INCREASE IN HYPOGLYCEMIC ADMISSIONS: CALIFORNIA HOSPITAL DISCHARGE DATA

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Objectives: To compare the percentage of diabetics admitted to the hospital due to hypoglycemia in 1990–1993 (period 1) to that in 1997–2000 (period 2).

Methods: We analyzed data from the California Hospital Discharge Data Program. Eligibility included diabetic (ICD code 250) subjects aged ≥25 years old who were hospitalized due to hypoglycemia (ICD Codes 250.8) during the periods 1990–1993 and 1997–2000. Data were analyzed by demographics and health insurance status.

Results: Of the 2,905,091 hospitalized diabetics, 50,017 (1.7%) were due to hypoglycemia. The percentage of hospitalization due to hypoglycemic varied by sex, age, race/ethnicity, and insurance status (P=.0001). Male, Hispanic, age 25–64 years, with Medical/Medicare insurance had higher odds of being hospitalized due to hypoglycemia relative to other groups (P<.001). The percentage of diabetics hospitalized due to hypoglycemia increased from period 1 to period 2 (1.3% vs 2.0%, P=.0001). Diabetics hospitalized in period 2 had higher adjusted odds of being hospitalized due to hypoglycemia relative to those admitted in period 1 (OR=1.6, P<.0001).

Conclusion: Our data show an increase in the hospitalization due to hypoglycemia in diabetic patients. Enhanced patient education about self-monitoring of blood sugar and recognizing and treating the symptoms of hypoglycemia may help to minimize hypoglycemic hospitalizations. (*Ethn Dis*. 2007;17:536–540)

Key Words: Hypoglycemia, Hospital Admissions, Diabetes

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INTRODUCTION

The cardiac, eye, renal, peripheral vascular and other complications of diabetes mellitus (DM), type 1 and/or type 2 have been steadily increasing. The economic cost of diabetes in the United States in 2003 was approximately $132 billion and continues to rise.[1] Tighter glucose control has been demonstrated to reduce clinical complications and ultimately reduce overall health care costs (Diabetes Control and Complications Trial [DCCT], the United Kingdom Prospective Diabetes Study Research Group [UKPDS] cost estimates).[2,3] The recommendations from these studies have been widely implemented within the last few years. Iatrogenic hypoglycemia often causes morbidity and sometimes mortality and is a not uncommon complication of, and barrier to, tight control of DM.[4]

Many hospital admissions with hypoglycemia in diabetic elderly patients have been identified to be due to drug-drug interactions.[5] Severe hypoglycemia is a major problem for patients with diabetes due to limited patient awareness of signs and symptoms. Cohabitants of patients recall significantly more episodes of severe hypoglycemia than the patients do.[6] In Germany, diabetes-related emergencies are frequent and potentially life threatening. A study in Germany reported that emergency medical service personnel provided pre-hospital care for patients with diabetes-related emergencies including hypoglycemia. This, in addition to patient education, reduced mortality from 4.9% to 0%.[7]

While hypoglycemia in neonates and children has been extensively reviewed in the literature,[6–10] limited data exists regarding hospital admission due to severe hypoglycemia in adults. To better understand the impact of more aggressive glucose control on significant hypoglycemia, we examined the trends of hospital admissions due to hypoglycemia in diabetics from 1990–1993 and 1997–2000 in the state of California.

The economic cost of diabetes in the United States was approximately $132 billion in 2003 and continues to rise.[1]

METHODS

This study was a secondary database analysis of the public California Hospital Discharge Database for the years 1990 to 1993 and 1997 to 2000. This database includes comprehensive records of most of the hospital inpatient discharges from the acute care hospitals.[11] We identified patients who had hypoglycemia as the primary diagnosis for the hospitalization using the ICD-9 code 250.8. We identified patients who had diabetes mellitus in the other diagnosis fields. The diagnosis of diabetes mellitus was based on inpatient hospital diagnosis codes 250 from the International Classification of Diseases, Ninth Revision (ICD-9). The ICD-9 code of 250 does not include gestational diabetes, hyperglycemia or non- clinical diabetes. The percentage of hospitalized diabetics due to hypoglycemia was calculated by dividing the number of hospitalizations due to hypoglycemia by the total number of diabetic hospitalizations and is reported as a percentage.

From each subject diagnosed with diabetes in the hospital record, we identified age, race, sex, year of admission, diagnosis of hypoglycemia, and payment source (insurance). Diagnosis of hypoglycemia was categorized into two categories (yes, no). The sociodemographic variables included in this study were: age 25 to 64 years, ≥65 years); sex (male and female); race/ethnicity (White, African American, Hispanic and Asian/others); and insurance status (Medicare/Medical and other insurance). Data were collapsed over the hospitalization years into two time periods: period 1 (1990 to 1993) and period 2 (1997 to 2000). We calculated the percentage of diabetics admitted to the hospital due to hypoglycemia and compared this percentage for the two time periods. The change in the percentage of diabetic hospitalization due to hypoglycemia over the two time periods is calculated using the formula:[(percent in period 2 - percent in period 1) /percent in period 1]*100. Data are reported by sex, race/ethnicity, age categories, and insurance status. Chi-square tests were used to assess the difference in hospitalization due to hypoglycemia in the two time periods. Logistic regression analyses were conducted to examine the relationship between hospitalization periods due to hypoglycemia, adjusting for pre-specified potential confounding variables (age, sex, and race/ethnicity, and insurance). Logistic regression analysis is presented as odds ratios and 95% confidence intervals. In all cases, a two-tailed $P<0.05$ was considered statistically significant. Data were analyzed using SPSS, version 13.0 (Statistical Package for Social Science, Chicago, Ill).

RESULTS

The study includes 2,905,091 diabetic hospitalizations for patients ≥25 years of age, with 39% occurring during 1990–1993 and 61% recorded during 1997–2000. Of all diabetic hospitalizations, 50,017 (1.7%) hospitalizations were due to hypoglycemia. Most (71.1%) of the diabetes-related hypoglycemia hospitalizations occurred during the period 1997–2000. The percentage of hospitalizations due to hypoglycemia increased over time: hospitalizations were 0.7% higher in period 2 compared to period 1 (2.0% vs 1.3%, $P=.0001$; Table 1). Over the two study time periods, we found a 56% increase in the total number of diabetic hospitalizations and a 146% increase in diabetic hospitalizations due to hypoglycemia. The corresponding increase in the percentage of diabetic hospitalizations due to hypoglycemia is 58% between the two time periods (Table 1). It is apparent from Table 1 that overall diabetic hospitalizations due to hypoglycemia were higher in 1997–2000 period and hypoglycemic hospitalizations vary across sex, age, race/ethnicity, and insurance status ($P=.0001$).

Comparing the two time periods of this study, there was a 58% increase in the percentage of diabetic hospitalizations due to hypoglycemia. The highest percent change in diabetic hospitalizations due to hypoglycemia was found among patients ≥65 years of age (113%), Asian/other patients (113%), female (80%), African American patients (79%), and those with Medicare/Medical health insurance (73%) (Table 2).

Multiple logistic regression analysis in Table 3 revealed that age (25–64 years), sex (male), race/ethnicity (Hispanics), and insurance status (Medicare/Medical) were significant predictors for diabetic hospitalizations due to hypoglycemia. After controlling for the confounders in the model, the overall odds of diabetic hospitalization due to hypoglycemia in the time period 1997–2000 was about one and a half times (OR=1.6) the odds in 1990–1993 time period (Table 3).

Table 1. Number and percent of diabetic admissions due to hypoglycemia by admission time period, demographic variables and insurance status

Variable	Diabetes	Hypoglycemia	Percent	*P*-value
Admission year				
1990 to 1993	1,134,022	14,438	1.3	.0001
1997 to 2000	1,771,069	35,579	2.0	
Sex				
Male	1,348,171	27,318	2.0	.0001
Female	1,556,860	22,696	1.5	
Age group				
25 to 64 years	1,185,120	26,849	2.3	.0001
≥65 years	1,719,971	23,168	1.4	
Ethnicity				
White	1,684,211	25,349	1.5	.0001
African American	340,559	6,863	2.0	
Hispanic	628,984	14,312	2.3	
Asian/Other	251,249	3,491	1.4	
Insurance				
Medical/Medicare	2,078,171	33,672	1.6	.0001
Other	826,025	16,321	2.0	

DISCUSSION

Our data show that within the inclusive years there had been an increasing trend in the hospitalization of diabetics with significant hypoglycemia. Of the 2,905,091 diabetic hospitalizations, 50,017 (1.7%) were due to

Table 2. Percentage of diabetic admissions due to hypoglycemia comparing the two time periods of admission (1990–1993 vs 1997–2000) by demographic variables and insurance status

Variables	1990 to 1993			1997 to 2000			Percent change (difference/ initial)*100
	Diabetes	Hypoglycemia	Initial %	Diabetes	Hypoglycemia	%	
Sex							
Male	516,994	8,304	1.6	831,177	19,014	2.3	43.7
Female	617,009	6,133	1.0	939,851	16,563	1.8	80.0
Age group							
25 to 64 years	474,456	9,106	1.9	710,664	17,743	2.5	31.6
≥65 years	659,566	5,332	0.8	1,060,405	17,836	1.7	112.5
Ethnicity							
White	697,560	8,340	1.2	986,651	17,009	1.7	41.7
Black	137,051	1,846	1.4	203,508	5,017	2.5	78.6
Hispanic	220,383	3,652	1.7	408,601	10,660	2.6	52.9
Asian/Other	79,028	600	0.8	172,221	2,891	1.7	112.5
Insurance							
Medical/ Medicare	79,814	8,835	1.1	1,280,027	24,837	1.9	72.7
Other	33,5871	5,603	1.7	490,154	10,718	2.2	29.4

hypoglycemia. The percentage of diabetic hospitalization due to hypoglycemia increased significantly from period 1 to period 2 (1.3% vs 2.01%). However, the overall prevalence is low and the absolute increase is small. Although the study was not designed to explain why there was a significant increase in hypoglycemic hospitalization from 1990 to 2000, certain facts may explain the increase. In the last decade, we have experienced a significant paradigm shift in the management of diabetes. In 1995, new target levels of fasting plasma glucose (less than 7.8 mmol/L [140 mg/dL]) and HbA1C levels (below 7.0%) were proposed.[12] At the same time, in late 1996, the American Diabetes Association's (ADA) expert committee changed the diagnostic criteria for diabetes (fasting plasma glucose level of 7 mmol/L [126 mg/dL] or more), thereby effectively increasing the number of diagnosed diabetics.[10,12] This might have increased the total number of diabetic patients admitted with a diagnosis of diabetes but is unlikely to have increased the number of patients under strict control with pharmacologic intervention.

In addition, newer medications for diabetes, including the combination of oral hypoglycemic agents and insulin, are being used.[13] Also, healthcare providers are more aggressive in achieving tight glycemic control, which can potentially cause hypoglycemic episodes.[14] Furthermore, many diabetic patients have associated hypertension and are on antihypertensive medications that can potentially decrease blood glucose levels.[15] Increased use of herbal preparations may also potentially cause drug interactions leading to hypoglyce-

Table 3. Odds ratio and 95% confidence interval (CI) of diabetic admissions due to hypoglycemia*

Variable	Odds Ratio	95% CI	*P*-value
Admission year			
1990 to 1993	Reference	–	
1997 to 2000	1.58	1.55–1.61	.0001
Sex			
Male	Reference	–	
Female	0.72	0.71–0.74	.0001
Age group			
25 to 64 years	Reference	–	
≥ 65 years	0.61	0.60–0.62	.0001
Ethnicity			
White	Reference	–	
African American	1.25	1.22–1.29	.0001
Hispanic	1.39	1.36–1.42	.0001
Asian/Other	0.88	0.85–0.91	.0001
Insurance			
Medical/Medicare	Reference	–	
Other	0.95	0.93–0.97	.0001

* For all data across each period, except for the comparisons by admission year.

The percentage of diabetic hospitalization due to hypoglycemia increased significantly from period 1 to period 2 (1.3% vs 2.01%).

mia.[16] Several reports have found elderly patients with diabetes being hospitalized due to hypoglycemia secondary to drug-drug interactions.[16–19] Co-trimoxazole and floroquinolones were some of the antibiotics that have been associated with hypoglycemia in elderly patients.[15,18] We did not find an increase in the percentage of hospitalizations due to hypoglycemia in the elderly compared to younger patients in our study.

Our data showed that hospitalization due to hypoglycemia had increased across all adults. However, males, compared to females, had even higher odds to be hospitalized due to hypoglycemia (P=.0001). Among the different races, Whites had the highest number of hospitalizations due to hypoglycemia, followed by the Hispanics, then Blacks and Asians/other. The highest percentage of hospitalizations due to hypoglycemia was among Hispanics followed by African American. The ethnic differences may be due to different lifestyles, insurance availability, utilization of medical services and other factors.

The hypoglycemic data from published studies showed varying frequency or incidence. The Diabetes Control and Complications Trial (DCCT), for example, recorded the incidence of type 1 diabetics who suffer severe hypoglycemia to be only 0.62 episodes per patient per year for patients in the intensively treated arm, which is much lower than the European figures of 1.0 to 1.6.[10] In the UKPDS study, the significant major hypoglycemic episodes occurred only in 0.8%, 0.5% and 1.4% of patients per year among patients on sulfonylureas, metformin, and insulin, respectively, and 0.2% in patients with diet therapy.[10,20,21] Direct comparisons with DCCT and UKPDS trials cannot be made because of difference in study design and sampling methods.

Miller et al, in a specialized diabetic clinic that serves a predominantly African American population in urban Atlanta Georgia, found the prevalence of severe hypoglycemia among type 2 diabetics who were treated with insulin to be only 0.5%.[22] The patients in this study were closely followed by dietitians and intensively educated on hypoglycemia by diabetic nurse specialists, and adequately adhered to a strict follow-up regimen with specialists. In an earlier study in England, Leese et al[2] utilized a large population-based study that found that the prevalence of severe hypoglycemia in insulin-treated patients with type 2 diabetes was much higher than that reported previously.[22] The prevalence of severe hypoglycemia was 7.1% for type 1 diabetics, 7.3% for type 2 diabetics treated with insulin and 0.8% for type 2 diabetics treated with sulfonylurea tables. The risk factors for severe hypoglycemia in this study were age, duration of diabetes and socioeconomic status.[2] In our study of the general population, the percentage of hypoglycemia was higher than the previous controlled studies and showed an increasing trend over the study period from 1.3% to 2.0%. The factors associated with hospitalization due to hypoglycemia in our study were sex, age, race/ethnicity and insurance status.

Previous studies have reported frequencies and incidence of hypoglycemia in treated type 1 and type 2 diabetics. Our study is unique because it examined the trend of hospitalization due to hypoglycemia. Our study had several limitations. Since we used the admission diagnosis variables from California Hospital Discharge Database, other variables such as medications, duration of diabetes, level of education, lifestyles and comorbid conditions were not available. Head-to-head comparison between our study and others described in literature may not be possible because of non-uniformity of study design, methodological variations and, above all, difference in population characteristics. In addition, our study findings were limited to a population able to go to the hospital and living in the state of California. Causal inference can not be drawn from our data because of the temporal ambiguity and our inability to identify the actual causes of hypoglycemia from this retrospective data. There is a possibility of underreporting of the hypoglycemia cases in our study probably because of under coding of diabetes in the hospital discharge data, and lack of information on patients with hypoglycemia who were discharged from the emergency room.

In conclusion, our study shows a significant increase in the number of hospitalizations due to hypoglycemia among treated diabetics over the two periods studied, period 1(1990–1993) and period 2 (1997–2000). The increase in hospitalization due to hypoglycemia was more evident among older patients (≥65 years), Asian/other race, female, African American, and those who had Medical/Medicare health insurance. While aggressive diabetes care remains important, the clinical and financial implications of severe hypoglycemia should not be ignored. Patient education regarding diet, self-monitoring of blood sugar, recognizing the symptoms of hypoglycemia, and treatment of symptoms can help to minimize the hospitalizations due to hypoglycemia. Future studies should address these issues to minimize hospitalizations due to hypoglycemia.

ACKNOWLEDGMENTS

This project was supported in part by G12-RR03026, P20-RR11145, U54 RR019234, and U54 RR14616 from NIH/NCRR and P20MD000182 from the NIH/NCMHD.

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