Health Care Service and Outcomes Among an Estimated 6.7 Million Ambulatory Care Diabetic Foot Cases in the U.S.

Grant H. Skrepnek,[1] Joseph L. Mills Sr.,[2] Lawrence A. Lavery,[3] and David G. Armstrong[4]

Diabetes Care 2017;40:936–942 | https://doi.org/10.2337/dc16-2189

OBJECTIVE

To evaluate ambulatory clinical cases of diabetic foot ulcers (DFUs) and diabetic foot infections (DFIs) in the U.S. from 2007 to 2013 and to assess outcomes of emergency department or inpatient (ED/IP) admission, number of clinic visits per year, and physician time spent per visit.

RESEARCH DESIGN AND METHODS

A cross-sectional historical cohort analysis was conducted by using the nationally representative Centers for Disease Control and Prevention National Ambulatory Medical Care Survey data from 2007 to 2013, including patients age ≥18 years with diabetes and either DFIs or DFUs. Study outcomes were analyzed by using generalized linear models controlling for key demographics and chronic conditions.

RESULTS

Across the estimated 5.6 billion ambulatory care visits between 2007 and 2013, 784.8 million involved diabetes and ∼6.7 million (0.8%) were for DFUs (0.3%) or DFIs (0.5%). Relative to other ambulatory clinical cases, multivariable analyses indicated that DFUs were associated with a 3.4 times higher odds of direct ED/IP admission (CI 1.01–11.28; $P = 0.049$), 2.1 times higher odds of referral to another physician (CI 1.14–3.71; $P = 0.017$), 1.9 times more visits in the past 12 months (CI 1.41–2.42; $P < 0.001$), and 1.4 times longer time spent per visit with the physician (CI 1.03–1.87; $P = 0.033$). DFIs were independently associated with a 6.7 times higher odds of direct ED referral or IP admission (CI 2.25–19.51; $P < 0.001$) and 1.5 times more visits in the past 12 months (CI 1.14–1.90; $P = 0.003$).

CONCLUSIONS

This investigation of an estimated 6.7 million diabetic foot cases indicates markedly greater risks for both ED/IP admissions and number of outpatient visits, with DFUs also associated with a higher odds of referrals to other physicians and longer physician visit times.

An estimated 9.3% of people living in the U.S. are affected by diabetes, with both prevalence and costs continuing to increase (1). From 2007 to 2013, the prevalence of diabetes increased by 26%, and costs increased by 41% (2,3). Overall, the average direct medical costs for patients with diabetes has been observed to be 2.3 times higher than those without the disease (3). More than 20% of U.S. hospitalizations are of patients with diabetes (4).

[1]College of Pharmacy, University of Oklahoma Health Sciences Center, Oklahoma City, OK
[2]Department of Plastic Surgery, University of Texas Southwestern Medical Center, Dallas, TX
[3]Division of Vascular Surgery and Endovascular Therapy, Michael E. DeBakey Department of Surgery, Baylor College of Medicine, Houston, TX
[4]Division of Vascular and Endovascular Surgery and Southern Arizona Limb Salvage Alliance, Department of Surgery, University of Arizona College of Medicine, Tucson, AZ

Corresponding author: Grant H. Skrepnek, grant-skrepnek@ouhsc.edu.

Received 11 October 2016 and accepted 19 April 2017.

The diabetic foot condition is both complex and costly, with at least one-third of the treatment involving foot ulcer care (2,4–6). The lifetime risk for developing tissue loss through a diabetic foot ulcer (DFU) is at least 15–25% among individuals with diabetes (7,8). Approximately 60% of DFUs progress to become diabetic foot infections (DFIs), and 20% of those infections lead to some form of amputation (9,10). From 2005 to 2010, 80% of patients with DFUs who presented to emergency departments (EDs) in the U.S. were admitted as an inpatient (IP), with 16% requiring an amputation (5). After a DFU heals or requires amputation, the risk of reulcerations also remains high despite advances in treatment and prevention. Given that 30–80% of individuals with previous DFUs will experience recurrence within 1 year, the cycle of increased risk of infection and amputation can continue, particularly among high-risk patients (11,12). Mortality rates among patients with amputations related to DFUs parallel pancreatic and lung cancer, with only a 20–61% 5-year survival rate (5,6,13,14).

Although widely appreciated that much morbidity and resource allocations are borne on the IP side of the equation, limited research has been conducted involving the outpatient care of individuals with DFUs and DFIs at the population level. As such, the overall purpose of this study was to evaluate ambulatory clinical cases of DFUs and DFIs in the U.S. from 2007 to 2013 and to assess outcomes of ED/IP admissions, referral to other physicians, number of clinic visits per year, and physician time spent per visit.

RESEARCH DESIGN AND METHODS

This cross-sectional historical cohort investigation used nationally representative Centers for Disease Control and Prevention (CDC) National Ambulatory Medical Care Survey (NAMCS) data from 2007 to 2013 that sampled ambulatory, clinic-based physician office visits across the U.S. (15). These publically available, fully deidentified and anonymized data capture numerous elements related to the physician-patient visit or encounter among nonfederally employed clinicians (i.e., as designated by the American Medical Association or the American Osteopathic Association). The sampling unit defined within NAMCS is that of the actual encounter or visit; thus, analyses are limited regarding extensive longitudinal patient-level assessments. NAMCS yields unbiased population-based estimates through multistage sampling and statistical estimation (i.e., adjustments for nonresponse bias and selection probability, weight smoothing, ratio adjustments for physician specialties), which included 2,705 physicians and 54,873 visits within the 22 most populous U.S. states in 2013. Overall, the population-based estimates in the current work are based on 236,479 unweighted adult patient visits from 2006 to 2013.

Inclusion criteria were adult ambulatory clinic patients age $\geq$18 years. DFU and DFI cases were identified through diagnostic codes, with DFUs determined specifically by using the validated method of Sohn et al. (16), which includes ICD-9-CM codes of any listed diagnosis of diabetes (250.xx) in addition to either 707.1x (ulcer of minor limb, except pressure ulcer) or 707.9 (chronic ulcer, unspecified). DFI cases were identified on the basis of Holzer et al. (17), Mayfield et al. (18), and Sohn et al. to include diabetes with additional diagnoses of either cellulitis and abscess of the toe, foot, or unspecified digit (681.1, 682.7, 681.9, 682.6), osteomyelitis (730.06–730.09, 730.16–730.19, 730.26–730.29), gangrene (785.4), or paronychia (681.11).

The study outcomes were *1*) referral of the case to an ED/IP admission directly from the ambulatory clinic, *2*) referral to other physician, *3*) number of ambulatory care visits in the past year, and *4*) time spent directly with the physician measured in minutes. Across the overall time frame of the study, the independent variables of interest were the presence of a DFU or DFI, patient demographics (age, sex, race, ethnicity, and primary payer), other chronic comorbid diseases/clinical characteristics (arthritis, asthma, cancer, cerebrovascular disease, congestive heart failure [CHF], chronic renal failure, chronic obstructive pulmonary disease [COPD], depression, diabetes excluding DFUs or DFIs, hyperlipidemia, hypertension, ischemic heart disease, obesity, and osteoporosis), and year (2007–2013).

Multivariable generalized linear regression models were used to assess the odds ratios (ORs) or incidence ratios (IRs) as binomial/logistic for ED/IP admission, negative binomial for number of past visits, and zero-truncated negative binomial for time spent with the physician (19,20). Coefficient estimates, therefore, may be interpreted as broad relative risk measures where values significantly $<$1.0 indicate decreasing odds, values significantly $>$1.0 suggest increased odds, and values equal to 1.0 infer no association (20). To capture the complex weighted sampling methodology used within NAMCS and to allow for nationally representative estimations, Taylor series methods were incorporated in calculating SEs (15). As explicitly advised by the National Center for Health Statistics, an evaluation of all statistical estimates was undertaken to ensure appropriate population weighting (i.e., wherein estimates would be deemed unreliable if $\leq$30 raw sample records were analyzed and if the SE was $>$30%) (15). All analyses were performed with SAS 9.4 (SAS Institute, Cary, NC) or Stata/MP 14.2 (StataCorp, College Station, TX) statistical software.

RESULTS

Across the estimated 5.6 billion total adult ambulatory care visits in the U.S. from 2007 to 2013, DFU and DFI cases were $\sim$2.5 and 4.2 million, respectively, constituting a total prevalence 8.6 per 1,000 diabetes-related cases. Over time, the percentage of diabetes cases involving DFUs increased slightly (DFU_{2007} = 3.6 per 1,000 diabetes cases, DFU_{2013} = 5.2 per 1,000 diabetes cases; $P < 0.05$), whereas the percentage of cases involving DFIs decreased (DFI_{2007} = 7.4 per 1,000 diabetes cases, DFI_{2013} = 5.4 per 1,000 diabetes cases; $P < 0.05$). The average age among patients with DFUs was 66.5 $\pm$ 15.9 years and for those with DFIs, 61.3 $\pm$ 10.8 years, with the majority of being male (DFU_{male} = 64.6%, DFI_{male} = 62.7%, $diabetes_{male}$ = 46.9%; $P < 0.01$). Compared with diabetes-related visits and without controlling for other factors, the proportions of patients with DFUs were statistically higher for white race, Medicare, and cerebrovascular disease, whereas those of patients with DFIs were higher for chronic renal failure ($P < 0.05$). With regard to outcomes, unadjusted analyses indicated that DFUs were associated with 3.3 more visits in the past 12 months, whereas DFIs were associated with 1.9 more past visits (DFU_{visits} = 6.7 $\pm$ 8.8, DFI_{visits} = 5.3 $\pm$ 6.6, $diabetes_{visits}$ = 3.4 $\pm$ 5.8; $P < 0.05$). A significantly higher proportion of patients with DFUs and DFIs were referred to EDs or admitted

as IPs versus patients with only diabetes ($DFU_{ED/IP\ admission}$ = 3.1%, $DFI_{ED/IP\ admission}$ = 5.3%, $diabetes_{ED/IP\ admission}$ = 0.8%; $P < 0.05$). No statistical difference was found in the unadjusted time spent with the physician (DFU_{time} = 26.1 ± 26.1, DFI_{time} = 22.8 ± 20.5, $diabetes_{time}$ = 21.6 ± 13.6; $P > 0.05$). Table 1 presents the full descriptive statistics for DFUs, diabetes, and overall ambulatory care in the U.S. from 2007 to 2013.

Table 1—Descriptive statistics of adult ambulatory care visits related to DFUs, DFIs, and diabetes in the U.S., 2007–2013 (weighted)

	DFU (*n* = 2,488,153)	DFI (*n* = 4,225,245)	Diabetes (*n* = 784,763,603)	Overall (*n* = 5,564,576,334)
Patient demographics				
Age (years)	66.5 ± 15.9	61.3 ± 10.8	63.2 ± 13.9	54.5 ± 18.6
Male sex	64.6**	62.7**	46.9	39.2
Race				
White	92.5*	83.8	80.7	84.6
Black	2.9*	14.4	13.9	10.5
Other	4.6	1.8	5.5	4.9
Medicare	63.6*	40.2	47.5	30.4
Medicaid	19.6	10.8	12.0	9.2
Clinical characteristics				
DFU	100	0.0	0.3	<0.1
DFI	0.0	100	0.5	<0.1
Arthritis	18.4	23.1	20.0	16.0
Asthma	6.9	9.8	6.9	5.8
Cancer	4.8	8.5	7.8	7.2
Cerebrovascular disease	13.2**	2.8	4.5	2.2
CHF	7.9	9.8	5.4	2.3
Chronic renal failure	7.9	16.3**	6.6	2.2
COPD	9.2	6.3	6.7	4.5
Depression	6.5	9.3	11.6	11.0
Diabetes	100	100	100	14.1
Hyperlipidemia	25.4*	33.7	42.6	19.7
Hypertension	60.0	63.6	66.3	33.0
Ischemic heart disease	10.6	5.9	10.3	4.9
Obesity	14.4	26.2	18.0	8.2
Osteoporosis	4.4	0.5***	3.8	3.3
One chronic condition	25.0	14.8	12.4	26.6
Two chronic conditions	20.7	31.6	23.6	17.0
Three or more chronic conditions	54.3	53.6	64.0	19.8
Number of chronic diseases	2.9 ± 1.7	3.2 ± 1.3	3.1 ± 1.4	1.1 ± 2.2
Year				
2007	14.8	17.7	12.9	14.4
2008	9.4	17.0	13.5	14.1
2009	20.1	19.5	16.8	15.3
2010	13.0	7.9	14.2	14.7
2011	8.4	15.1	15.6	14.0
2012	10.5	8.4	12.5	13.6
2013	23.9	14.4	14.5	13.9
Outcomes				
Number of visits in the past 12 months	6.7 ± 8.8*	5.3 ± 6.6*	3.4 ± 5.8	2.7 ± 6.9
Time spent with the physician (min)	26.1 ± 26.1	22.8 ± 20.5	21.6 ± 13.6	21.7 ± 13.5
ED/IP admission	3.1*	5.3***	0.8	0.7
Referral to other physician	19.2	12.6	10.6	8.9

Data are mean ± SD or %. Unweighted sample sizes: DFU = 117; DFI = 127; diabetes = 31,643; overall = 236,479. ***$P < 0.001$; **$P < 0.01$; *$P < 0.05$ (independent group *t* test or χ^2 vs. patients with diabetes).

The multivariable analysis that controlled for potential differences across patient demographics, clinical characteristics, and year is presented in Table 2 and graphically in Fig. 1 according to the four study outcomes: *1*) ED/IP admission, *2*) referral to other physician, *3*) number of ambulatory care visits in the past year, and *4*) time spent with the physician measured in minutes. Independent of all other measured factors, DFUs were associated with a significantly increased odds across all outcomes, whereas DFIs were associated with a higher odds of ED/IP admission and number of past visits ($P < 0.05$). More specifically, DFUs were associated with a 3.37 times higher odds of direct ED referral or IP admission (CI 1.01–11.28; $P = 0.049$), 2.05 times higher odds of referral to another physician (CI 1.14–3.71; $P = 0.017$), 1.85 times more visits in the past 12 months (CI 1.41–2.42; $P < 0.001$), and 1.38 times longer time spent per visit with the physician (CI 1.03–1.87; $P = 0.033$). DFIs were independently associated with a 6.72 times higher odds of direct ED referral or IP admission (CI 2.25–19.51; $P < 0.001$) and 1.47 times more visits in the past 12 months (CI 1.14–1.90; $P = 0.003$); no significant difference was observed in referrals to other physicians or time spent per visit with the physician ($P > 0.05$).

In relative terms beyond DFUs or DFIs, only cancer and DFUs were associated with increases across all outcomes, whereas DFIs, CHF, and COPD were associated with more ED/IP admissions and past annual visits (Table 2 and Fig. 1). Depression and osteoporosis were associated with a higher odds of past annual visits and longer times spent with the physician. A majority of conditions were associated with a higher odds of referral to other physicians. More specifically, other disease states associated with a significantly increased odds of ED/IP admission were cancer (OR 1.36), cerebrovascular disease (OR 1.57), CHF (OR 2.56), COPD (OR 1.50), and ischemic heart disease (OR 1.54) ($P < 0.05$). A higher odds of referrals to other physicians was significantly associated with arthritis (OR 1.22), asthma (OR 1.01), cancer (OR 1.23), cerebrovascular disease (OR 1.18), CHF (OR 1.05), depression (OR 1.16), diabetes (OR 1.12), hyperlipidemia (OR 1.16),

Table 2—Multivariable regression analyses of study outcomes

	Referral to ED/IP admission,[A] OR (95% CI)	Referral to other physician,[A] OR (95% CI)	Number of visits in the past 12 months,[B] IR (95% CI)	Time spent with the physician measured in minutes,[C] IR (95% CI)
Patient demographics				
Age (years)	0.99 (0.99–1.00)	0.99 (0.99–1.00)	0.99 (0.99–1.00)	1.00 (0.99–1.01)
Male sex	1.09 (0.94–1.25)	1.11*** (1.15–1.31)	0.95*** (0.93–0.98)	1.02* (1.01–1.03)
Black race (vs. white race)	0.95 (0.71–1.27)	1.13 (1.03–1.24)	0.98 (0.94–1.02)	0.99 (0.98–1.02)
Other race (vs. white race)	0.81 (0.48–1.36)	1.09 (0.97–1.22)	1.06* (1.01–1.13)	1.01 (0.98–1.04)
Medicare (vs. other health care coverage)	1.07 (0.84–1.37)	0.92 (0.87–0.97)	1.09*** (1.05–1.12)	0.98* (0.96–0.99)
Medicaid (vs. other health care coverage)	1.87*** (1.39–2.50)	1.06 (0.96–1.17)	1.26*** (1.21–1.31)	0.98* (0.95–0.99)
Clinical characteristics				
DFU	3.37* (1.01–11.28)	2.05* (1.14–3.71)	1.85*** (1.41–2.42)	1.38* (1.03–1.87)
DFI	6.72*** (2.32–19.51)	1.29 (0.65–2.58)	1.47** (1.14–1.90)	0.98 (0.74–1.29)
Arthritis	0.95 (0.75–1.22)	1.22*** (1.15–1.31)	1.08*** (1.05–1.12)	1.00 (0.98–1.02)
Asthma	0.90 (0.65–1.24)	1.01* (1.01–1.20)	1.05 (0.99–1.11)	1.01 (0.99–1.03)
Cancer	1.36* (1.01–1.83)	1.23*** (1.14–1.34)	1.24*** (1.17–1.31)	1.12*** (1.08–1.16)
Cerebrovascular disease	1.57* (1.07–2.29)	1.18* (1.03–1.35)	1.00 (0.96–1.05)	1.06*** (1.03–1.09)
CHF	2.56*** (1.86–3.54)	1.05 (0.92–1.19)	1.20*** (1.14–1.27)	1.01 (0.98–1.04)
Chronic renal failure	1.21 (0.68–2.15)	1.06 (0.90–1.24)	1.11* (1.02–1.22)	1.08*** (1.04–1.12)
COPD	1.50* (1.10–2.05)	1.02 (0.92–1.13)	1.14*** (1.09–1.19)	0.99 (0.97–1.01)
Depression	0.87 (0.68–1.10)	1.16*** (1.09–1.24)	1.64*** (1.55–1.74)	1.15*** (1.13–1.18)
Diabetes (excluding DFUs and DFIs)	1.12 (0.91–1.37)	1.12*** (1.05–1.19)	1.08*** (1.05–1.11)	1.01 (0.99–1.02)
Hyperlipidemia	0.68* (0.51–0.90)	1.16*** (1.08–1.24)	0.94*** (0.92–0.97)	1.02 (0.99–1.04)
Hypertension	0.98 (0.81–1.20)	1.02 (0.97–1.07)	0.99 (0.96–1.01)	1.01 (0.99–1.09)
Ischemic heart disease	1.54* (1.08–2.19)	1.04 (0.93–1.17)	0.99 (0.95–1.05)	1.02 (0.99–1.04)
Obesity	1.01 (0.79–1.30)	1.25*** (1.17–1.34)	1.03 (0.99–1.07)	1.02* (1.01–1.04)
Osteoporosis	0.89 (0.55–1.45)	1.22** (1.08–1.37)	1.12*** (1.05–1.21)	1.07*** (1.04–1.11)
Year				
2007–2013	0.98 (0.91–1.05)	1.03** (1.01–1.05)	0.99 (0.98–1.00)	1.03*** (1.02–1.03)

Overall weighted sample size = 5,564,576,334. [A]Binomial/logistic generalized linear model. [B]Negative binomial generalized linear model. [C]Truncated negative binomial regression.***$P < 0.001$; **$P < 0.01$; *$P < 0.05$.

obesity (OR 1.25), and osteoporosis (OR 1.22). Numerous conditions also were associated with a significantly higher number of past visits, including arthritis (IR 1.08), cancer (IR 1.24), CHF (IR 1.20), chronic renal failure (IR 1.11), COPD (IR 1.14), depression (IR 1.64), diabetes (IR 1.08), and osteoporosis (IR 1.12). Finally, longer times spent with the physician during a single visit were found for cancer (IR 1.12), cerebrovascular disease (IR 1.06), chronic renal failure (IR 1.08), depression (IR 1.15), obesity (IR 1.02), and osteoporosis (IR 1.07) ($P < 0.05$).

CONCLUSIONS

Relative to ~5.6 billion ambulatory care visits in the U.S. from 2007 to 2013, the estimated 2.5 million DFU and 4.2 million DFI cases studied were associated with a markedly greater odds for ED/IP admissions and number of ambulatory care visits, with DFUs also associated with a higher odds of referrals to other physicians and longer physician visit times. Independent of other chronic conditions, and relative to these, DFUs and DFIs were either similar to or exceeded the ED/IP admission odds, including for cancer, cerebrovascular disease, CHF, COPD, and ischemic heart disease. In addition, DFUs and DFIs had significantly higher odds of ED/IP admission compared with arthritis, asthma, chronic renal failure, depression, diabetes, hyperlipidemia, hypertension, obesity, and osteoporosis. Compared with all other ambulatory care visits in the U.S., both cancer and DFUs were associated with increases across all outcomes. DFI, CHF, and COPD were associated with a higher odds of ED/IP admissions and more past annual visits.

People with diabetes reportedly have higher rates of hospitalization and longer IP lengths of stay than the general population (4). Duhon et al. (21) reported that DFI-related hospital discharges decreased by >50% from 1996 to 2010, decreasing from 23 per 1,000 diabetes discharges to 11 per 1,000. Ali et al. (22) observed that although diabetes preventive practices improved significantly in the U.S. from 1999 to 2010, 30–50% failed to achieve various treatment goals, and numerous investigations have observed poor adherence to guideline-recommended foot care in patients with diabetes, including annual foot examinations. Both in the U.S. and globally, the burden of diabetic foot disease has been projected to increase in accordance to the increased prevalence of diabetes (13). In the current work, the prevalence of DFU and DFI ambulatory care visits was substantially lower than in acute ED/IP settings, averaging 3.2 DFUs and 5.4 DFIs per 1,000 diabetes visits. Of note, this prevalence decreased for DFIs from 7.4 per 1,000 patients with diabetes in 2007 to 5.4 per 1,000 in 2013 and increased for DFUs from 3.6 per 1,000 in 2007 to 5.2 per 1,000 in 2013 ($P < 0.05$). Although the prevalence of diabetes is estimated at 9.3% of the U.S. population, the current work suggests that 14.1% of ambulatory care visits involve patients with diabetes (1). Estimates indicate that up to 15–25% of patients with diabetes develop foot ulcers, and >33% of diabetes care involves foot conditions (7,8).

Across patients with diabetes overall, Menchine et al. (23) emphasized that acute care outcomes from ED/IP settings depend on the continuum of prevention

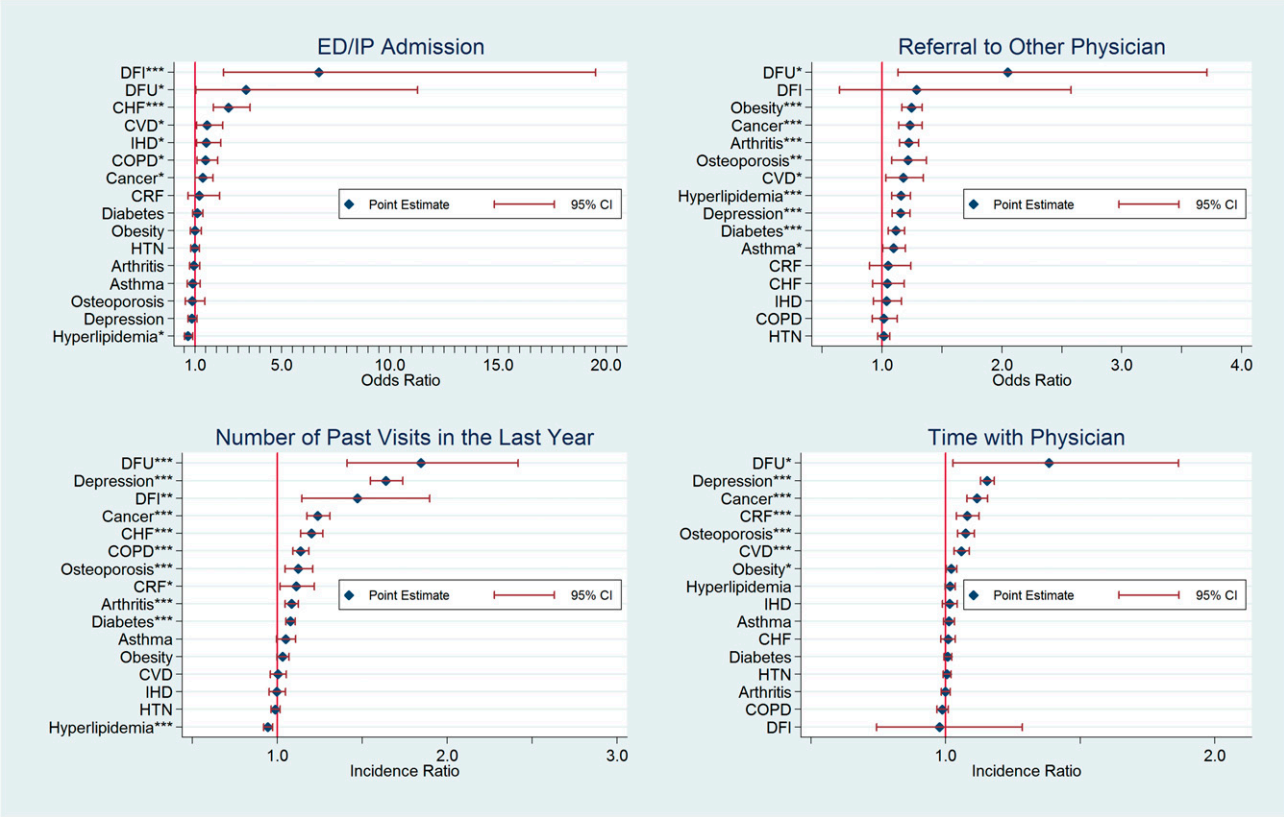

Figure 1—Graphical depiction of multivariable regression coefficients of study outcomes. Multivariable generalized linear regressions: ED/IP admission and referral to other physician = binomial/logistic; number of visits in the past year = negative binomial; and time with physician = truncated negative binomial. Overall weighted sample size = 5,564,576,334. *$P < 0.05$; **$P < 0.01$; ***$P < 0.001$. CVD, cerebrovascular disease; CRF, chronic renal failure; HTN, hypertension; IHD, ischemic heart disease.

and treatment practices within ambulatory settings. These authors reported that approximately two-thirds of patients with diabetes who present to EDs are treated and released without requiring a hospital admission. Specific to DFUs, however, Skrepnek et al. (5) found that 81.2% of DFU-related ED cases were admitted to the hospital, whereas only 17.3% were treated and released directly from the ED. A potential reliance on ED care may be related to numerous factors, including a lack of primary care, the development of diabetes-related complications, and poor adherence to diabetes prevention and control (5). The importance of risk factor control for patients with diabetes is routinely emphasized, particularly preventive care and management of comorbid conditions (1,7). With regard to worsening disease severity or patient complexity in ambulatory care settings, Ashman and Beresovsky (24) reported that the most prevalent chronic condition triad in 2009 was hypertension, hyperlipidemia, and diabetes, with visits among patients with multiple chronic conditions increasing as a function of age and Medicare or Medicaid insurance coverage. Specific to diabetes, Moore et al. (25) analyzed patient complexity in diabetes-related ambulatory care in the U.S. from 2008 to 2010, reporting that 72.2% of all diabetes visits involved two or more chronic conditions and 48.1% involved three or more. The current research also found that >75% of patients with DFUs or DFIs also had two or more conditions, with >50% having three or more. Only among patients with diabetes were the number of chronic diseases observed to increase (albeit small) from 2.9 ± 1.3 in 2007 to 3.2 ± 1.6 in 2013 ($P < 0.001$); no significant differences were noted among either DFI or DFU visits ($P < 0.05$).

Referrals of patients to other physicians for numerous disease states has been investigated within the context of both quality and cost in health care (26–28). Greenfield et al. (26) were among the first to report that referrals are associated with increased costs independent of health status. Although referrals may be a signal of poor prevention, worsening disease severity, or higher patient complexity, an improvement in quality of care among appropriately referred patients can ultimately enhance overall coordination of care (26–28). Among ambulatory visits in the U.S. from 1999 to 2009, Barnett et al. (29) reported a 92% increase in physician referrals of 4.8–9.3%. Over time, these researchers observed increasing rates of referrals for cardiovascular; dermatological; ear, nose, and throat; gastrointestinal; and orthopedic complaints (29). Across all visits in the current investigation, referrals increased from 7.9% in 2007 to 9.9% in 2013 (a 26% unadjusted increase), representing a 2.9% adjusted annual increase after controlling for demographic and clinical factors (OR 1.03; $P = 0.006$). Some 19.2% of DFUs resulted in referrals and were associated with an approximate twofold increased adjusted odds (OR 2.05; $P = 0.017$).

Physician visit time has been investigated as a correlate for numerous factors, including medical malpractice, payments, quality of care, and patient trust (30,31). Across all ambulatory care patients, Shaw

et al. (32) found that primary care physician time with patients increased from 17.9 to 20.3 min between 1993 and 2010 and that increases occurred irrespective of specialty, patient age, or number of chronic diseases. In an earlier work, Mechanic et al. (33) had also reported physician visit times to increase (16.3–18.3 min from 1989 to 1999 and 18.0–20.8 min from 1997 to 2005; $P < 0.05$). Chen et al. (34) published that the longer visit times between 1997 and 2005 were associated with older age, white race, and internist versus general/family practitioner care. Furthermore, these authors reported that visit times for patients with diabetes increased by 4.2 min ($P < 0.05$). Although indirectly related to diabetes, the excess time burden of other conditions also has been investigated. For example, Tsai et al. (35) reported that obesity is associated with an extra 8% longer time in primary care visits; the current work observed a 2% increase ($P = 0.029$). Relative to the diabetic foot, the current study reports a 38% longer adjusted visit time with DFUs ($P = 0.033$), whereas no difference was observed for DFIs ($P = 0.868$). Numerous other chronic conditions also are associated with longer adjusted visits, including depression (15%), cancer (12%), COPD (8%), and osteoporosis (7%) ($P < 0.05$). After adjusting for demographics and chronic diseases, a 3% longer visit time was observed per year from 2007 to 2013 ($P < 0.001$). With regard to the number of visits per year, Burt et al. (36) reported an annual 4.0 ambulatory care visits per person in the U.S. from 1995 to 2005, with higher visit rates associated with increased age and black race. Increases of 20% and 37% also occurred among primary care and specialty offices, respectively (36). The current work found the mean number of visits in the past 12 months to be 6.7 for DFUs and 5.3 DFIs, which are significantly greater than the 3.4 past visits for diabetes and 2.7 past visits for the adult U.S. population. After adjusting for demographics and other potential chronic conditions, DFUs and DFIs were associated with 85% and 47% more adjusted past visits, respectively ($P < 0.05$). Several other conditions were also associated with increases, including cancer (24%), CHF (20%), chronic renal failure (11%), COPD (14%), depression (64%), and osteoporosis (12%) ($P < 0.05$). No change was found across the 2007–2013 time frame ($P = 0.201$).

Although the current investigation used ambulatory, clinic-based physician office visit data that provide nationally representative estimates, certain limitations should be considered. Relative to the diabetic foot, a lack of information was available for wound classification with respect to extent, degree of ischemia, or infection severity. Prior research confirms the importance of wound classification as a direct correlate to patient outcomes (9,10). The CDC NAMCS uses a single visit as its unit of analysis to ensure patient anonymity and confidentiality (15). Therefore, an analysis that followed each patient longitudinally could not be conducted. In addition, an investigation that compared direct observation from clinical sites with data captured within the CDC NAMCS reported a systematic underestimation of the number of clinical services provided by primary care physicians and an overestimation of visit times (37). Although general medication classes are present within NAMCS, several interventions specific to DFIs and DFUs were not captured. Despite a broad demographic and chronic disease information analysis, unmeasurable or exogenous factors may be present that were not captured. Caution should be used in extrapolating findings beyond the population level to either specific patients or health care systems.

The interpretation and policy application of population-level outcome assessments of the diabetic foot remain complex partially because of patient- and clinician-level challenges in preventing, assessing, and treating root causes (5). Continued work must be directed toward optimizing access, cost, and quality as well as toward understanding treatment preferences and perceptions of both patients and providers (5,14,38). A fractured continuum of care has been observed, including marked disparities and amputations, substantial underdiagnoses of complications, and numerous persons having lower likelihoods of receiving preventive care, poorer communication with health care professionals, and lower adherence to self-examination and self-management (5,14,38,39). Because patients with diabetes who receive care from an interdisciplinary team that includes a foot specialist have an approximately $\geq$50% reduction in the risk of amputation, global initiatives have created preventive foot care programs that emphasize components of health literacy and patient education (39). Conversely, eliminating preventive care programs has been observed to have imperiling effects, with a 49% increase in amputations, sepsis, or death; 37% increase in hospitalizations; 23% longer hospital lengths of stay; and 38% increase in charges (40).

In conclusion, the diabetic foot has been ubiquitously observed to be associated with poor outcomes. This investigation of an estimated 6.7 million DFU and DFI ambulatory care visits in the U.S. from 2007 to 2013 found that DFUs and DFIs were associated with markedly higher odds of ED/IP admissions and number of ambulatory care visits, equaling or exceeding numerous serious chronic disease states. DFUs were also associated with a higher odds of referrals to other physicians and longer physician visit times, paralleled only by cancer. The development and assessment of multidisciplinary approaches to provide enhanced, coordinated prevention and treatment for this often-ignored condition should remain a priority for policymakers, providers, and patients.

Acknowledgments. This project used publicly available data from the U.S. Centers for Disease Control and Prevention.

Duality of Interest. G.H.S. is on an advisory board for Novo Nordisk. L.A.L. is on a speakers' bureau for Osiris, Integra, and Smith & Nephew; is a consultant/advisor to KCI Concepts, Aplion Medical, Harbor MedTech, PODOMETRICS, and HyperMed; and has received research funding from GlaxoSmithKline, KCI Concepts, and Cardinal Health. No other potential conflicts of interest relevant to this article were reported.

Author Contributions. G.H.S. and D.G.A. conceived the research hypotheses, developed the methodological framework, conducted the statistical analyses, interpreted the results, and wrote the manuscript. J.L.M. and L.A.L. conceived the research hypotheses, interpreted the results, and wrote the manuscript. All authors approved the final manuscript. G.H.S. and D.G.A. are the guarantors of this work and, as such, had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

References

1. Centers for Disease Control and Prevention. *National Diabetes Statistics Report: Estimates of Diabetes and Its Burden in the United States, 2014*. Atlanta, GA, U.S. Department of Health and Human Services, 2014

2. Vigersky RA, Fitzner K, Levinson J; Diabetes Working Group. Barriers and potential solutions to providing optimal guideline-driven care to patients with diabetes in the U.S. Diabetes Care 2013;36:3843–3849

3. American Diabetes Association. Economic costs of diabetes in the U.S. in 2012. Diabetes Care 2013;36:1033–1046
4. Kim S, Boye KS. Excessive hospitalizations and its associated economic burden among people with diabetes in the United States. Value Health 2009;12:267–272
5. Skrepnek GH, Mills JL Sr, Armstrong DG. A diabetic emergency one million feet long: disparities and burdens of illness among diabetic foot ulcer cases within emergency departments in the United States, 2006-2010. PLoS One 2015;10: e0134914
6. Skrepnek GH, Armstrong DG, Mills JL. Open bypass and endovascular procedures among diabetic foot ulcer cases in the United States from 2001 to 2010. J Vasc Surg 2014;60:1255–1264
7. Singh N, Armstrong DG, Lipsky BA. Preventing foot ulcers in patients with diabetes. JAMA 2005; 293:217–228
8. Armstrong DG, Nguyen HC, Lavery LA, van Schie CH, Boulton AJ, Harkless LB. Off-loading the diabetic foot wound: a randomized clinical trial. Diabetes Care 2001;24:1019–1022
9. Lavery LA, Armstrong DG, Murdoch DP, Peters EJG, Lipsky BA. Validation of the Infectious Diseases Society of America's diabetic foot infection classification system. Clin Infect Dis 2007;44:562–565
10. Lavery LA, Armstrong DG, Wunderlich RP, Tredwell J, Boulton AJM. Diabetic foot syndrome: evaluating the prevalence and incidence of foot pathology in Mexican Americans and non-Hispanic whites from a diabetes disease management cohort. Diabetes Care 2003;26:1435–1438
11. Lavery LA, Peters EJ, Williams JR, Murdoch DP, Hudson A, Lavery DC; International Working Group on the Diabetic Foot. Reevaluating the way we classify the diabetic foot: restructuring the diabetic foot risk classification system of the International Working Group on the Diabetic Foot. Diabetes Care 2008;31:154–156
12. van Netten JJ, Price PE, Lavery LA, Monteiro-Soares M, Rasmussen A, Jubiz Y, Bus SA; International Working Group on the Diabetic Foot. Prevention of foot ulcers in the at-risk patient with diabetes: a systematic review. Diabetes Metab Res Rev 2016;32(Suppl. 1):84–98
13. Boulton AJM, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The global burden of diabetic foot disease. Lancet 2005;366:1719–1724
14. Barshes NR, Sigireddi M, Wrobel JS, et al. The system of care for the diabetic foot: objectives, outcomes, and opportunities. Diab Foot Ankle 2013;4:21847
15. Centers for Disease Control and Prevention. *2013 NAMCS Micro-Data File Documentation*. Atlanta, GA, Centers for Disease Control and Prevention, 2016
16. Sohn MW, Budiman-Mak E, Stuck RM, Siddiqui F, Lee TA. Diagnostic accuracy of existing methods for identifying diabetic foot ulcers from inpatient and outpatient datasets. J Foot Ankle Res 2010;3:27
17. Holzer SE, Camerota A, Martens L, Cuerdon T, Crystal-Peters J, Zagari M. Costs and duration of care for lower extremity ulcers in patients with diabetes. Clin Ther 1998;20:169–181
18. Mayfield JA, Reiber GE, Maynard C, Czerniecki JM, Caps MT, Sangeorzan BJ. Trends in lower limb amputation in the Veterans Health Administration, 1989-1998. J Rehabil Res Dev 2000;37:23–30
19. Skrepnek GH. Regression methods in the empiric analysis of health care data. J Manag Care Pharm 2005;11:240–251
20. Skrepnek GH, Olvey EA, Sahai A. Econometric approaches in evaluating cost and utilization within pharmacoeconomic analyses. Pharm Policy Law 2012;14:105–122
21. Duhon BM, Hand EO, Howell CK, Reveles KR. Retrospective cohort study evaluating the incidence of diabetic foot infections among hospitalized adults with diabetes in the United States from 1996-2010. Am J Infect Control 2016;44: 199–202
22. Ali MK, Bullard KM, Saaddine JB, Cowie CC, Imperatore G, Gregg EW. Achievement of goals in U.S. diabetes care, 1999-2010. N Engl J Med 2013; 368:1613–1624
23. Menchine MD, Wiechmann W, Peters AL, Arora S. Trends in diabetes-related visits to US EDs from 1997 to 2007. Am J Emerg Med 2012; 30:754–758
24. Ashman JJ, Beresovsky V. Multiple chronic conditions among US adults who visited physician offices: data from the National Ambulatory Medical Care Survey, 2009. Prev Chronic Dis 2013;10: E64
25. Moore M, Gibbons C, Cheng N, Coffman M, Petterson S, Bazemore A. Complexity of ambulatory care visits of patients with diabetes as reflected by diagnoses per visit. Prim Care Diabetes 2016;10:281–286
26. Greenfield S, Nelson EC, Zubkoff M, et al. Variations in resource utilization among medical specialties and systems of care. Results from the Medical Outcomes Study. JAMA 1992;267:1624–1630
27. Glenn JK, Lawler FH, Hoerl MS. Physician referrals in a competitive environment. An estimate of the economic impact of a referral. JAMA 1987; 258:1920–1923
28. Franks P, Williams GC, Zwanziger J, Mooney C, Sorbero M. Why do physicians vary so widely in their referral rates? J Gen Intern Med 2000;15: 163–168
29. Barnett ML, Song Z, Landon BE. Trends in physician referrals in the United States, 1999-2009. Arch Intern Med 2012;172:163–170
30. Fiscella K, Meldrum S, Franks P, et al. Patient trust: is it related to patient-centered behavior of primary care physicians? Med Care 2004;42: 1049–1055
31. Lau DT, McCaig LF, Hing E. Toward a more complete picture of outpatient, office-based health care in the U.S. Am J Prev Med 2016;51:403–409
32. Shaw MK, Davis SA, Fleischer AB, Feldman SR. The duration of office visits in the United States, 1993 to 2010. Am J Manag Care 2014;20:820–826
33. Mechanic D, McAlpine DD, Rosenthal M. Are patients' office visits with physicians getting shorter? N Engl J Med 2001;344:198–204
34. Chen LM, Farwell WR, Jha AK. Primary care visit duration and quality: does good care take longer? Arch Intern Med 2009;169:1866–1872
35. Tsai AG, Abbo ED, Ogden LG. The time burden of overweight and obesity in primary care. BMC Health Serv Res 2011;11:191
36. Burt CW, McCaig LF, Rechtsteiner EA. Ambulatory medical care utilization estimates for 2005. Adv Data 2007;388:1–15
37. Gilchrist VJ, Stange KC, Flocke SA, McCord G, Bourguet CC. A comparison of the National Ambulatory Medical Care Survey (NAMCS) measurement approach with direct observation of outpatient visits. Med Care 2004;42:276–280
38. Gaskin DJ, Thorpe RJ Jr, McGinty EE, et al. Disparities in diabetes: the nexus of race, poverty, and place. Am J Public Health 2014;104:2147–2155
39. Lavery LA, Wunderlich RP, Tredwell JL. Disease management for the diabetic foot: effectiveness of a diabetic foot prevention program to reduce amputations and hospitalizations. Diabetes Res Clin Pract 2005;70:31–37
40. Skrepnek GH, Mills JL, Armstrong DG. Foot-in-wallet disease: tripped up by "cost-saving" reductions? Diabetes Care 2014;37:e196–e197