	<0.0001

^aP-value showing the significance of variation in percentages in subgroups, from the Wald chi-square value.

^bNumbers differ slightly from those in Table 1 due to adjusting for sex, age, ethnicity and nurse group.

^cThe Ipswich test, developed to encourage foot examinations, is positively predictive of at-risk feet.²⁴

^dOther foot assessments in 2006–2008 related to wounds and injuries (73%), temperature and skin (19%) and footwear and referrals (8%), and in 2016 for corns calluses, gout and capillary filling (n=5).

^eOther foot-care education included toe and nail care, wounds, pain, foot complications, orthotics and sensation.

Table 3: Comparisons between the proportions of nurses in 2006–2008 and 2016 who self-reported routinely performing foot examinations and providing foot and wound care during diabetes consultations.

Variable and level	Survey 2006–2008	Survey 2016	Wald P-value ^a
	Weighted % (number sampled)	Weighted % (number sampled)	
Total nurses sampled	287	336	
Routine assessments and education delivered by nurses			
Foot examinations	31 (91)	45 (158)	0.0004
Foot-care education	13 (37)	28 (103)	<0.0001
Providing wound care	20 (57)	19 (64)	0.83

^aP-value showing the significance of variation in percentages, from the Wald chi-square value.

Table 4: Multivariate prevalence ratios of self-reported routine foot and wound care by nurses in the 2016 survey, after weighting for the proportions of nurses sampled and adjusting for hours of diabetes education and years since graduation (n=336)—from log binomial regression.

Routine care	Prevalence ratios (95% CI)					
	Diabetes education (hours)			Year of graduation		
	<5 (n=108)	5–20 (n=117)	>20 (n=106)	2003–2015 (n=109)	1985–2002 (n=108)	1964–1984 (n=109)
Foot examinations	1.00	1.14 (0.98–1.33)	1.51 (1.31–1.75) ^c	1.00	0.87 (0.76–1.00)	0.93 (0.81–1.07)
Foot care education	1.00	1.30 (1.03–1.64) ^a	1.84 (1.48–2.30) ^c	1.00	0.79 (0.64–0.97) ^a	0.88 (0.72–1.07)
Wound care	1.00	0.54 (0.42–0.70) ^c	0.33 (0.23–0.45) ^c	1.00	1.63 (1.26–2.10) ^c	1.00 (0.74–1.33)

^ap-value <0.05; ^bp-value <0.01; ^cp-value <0.001.

less than five hours' education. In contrast, the nurses' year of graduation (a proxy for experience) was not consistently related to foot-care education or wound care.

Discussion

There has been an upward trend in nurses conducting foot examinations for people with diabetes (from 45% to 57%) between 2006–2008 and 2016. This increase has been largely driven by PNs increasing examinations from 36% to 58%, offsetting the trend for SNs, where there has been a decrease from 46% to 26%. This has been accompanied by an increase in the proportion of patients receiving foot-care education and advice (from 26% to 65%) over the same period, which occurred uniformly in all three nurse groups. The trends are unlikely

to be due to differences in patients between the two surveys, as demographic characteristics were similar except for an increase in non-European patients in 2016.²³ These findings are consistent with an upward trend for foot examinations in people with diabetes in North America,²⁵ which is associated with a new nurse-led model of care in a family practice²⁶ and in Hispanic people with diabetes.²⁷

The significant increase in the number of PNs between 2006–2008 and 2016²², and in the proportion who conducted foot examinations and gave recommended foot-care education,^{28,29} indicates an increased capability in their management of people with diabetes. In contrast, the decrease in the proportion of SNs conducting foot examinations in the latter survey is possibly due to their decreased numbers²² and

increased workloads (based on the number of patients consulted).²³ This trend for a higher proportion of foot examinations in patients consulted on the randomly selected day (Table 2) is backed up by the surveyed nurses reporting that they were more likely to routinely conduct foot examinations and provide foot-care education in 2016 compared with nurses surveyed in 2006–2008 (Table 3).

The increased foot care management by nurses in 2016 may be due to an increase in nurses' knowledge of foot disease in the 2016 survey compared with nurses in 2006–2008,³⁰ as nurses undertaking diabetes education were more likely to routinely conduct foot examinations and provide foot-care education in 2016 (Table 4). Similar associations with increased foot examinations have been reported for NPs (although not for PNs) in Slovenia attending general family practice education,³¹ and similarly for hospital-based nurses in relation to managing patients with foot ulcerations in Sri Lanka³² and Pakistan.³³

Previous findings from the 2006–2008 survey highlighted that few PNs were able to state all the major risk factors for diabetes complications.³⁰ This may reduce their ability to classify a patient's risk of foot disease. Age, being male or Māori, duration of diabetes, economic deprivation,⁸ being rural-based,^{6,7} obesity, retinopathy⁷ and renal disease²⁰ all increase the risk of foot disease, in addition to being major risk factors for all diabetes-related complications. Patients with foot deformities, neuropathy, PAD and a previous or current foot ulcers are at an even higher risk^{19,20,29} of non-healing wounds that result in lower-limb amputation.³⁴ Thus, further education for PNs could result in more people with diabetes receiving appropriate foot care.

Although international guidelines on foot management differ,³⁵ it is recommended that all people with diabetes have an annual foot examination and are classified by their risk of developing foot ulceration or disease.¹⁹ Classification is based on low risk (normal sensation and palpable pulses), moderate risk (neuropathy or absent pulses) or high risk (moderate with a foot deformity, skin changes or previous ulcer),¹⁹ with corresponding annual, 3–6 monthly or 1–2 monthly foot examinations

based on risk level,²⁹ and specialist service follow-ups for those at high risk.^{19,36} The national guideline recommends annual and 3–6 monthly foot examinations for people with diabetes with low- and high-risk feet, respectively.²⁸ Despite this, 43% of patients in 2016 did not have their feet examined during the nurse consultation, and of those patients, 23% had no available record of their last foot examination (including 51% of patients consulted by SNs). The latter may be due to the different patient electronic management system used in secondary care, which is where most SNs are based, compared with that used in primary care. A similar proportion of people with diabetes in primary care in the UK had records of foot examinations, although fewer patients had records in Ireland (65%), in comparison with 79% and 83% in Scotland and England, respectively.³⁷

Despite a 9% increase in the population of Auckland to 1.5 million³⁸ and a 35% increase in people diagnosed with diabetes³⁹ between 2006 and 2017, significantly fewer people with diabetes received wound care (14%) in 2016 compared with 29% in 2006–2008 (Table 2). The introduction of multidisciplinary podiatry outpatient clinics in Auckland, which is associated with improved footcare,⁴⁰ may have contributed to the reduction in wound care in general practice and district nursing services, enabling the latter to reserve care for the elderly, Pacific and Māori populations⁴¹ and the housebound.⁴² However, there is a paucity of reports quantifying each service's contribution to the provision of wound care.

In addition to risk-factor management, patient education is the hallmark of best practice in reducing the development and recurrence of diabetes-related foot disease.¹⁹ Patient awareness is reportedly poor.¹⁹ Health literacy has been identified as an important barrier to good foot care,⁴³ and patient education interventions are only weakly associated with primary prevention.^{3,44} A New Zealand study reported that 85% of Māori people with diabetes displayed a good knowledge of foot care, but despite this, over half developed pre-ulcerative foot lesions.⁷

Despite the global cost of diabetes-related foot disease, there continues to be a lack of interest and funding to test quality

interventions for primary prevention and for treatment to reduce lower-leg amputations, with the exception for off-loading for pre-ulcerative areas.^{3,45} The lack of evidence for preventative educational interventions (particularly for patients with neuropathy),³⁶ and for access to quality foot-care services, contribute to the wide variation in lower-leg amputations globally,⁴⁶ including a four-fold difference in major amputations in New Zealand¹² and a 10-fold variation across primary care trusts in England.¹⁴

Primary care nurses are well placed to screen and classify people with diabetes who are at risk of developing diabetes-related foot disease and organise specialist referrals for patients at high risk or with a current ulceration.¹⁹ Despite the lack of good evidence for preventative interventions, foot examinations, foot-care education, early referrals and treatment are associated with a reduction in foot ulceration.⁴⁷ An increase in nurses conducting foot examinations was associated with fewer lower-leg amputations for people with diabetes in Germany,⁴⁸ and a new referral service for patients with foot ulcers reduced the incidence of amputation in the UK and Germany.³

Limitations of the 2016 study include the inability to sample one-third of DNs in the Auckland region, potentially causing underrepresentation of this group of nurses. Despite this, results are expected

to be fully representative of PNs and SNs and for all nurse-groups in 2006–2008 and for the patients consulted during both study periods, because of the random sampling of nurses and patients and high response rates. The three district nursing services also follow a similar model of care and criteria for accepting patients for home-based care.⁴¹ Weighting the sampled patients potentially under- or over-inflates differences between patient survey groups, as this is based on the assumptions that the same nurse provides the same care to all patients consulted, and that patients not surveyed to have similar demographic and biophysical characteristics to those surveyed by the same nurse. It is acknowledged that patients may have differed, although DNs and SNs typically consult patients who have more diabetes-related complications and comorbidities than patients consulted by PNs.⁴⁹

Over the past 10 years, an increasing trend in improved foot management by PNs was evident. Nurses attending diabetes education was positively associated with conducting foot examinations and providing recommended foot-care education. However, patient records of previous examinations were incomplete and not all patients had a foot examination over the past year. In addition, foot-disease risk assessments and the recommended frequency of examinations were lacking.

Competing interests:

Nil.

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