



Diabetes mellitus and infection: an evaluation of hospital utilization and management costs in the United States



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ABSTRACT

Aims: The objective of this study is to evaluate the number of diabetics that seek medical treatment in emergency departments or require hospitalization for infection management in the United States. This study also assesses the socioeconomic impact of inpatient infection management among diabetics.

Methods: We accessed the Healthcare Cost and Utilization Project's Nationwide Emergency Department Sample database and the Nationwide Inpatient Sample database to perform a retrospective analysis on diabetics presenting to the emergency department or hospitalized for infection management from 2006 to 2011.

Results: Emergency Department: Since 2006, nearly 10 million diabetics were annually evaluated in the emergency department. Infection was the primary reason for presentation in 10% of these visits. Among those visits, urinary tract infection was the most common infection, accounting for over 30% of emergency department encounters for infections. Other common infections included sepsis, skin and soft tissue infections, and pneumonia. Diabetics were more than twice as likely to be hospitalized for infection management than patients without diabetes.

Hospitalization: Since 2006, nearly 6 million diabetics were annually hospitalized. 8–12% of these patients were hospitalized for infection management. In 2011, the inpatient care provided to patients with DM, and infection was responsible for over \$48 billion dollars in aggregate hospital charges.

Conclusions: Diabetics commonly present to the emergency department and require hospitalization for infection management. The care provided to diabetics for infection management has a large economic impact on the United States healthcare system. More efforts are needed to develop cost-effective strategies for the prevention of infection in patients with diabetes.

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1. Introduction

Diabetes mellitus (DM) is one of the most common systemic diseases worldwide. Currently, DM affects an estimated 366 million people. By 2030, it is estimated that over 550 million people will have DM—affecting more than 1 in 3 Americans (Centers for Disease Control and Prevention, 2011; International Diabetes Federation, 2011). In the United States, DM is the 7th leading cause of death and has been shown to be an independent risk factor for early death. DM is associated with multiple co-morbid conditions—including infection. Patients with type 1 and type 2 DM are at increased risk for infection secondary to poor glycemic control, diabetic neuropathy, and impaired innate and adaptive immune responses (Chen, Jackson, & Boyko, 2009; Geerlings & Hoepelman, 1999; Valerius, Eff, Hansen,

et al., 1982). Diabetics are at increased risk for community-acquired infections as well as rare infections like malignant otitis externa, rhinocerebral mucormycosis, and emphysematous pyelonephritis (Geerlings, 2008; Muller, Gorter, Hak, et al., 2005; Shah & Hux, 2003). Sepsis also occurs more frequently and has a higher mortality rate in patients with DM than in other individuals (Shah & Hux, 2003). In general, patients with diabetes are often more likely to develop recurrent infections or complications from infections that require inpatient hospital management (Joshi, Caputo, Weitekamp, & Karchmer, 1999).

The care provided to diabetics imposes a substantial burden on the United States healthcare system in the form of increased medical costs, chronic disability, and premature mortality. Medical costs for diabetics are ~2.3-fold higher than non-diabetic patients. Nearly half of the direct medical costs of diabetic care are believed to be associated with management of diabetic complications (Anonymous, 2014; Ward, Alvarez, Vo, & Martin, 2014). In 2012, the American Diabetes Association (ADA) estimated that DM increased healthcare costs to \$245 billion—a 41% increase from 2007 (Anonymous, 2014).

Conflict of interest: The authors have nothing to disclose and no conflicts of interest.

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To date, the economic burden and resource allocation for common diabetic complications like infection are not well defined. Given the increasing prevalence of DM in the United States, there is a need to quantify the frequency in which diabetics seek care for infection and evaluate the associated costs and healthcare resource allocation. Thus, using the largest publically available all-payer emergency department (ED) and inpatient databases in the United States, we evaluate the number of diabetics requiring ED treatment or hospitalization for infection and estimate the financial impact associated for inpatient infection management in the presence of DM.

2. Materials and methods

2.1. Data source

A retrospective analysis was performed using the Healthcare Cost and Utilization Project's (HCUP) Nationwide Emergency Department Sample database (NEDS) and the Nationwide Inpatient Sample database (NIS). The Healthcare Cost and Utilization Project databases (HCUP), sponsored by the Agency for Healthcare Research and Quality (AHRQ), were designed to identify and track trends in hospital utilization, access, cost, and outcome across the United States (HCUP Nationwide Emergency Department Sample (NEDS); HCUP Nationwide Inpatient Sample (NIS)).

The HCUP-NEDS is the largest all-payer emergency department database available in the United States. In 2011, it included data from 950 emergency departments in 30 states and encompasses 30 million patient encounters. National estimates are weighted to reflect all 50 states (HCUP Nationwide Emergency Department Sample (NEDS)). The HCUP-NIS is the largest inpatient database available in the US. It is a sample of US community hospitals, defined as all non-Federal, short-term, general, and other specialty hospitals, excluding hospital units of institutions. In 2011, the NIS included 1,049 hospitals in 46 states resulting in data from over 8 million hospitalizations. It is estimated that the sampling includes over 90 percent of discharges from US community hospitals (HCUP Nationwide Inpatient Sample (NIS)). National estimates were weighted to reflect all 50 states.

2.2. Patient identification

2.2.1. HCUP-NEDS

Patients presenting to the ED with primary diagnosis of DM were identified using the AHRQ's Clinical Classification Software (CCS), a system that groups over 12,000 ICD-9-CM diagnosis codes into 260 clinically meaningful categories (HCUP Clinical Classifications Software for ICD-9-CM). Diabetics were identified using CCS diagnosis codes for DM without complications (CCS 49) and DM with complications (CCS 50). The CCS software was used in place of ICD-9-CM codes so that we could capture a larger patient population and a population already assigned to defined cohorts. Related diagnoses were also identified using the CCS. Data collected included number of

ED visits, number of hospital admissions, and associated secondary diagnoses.

2.2.2. HCUP-NIS

The HCUP-NIS uses the same CCS as the HCUP-NEDS. Patients hospitalized with the principal diagnosis of DM and the associated diagnoses were identified using the CCS (CCS 49 and 50). Data collected included number of hospitalizations, secondary diagnoses, and length of hospital stay. Hospital economics were evaluated by examining hospital charges. These charges represent what the hospital billed the patient for services rendered during the hospitalization and do not reflect reimbursement.

2.3. Data analysis

To report national estimates, the HCUP-NIS and HCUP-NEDS developed discharge weights using the American Hospital Association Universe. With each national estimate, the HCUP-NIS and HCUP-NEDS report standard errors that were calculated using SUDAAN software (RTI International, Research Triangle Park, NC, USA). Statistical significance was determined using a two-tailed *p*-value. A *p*-value <0.05 was considered statistically significant.

3. Results

3.1. Diabetics commonly seek medical attention in the ED for infection management

According to 2006 HCUP-NEDS data, 8.8 million diabetic patients were evaluated in the ED. By 2011, this number rose to roughly 12.5 million. In 2006, 850,000 diabetic patients were treated in the ED for infection, and over 500,000 were hospitalized for additional inpatient management. By 2011, 1.2 diabetics were evaluated in the ED for infection, and 817,000 were hospitalized for infection management (Table 1). Skin and soft tissue infections, sepsis, pneumonia, and urinary tract infections (UTI) were the most frequent infections encountered. Since 2006, UTI accounted for the highest proportion of annual infections, followed closely by skin infections and pneumonia.

To verify the association of DM and UTI, we utilized the HCUP-NEDS to evaluate the number of patients that present to the ED with the primary diagnosis of UTI. From 2006 to 2011, nearly 3 million patients present annually to the ED for UTI evaluation. Ten percent of these patients have DM. Patients with UTI in the presence of DM are more than two-times more likely to be hospitalized for UTI management than patients without DM.

3.2. Diabetics are routinely hospitalized for infection management

According to 2007 HCUP-NIS data, over 5 million diabetic patients were hospitalized. In 2011, this number increased to 8.2 million. During this period, the number of diabetics annually hospitalized for inpatient infection management increased from 453,000 to over

Table 1
Number of emergency department encounters and admissions for diabetes mellitus by category.

	2006	2007	2008	2009	2010	2011
Total ED visits	101,490,523	103,307,733	105,539,163	109,292,495	109,236,834	111,724,125
Total DM ED visits	8,805,278	9,679,460	10,493,736	11,144,124	11,842,563	12,455,306
DM + infection	852,027	1,266,244	1,610,047	1,717,267	1,813,767	1,926,305
DM + UTI	258,941	286,919	310,521	330,609	358,707	377,390
DM + skin infection	263,716	287,526	305,085	324,891	355,772	379,691
DM + pneumonia	273,703	283,848	296,297	311,078	300,635	314,883
DM + sepsis	55,667	63,600	204,699	227,181	255,318	297,824
Total DM infection admissions	505,129	541,517	700,337	752,501	785,984	817,632

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