

Provider Response to Insulin-Induced Hypoglycemia in Hospitalized Patients

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BACKGROUND: Risk of hypoglycemia is a major barrier to the implementation of tight blood glucose (BG) control in hospitalized patients. The objective of this study was to evaluate the changes in diabetes treatment after an episode of hypoglycemia. **METHODS:** The study was a retrospective data analysis of patients who received 50% dextrose for an episode of hypoglycemia. Data on immediate and subsequent changes in the antidiabetic medications the patients received were collected and evaluated by 2 diabetes specialists.

RESULTS: Data from 52 patients were included in the study. Mean BG at the time of dextrose administration was 52.1 ± 9.3 mg/dL (range 31-68). Mean BG during the 24 hours before the hypoglycemic episode was 137.5 ± 57.0 mg/dL (range 63-287). Insulin dose was held at the time of the hypoglycemic episode in all 52 patients. Diabetes specialists agreed with this decision 100% of the time. Changes were subsequently made in the treatment of only 21 patients (40%), and diabetes specialists agreed with the changes made for 11 of these patients (52%). Thirty-one patients (60%) received no changes in treatment, and diabetes specialists agreed with that decision for 10 patients (32%).

CONCLUSIONS: Provider response in making treatment changes after an episode of hypoglycemia is suboptimal. Standardized protocols to make changes in diabetes treatment after an episode of hypoglycemia need to be tested. *Journal of Hospital Medicine* 2007;2:258-260. © 2007 Society of Hospital Medicine.

KEYWORDS: hypoglycemia, diabetes mellitus, insulin, hospitalized patient.

Glycemic control in hospitalized patients is receiving greater attention. The American Diabetes Association and the American College of Endocrinology recently issued a joint consensus statement on the need to implement tight blood glucose (BG) control in hospitalized patients.^{1,2} The Joint Commission on Accreditation of Healthcare Organizations (JACHO) has developed an Advanced Inpatient Diabetes Care Certification Program for hospitals. However, despite all these efforts, it has been difficult to change how well glucose is controlled.³ A major hurdle in implementing glycemic control strategies is the prevalent fear of hypoglycemia among hospital staff. Although there are multiple protocols for insulin treatment,⁴⁻⁷ guidelines for the prevention and treatment of hypoglycemia are lacking. Once a hypoglycemic episode has occurred, reducing the dosage of diabetes medications may reduce subsequent episodes. This study was conducted to assess whether diabetes medications were decreased following an episode of hypoglycemia that led to treatment with intravenous (IV) dextrose.

METHODS

Data were collected by the Diabetes Subcommittee of the Pharmacy and Therapeutics Committee as part of a quality improvement initiative. Hypoglycemic episodes were identified by computerized orders for 50% dextrose solution. All orders in a 1-month period (June 2006) were collected. Characteristics of patients experiencing these episodes were identified from the electronic medical records (EMR). The following data were collected: age, sex, history of diabetes, serum creatinine, diabetes medications at time of hypoglycemia, blood glucose at time of hypoglycemia, and all BG values in the 24 hours before hypoglycemia. BG values included those obtained in the laboratory as well as those obtained by bedside blood glucose testing. Treatment changes made right when the hypoglycemic episode occurred (immediate) and within 24 hours of the hypoglycemic episode (subsequent) were evaluated by 2 diabetes specialists, a board-certified endocrinologist and a nurse-practitioner working on the diabetes management service. The 2 practitioners regularly work together, but the data were evaluated independently. Because there are no specific guidelines, the appropriateness of change in treatment was based on general guidelines and experience. For example, if hypoglycemia developed while a patient was on insulin infusion therapy, it was appropriate to stop the drip when the episode of hypoglycemia occurred and to restart it at a lower rate according to the insulin infusion protocol. No subsequent changes would have been made in a situation such as this, and it was deemed appropriate. However, if a patient developed hypoglycemia while on subcutaneous (SC) insulin and then insulin was either completely discontinued or no change was made in subsequent orders, it was deemed inappropriate. The 2 diabetes specialists agreed in 87% of cases ($\kappa = 0.68$, 95% CI 0.53-0.84). In the 13% of cases in which the diabetes specialists had different opinions, they conferred to reach agreement. In patients with more than 1 episode, data related to the first episode were evaluated. Data are presented as means with SDs.

RESULTS

The EMR contained information on time of episode of hypoglycemia and medication changes for 52 patients, all of whom were in the study. Patient characteristics and mean blood glucose level are shown in Table 1. All patients were being treated with insulin when the episode of hypoglycemia occurred: 9 were on intravenous (IV) insulin alone, 3

TABLE 1
Demographics of Patients in the Study

Number of patients	52
Age (years)	64.8 \pm 15.8
Sex (male:female), n	29:23
Preexisting diabetes, n (%)	
No diabetes	17 (33%)
Type 1 diabetes	9 (17%)
Type 2 diabetes	26 (50%)
Serum creatinine (mg/dL)	2.1 \pm 1.9
Serum creatinine \geq 2 mg/dL, n (%)	21 (40%)
BG at time of hypoglycemia (mg/dL)	52.1 \pm 9.3
Mean BG during 24 hours before hypoglycemic episode (mg/dL)	137.5 \pm 57.0
Mean BG during 24 hours after hypoglycemic episode (mg/dL)	112 \pm 74.7

on IV and subcutaneous (SC) insulin, 30 on scheduled SC insulin, and 10 on sliding-scale SC insulin alone. Three patients were prescribed sulfonylurea drugs in addition to insulin. Insulin dosage of all 52 patients was held at the time of the hypoglycemic episode. Diabetes specialists agreed with this decision 100% of the time. Only 21 patients (40%) subsequently had reductions made in their treatment dosage, and diabetes specialists agreed with the changes made for 11 of these patients (52%). Thirty-one patients (60%) had no changes made to their treatment, and diabetes specialists agreed with that decision for 10 of these patients (32%). When diabetes specialists disagreed with a decision, they would have decreased the insulin dose or changed the regimen in a different way. Details on the changes in treatment and whether diabetes specialists agreed with the changes are shown in Table 2. Twenty-four hours after an episode of hypoglycemia, mean blood glucose of patients whose providers had made changes was 190.7 \pm 87.9 mg/dL and that of patients whose providers had not made changes was 122.6 \pm 43.2 mg/dL ($P = \text{NS}$). The mean BG of patients for whom the diabetologists agreed with the decision was 110.7 \pm 90.3 mg/dL, and that of patients for whom they disagreed with the decision was 139.7 \pm 42.8 mg/dL ($P = \text{NS}$).

DISCUSSION

These results suggest that treatment modification following an episode of hypoglycemia may be suboptimal. These data provide no information about the clinical circumstances leading to the choice of treatment with IV dextrose, as opposed to oral glucose or glucagon. Presumably, dextrose was chosen for many patients whom the physician considered to require the most urgent treatment. Appropriately, immediate

TABLE 2
Types of Subsequent Changes in Treatment and When Diabetes Specialists Agreed

Change	Number of patients receiving change	Number of patients for whom diabetes specialists agreed with change, n (%)
Basal insulin decreased	6	6 (100%)
Basal insulin stopped	2	0 (0%)
IV insulin changed to scheduled SC insulin	2	1 (50%)
IV insulin to SC sliding-scale insulin	1	0 (0%)
Change in sliding-scale insulin dose	3	1 (33%)
Sliding-scale insulin stopped	1	1 (100%)
IV insulin started	1	1 (100%)
Sulfonylurea stopped	1	1 (100%)
Scheduled insulin changed to sliding scale	1	0 (0%)
Insulin discontinued	3	0 (0%)
No change	31	10 (32%)

treatment with insulin was held for all patients. On the other hand, 60% of the patients continued to receive the same insulin dose 24 hours after the hypoglycemic episode. Diabetes specialists judged continuation of the same dose as inappropriate in two thirds of the cases. Even when changes in treatment were made, those changes were judged suboptimal in half the cases. Blood glucose level 24 hours after an episode of hypoglycemia reflects these problems. These findings suggest that opportunities to prevent hypoglycemic episodes in the future are frequently missed. Lack of knowledge and/or guidelines for adjusting insulin dose following an episode of hypoglycemia seemed to have led to suboptimal changes for most patients.

Overall incidence of hypoglycemia (<60 mg/dL) among patients with diabetes admitted to a hospital has been reported to be 23%.⁸ In patients receiving continuous intravenous insulin infusion, the incidence of hypoglycemia has been variously reported as from 1.2% to 18.7%.^{9,10} All insulin infusion protocols have guidelines for the immediate treatment of hypoglycemia and recommend steps to prevent further episodes. Although many hospitals have protocols for immediate action when hypoglycemia occurs (eg, hold insulin, give juice or dextrose), to our knowledge, no specific guidelines exist for adjustment of subcutaneous insulin following an episode of hypoglycemia. The vast majority of patients in a hospital are treated with SC insulin as opposed to IV insulin, and fear of hypo-

glycemia is a major barrier to intensified therapy. If widely applied, standardized protocols have the potential to be effective in preventing hypoglycemia.⁹

A limitation of our study was that it was a retrospective data analysis. We did not look at changes in clinical condition, in nutrition, and in other medications that might have led to the episode of hypoglycemia and affected the decision about which antidiabetic medications to treat with. Data on further episodes of hypoglycemia were also not available.

In conclusion, we have shown that treatment changes after an episode of hypoglycemia are chaotic and may be suboptimal. Standardized protocols may be helpful for making effective changes and potentially can reduce the risk of further episodes of hypoglycemia.

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