Hospitalization and Discharge Education of Emergency Department Patients With Hypoglycemia

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Purpose

The purpose of this study is to evaluate the content and adequacy of emergency department (ED) discharge instructions and factors associated with hospitalization in patients presenting with hypoglycemia.

Methods

This is a retrospective cohort study at 3 adult EDs. A 1-year consecutive sample of hypoglycemia cases were identified using ICD-9-CM codes and were confirmed by chart review. Clinical variables and written discharge instructions were analyzed by chart abstraction.

Results

Six hundred thirty-six charts of patients with possible hypoglycemia were reviewed, of which 436 (64%) hypoglycemia cases were confirmed. The median age was 64. Hypoglycemia was associated with sulfonylurea use for 78 (16%) patients and insulin alone for 286 (65%) patients. Written discharge instructions advised frequent blood glucose checks in 21% of patients and medication dose adjustment in 27% of patients and rarely recommended avoiding recurrent hypoglycemia (3%), checking glucose before driving (0.4%), or obtaining glucagon emergency kits (2%). Hospitalization resulted from 177 (41%) visits and was associated with older age (age 65-74 [odds ratio 5.7] and age ≥75 [odds ratio 7.9]), sulfonylurea use (odds ratio 3.5), ≥3 hypoglycemic episodes (odds ratio 3.1), no documented diabetes medications

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(odds ratio 2.1), current primary care provider (odds ratio 4.2), and hypoglycemia as a secondary diagnosis (odds ratio 4.7).

Conclusions

ED written discharge instructions appeared inadequate in providing recommended education for patients with severe hypoglycemia. Older age and sulfonylurea use were independently associated with hospital admission. Although hypoglycemia is generally considered a self-limited condition, 2 of every 5 patients required hospitalization, which likely reflects an older and more complex patient population.

Hypoglycemia is a common complication of diabetes therapy and can have a profound impact on quality of life.[1] Although tight glycemic control is a hallmark of lower rates of complications, the barrier of hypoglycemia is the major limiting factor in maintaining the glycemic control necessary for improved clinical outcomes.[2-5] Mild or self-treated episodes of hypoglycemia are common, especially in type 1 diabetes, with reported rates of 2 episodes per week.[6] Severe hypoglycemia or episodes requiring external assistance may occur at least once a year and are a significant cause of morbidity.[6-8]

Although some episodes of severe hypoglycemia are treated at home by administration of oral glucose or parenteral glucagon by family members, the most severe episodes require ambulance or emergency department (ED) visits.[9] Although ED visits for severe hypoglycemia are a small percentage of the total episodes of hypoglycemia in diabetes, they serve as a good epidemiological marker of the complication and result in significant economic and psychological costs.[10] Most data on the incidence and distribution of hypoglycemia are based on highly selected patients in the setting of large randomized clinical trials[2-4,8] and may not generalize to the entire population. An ED visit for hypoglycemia is an important event for its significance to the patient, the cost to the system, and the opportunity for education and intervention.

The ED visit often consists of restoring normoglycemia, ensuring safe maintenance of normoglycemia, and discharging the patient. Sometimes a patient may require additional observation or hospital admission. The factors associated with this prolonged observation are unknown. Additionally, a hypoglycemic event requiring an ED visit often requires substantial education and outpatient referral. The current content of discharge instructions after an ED visit for hypoglycemia has not been reported, including advice on avoidance of recurrent hypoglycemia, medication adjustment, and close outpatient follow-up.

The purpose of this study is to evaluate the content and adequacy of ED discharge instructions and factors associated with hospitalization in patients presenting with hypoglycemia.

Materials and Methods

Study Design

This is a multicenter, retrospective cohort study using a structured medical record review of ED patients presenting with hypoglycemia. Institutional Review Board approval was obtained with waiver of informed consent at each site.

Study Setting and Population

This study was conducted at 3 US academic hospitals that are active participants in the Emergency Medicine Network (www.emnet-usa.org). The EDs have a combined annual visit volume of 175 000 adults and are staffed by emergency medicine, internal medicine, and surgery residents; patient care is supervised by attending emergency physicians 24 h/d.

The electronic medical record systems at each site were searched for the following *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes in any diagnosis field, which were used to identify possible hypoglycemia visits: 250.3 (diabetes with other coma), 250.8 (diabetes with other specified manifestations) 251.0 (hypoglycemic coma), 251.1 (other specified hypoglycemia), 251.2 (hypoglycemia, unspecified), 270.3 (leucine-induced hypoglycemia), 775.0 (hypoglycemia in an infant born to a diabetic mother), 775.6 (neonatal hypoglycemia), and 962.3 (poisoning by insulin and antidiabetic agents). Only ED-based admission codes were examined, to avoid inclusion of incident hypoglycemia that occurred during inpatient

hospitalization. This strategy was based on detailed examination of the ICD-9-CM coding manual,[11] review of the experience from previously reported approaches,[12-16] and discussion with coding experts.

For chart validation of hypoglycemia, all ED visits with candidate ICD-9-CM codes between July 1, 2005, and June 30, 2006, were identified at each site, and written ED charts were obtained. For patients with multiple ED visits during the data collection period, only the first visit was included to avoid overrepresentation of demographic data by certain patients. To enhance the reliability of our chart review, only charts with complete ED nursing notes and emergency physician notes were abstracted, and all other charts were considered incomplete. The number of hypoglycemia visits for all nonabstracted visits was estimated (ie, incomplete records and subsequent visits by same patient) using the authors' new ICD-9-CM coding algorithm.[17]

As ED charts were reviewed, cases of hypoglycemia were confirmed based on the following criteria: (1) any documented prehospital or ED glucose value (serum or capillary) <70 mg/dL (<3.9 mmol/L) or (2) charted physician discharge diagnosis of hypoglycemia. The glucose threshold was based on the consensus recommendation of the American Diabetes Association Workgroup on Hypoglycemia.[18] Physician diagnosis of hypoglycemia was used to include clinically diagnosed cases for which hypoglycemia resolved prior to first blood glucose determination (eg, patients who received oral or parenteral glucose for symptoms consistent with hypoglycemia prior to blood glucose determination and whose symptoms improved after treatment).

Study Protocol

Three paid research assistants were taught data abstraction using 10 training charts, and their performance was monitored throughout the data collection. Using a standardized data abstraction form, trained reviewers performed a detailed chart review for all confirmed cases of hypoglycemia, and the research group met weekly to maintain consistency in data collection and resolve disputes. The primary reviewers were blinded to the study hypotheses. Additionally, 2 reviewers independently abstracted a 10% convenience sample of charts to evaluate interrater agreement in data collection.

Patient and visit-related characteristics were recorded, based on ED electronic records and written nursing and physician documentation. Data not documented in the written or electronic medical record were presumed absent. Patient characteristics included demographics; type 1 or type 2 diabetes, if specified; and current home diabetes medications (insulin, sulfonylurea, and/or other oral hypoglycemics). Patients with documentation of "non–insulin-dependent diabetes" or oral hypoglycemic use were considered to have type 2 diabetes, but diabetes type could not be identified for patients with documentation of "insulin-dependent diabetes." Visit characteristics were documented, including mode of arrival, any prehospital glucose values, prehospital treatment, ED glucose values, and ED treatment. The prehospital setting was defined as home, outpatient, or ambulance events within 4 hours of ED presentation. Additionally, the presumed cause of the hypoglycemic episode, ED length of stay for discharged or observation patients, and patient disposition were recorded, if specifically documented. Hospital admission was confirmed by electronic records and verified during chart review from physician and nursing documentation. For nonadmitted patients, written discharge instructions for documented recommendations and follow-up care were evaluated. There were no standardized written discharge instructions for hypoglycemia at any of the studied institutions. Finally, ED-derived ICD-9-CM codes were evaluated, from electronic medical records, to determine whether hypoglycemia was the primary (first-listed) diagnosis or a secondary diagnosis.

Data Analysis

Statistical analysis was performed using Stata 9.0 (College Station, Tex), and data were summarized using basic descriptive statistics with 95% confidence intervals (CI). Continuous variables (age and glucose values) were presented using summary measures and further stratified into clinically meaningful categories. Interrater agreement was measured for chart abstraction by calculating the κ statistic for the subgroup of double-abstracted charts.

Crude associations of specified patient and clinical variables with the outcome of hospital admission were measured using the chi-square test. Variables with $P < .10$ on univariate analysis were entered into a backward-selection, multivariate logistic regression model to determine independent associations with the primary outcome of hospital admission. Age and glucose were analyzed as categorical variables, based on a priori grouping, to

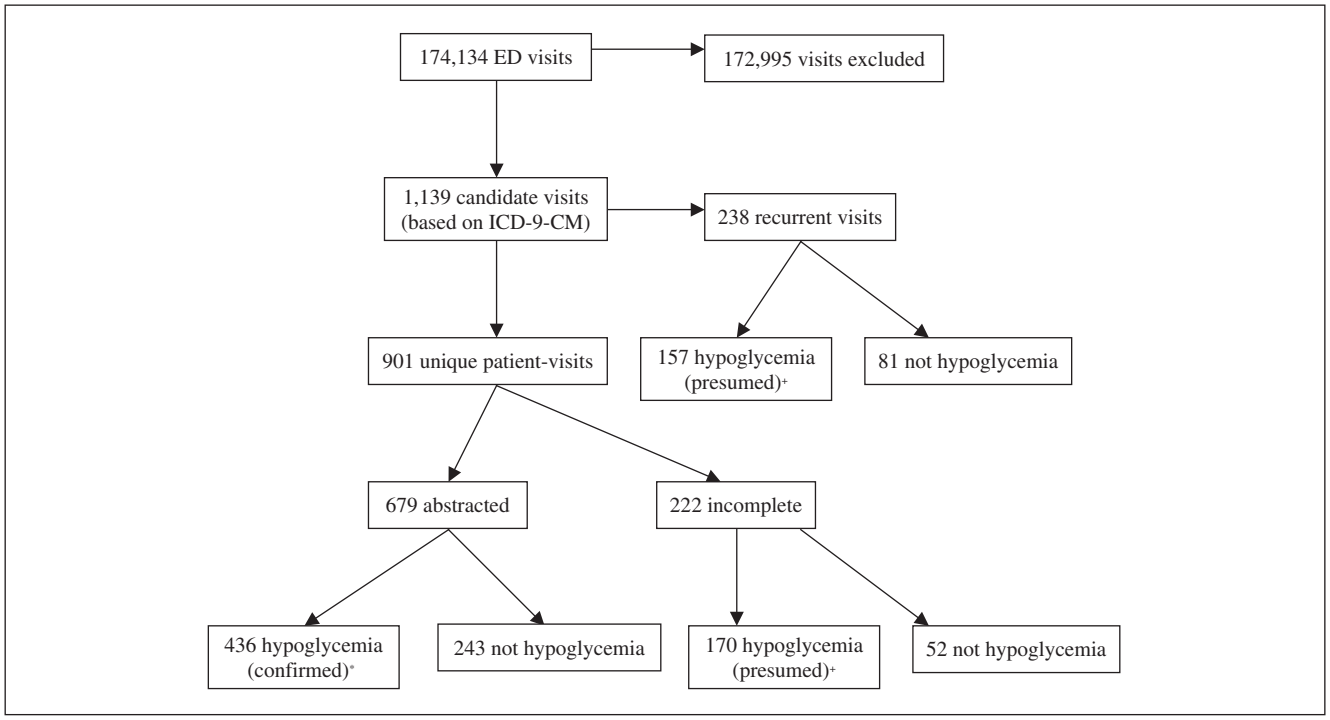

Figure 1. Identification and chart abstraction of emergency department (ED) visits for hypoglycemia. ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification*. Based on *detailed chart review and +ICD-9-CM coding algorithm.

enhance interpretability. Reference groups for categorical variables were chosen based on a prevalent, lower risk subgroup to facilitate comparison. There were no interaction terms of clinical interest, so to avoid multiple testing, interaction terms were not used in the model. Only variables with $P < .05$ were retained in the final model, unless they significantly confounded associations of other retained variables. Results of regression are presented as odds ratios (OR) with 95% CIs. Goodness of fit for the final model was evaluated using the Hosmer-Lemeshow test.

Results

Of the 174 134 ED visits at the 3 institutions during the data collection period, 901 patients with candidate ICD-9-CM codes were identified. These patients accounted for 1139 visits with possible hypoglycemia (ie, 0.5% of all ED visits). Complete documentation was available for 679 (75%) of first visits by included patients. Distribution of candidate ICD-9-CM codes and demographic data (age, sex, and race/ethnicity) were similar among abstracted and incomplete/missing charts (data not shown).

The initial chart review confirmed 436 hypoglycemia visits. Diabetic ulcers and cellulitis identified by ICD-9-CM code 250.8 (diabetes with other manifestations) were the most common nonhypoglycemia diagnoses among flagged charts. Confirmation of hypoglycemia had a very high interrater agreement ($\kappa = 0.97$), and data from detailed chart review were similarly reliable ($\kappa = 0.92$). Figure 1 displays confirmed and presumed cases of hypoglycemia based on detailed chart review and the authors' new ICD-9-CM coding algorithm (unpublished data), respectively. An estimated 763 hypoglycemia visits (436 confirmed, 327 presumed) occurred during the study, which represents 0.4% of total ED visits during the 1-year study period.

Characteristics of Study Subjects

Patient characteristics for the 436 abstracted hypoglycemia visits are summarized in Table 1. The median age was 64 (interquartile range [IQR] 46-76). Table 2 presents the clinical characteristics of the hypoglycemia visits. The median initial prehospital glucose was 40 mg/dL (2.2 mmol/L [IQR 28-57]), and initial ED glucose was 87 mg/dL (4.8 mmol/L [IQR 52-144]). The most commonly

Table 1

Patient Characteristics of 436 Emergency Department Visits for Hypoglycemia

	Total (N = 436)		Admitted (n = 177)		Discharged/Other (n = 259)	
Variable	**n**	**% (95% CI)**	**n**	**% (95% CI)**	**n**	**% (95% CI)**
Age						
<45	95	22 (18-26)	20	21 (13-31)	75	79 (69-87)
45-64	126	29 (25-33)	32	25 (18-34)	94	75 (66-82)
65-74	99	23 (19-27)	52	53 (42-63)	47	47 (58-37)
≥75	116	27 (22-31)	73	63 (53-72)	43	37 (47-28)
Sex						
Female	216	50 (45-54)	95	44 (37-51)	121	56 (49-63)
Male	220	50 (46-55)	82	37 (31-44)	138	63 (56-69)
Race/ethnicity						
White	278	64 (59-68)	115	41 (36-47)	163	59 (53-64)
Black	101	23 (19-27)	35	35 (25-45)	66	65 (55-75)
Hispanic	24	6 (3-8)	16	67 (45-84)	8	33 (16-55)
Asian	17	4 (2-6)	5	29 (10-56)	12	71 (44-90)
Other	16	4 (2-5)	6	38 (15-65)	10	72 (35-85)
Insurance						
Medicare only	122	28 (24-32)	69	57 (47-66)	53	43 (34-53)
Medicaid (with or without Medicare)	143	33 (28-37)	65	45 (37-54)	78	55 (46-63)
Any private insurance	155	36 (31-40)	41	26 (20-34)	114	74 (66-80)
No insurance	15	3 (2-5)	2	13 (2-40)	13	87 (60-98)
Primary care provider						
Yes	390	89 (87-92)	169	43 (38-48)	221	57 (52-62)
No	46	11 (8-13)	8	17 (8-31)	38	83 (69-92)
Diabetes						
Type 1	41	9 (7-12)	9	22 (11-38)	32	78 (62-89)
Type 2	144	33 (29-37)	80	56 (47-64)	64	44 (36-53)
Unspecified diabetes	201	46 (41-51)	66	33 (26-40)	135	67 (60-74)
Not documented	50	11 (8-14)	22	44 (30-59)	28	56 (41-70)
Diabetes medication						
Insulin only	286	65 (61-70)	89	31 (26-37)	197	69 (63-74)
Sulfonylurea only	61	14 (11-18)	42	69 (56-80)	19	31 (20-44)
Insulin + sulfonylurea	17	4 (2-6)	12	71 (44-90)	5	29 (10-56)
Neither documented	72	17 (13-20)	34	47 (35-59)	38	53 (41-65)

CI, confidence interval.

Table 2

Clinical Characteristics for Emergency Department (ED) Visits With Hypoglycemia

	Total (N = 436)		Admitted (n = 177)		Discharged/Other (n = 259)	
Variable	**n**	**% (95% CI)**	**n**	**% (95% CI)**	**n**	**% (95% CI)**
Mode of arrival						
Ambulance	298	68 (64-73)	121	41 (35-46)	177	59 (54-65)
Walk-in	86	20 (16-24)	32	37 (27-48)	54	63 (52-73)
Not documented	52	12 (9-15)	24	46 (32-61)	28	54 (39-68)
Prehospital glucose						
<50 mg/dL	226	52 (47-57)	88	39 (33-46)	138	61 (54-67)
50-69 mg/dL	56	13 (10-16)	20	36 (23-50)	36	64 (50-77)
70-99 mg/dL	17	4 (2-6)	4	24 (7-50)	13	76 (50-93)
≥100 mg/dL	17	4 (2-6)	5	29 (10-56)	12	71 (44-90)
NA/not documented	120	28 (23-32)	60	50 (41-59)	60	50 (41-59)
Prehospital treatment						
IV dextrose	151	35 (30-39)	67	44 (36-53)	84	56 (47-64)
Glucagon	38	9 (6-12)	17	45 (29-62)	21	55 (38-71)
Oral glucose	153	35 (31-40)	41	27 (20-35)	112	73 (65-80)
Initial ED glucose						
<50 mg/dL	91	21 (17-25)	39	43 (33-54)	52	57 (46-67)
50-69 mg/dL	79	18 (15-22)	43	54 (43-66)	36	46 (34-57)
70-99 mg/dL	57	13 (10-17)	27	47 (34-61)	30	53 (39-66)
≥100 mg/dL	174	40 (35-45)	54	31 (24-38)	120	69 (62-76)
None documented	35	8 (6-11)	14	40 (24-58)	21	60 (42-76)
Total ED capillary glucose values						
1	103	24 (20-28)	31	30 (21-40)	72	70 (60-79)
2	108	25 (21-29)	45	42 (32-52)	63	58 (48-68)
3	70	16 (13-20)	31	44 (32-57)	39	56 (43-68)
≥4	114	26 (22-31)	54	47 (38-57)	60	53 (43-62)
None documented	41	9 (7-13)	16	39 (24-55)	25	61 (45-76)
Total glucose values <70 mg/dL[a]						
1	266	61 (56-66)	103	39 (33-45)	163	61 (55-67)
2	86	20 (16-24)	39	45 (35-56)	47	55 (44-65)
≥3	35	8 (6-11)	22	63 (45-79)	13	37 (21-55)
None documented	49	11 (8-15)	13	27 (15-41)	36	73 (59-85)
ED treatment						
IV dextrose	183	42 (37-47)	94	51 (44-59)	89	49 (41-56)
Octreotide	13	3 (2-5)	8	62 (32-86)	5	38 (14-68)
Glucagon	1	0 (0-1)	1	100	0	0
Oral glucose	226	52 (47-57)	76	34 (27-40)	150	66 (60-73)
ICD-9-CM code position						
First	319	73 (69-77)	103	32 (27-38)	216	68 (62-73)
Second or later	117	27 (23-31)	74	63 (54-72)	43	37 (28-46)

CI, confidence interval; NA, not applicable; IV, intravenous; ICD-9-CM, *International Classification of Diseases, Ninth Revision, Clinical Modification.*
[a]Prehospital or emergency department.

charted causes of hypoglycemia were missed or delayed meal (162 [37%]), new or changed dose of diabetes medication (56 [13%, 95% CI]), recent illness (16 [4%]), and alcohol use (11 [3%]). Etiology of hypoglycemia was unknown or not charted for 196 visits (45%).

Discharge Education

Among the 259 nonadmitted patients, the median ED length of stay was 5.5 hours (IQR 3.7-8.6). Written ED discharge instructions were located for 214 (83%) nonadmitted patients. Written instructions indicated that patients were usually advised to follow up with a primary care physician and/or endocrinologist (202 [94%]) but were inconsistently advised to check blood glucose frequently (46 [21%]) or to consider medication dose adjustment (57 [27%]). Additionally, emergency physicians rarely recommended avoiding recurrent hypoglycemia to improve glucose counterregulation (7 [3%]), checking glucose before driving (1 [0.4%]), or obtaining a glucagon emergency kit (4 [2%]).

Clinical Data

Of the 436 abstracted visits, 177 (41%) resulted in hospital admission and 202 (46%) resulted in primary ED discharge; 44 (10%) visits resulted in patients being placed on ED observation status prior to discharge; and in 13 (3%) visits, patients left against medical advice. Hypoglycemia was the primary diagnosis for 319 (73%) cases. When hypoglycemia was a secondary diagnosis, the most common first-listed diagnoses were infection (n = 23, 20%), syncope/presyncope (n = 19, 16%), trauma (n = 12, 10%), and renal insufficiency (n = 11, 9%).

Table 3 summarizes variables independently associated with hospital admission in the logistic regression model. Hosmer-Lemeshow testing indicated appropriate goodness of fit for the logistic regression model ($P = .13$).

Table 3

Variables Independently Associated With Hospital Admission in Emergency Department (ED) Patients With Hypoglycemia

Variable	OR (95% CI)
Age (reference: age <45 y)	
45-64 y	1.5 (0.7-3.2)
65-74 y	5.7 (2.7-12.2)
≥75 y	7.9 (3.6-17.4)
Presence of PCP	4.2 (1.6-11.1)
Type 2 diabetes	0.8 (0.4-1.5)
Home diabetes medications (reference: insulin only)	
Sulfonylurea agents	3.5 (1.5-7.0)
Other oral hypoglycemic agents	3.5 (0.9-13.1)
None documented	2.1 (1.1-4.0)
≥3 prehospital/ED glucose values <70 mg/dL (reference: 1 glucose value <70 mg/dL)	3.1 (1.3-7.4)
Hypoglycemia charted as secondary diagnosis[a]	4.7 (2.8-8.1)

OR, odds ratio; CI, confidence interval; PCP, primary care provider. Table is based on a multivariate logistic regression model.
[a]Most common other primary diagnoses were infection, syncope, trauma, and renal insufficiency.

Discussion

To the authors' knowledge, this is the largest study of ED visits for hypoglycemia. Hypoglycemia was a relatively common presentation, accounting for an estimated 0.4% of all ED visits, which would translate to approximately 450 000 ED visits annually in the United States. This reflects the increased focus on intensive glucose control in diabetes care, which reduces the rate of long-term complications but increases the rate of hypoglycemia.[3,8,12]

Prior studies, mainly in the setting of clinical trials or longitudinal cohort studies, captured a wider array of hypoglycemia visits, including patients treated outside the ED.[2-6,8,10,12] Contrary to the patients in those studies, who were younger and predominantly had type 1 diabetes, half of our patients were age 65 or older and many had documented type 2 diabetes. Additionally, two thirds of hypoglycemia patients were taking insulin only, whereas one third were not; this suggests that oral hypoglycemic use comprises an important subgroup in evaluation of hypoglycemia in ED patients.

The rate of hospital admission in our analysis (41%) was higher than anticipated. Brackenridge et al[19] found that only 11% of patients with hypoglycemia in a U.K. accident and emergency department were admitted, although the patient population was younger (mean age 52.6) and predominantly insulin-treated (93%). The data support our hypothesis that older age and sulfonylurea use are associated with higher odds of hospitalization. Older

patients are at higher risk from hypoglycemia and additionally have more medical comorbidities, both of which likely drive the increased admission rate. Sulfonylurea-associated hypoglycemia often requires prolonged observation, given the risk for recurrent episodes of hypoglycemia.[20] Accordingly, 69% of patients taking sulfonylurea agents were hospitalized. Furthermore, recurrent hypoglycemia (≥3 documented prehospital or ED episodes) was independently associated with admission.

Although admission rates as high as 95% have been reported for hypoglycemia visits in patients with type 2 diabetes,[10] diabetes type was not independently associated with admission in this analysis. Although the crude admission rate was higher in patients with type 2 diabetes compared with others (56% vs 33%, respectively), this association was not statistically significant when other factors such as age and sulfonylurea use were controlled. These findings are limited, however, by the inability to determine diabetes type based on chart review in half of the patients.

When hypoglycemia was a secondary diagnosis, the odds of admission were 4.7 times higher. The most likely explanation is that hypoglycemia can be caused by or result in other conditions that more likely prompt admission. For instance, in these cases, the first-listed diagnoses were most often infection, syncope, trauma, or renal insufficiency, which were associated with higher rates of admission. Patients with primary care providers had 4-fold higher odds of admission. A possible explanation for this is that patients without a source of primary care may present for less severe episodes of hypoglycemia, whereas those with primary care may be more likely to present for more severe or complicated episodes. Patients without documentation of diabetes medications were twice as likely to be admitted as those on insulin. Although some of these charts may lack documentation of actual diabetes medications, other patients may also have had hypoglycemia caused by other problems mandating admission (eg, infection or renal insufficiency). These potential explanations need further study.

Identifying the cause of hypoglycemia is an important component of management and prevention. Half of the charts indicated a missed meal or a change in diabetes medication as the documented cause of hypoglycemia. These causes are amenable to education and intervention to reduce of the risk of recurrent hypoglycemia. Nearly half of the charts, however, lacked any documentation regarding cause or unknown cause. If charting reflected actual medical decision making for these patients, a significant opportunity may be missed to identify and correct causes of hypoglycemia. Conversely, if care were more complete than documentation suggested, education about charting could mitigate medicolegal risk.

An important component of care for patients with hypoglycemia should be education and careful instructions to help avoid recurrence of and morbidity from hypoglycemia.[21,22] Data from the outpatient setting suggest that educational intervention causes a sustained reduction in the incidence of severe hypoglycemia.[23] Our results reveal that emergency physicians provided inadequate written discharge instructions. Although most patients were appropriately referred for outpatient follow-up, the importance of close blood glucose monitoring and avoidance of hypoglycemia was not documented in most discharge instructions. Hypoglycemic autonomic failure may occur in patients with recent hypoglycemia and can lead to defective glucose counterregulation and hypoglycemic unawareness.[5,24,25] Prior studies suggest that 2 to 3 weeks of scrupulous avoidance of hypoglycemia reverses hypoglycemic unawareness and improves glucose counterregulation, which reduces risk of recurrent and severe episodes of hypoglycemia.[26-28]

National guidelines recommend that all patients at risk for hypoglycemia be advised to check blood glucose before driving,[21-22] but this was rarely documented in our sample of ED visits. Additionally, glucagon emergency kits were discussed in only 2% of discharge instructions. These devices are recommended for any patient with an episode of severe hypoglycemia,[22] in the same way that home epinephrine kits are recommended for patients with severe allergic reactions. Discussion of glucagon kits has not been incorporated in ED practice, but the ED may be an important venue to emphasize their value. Patient education is an important component of care for all diabetic patients with hypoglycemia and is an area for substantial improvement. Template discharge handouts could easily mitigate the deficiencies that were observed. The ideal content of these instructions to improve patient outcomes requires further study.

This study has some potential limitations. The characteristics of hypoglycemia visits were based on ED visits at 3 academic medical centers in the United States and may not generalize to other geographic areas. The case definition allowed identification only of those patients whose ICD-9-CM codes noted hypoglycemia. Additionally, recurrent hypoglycemia visits and 25% of eligible charts with missing or incomplete data were excluded. Although this lowered the number of total cases identified, the distribution of ICD-9-CM codes and demographic characteristics were similar for abstracted and nonabstracted charts,

and the likelihood of biased estimates was small. The accuracy of case validation and abstracted data depended on chart review, which is limited by the possibility of missing, incomplete, or unreliable information. For example, this limited the ability to determine diabetes type, because terms such as "insulin-dependent diabetes" could not be used to reliably classify patients as having type 1 or type 2 diabetes. Standardized definitions and training of abstractors limited the potential for bias, and high interrater agreement demonstrated internal reliability of the chart review. Additionally, the content of verbal instructions could not be evaluated, which limited the ability to fully assess the adequacy of discharge instructions.

Conclusions

ED written discharge instructions appeared inadequate in providing recommended education for patients with severe hypoglycemia. Older age and sulfonylurea use were independently associated with hospital admission. Although hypoglycemia is generally considered a self-limited condition, 2 of every 5 patients required hospitalization, which likely reflects an older and more complex patient population. Opportunities for improvement in the management of ED patients with hypoglycemia center on recognition and documentation of cause and improved discharge instructions.

References

1. Gonder-Frederick LA, Clarke WL, Cox DJ. The emotional, social, and behavioral implications of insulin-induced hypoglycemia. Semin Clin Neuropsychiatry. 1997;2:57-65.
2. The Diabetes Control and Complications Trial Research Group. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med. 1993;329:977-986.
3. The United Kingdom Prospective Diabetes Study Research Group. Intensive blood glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes. Lancet. 1998;352:837-853.
4. The United Kingdom Prospective Diabetes Study Research Group. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes. Lancet. 1998;352:854-865.
5. Cryer PE. Hypoglycaemia: the limiting factor in the glycaemic management of type I and type II diabetes. Diabetologia. 2002;45:937-948.
6. MacLeod KM, Hepburn DA, Frier BM. Frequency and morbidity of severe hypoglycaemia in insulin-treated diabetic patients. Diabet Med. 1993;10:238-245.
7. Laing SP, Swerdlow AJ, Slater SD, et al. The British Diabetic Association Cohort Study II: cause-specific mortality in patients with insulin-treated diabetes mellitus. Diabet Med. 1999;16:466-471.
8. DCCT Research Group. Hypoglycemia in the diabetes control and complications trial. Diabetes. 1997;46;271-286.
9. Bell DS, Cutter G. Characteristics of severe hypoglycemia in the patient with insulin-dependent diabetes. South Med J. 1994;87:616-620.
10. Holstein A, Plaschke A, Egberts EH. Incidence and costs of severe hypoglycemia. Diabetes Care. 2002;25:2109.
11. The International Classification of Diseases, 9th revision, Clinical Modification. 5th ed. Salt Lake City, Utah: Medicode; 1997.
12. Johnson ES, Koepsell TD, Reiber G, Stergachis A, Platt R. Increasing incidence of serious hypoglycemia in insulin users. J Clin Epidemiol. 2002;55:253-259.
13. Shorr RI, Ray WA, Daugherty JR, Griffin MR. Incidence and risk factors for serious hypoglycemia in older persons using insulin or sulfonylureas. Arch Intern Med. 1997;15:1681-1687.
14. Herings RMC, de Boer A, Stricker BHCh, Leufkens HGM, Porsuis A. Hypoglycemia associated with use of inhibitors of angiotensin converting enzyme. Lancet. 1995;345:1195-1198.
15. Morris AD, Boyle DIR, McMahon AD, et al. ACE inhibitor use is associated with hospitalization for severe hypoglycemia in patients with diabetes. Diabetes Care. 1997;20:1363-1367.
16. Shorr RI, Ray WA, Daugherty JR, Griffin MR. Antihypertensives and the risk of serious hypoglycemia in older persons using insulin or sulfonylureas. JAMA. 1997;278:40-43.
17. Ginde AA, Blanc PB, Lieberman RM, Camargo CA Jr. Validation of ICD-9 coding to identify emergency department patients with hypoglycemia. BMC Endocr Disord. 2008;8:4.
18. American Diabetes Association Workgroup on Hypoglycemia: Defining and reporting hypoglycemia in diabetes. Diabetes Care. 2005;28:1245-1249.
19. Brackenridge A, Wallbank H, Lawrenson RA, Russell-Jones D. Emergency management of diabetes and hypoglycaemia. Emerg Med J. 2006;23:183-185.
20. Harrigan RA, Nathan MS, Beattie P. Oral agents for the treatment of type 2 diabetes mellitus: pharmacology, toxicity, and treatment. Ann Emerg Med. 2001;38:68-78.
21. Cryer PE, Davis SN, Shamoon H. Hypoglycemia in diabetes. Diabetes Care. 2003;26:1902-1912.
22. American Diabetes Association. Standards of medical care in diabetes—2007. Diabetes Care. 2007;30:S4-S41.
23. Nordfeldt S, Johansson C, Carlsson E, Hammersjo JA. Persistent effects of a pedagogical device targeted at prevention of severe hypoglycaemia: a randomized controlled study. Acta Paediatr. 2005;94:1395-1401.
24. Segel SA, Paramore DS, Cryer PE. Hypoglycemia-associated autonomic failure in advanced type 2 diabetes. Diabetes. 2002;51:724-744.
25. Dagogo-Jack SE, Craft S, Cryer PE. Hypoglycemia-associated autonomic failure in insulin-dependent diabetes mellitus. J Clin Invest. 1993;91:819-828.
26. Fanelli C, Pampanelli S, Epifano L, et al. Long-term recovery from unawareness, deficient counterregulation and lack of cognitive dysfunction during hypoglycaemia following institution of rational intensive insulin therapy in IDDM. Diabetologia. 1994;37:1265-1276.
27. Cranston I, Lomas J, Maran A, Macdonald I, Amiel SA. Restoration of hypoglycaemia awareness in patients with long-duration insulin dependent diabetes. Lancet. 1994;344:283-287.
28. Dagogo-Jack S, Rattarasarn C, Cryer PE. Reversal of hypoglycemia unawareness, but not defective glucose counterregulation, in IDDM. Diabetes. 1994;43:1426-1434.