Incidence of Falls, Risk Factors for Falls, and Fall-Related Fractures in Individuals With Diabetes and a Prior Foot Ulcer

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OBJECTIVE — To describe the incidence of falls, risk factors for falls, and the frequency of fall-related fractures in a cohort of individuals with diabetes and a prior foot ulcer.

RESEARCH DESIGN AND METHODS — A total of 400 individuals with diabetes and a prior foot ulcer were recruited from two western Washington State health care organizations and followed prospectively for 2 years. Diabetes, demographic, and health information was collected at baseline, 1 year, and 2 years. Data on falls were collected at baseline, 4 weeks, and every 17 weeks thereafter. Medical records were abstracted to confirm fall-related morbidity.

RESULTS — The average age of the study population was 62 years, with 77% male and 23% female. Approximately 32% had fixed foot deformities, 58% had insensate feet, and 76% had comorbid conditions. Of the participants, 252 (64%) reported at least one fall during the 2-year study period. The overall incidence of falls in this cohort was 1.25 falls/person-year (95% CI 1.17–1.33). For the 164 participants (41%) who reported two or more falls, a BMI $\geq$30 kg/m^2, the presence of one or more comorbid conditions, and insensate feet increased the risk. Two or more falls of any type were associated with a higher fracture risk. Although women were not at significantly greater risk for falls than men, their fracture incidence was 3.6 times higher.

CONCLUSIONS — Falls are very common in individuals with diabetes and prior foot ulcers. A small percentage of falls resulted in fractures. The risk of a fall-related fracture was significantly higher in women than in men. Increased attention to falls and fall prevention is indicated for diabetes care providers.

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Falls and fall-related fractures are a source of enormous morbidity with high resultant health care and disability costs. Among people age 65 years and older, falls are the most common cause of injury and hospital admission for trauma and account for 87% of fractures (1). Factors reported to contribute to falls include problems with gait and balance as well as neurological and musculoskeletal disabilities (2).

A higher frequency of falls is reported in people with diabetes. Cross-sectional data from the Third National Health and Nutrition Examination Survey indicate that among people age 60 years and over, women with diabetes are 1.6 times more likely to have fallen in the previous year (95% CI 1.21–2.08) and twice as likely to have falls with injuries (1.25–3.22) than women without diabetes. Men with diabetes have a higher frequency of falls, although this finding was not statistically significant (3). A survey of 638 African-Americans in St. Louis, MO, reported that individuals with diabetes had a 2.5-fold increase in falls and falls with injuries compared with individuals without diabetes (4).

To further quantify the relationship between diabetes and falls, we hypothesized that individuals with diabetes and a prior foot ulcer would be at very high risk of falls. We also hypothesized that insensate feet would be a risk factor for falls. This article describes the incidence of falls, risk factors for falls, and fall-related fractures in a cohort of 400 individuals with diabetes and a prior foot ulcer who were followed prospectively for 2 years.

RESEARCH DESIGN AND METHODS

— Individuals with diabetes and a history of a serious foot lesion were recruited for a clinical trial of footwear from two western Washington State health care organizations—the Department of Veterans Affairs Puget Sound Health Care System (VA) and Group Health Cooperative of Puget Sound (GHC)—between August 1997 and December 1998. Eligibility requirements included diagnosed diabetes, age 45–84 years, history of a foot ulcer, no foot deformities requiring a custom shoe, ability to walk one block and climb one flight of stairs daily, and willingness to consent to randomization and study footwear provisions. Patients were excluded from the study for a prior lower-extremity amputation of more than one digit, Charcot foot deformity, or requirement of custom shoes or nontraditional footwear for daily activities. Men were recruited from both

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Abbreviations: GHC, Group Health Cooperative of Puget Sound; VA, Department of Veterans Affairs Puget Sound Health Care System.

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A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Falls in a cohort of individuals with diabetes and prior foot ulcers*

Individuals	Individuals with no falls	Individuals with falls	Total	*P*
n	148	252	400	—
Demographic findings				
Average age (years)	61.6	62.8	62.4	0.22
Sex (%)				
M (n = 309)	76.3	77.8	77.2	0.74
F (n = 91)	23.6	22.2	22.7	
Race (%)				0.03
White (non-Hispanic)	71.9	81.5	78.0	
Non-white	28.1	18.5	22.0	
Married/living together (%)	64.4	59.4	61.2	0.33
Years of education (average)	14.5	14.2	14.3	0.38
Site of medical care				0.09
VA (%)	58.9	50.0	53.3	
GHC (%)	41.1	50.0	46.7	
Health history findings				
Years diagnosed diabetes (%)				0.26
<6 years	31.7	33.9	33.1	
6–24 years	60.0	53.1	55.6	
≥25 years	8.3	13.0	11.3	
Fixed foot deformities (%)	31.9	31.5	31.7	0.93
Any comorbid condition (%)	65.8	81.5	75.7	0.001
Insensate feet (%)	52.1	61.8	58.3	0.06
Falls				
Number of falls				
Total number of falls		923 (100%)		
Received medical care		153 (16.6%)		
No medical care received		770 (83.4%)		
Fall incidence/person-year (95% CI)		1.25 (1.17–1.33)		

organizations. Women came only from GHC because of the small number of female veterans. Outcome data were collected on foot ulcers, falls, and fall-related fractures.

Diabetes, demographic, health, foot, and functional status information and lower-limb sensory perception using the Semmes-Weinstein 5.07 monofilament were collected at baseline, 1 year, and 2 years. A history of six comorbid conditions (stroke, cardiovascular bypass surgery, chronic respiratory disease, heart failure, cancer, or depression) was obtained at baseline. A fall was defined as a person inadvertently ending up on the ground or at a lower level (5). Data on falls were collected through structured participant interviews at baseline, 4 weeks, and every 17 weeks thereafter for 2 years. Data collected included the circumstances of each fall, whether medical care was sought, and whether hospitalization was required. Medical records were abstracted for participants with falls requiring medical attention.

Analysis

Frequency tables were constructed to describe demographic and health history characteristics of the population using SAS version 8.02 (6) and STATA version 6.0 (7). We analyzed falls by participant to determine the frequency of falls in those participants with falls. The incidence of falls in this cohort was calculated using standard person-time methods. Nonambulatory person-time was excluded. The χ^2 contingency tables were used to compare the proportions of participants never falling or ever falling. Multivariate logistic regression was used to investigate risk factors for at least one fall and for two or more falls. These results are reported using adjusted odds ratios and 95% CIs. Risk factors associated with fall-related fractures are reported using univariate odds ratios because of the small number of fractures.

RESULTS — There were 400 participants enrolled in the study: 187 men from the VA, and 122 men and 91 women from GHC. Table 1 shows that the average participant's age was 62 years and average education was 14 years, and 67% of participants had been diagnosed with diabetes for over 6 years. Falls were significantly more common in white non-Hispanic participants and in individuals with one or more comorbid conditions. A higher percentage of participants with insensate feet (62%) reported falls compared with participants with sensate feet (52%), although this finding was not statistically significant. During the 2-year follow-up period, 252 participants (63%) reported 923 falls. Overall, participants reported that 17% of falls required medical care. However, in participants who reported more than one fall, 31% required medical care. The overall incidence of falls in this cohort was 1.25 falls/person-year (95% CI 1.17–1.33).

Table 2 shows the risk factors associated with falls. When we evaluated the risk factors for only one fall, we found that only the presence of one or more comorbid conditions increased the risk of falls. Comorbid conditions were more common in the VA population. Risk factors for multiple falls included BMI ≥30 kg/m^2, one or more comorbid conditions, and

Table 2—*Risk for one or multiple falls by demographic and health characteristics in individuals with diabetes and a prior foot ulcer*

Variable	Participants with any fall (n = 252)		Participants with multiple falls (n = 164)	
	Odds ratio	95% CI	Odds ratio	95% CI
≥1 comorbid condition	2.10	1.28–3.44*	2.29	1.29–4.08*
Insensate feet	1.39	0.89–2.20	1.87	1.1–3.2†
Foot deformity	0.81	0.50–1.30	0.82	0.49–1.41
VA care source	1.44	0.86–2.42	1.84	1.02–3.31†

Controlling for age, sex, diabetes duration, BMI, ever smoked, and study footwear group. *$P < 0.05$; †$P < 0.01$.

Table 3—*Univariate analysis of fall-related fracture risk in 400 patients with a prior foot ulcer*

Variable	*n*	% Affected	Crude odds ratio	95% CI
Sex				
F	7	7.7	3.59	1.2–10.6*
M	7	2.3		
Foot sensation				
Insensate feet	7	3.0	0.71	0.24–2.05
Sensate feet	7	4.2		
Comorbid conditions				
≥1 comorbid conditions	8	2.6	0.41	0.13–1.22
No comorbid conditions	6	6.2		
Diabetes duration ≥25 years	4	8.9	6.34	1.08–37.1*
Footwear				
Wearing own footwear (control subjects)	11	6.9	5.8	1.6–21.6†
Wearing special study footwear	3	1.25		
Fractures rate				
Men		12.4 fractures/1,000 person-years		5.0–25.6
Women		40.2 fractures/1,000 person-years		16.2–82.8

*$P < 0.05$; †$P < 0.01$.

insensate feet. Female sex was not a significant risk factor for falls.

Table 3 shows risk factors for fractures from falls. There were 15 fall-related fractures reported by seven men (one with two fractures) and seven women. All seven men were ≥65 years old, whereas four of the seven women were ≥65 years old. Fractures locations were as follows: six ankle, three proximal humerus, one radius, one tibial plateau, one tibia and fibula, one hip, one rib, and one lumbar spine. Table 3 shows that fracture risk was significantly higher in women, in individuals who had diabetes for ≥25 years, and in study participants who wore their own footwear rather than special study shoes. The fracture rate was threefold higher in women than in men (40.2/1,000 vs. 12.4/1,000 person-years, respectively).

CONCLUSIONS — The frequency of falls among study participants was much higher than expected. After 1 year, 54% of our study cohort (ages 45–84 years) reported at least one fall. This result compares to the 33% of individuals aged ≥65 years with and without diabetes who fall each year, according to the National Center for Injury Prevention and Control at the Centers for Disease Control (8). The incidence for falls in our cohort was 104.2 falls per 1,000 person-months, which is 2.5-fold higher than the incidence rate of 41.4 falls per 1,000 person-months reported in an 18-month prospective study of 409 randomly selected community-dwelling individuals with and without diabetes aged ≥65 years residing in Montreal (9).

Although we expected that insensate feet (as a result of diabetic peripheral neuropathy) would be associated with an increased incidence for any fall, insensate feet significantly increased the risk only for two or more falls. Only the presence of a comorbid condition increased the overall risk of any fall. Comorbid conditions were more prevalent in the VA population. Having one fall appeared to be a random event, whereas two or more falls was not. When controlling for age, sex, diabetes duration, foot deformity, footwear, and smoking, only BMI ≥30 kg/m^2, comorbidity, and the presence of insensate feet increased the risk of multiple falls.

Overall, participants in this cohort sought medical care for 17% of reported total falls (153/923 falls). We observed 15 fractures in 14 participants (9%). The fracture risk was not increased in participants with insensate feet. In a study of 80 patients with type 1 diabetes, Cavanagh et al. (10) reported that individuals with diabetes and peripheral sensory neuropathy were 15 times more likely to report fall-related injuries than individuals without neuropathy.

There are several study limitations. The focus of most previously published work on incidence and risk factors for falls is on populations aged ≥60 years. This cohort of participants was between age 45 and 84 years at baseline. Few studies provide fall rates for people with and without diabetes for comparison. In addition, recall bias in some participants may have resulted in an underestimation of the number or seriousness of falls. We asked participants whether they sought medical care for falls, recorded their responses, and reviewed only those medical records. We did not uniformly record all minor injuries. Although participants may have different thresholds for seeking medical care, all participants had good access to medical care because of their affiliation with comprehensive health care systems. In addition, some individuals at high risk of serious falls may have been excluded from study participation because eligibility criteria included the ability to walk at least one block and climb one flight of stairs daily.

These results suggest that attention to falls in individuals with diabetes is needed. Clinicians need to be aware of fall risk factors in their patients. They also need to discuss with their at-risk patients the strategies to prevent fall-related injuries that can impair function and independence.

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