

# Direct Medical Costs of Hypoglycemia Hospitalizations in the United States

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## BACKGROUND

- The prevalence of diabetes mellitus has increased significantly over time. Approximately 12% of the United States (US) population aged 20 years and over is estimated to be living with diabetes mellitus.<sup>1</sup>
- Aggressive treatment strategies for managing diabetes mellitus may have helped reduce hyperglycemia-related health care events, but at the same time, they may have also resulted in increased hypoglycemia events, especially among older patients and those with higher comorbidities.<sup>2</sup>
- A recent study reported that the rate of hypoglycemia-related hospitalizations in the US increased between 1991 and 2011, but with a declining trend observed from 2007 through 2011.<sup>3</sup> In a follow-up study, Lipska and colleagues found that the rate of severe hypoglycemia remained high and unchanged over time.<sup>4</sup>
- While trends in the rate of hypoglycemia-related health care events have been explored in several studies, very little is known about trends in hypoglycemia-related health care costs.

## OBJECTIVE

- To explore trends in direct medical costs associated with hypoglycemia-related hospitalizations using nationally representative data from the US.

## METHODS

### Data Source

- Data for years 2001 through 2011 were obtained from the Healthcare Cost and Utilization Project National Inpatient Sample (NIS).
  - The NIS database is a cross-sectional survey of data based on stratified random sampling of discharges in community hospitals in the US.
  - It is the largest publicly available inpatient care database in the US, containing data on > 7 million inpatient hospital stays of individuals covered by Medicare, Medicaid, or private insurance as well as the uninsured.
  - From 2001 through 2011, the NIS included 100% of hospitalizations from the random 20% sample of acute-care hospitals (approximately 1,000 hospitals) in the US.
  - NIS data are commonly used to produce national estimates of health care utilization, access, charges, quality, and outcomes and to assess trends over time.

### Cohort Selection

- Hospital discharges with a diagnosis of hypoglycemia were identified using a previously validated algorithm based on International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes.
  - Principal discharge diagnoses for hypoglycemia (ICD-9-CM: 251.0, 251.1, 251.2, 962.3) had to occur in conjunction with a secondary ICD-9-CM diagnosis code for diabetes (250.xx).
  - Principal discharge diagnosis of diabetes with other manifestations (diabetic hypoglycemia—not otherwise specified or hypoglycemic shock—not otherwise specified) (ICD-9-CM code: 250.8), with the exclusion of admissions that occurred in conjunction with any of the following secondary ICD-9 codes: 259.8, 272.7, 681.xx, 682.xx, 686.9x, 707.xx, 709.3, 730.0-730.2, or 731.8.
- Patients were required to be aged  $\geq 18$  years at the time of hospitalization.

### Study Measures

- Total costs were estimated by applying Medicare average cost-to-charge ratios to reported charges.
- Costs were adjusted for inflation to 2014 US dollars using the medical care component of the US Consumer Price Index.
- NIS-assigned discharge weights were used to derive nationally representative estimates.

### Analysis

- Descriptive statistics were used to describe patient characteristics associated with eligible discharges during the study period.
- The AHRQ Elixhauser comorbidity index (excluding uncomplicated and complicated diabetes) was used to determine comorbidity burden.
- Multivariable generalized linear models were performed to assess average costs per hospitalization by calendar year.
  - All models were risk adjusted for age, sex, and comorbidities.
  - Least-square means statistics were used to produce adjusted, calendar-year-specific cost estimates.
- Total annual costs were calculated by multiplying the per-hospitalization estimated costs in each calendar year by the number of hypoglycemia-related hospital discharges in the given calendar year.
- All analyses were performed using SAS version 9.4.

## RESULTS

- An estimated total of 1.5 million patients were admitted for hypoglycemia during the study period; hypoglycemia hospitalizations increased from 115,367 in 2001 to 161,267 in 2011 (Figure 1).
- The number of hospitalizations increased across all age groups, but the largest increase was observed in the age group 45-64 years, with a 68% higher number of hospitalizations in 2011 compared with 2001.
- The total inflation-adjusted annual costs for hypoglycemia-related hospitalizations in 2001 were \$1.2 billion, with an

average cost of \$10,343 (95% confidence interval [CI]: \$10,187-\$10,500) per hospitalization (Figure 2).

- In 2011, the average cost per hospitalization remained relatively unchanged (\$10,139 [95% CI: \$10,011-\$10,268]), but the total annual costs increased to \$1.6 billion (Figure 2).
- In the age-stratified analysis, the estimated costs per hospitalization were highest in the age group 45-64 years (\$12,131 [95% CI: \$12,063-\$12,198]) and lowest in the age group  $\geq 85$  years (\$8,401 [95% CI: \$8,260-\$8,541]).

Figure 1. Trend in Total Hospital Discharges for Hypoglycemia in the United States, by Age Group (2001-2011)

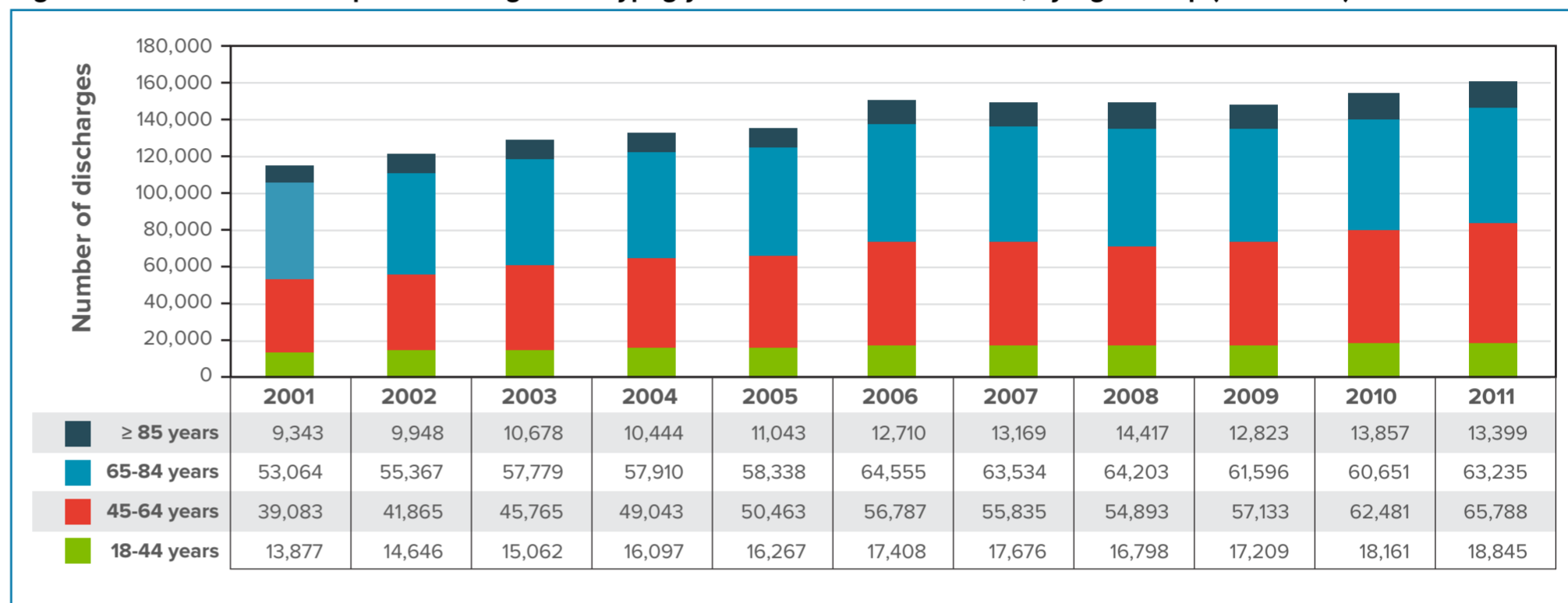
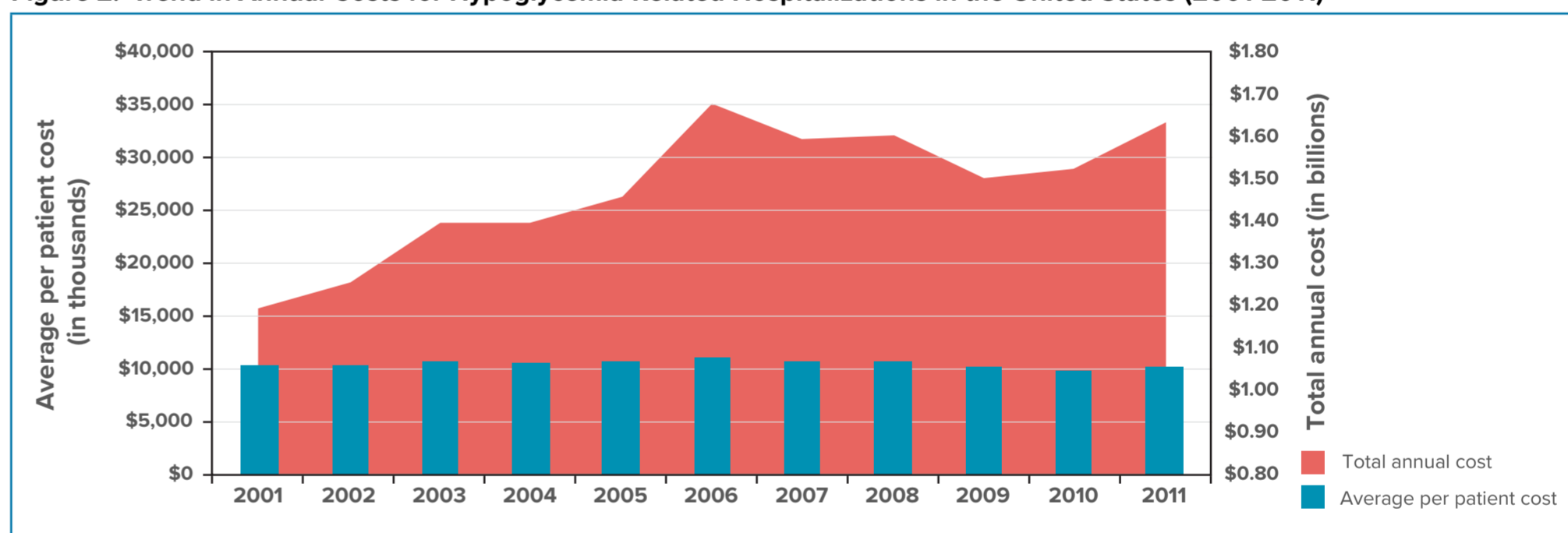


Figure 2. Trend in Annual Costs for Hypoglycemia-Related Hospitalizations in the United States (2001-2011)



## DISCUSSION

- The increasing trend in the number of hypoglycemia-related incidents requiring inpatient hospitalization and the total annual costs associated with this increase, as observed in our analysis, might be explained, at least partially, by the increase in the prevalence of diabetes in the general population.<sup>1</sup>
- However, further research is needed to understand other factors that are likely associated with this increasing trend.
- The disproportionately higher increase in the hypoglycemia-related hospitalizations observed in the age group 45-64 years also warrants further exploratory research.
- There are certain limitations to this study:
  - First, the NIS data capture hospitalizations rather than patients, so our estimates do not represent the number of patients; it is possible that some patients had multiple hospitalizations during a given calendar year.
  - Second, the sample size in the NIS data for patients younger than 18 years is too small to produce nationally representative estimates. Therefore, only adult patients were included.
  - Third, the diagnosis codes used to identify hypoglycemia are subject to misclassification. Besides, any changes in the coding practices over time (in relation to financial incentives) may have impacted the prevalence of hypoglycemia observed in our analysis.

## CONCLUSIONS

- Direct medical costs associated with hypoglycemia-related hospitalizations in the US are substantial and have increased in recent years, driven primarily by growth in hypoglycemia discharges.
- The findings of this analysis suggest a need for more effective approaches to therapeutic management of patients with diabetes in efforts to reduce economic burden on the US health care system.

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