

# Treatment of Hypoglycemia in Hospitalized Adults

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## A Descriptive Study

### Purpose

The purpose of this study was to describe hypoglycemia treatment patterns in 2 Midwestern hospitals.

### Methods

To describe hypoglycemia treatment patterns, a retrospective chart review of 210 patients who experienced hypoglycemia while hospitalized at 2 Midwestern hospitals was conducted. A total of 484 episodes of hypoglycemia were analyzed for adherence to the 5 steps of the practice guidelines found in the respective hospital policy manuals.

### Results

Adherence to practice guidelines was low. There was not a single case of adherence to all 5 steps at either study hospital. Adherence to the steps of the guidelines ranged from a low of 2.1% for completion of a 1-hour post-hypoglycemia treatment blood glucose to a high of 70.9% for documentation of the event.

### Conclusions

Adherence to hypoglycemia practice guidelines was low. Because of the high prevalence of diabetes in acute care settings, it is imperative that hospital care providers become proficient at basic diabetes management.

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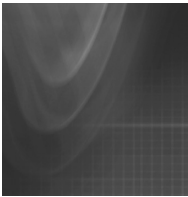
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**D**iabetes has become an increasingly common comorbid condition in acute care settings in the United States. In 2001, diabetes as a primary or secondary reason for admission to the hospital accounted for 24.2 million hospital days. Between 1980 and 2001, the number of patients with diabetes admitted annually to hospitals increased more than 100%, from 2.2 million to 4.6 million.<sup>1</sup> Although the relationship between chronic hyperglycemia and long-term complications has been well documented, attention has only recently turned to the effect of hyperglycemia on patient outcomes in acute care settings. Research has suggested that achieving normoglycemia in hospitalized patients may improve patient outcomes.<sup>2,3</sup> Maintaining normoglycemia in hospitalized patients, however, is time intensive and challenging for care providers. It requires frequent bedside monitoring of blood glucose (BG) levels and attention to caloric intake as well as current knowledge of the action and timing of the many medications that lower BG.<sup>4</sup> In addition, achieving normoglycemia has been shown to increase the risk of hypoglycemia.<sup>5</sup>

Hypoglycemia, defined as a BG level of less than 70 mg/dL (3.9 mmol/L),<sup>6,7</sup> is a commonly occurring adverse drug reaction in hospitalized patients,<sup>8-11</sup> and the recent emphasis on normalization of BG levels in hospitalized patients has made hypoglycemia an even greater threat in this group of patients. Because of its propensity to induce hypoglycemia, insulin has been identified by the Joint Commission on the Accreditation of Healthcare Organizations as one of the top 5 high-alert drugs used in hospital settings.<sup>12</sup>

There are few studies on hypoglycemia in the hospital setting. Fischer et al<sup>9</sup> studied the prevalence of hypoglycemia among 7763 patients admitted to a tertiary care hospital in a 6-month period. They found an incidence of hypoglycemia of 1.2% in hospitalized patients and a total of 137 episodes occurring among 94 patients. The authors defined hypoglycemia as less than 50 mg/dL (2.8 mmol/L), lower than the level of less than 70 mg/dL (3.9 mmol/L) as proposed by other authors.<sup>6,7</sup> The BG levels obtained at the bedside were not included in the study. These 2 factors suggest that the actual rate of hypoglycemia was much greater than that reported by these authors. Of the 42 patients in the study with a diagnosis of diabetes, decreased caloric intake was identified as the presumptive cause of hypoglycemic events in half of the patients. Renal insufficiency was

noted in 49% of the total group and emerged as the greatest risk factor.<sup>9</sup>

Malone et al<sup>11</sup> described the incidence of hypoglycemia in hospitalized patients with diabetic ketoacidosis, identified factors associated with increased risk of hypoglycemia, and described documentation by nurses and physicians. A retrospective chart review was performed on all records of patients admitted with diabetic ketoacidosis over a 29-month period to 3 urban teaching hospitals. A total of 221 admissions met the criteria. Hypoglycemia was defined as a BG level less than 50 mg/dL (2.8 mmol/L) and occurred in 30% of the admissions, with a total of 124 episodes. Multivariate analysis revealed NPO status to be a strong predictor of hypoglycemia. The charts were reviewed for nurse and physician documentation of the first hypoglycemic event only. Physician documentation was present in 45.5% of the first episodes and was mentioned as a discharge diagnosis only 21% of the time. Nurse documentation was present in 80.3% of first episodes. The authors speculated that greater physician concern as evidenced by documentation would be accompanied by a decrease in future hypoglycemic events.<sup>11</sup>

Krešević and Slavin<sup>10</sup> analyzed 46 episodes of hypoglycemia among 13 diabetic patients admitted to a general medical unit. Hypoglycemia was defined as a BG level of less than 60 mg/dL (3.3 mmol/L). All but 11 of the episodes were associated with insulin administration. Decreased oral intake in conjunction with a low serum albumin level was found to be a predictor of hypoglycemia. Poor documentation of caloric intake in patients receiving insulin or oral hypoglycemic agents was identified as an area for improvement that could potentially aid in the prevention of hypoglycemia. A lack of standardization in treatment was also evident. Various treatments ranging from intravenous dextrose to orange juice with sugar were used.

A study by Dinardo et al<sup>8</sup> revealed approximately 700 episodes of hypoglycemia per month at a university hospital. A nurse-led treatment protocol was initiated to address this common iatrogenic event. Prior to introduction of the protocol, nurses' knowledge and confidence in treating hypoglycemia were assessed. The mean score among the 49% of nurses who rated themselves as confident in their ability to detect and treat hypoglycemia was 75%; the 15% of nurses who rated themselves as very confident had a mean score of 84%. Three months later,

a follow-up study of 48 of the original 101 nurses indicated that nurses remained confident in their ability to treat hypoglycemia, and knowledge of when to retest was retained; however, the ability to recognize patients at risk declined.<sup>13</sup>

A study conducted to determine causes of hyperglycemia and hypoglycemia in adult inpatients suggested that most hypoglycemic events were preventable through adjustment of antidiabetic medications and attention to caloric intake.<sup>14</sup> In that study, the primary investigator sought information on causes of the hypoglycemic events from the medical record as well as through provider and patient interviews within 24 hours of randomly selected events. In 18 of 24 episodes, the underlying cause of hypoglycemia was found to be failure to adjust glucose-lowering medications in response to decreased caloric intake and patients leaving the unit for diagnostic tests.<sup>14</sup>

Hospital care providers may be alerted to hypoglycemia by assessment of patient signs and symptoms or through routine bedside monitoring of BG levels. The American Association of Diabetes Educators (AADE) recommends administration of 10 to 15 g of carbohydrates followed by a repeat BG assessment in 15 minutes. The treatment is repeated until the BG level is greater than 70 mg/dL (3.9 mmol/L).<sup>6</sup> Since BG levels will start to fall again after 1 hour, it is necessary to repeat the BG level assessment 1 hour after hypoglycemia is resolved to determine if the BG level is again lower than 70 mg/dL (3.9 mmol/L).<sup>6</sup> In addition to treating hypoglycemia, the physician must be notified when hypoglycemia occurs so that diet and dose of insulin or oral hypoglycemic agents can be reviewed and adjusted.

The results reported here are part of a larger study that examined the relationship of nurse staffing levels to adherence to the practice guidelines and patient outcomes in the treatment of hypoglycemia. The purpose of this study was to describe hypoglycemia treatment patterns in 2 large Midwestern hospitals.

## Methods

To describe hypoglycemia treatment patterns, a retrospective chart review of 105 patients at 2 Midwestern hospitals who experienced hypoglycemia while hospitalized was conducted. A total of 484 episodes of hypoglycemia were analyzed for adherence to the 5 steps of

the practice guidelines found in the respective hospital policy manuals. The 2 study hospitals were located in the same Midwestern state. Hospital A is a 370-bed, nonteaching hospital, and Hospital B is a 450-bed teaching hospital. Both hospitals have practice guidelines for the treatment of hypoglycemia that are consistent with the AADE practice guidelines. Glucose tablets and juice were available on all units at both hospitals. No specific competency for hypoglycemia management was required at either hospital. The hypoglycemia treatment guidelines were available both online and in a paper policy and procedure manual at both hospitals.

Differences in the practice settings at the 2 hospitals were identified. Electronic documentation had been in place for 2 years prior to the study at hospital A, while documentation at hospital B was by hand, on traditional paper medical records. At hospital A, hypoglycemia was likely to be reported directly to the attending physician, and at hospital B, hypoglycemia would likely have been reported to a resident physician. At hospital A, employees of the laboratory are responsible for bedside BG monitoring and the nursing staff is responsible for treatment, documentation, and physician notification. At hospital B, nursing staff perform bedside BG monitoring as well as treatment, documentation, and communication of hypoglycemia.

A list of all adult patients at each hospital who experienced hypoglycemia was identified by the laboratory information systems. Hypoglycemia was defined as a serum BG level less than 70 mg/dL (3.9 mmol/L) through venous blood draw or bedside capillary assessment. This definition is consistent with the hospital practice guideline and the AADE definition. Only adult patients on medical surgical units were included. At hospital A, 105 patient records were retrievable from the Medical Information Department. The procedure was repeated at hospital B, and data collection concluded when 105 patient records were retrieved.

A checklist of expected behaviors described in the hypoglycemia practice guideline at the 2 hospitals was derived and used to analyze the care provided. The 5 major components of the hypoglycemia treatment guidelines are (1) administration of 15 g of carbohydrates, (2) BG retest performed in 15 minutes, (3) BG retest performed 1 hour after hypoglycemia resolved, (4) physician notified, and (5) hypoglycemia event documented in the patient record. Since it was unlikely that the BG test

Table 1  
Descriptive Statistics for Patient Characteristics

Variable	Hospital A (n = 105)				Hospital B (n = 105)			
	n	%	Mean	SD	n	%	Mean	SD
No. of episodes	195		1.9	1.59	289		2.75	2.11
Patient age, y			79	15			68.33	15.87
Sex								
Female	65	61.9			61	58		
Male	40	38.1			44	42		
Race								
Black	1	0.5			71	67.6		
Caucasian	101	96.2			34	32.4		
Native American	3	2.9						
Comorbid conditions								
Type 2 diabetes	90	85.7			88	83.8		
Cardiac	84	80			91	86.7		
Renal	47	44.8			54	52.4		
Infectious disease	27	25.7			44	41.9		
Cancer	4	3.8			16	15.2		
Type 1 diabetes	11	10.5			13	12		
Patients on insulin or oral hypoglycemic agents	96	91			98	93		
Patients on sliding-scale protocol	95	90.4			84	80		

would be repeated in exactly 15 or 60 minutes, it was necessary to determine an acceptable time range. Three nurses with inpatient diabetes management experience agreed that a range of 10 to 20 minutes for the 15-minute BG and 50 to 70 minutes for the 1-hour BG were acceptable ranges.

In determining whether the first behavior of the guideline (administration of 15 g of carbohydrates) was performed, the narrative nurses' progress notes were examined to estimate of the number of carbohydrates administered. The time elapsed until a follow-up BG level was obtained following treatment of hypoglycemia was recorded in minutes. The time recorded for all BG levels was the time recorded in the laboratory information system. Notification of the physician was determined by examining nurse progress records and physician's orders for evidence of physician notification.

## Results

### Characteristics of the Sample: Hospital A

The records of 105 patients at hospital A were examined. Patients in this hospital experienced 195 episodes of hypoglycemia, a mean of 1.9 times per patient (range, 1-13). The patients ranged in age from 22 to 90 years (mean = 79, SD = 15). Most were female (62%), were Caucasian (96%), and had type 2 diabetes (86%). The main comorbid condition was cardiovascular disease (80%). Almost all patients received insulin or an oral hypoglycemic agent (91%), and 90% were on sliding-scale protocols. Additional sample characteristics can be found in Table 1.

**Treatment of hypoglycemia.** At the time of initial detection, the BG levels ranged from 24 to 69 mg/dL

(1.3-3.8 mmol/L; mean = 56.85, SD = 9.54 mg/dL). According to practice guidelines of hospital A, hypoglycemia of 50 to 69 mg/dL (2.8-3.8 mmol/L) should be treated with 15 g of carbohydrate, and if the BG is less than 50 mg/dL (2.8 mmol/L), an additional 15 g of carbohydrates should be administered. Only 34 (17%) patients were treated with the correct dose of carbohydrates. In 36 (18%) episodes, the patient was treated with more than the correct number of grams (range, 30-70 g). Six (3%) patients received too little. There was no documentation in 83 (43%) cases, and the amount of carbohydrates administered was not specified in 36 (18%) episodes.

Following detection of hypoglycemia, only 17 (9%) patients had a follow-up BG assessment in an acceptable time frame of 10 to 20 minutes. Five patients were discharged following a hypoglycemic event without any follow-up BG test being performed. According to the practice guidelines, the BG level should be checked again 1 hour after the hypoglycemia resolves. A third BG test was performed in 49 (25%) episodes, but in only 10 (5%) episodes was the BG test performed within an acceptable time frame of 50 to 70 minutes. The mean for BG 3 was 127.49 mg/dL (7.0 mmol/L; SD = 60.63 mg/dL) with a range of 43 to 361 mg/dL (2.4-19.9 mmol/L).

The next step in the practice guidelines calls for the nurse to document the episode in the nurse progress notes. This was done in 106 (54%) instances. Finally, the guidelines state that the physician should be notified of the episode. In only 30 (15%) instances was physician notification documented in either the nurse progress notes or through documentation of verbal orders in the medical order section of the record. The final step of the policy at hospital A called for the nurse to continue monitoring the BG level for several hours after resolution of the event. In only 8 (4%) events was an additional follow-up BG test performed.

### Sample Characteristics: Hospital B

At hospital B, the 105 patients experienced a total of 289 episodes of hypoglycemia, with a mean of 2.75 episodes per patient (SD = 2.11). Most were female (58%), were African American (68%), and had type 2 diabetes (89%). Comorbid conditions included predominantly cardiovascular disease (87%) and renal disease (51%). Almost all patients received insulin or an oral hypoglycemic agent (93%), and 80% were on sliding-scale protocols. Additional demographics are listed in Table 1.

**Treatment of hypoglycemia.** At the time of initial detection, the BG levels ranged from 20 to 69 mg/dL (1.1-3.8 mmol/L; mean = 53.73, SD = 10.03 mg/dL). According to the practice guidelines of hospital B, all episodes of hypoglycemia are to be treated with 15 g of carbohydrates. Only 9 (3%) episodes were treated with the correct amount. A total of 112 (39%) episodes were treated with more than 15 g (range, 24-70 g). There was no documentation in 81 (28%) cases, and the amount of carbohydrate administered was not specified in 87 (30%) episodes. Two episodes were treated with glucagon, and 1 was treated with 10% dextrose intravenous fluids per physician's order.

Following detection of hypoglycemia, only 17 (6%) patients had a follow-up BG test in the acceptable 10- to 20-minute range. Four patients were discharged following an episode of hypoglycemia without another BG test being performed. A third BG sample was drawn in 47 (16%) episodes, and in only 6 (2%) episodes was the BG test performed within 50 to 70 minutes. The mean of BG 3 was 126.67 mg/dL (6.7 mmol/L; SD = 69.11 mg/dL). A fourth BG sample was drawn in 9 (3%) episodes, with a mean result of 116.67 mg/dL (6.4 mmol/L; SD = 48.15 mg/dL). Additional descriptive statistics for treatment of hypoglycemia can be found in Table 2. Documentation of the event was present in 205 (71%) instances. Only 83 (28%) records examined had documentation of physician notification.

## Discussion and Implications

Adherence to the hypoglycemia treatment guidelines was low. There was not a single case of adherence to all 5 steps at either study hospital. Although diabetes is a highly prevalent diagnosis among hospitalized patients, it is rarely the reason for admission to the hospital. Other authors have argued that diabetes care in acute care settings is not adequately addressed and that the focus of care is on the condition for which the patient was admitted.<sup>15</sup> Care providers may be very familiar with the specialty area in which the patient was admitted but unfamiliar with diabetes management. Recent research has suggested a strong link between diabetes management and patient outcomes in acute care settings,<sup>2,3</sup> so it is critical that all care providers become competent in basic diabetes management and make appropriate endocrine referrals.



Table 2  
Descriptive Statistics for Treatment of Hypoglycemia

Variable	Hospital A			Hospital B		
	n	Mean (SD)	Range	n	Mean (SD)	Range
BG at time 1, mg/dL	195	56.85 (9.54)	24-69	289	53.73 (10.03)	20-69
Time to BG 2, min	190	95.85 (130.67)	6-840	285	161.76 (160.82)	3-699
BG 2, mg/dL	190	101.72 (44.36)	39-373	285	117.95 (59.47)	33-350
Time to BG 3, min	49	121.81 (64.89)	39-239	47	107.34 (63.50)	27-290
BG 3, mg/dL	49	127.49 (60.63)	43-361	47	126.66 (69.11)	35-394
BG 4, mg/dL	9	154.62 (57.70)	84-256	9	116.67 (48.15)	53-202

BG, blood glucose.

This study examined a large number of hypoglycemia events (N = 484) in 13 medical-surgical units in 2 geographically distant hospitals in a Midwestern state. Several limitations are identified. First, because this study was conducted at 2 hospitals in the same state, generalizability is limited. Second, data were collected from patient records. The use of medical record documentation as an indicator of quality has been identified as problematic.<sup>16</sup> Inherent in this data collection technique are missing data and questionable reliability and validity of data.

Unfortunately, a large number of the episodes of hypoglycemia that were determined by the laboratory information systems of the 2 study hospitals did not have documentation of the event in the hospital record. This limited the ability to analyze the treatment and determine whether there was physician notification of the event. It did not limit, however, the ability to determine if follow-up BG levels were obtained, as this information is relayed directly from the glucose meter to the laboratory information system.

Replication of this study is needed in a broader range of hospitals to increase generalizability and validate the findings of this study. Future studies could benefit from exploring hospital care providers' knowledge of and attitudes toward the hypoglycemia practice guidelines recommended by the AADE. Given the poor adherence rates found in this study, there is a need for additional research that documents observance of diabetes-related practice guidelines by hospital care providers. Future research

should also focus on interventions to improve treatment and prevention of hypoglycemia in hospitalized patients.

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