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## Major article

## Retrospective cohort study evaluating the incidence of diabetic foot infections among hospitalized adults with diabetes in the United States from 1996–2010

Bryson M. Duhon PharmD, BCPS<sup>a,b,c</sup>, Elizabeth O. Hand PharmD, BCPS<sup>a,b,c</sup>,  
Crystal K. Howell PharmD<sup>a,b</sup>, Kelly R. Reveles PharmD, PhD, BCPS<sup>a,b,\*</sup><sup>a</sup> Pharmacotherapy Division, College of Pharmacy, The University of Texas at Austin, Austin, TX<sup>b</sup> Pharmacotherapy Education and Research Center, The University of Texas Health Science Center at San Antonio, San Antonio, TX<sup>c</sup> University Health System, San Antonio, TX

## Key Words:

Diabetic foot infection  
Diabetes  
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Mortality**Background:** The prevalence of diabetes has increased over the last 2 decades; however, the national incidence of diabetic foot infections (DFIs) in the United States is unknown. We sought to determine national trends in DFIs among hospitalized adults in the United States over 15 years.**Methods:** This was a retrospective cohort study of the U.S. National Hospital Discharge Survey from 1996–2010. Adult patients with a principal diagnosis of foot infection and a secondary diagnosis of diabetes were identified using ICD-9-CM codes. Incidence was defined as DFI discharges per 100 diabetes discharges. Independent risk factors for DFI among diabetics were identified using multivariable logistic regression.**Results:** These data represent 1,059,552 DFI discharges over the study period. The incidence of DFI decreased from 1996 (2.3 DFIs/100 diabetes discharges) to 2010 (1.1 DFI/100 diabetes discharges). The proportion of patients experiencing lower-extremity amputation declined from 33.2% in 1996 to 17.1% in 2010. Peripheral vascular disease (odds ratio [OR], 2.89; 95% confidence interval [CI], 2.87–2.91), peripheral neuropathy (OR, 2.62; 95% CI, 2.60–2.64), and male sex (OR, 1.67; 95% CI, 1.66–1.68) were the leading risk factors for DFI.**Conclusion:** The incidence of DFI among hospitalized adults in the United States declined by more than half from 1996–2010.Copyright © 2015 by the Association for Professionals in Infection Control and Epidemiology, Inc.  
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Diabetes continues to be one of the most prevalent and devastating diseases in the United States. The Centers for Disease Control and Prevention (CDC) found that the age-adjusted prevalence of diagnosed diabetes increased sharply in the United States between 1995 and 2010 for all U.S. geographic regions.<sup>1</sup> In 2012, it was estimated that 29.1 million Americans, or 9.3% of the U.S. population, had diabetes.<sup>2</sup>

\* Address correspondence to Kelly R. Reveles, PharmD, PhD, BCPS, The University of Texas Health Science Center at San Antonio, Pharmacotherapy Education and Research Center, 7703 Floyd Curl Dr, MSC-6220, San Antonio, TX, 78229-3900.

E-mail address: [kdaniels46@utexas.edu](mailto:kdaniels46@utexas.edu) (K.R. Reveles).

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Diabetes remains the seventh leading cause of death in the United States, contributing to death in nearly a quarter million Americans annually.<sup>2</sup> This disease is also associated with substantial morbidity, including cardiovascular disease, nephropathy, and retinopathy. In addition, diabetes can result in impaired pain sensation after injury of the foot, which may consequently allow pathogens to overcome a damaged epidermal barrier and cause infection. The resulting diabetic foot infection (DFI) is a complex and challenging disease.

DFIs are the leading cause of nontraumatic lower-extremity amputations (LEAs) and result in approximately 66,000 amputations and \$176 billion in direct medical costs annually in the United States.<sup>2</sup> As the prevalence of diabetes increases, there have been continued efforts to control and prevent end-stage complications of the disease.<sup>3</sup> These efforts might result in reduced incidence of complications, such as DFI, in the United States; however, the

**Table 1**  
ICD-9-CM codes for DFI, health outcomes, and comorbidities

Diagnosis or procedure	ICD-9-CM code
Foot infection	
Gangrene	040.0; 440.24; 785.4 + (250.7 or 440.2X)
Osteomyelitis	730.07; 730.17; 730.27; 730.97
Ulcer	440.23; 707.1X
Cellulitis-abscess of foot	680.7; 682.7
Cellulitis-abscess of toe	681.10
Paronychia	681.11
Diabetes	250.00-250.93
Comorbidities	
Septicemia	038.0-038.9; 995.91-2
Renal failure	584.8-9; 586
Renal disease	240.4; 249.4; 403; 404; 585.1-585.9; 581.81; 583.81
Dialysis (procedure)	39.95; 54.98
Dialysis (diagnosis)	585.6; V45.1
Peripheral vascular disease	250.7; 443.8-9; 785.4; 997.2
Peripheral neuropathy	250.6; 357.2
Diabetic retinopathy	250.5; 362.XX
Lower-extremity amputation	84.10-7

national incidence of DFI has not been described longitudinally in recent years.

The primary objective of this study was to determine national trends in DFI incidence among hospitalized adults in the United States from 1996-2010. Secondary objectives included describing DFI health outcomes and identifying independent risk factors for DFI.

## METHODS

This was a retrospective cohort study using the CDC's U.S. National Hospital Discharge Survey (NHDS) from 1996-2010. The NHDS is a probability survey of short-stay, nonfederal hospitals in the United States.<sup>4</sup> The National Center for Health Statistics created the NHDS as its first survey of medical care delivery in 1965. The survey now uses a 3-stage sample design which includes geographic primary sampling units, hospitals within each sampling unit, and discharges within each hospital. The NHDS collects information on patient baseline demographics, geographic regions, payment source, and admission source and type. Diagnoses and procedures are collected using ICD-9-CM codes. National estimates are derived using data weights, which are created using software that adjusts for sample selection, nonresponse, and population weighting ratios. The use of data weighting has been previously validated.<sup>4</sup>

For this study, we included patients who met the following criteria:  $\geq 18$  years of age, principal discharge diagnosis of foot infection (cellulitis-abscess of the foot, cellulitis-abscess of the toe, gangrene, osteomyelitis, paronychia), and a secondary diagnosis of diabetes. The ICD-9-CM codes for each of the diagnoses collected can be found in Table 1.

Patient baseline characteristics, region, hospital size, hospital ownership, principal payment source, admission type, and admission source were collected according to the NHDS categories. We also included several comorbidities as defined by the ICD-9-CM codes (Table 1): diabetic retinopathy, dialysis, peripheral neuropathy, peripheral vascular disease, renal disease, and renal failure. DFI incidence was defined as DFIs per 100 diabetes discharges. Health outcomes collected included LEA, all-cause in-hospital mortality, hospital length of stay, osteomyelitis, and septicemia. Independent risk factors for DFI were identified using a multivariable logistic regression with DFI as the dependent variable and the

**Table 2**  
Patient baseline demographics and comorbidities (N = 1,059,552)

Demographic	Value
Age (y)	67 (56-76)
Male sex	617,727 (58.3)
Race	
White	637,467 (75.3)
Black	162,422 (19.2)
Other	46,571 (5.5)
Region	
Northeast	249,035 (23.5)
Midwest	269,992 (25.5)
South	413,799 (39.0)
West	126,726 (12.0)
Hospital size	
6-99 beds	212,001 (20.0)
100-199 beds	236,212 (22.3)
200-299 beds	223,398 (21.1)
300-499 beds	265,962 (25.1)
$\geq 500$ beds	121,979 (11.5)
Hospital ownership	
Proprietary	112,885 (10.7)
Government	132,634 (12.5)
Nonprofit	814,033 (76.8)
Principal payment source	
Medicare	462,728 (61.1)
Medicaid	67,781 (9.0)
Private	184,749 (24.4)
Self-pay	19,102 (2.5)
Other	22,748 (3.0)
Admission type	
Emergency	105,328 (31.6)
Urgent	88,353 (26.5)
Elective	129,617 (41.9)
Admission source	
Emergency room	99,885 (30.5)
Transfer	15,540 (5.1)
Referral	159,036 (48.5)
Other	52,123 (15.9)
Comorbidities	
Septicemia	12,373 (1.2)
Renal failure	25,643 (2.4)
Renal disease	121,605 (11.5)
Dialysis	74,346 (7.0)
Peripheral vascular disease	173,518 (16.4)
Peripheral neuropathy	210,770 (19.9)
Diabetic retinopathy	57,658 (5.4)

NOTE. Values are n (%) or median (interquartile range).

following covariates: age, sex, race, geographic region, hospital ownership, renal disease, diabetic retinopathy, dialysis, peripheral neuropathy, peripheral vascular disease, renal failure, and principal payment source. JMP 10.0 (SAS Institute, Cary, NC) was used for all analyses.

## RESULTS

These data represent 1,059,552 DFI discharges between 1996 and 2010. Patient characteristics are provided in Table 2. Overall, patients had a median age of 67 (interquartile range, 56-76) years, were predominately men (58%), were predominately white (75%), and lived in the South region of the United States (39%). Sixty-one percent of participants had a principal payment source of Medicare. Gangrene was the most common type of foot infection (38.9%), followed by foot cellulitis-abscess (20.7%), ulcer (17.7%), osteomyelitis (15%), and toe cellulitis-abscess (7.7%). Peripheral neuropathy (19.9%) and peripheral vascular disease (16.4%) were common in this population.

The total number of DFI discharges decreased by an average of 11% per year, from 86,563 in 1996 to 77,491 in 2010. DFI incidence decreased by 52% (2.3 DFIs/100 diabetes discharges in 1996 and 1.1

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