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ORIGINAL ARTICLE

Amputations and foot-related hospitalisations disproportionately affect dialysis patients

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Abstract

Patients with diabetes have increased risk for foot ulcers, amputations and hospitalisations. We evaluated a closed cohort of patients with diabetes and established risk factors in two high risk groups: (i) dialysis patients and (ii) patients with previous foot ulceration. We used claims data for diabetes (ICD-9 250.X), ulceration (ICD-9 707·10, 707·14 and 707·15) and dialysis (CPT 90935–90937) from the Scott and White Health Plan to identify 150 consecutive patients with diabetes on dialysis (dialysis group) and 150 patients with a history of foot ulceration (ulcer history group). We verified these diagnoses by manually reviewing corresponding electronic medical records. Each patient was provided 30 months follow-up period. The incidence of foot ulcers was the same in dialysis patients and patients with an ulcer history (210 per 1000 person-years). The amputation incidence rate was higher in dialysis patients (58·0 versus 13·3, $P < 0{\cdot}001$). Hospital admission was common in both study groups. The incidence of hospitalisation was higher in the ulcer history group (477·3 versus 381·3, $P < 0{\cdot}001$); however, there were more foot-related hospital admissions in the dialysis group (32·9% versus 14·0%, $P < 0{\cdot}001$) during the 30-month evaluation period. The incidence of ulcers, amputations and all-cause hospitalisations is high in persons with diabetes and a history of foot ulceration or on dialysis treatment; however, those on dialysis treatment have disproportionately higher rates of foot-related hospitalisations. Intervention strategies to reduce the burden of diabetic foot disease must target dialysis patients as a high-risk group.

Introduction

Foot ulcers are one of the most common complications leading to diabetes-related lower extremity amputations (LEAs) (1,2). Various risk factors [neuropathy, peripheral arterial disease (PAD) and infection] and risk groups (dialysis and previous foot ulcer) are associated with an increase in LEAs in people with diabetes, but the level of risk for each factor/group is different. For instance, diabetic patients with peripheral arterial occlusive disease have a higher rate of ulceration and amputation compared to diabetic patients with neuropathy; and a previous history of a foot ulceration or amputation have been associated with the highest likelihood for another foot-related event in the next year (3). Renal insufficiency is

Key Messages

- this data supports the increased risk for devastating foot complications in patients with diabetes on dialysis
- initially, we hypothesised that the ulcers would involve the heel or leg more often in dialysis patients, and ulcer location would be associated with more dire outcomes,

but this was not demonstrated; the location of ulcers was similar in both groups
- the frequency of foot ulcers, amputations and foot-related hospitalisations in dialysis patients were disproportionately high
- this study supports prioritising prevention services to diabetic patients on dialysis just as patients with a history of foot ulcers/amputations have been suggested
- recent studies suggesting infrequently provided prevention services for patient populations similar to those in this study support the need to more accurately define and treat those at risk for foot complications

also a risk factor for PAD (4). In the same vein, advanced renal failure and/or dialysis treatment have emerged not only as strong predictors for foot ulcers (5,6) and amputation (5,7) in people with diabetes, but also as strong predictors of mortality within amputees with diabetes (8). Therefore, people with diabetes and a previous foot ulcer or those on dialysis treatment represent easily identifiable risk groups where LEA prevention efforts can be most effective (9). Remarkably, there is a dearth of prospective data reporting the incidence of LEAs within these two risk categories, data that should inform the hierarchy of foot-risk stratification and thus prioritise preventive treatment based on risk. Additionally, end-stage renal disease requiring dialysis in particular, has not been included in most risk stratification models. The objective of this study was to identify the incidence of lower extremity ulcers, amputations and hospitalisations in persons with diabetes who were receiving dialysis therapy compared to persons in the highest foot-risk group: history of foot ulceration. The underlying hypothesis was that dialysis treatment is a risk factor equivalent to foot ulceration and amputation, and should be identified as an independent risk factor.

Methods

Our primary method of data collection was manual review of electronic medical records (EMRs). Initially, we used claims data for diabetes (ICD-9 250.X) and dialysis (CPT 90935–90937) from the Scott and White Health Plan to identify 150 consecutive patients with diabetes on dialysis (dialysis group) and 150 consecutive patients with diabetes and a history of foot ulceration (ulcer history group). Then, we reviewed each EMR which includes patient care notes, operative reports, hospital discharge summaries, imaging, labs and prescriptions. Diagnoses and clinical data were verified through manual review of detailed medical records. Scott and White is an integrated, multi-specialty physician group with approximately 550 physicians, 14 clinics, three dialysis centres and one 535-bed hospital. We enrolled subjects who were seen within the Scott & White plan from 1 January 2000 to 1 January 2006 until the pre-specified sample of 150 patients was achieved. Each patient's medical chart was then reviewed for 30 consecutive months following the predetermined initiating event or until their death. For the dialysis group, our evaluation began with the initiation of dialysis. For the ulcer history group, our evaluation began after the initial wound or amputation healed. We excluded subjects with acquired immunodeficiency syndrome (AIDS), trauma from motor vehicle accidents, and bilateral amputations.

Risk factors for foot ulceration, foot ulcerations and amputations were defined prospectively using the following criteria. PAD was defined as at least two non-palpable pedal pulses or an ankle brachial index less than 0·9. Neuropathy was defined as at least one site insensate to a 10-gram Semmes-Weinstein monofilament, abnormal vibration sensation (>25 V) or abnormal light touch. Ulcers were identified from progress records documenting a full-thickness foot wound. Amputations were identified from review of all operative reports listed in the EMRs. These records were then cross-verified with CPT codes for amputation (28800–28825, 27880–27889 and 27590–27598). Using this data we classified amputations into two groups: (i) amputation distal to the talonavicular and the calcaneocuboid joints (Chopart's joint), and (ii) amputation at, or proximal to a below-knee level.

Statistical analyses

Data pertaining to demographic characteristics (e.g. sex, age and race) was displayed for all subjects and summarised using descriptive statistics. The incidence rates of lower extremity complications were calculated for ulcerations, amputations, death and hospitalisation. We used a chi-square test to compare the proportion of subjects who developed complications within the 30-month follow-up period stratified by risk group.

Results

Demographics and the frequency of foot complications are shown in Tables 1 and 2. The documentation of PAD and neuropathy was inadequate in the medical records, and therefore no meaningful analysis was performed. During the study period, 73 (24·3%) of the patients had at least one ulcer. The number of foot ulcers ranged from 0 to 8. The incidence rate (per 1000 person-years) for first ulcerations was 82·7 in the dialysis group and 112·0 in the ulcer history group. When all ulcers, initial ulcers and sequel ulcers, were aggregated, the total was 158 ulcers. The cumulative incidence rate of ulcers

Table 1 Demographics of the study population

Demographics	Dialysis, $n=150$	Ulcer history, $n=150$	*P*-value
Age mean ± SE (min–max)	64·9 ± 1·0 (33–93)	74·3 ± 1·0 (49–97)	<0·001
Race			
White	77·3%	42·7%	<0·001
African American	13·3%	36·0%	<0·001
Hispanic	7·3%	18·7%	0·006
Other	2·0%	2·7%	NS
Male	40·7%	41·3%	NS
Type 2 diabetes	92·7%	92·0%	NS
Ulcer history	24·0%	100·0%	<0·011
Amputation history	11·3%	9·3%	NS

SE, standard error; NS, not significant.

Table 2 Lower extremity ulcers during the 30-month evaluation period*

	Dialysis, $n=150$	Ulcer history, $n=150$	*P*-value
Multiple ulcer events			
First ulcer	31	42	0·26
Second ulcer	20	20	0·15
Third ulcer	9	9	0·076
Fourth ulcer	7	4	0·051
Fifth ulcer	3	2	0·33
More than six ulcers (max 11)	9	2	0·058
Total number of ulcers	79	79	1·00
Ulcer location			
Forefoot	69·2%	74·7%	0·56
Midfoot	9·0%	6·3%	0·73
Heel	14·1%	11·4%	0·77
Ankle–leg	7·7%	7·6%	1·00
First ulcer incidence	82·7 (65·7–102·4)	112·0 (92·2–134·8)	0·033
Cumulative incidence	210·7 (183·0–240·9)	210·7 (183·0–240·9)	1·00
First ulcer that healed	(15) 48·4%	(28) 66·7%	0·184

*Incidence rates are reported in 1000 person-years and 95% confidence interval.

Table 3 Lower extremity amputations during the 30-month evaluation period*

Multiple amputation events	Dialysis, $n=150$	Ulcer history, $n=150$	*P*-value
First amputation	11	4	0·069
Second amputation	5	1	0·024
Third amputation	4	0	0·011
Fourth amputation	2	0	0·040
Total number of amputations	22	5	0·11
First amputation incidence	29·3 (19·4–41·7)	10·7 (5·1–19·0)	0·005
Cumulative incidence	72·0 (44·5–75·5)	13·3 (6·9–22·2)	<0·001
Amputation level			
Foot amputations	40·7% (11)	80% (4)	0·26
Leg amputations	59·2% (16)	20% (1)	0·26

*Incidence rates are reported in 1000 person-years and 95% confidence interval.

was the same in the dialysis group and ulcer history group (210 per 1000 person-years).

There were significantly more ulcers that required amputation in dialysis patients (34·2% versus 6·3%, $P < 0·001$, Table 3). The ratio of ulcers to amputations was 3·6 in the dialysis group and 15·8 in the ulcer history group. The amputation incidence ratio was 4·4, when the cumulative incidence rate of amputations in the ulcer history group was used as the index incidence rate. The same trend was observed when ulcer history and amputation history were evaluated. Only a small proportion of the patients in the ulcer history group had an amputation as a result of the ulcer (9·3%). In the dialysis group 24% of patients had an ulcer history, and 47·2% of ulcers resulted in an amputation.

There were significant differences in the frequency of amputations in dialysis patients. During the study period 16 patients (5·3% of all patients, Table 3) had at least one amputation. Multiple amputations were common and ranged from 0 to 5 amputations. The dialysis group experienced 11 initial and 11 repeat amputations (22 total), and the ulcer history group had four initial amputations and one repeat amputation (5 total) ($P < 0·001$). The incidence rate for first amputations and the cumulative incidence rate for amputations were 32·0 and 58·0 per 1000 person-years in the dialysis group and 10·7 and 13·1 per 1000 person-years in the ulcer history group ($P < 0·001$) respectively.

Table 4 Hospital admissions during the 30-month evaluation period*

	Dialysis, $n=150$	Ulcer history, $n=150$	*P*-value
First hospital admission	39	79	<0·001
Second hospital admission	32	44	0·009
Third hospital admission	21	25	0·590
Fourth hospital admission	15	15	0·617
Fifth hospital admission	11	9	0·698
More than six admissions (max 11)	25	7	0·005
All-cause incidence	381·3 (343·7–421·3)	477·3 (435·2–521·8)	<0·001
Foot-related incidence	125·3 (104·1–148·9)	66·7 (51·5–84·5)	<0·001
Mortality	21	42	0·005
Incidence rate	56·0 (19·1–123·7)	112·0 (54·9–196·8)	<0·001

*Incidence rates are reported in 1000 person-years and 95% confidence interval.

Hospital admission was common in both study groups (Table 4). The incidence of all-cause hospitalisation was higher in the ulcer history group (477·3 versus 381·3 per 1000 person-years, $P < 0·001$); however, there were more foot-related hospital admissions in the dialysis group (32·9% versus 14·0%, $P < 0·001$) during the 30-month evaluation period.

Discussion

The incidence of foot ulcers, amputations and foot-related hospitalisations demonstrate the disproportionate human and financial cost of lower extremity disease in patients with end-stage renal disease and diabetes. It has been previously suggested that a comprehensive foot care model is needed (10). The incidence of ulcers and amputations was higher in patients with diabetes on dialysis, compared to studies of the general diabetic population. The incidence of foot ulceration ranges from 40 to 68 per 1000 person-years (11,12) compared to 210 per 1000 person-years in patients on dialysis and with an ulcer history in this study. The actual incidence in the general population was much lower once the high-risk subpopulations we evaluated were considered and removed from the equation.

The incidence of amputation was very high (13·1 and 58·0 per 1000 person-years in patients with ulcer history and patients on dialysis) when compared to published amputation incidence rates in the USA, which range from 2·1 to 14·7 per 1000 person-years (1,2,12). The incidence density, when

multiple amputations in the same individuals were evaluated, was much higher in dialysis patients. The amputation results from dialysis patients in this study (58·0 per 1000 person-years) are similar to studies by Eggers and Margolis that report an 8–10 fold increase in amputations in patients with chronic kidney disease and patients who require dialysis therapy (7,13). The amputation incidence rate in patients with an ulcer history obtained in this study is also similar to previously reported rates (14).

The difference in the frequency of amputations associated with dialysis therapy may be due to higher rates and severity of peripheral vascular disease, neuropathy or diminished immune response with heightened susceptibility to infections (6). Ndip *et al.* reported that dialysis patients had a 2·4 times increased odds of having PAD compared to pre-dialysis patients (5). The majority of dialysis patients (64–71%) have PAD (5). In contrast, about 12% of patients with diabetes and normal renal function have PAD (12). The proportion of first ulcers that healed was only 48% in dialysis patients and 67% in patients with an ulcer history. The ratio of ulcer to amputation also demonstrated a greater propensity for ulcers to progress to amputation in patients on dialysis: 2·9 versus 15·8 in patients with an ulcer history. In addition, the incidence of foot-related hospitalisations provides another illustration of the severity of foot complication risk in patients with diabetes on dialysis (dialysis 32·9% and ulcer history 14%). This data support the increased risk for devastating foot complications in patients with diabetes on dialysis. Initially, we hypothesised that the ulcers would involve the heel or leg more often in dialysis patients, and ulcer location would be associated with more dire outcomes, but this was not demonstrated. The location of ulcers was similar in both groups (Table 2).

This study has several limitations. Because of the retrospective nature of the study, in many cases, the documentation of PAD, neuropathy and ulceration was inadequate. We may have missed foot ulcers that patients did not report or sought treatment at outside facilities. However, EMRs allowed us to document the ulcer location, start of ulceration, the date of healing or amputation, and ulcer recurrence. Prospective studies that use rigorous operational definitions and methodology will improve our understanding of factors that lead to ulcers and amputations in high-risk diabetic, subpopulations.

The frequency of foot ulcers, amputations and foot-related hospitalisations in dialysis patients was disproportionately high. This study supports prioritising prevention services to diabetic patients on dialysis similar to priority assigned to patients with a history of foot ulcers/amputations (3). Recent studies suggesting infrequently provided prevention services for patient populations similar to those in this study support the need to more accurately define and treat those at risk of foot complications (5).

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