

An Inpatient Hypoglycemia Committee: Development, Successful Implementation, and Impact on Patient Safety

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ABSTRACT

Background: Hypoglycemia is a major and preventable cause of morbidity and mortality in the hospital setting. Prevention of hypoglycemia in hospitalized patients relates to the practice climates and prescribing patterns of physicians, the development of safe and effective protocols, and the education of providers and nursing staff on hypoglycemia and its consequences.

Methods: Many hospitals use multidisciplinary committees to address issues of healthcare quality and patient safety. This article describes the creation of a subspecialty Hypoglycemia Committee, its design and function, and the steps taken to reduce hypoglycemia in a large, tertiary acute care hospital.

Results: The committee's initiatives included a systematic investigation of all severe hypoglycemic events, the development of a standalone hypoglycemia treatment protocol, reduction of sliding scale insulin therapy, revision of insulin order sets, and education of physicians and house staff. Hypoglycemic events have consequently decreased.

Conclusion: The Hypoglycemia Committee is unique in that every case of severe hypoglycemia is reviewed by physicians, endocrinologists, and diabetes specialists. This multidisciplinary approach can effect measurable decreases in preventable hypoglycemic events.

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INTRODUCTION

Hypoglycemia can have severe, life-threatening consequences. When the blood glucose (BG) level falls to 60 mg/dL (normal >70 mg/dL), most patients begin to exhibit signs and symptoms of hypoglycemia, both sympathetic (tachycardia, palpitations, diaphoresis, tremulousness) and parasympathetic (nausea and hunger).¹ Symptoms of neuroglycopenia can appear at a BG level of 50 mg/dL and include irritability, confusion, blurred vision, tiredness, difficulty speaking, and headaches.¹ The most severe and feared complications of hypoglycemia include seizure, coma, and death, which can occur at BG levels <40 mg/dL. Hypoglycemia is associated with an increased risk of death in critically ill patients.² Many recent studies have linked increased morbidity and mortality with tight glucose control (BG 80-110 mg/dL) in high-risk populations,²⁻⁵ primarily because of tight glucose control's association with more frequent episodes of hypoglycemia and higher mortality in critically ill patients.^{2,6}

As a result, the American Diabetes Association (ADA), the American College of Physicians (ACP), and other professional organizations no longer support tight glucose control in the inpatient setting, instead favoring less stringent glucose control with recommendations for premeal BG <140 mg/dL or random BG <180 mg/dL.^{6,7} The exception is in postcardiothoracic surgery patients for whom the data continue to support tight glucose control.⁸ In the intensive care unit, the currently recommended goal is BG 140-180 mg/dL.^{2,6}

Hypoglycemia in the hospital has financial repercussions. Medicare plans no longer cover expenses for hospital-acquired hypoglycemic coma, hyperglycemic coma, or diabetic ketoacidosis.⁹ And insulin is a risky drug. The Joint Commission defines a high-alert medication as a medication that has the highest risk of causing harm when it is misused and reports that insulin, primarily because of its hypoglycemic effect, is 1 of the top 5 high-alert medications used in

the inpatient setting.¹⁰ Both subcutaneous and intravenous insulin are on the Institute for Safe Medication Practices' high-alert list.

CAUSES OF HYPOGLYCEMIA IN THE HOSPITAL

Nutritional status plays a significant role in the development of hypoglycemia, and a patient's total caloric intake may decrease in the hospital. Patients receiving an 1,800-calorie diabetic diet in the hospital may consume considerably more calories at home. Patients may eat less in the hospital because of different food preferences in the home and the hospital, or appetites may be decreased because of acute illness. Fasting in preparation for studies or procedures and receiving enteral or parenteral nutrition substitutes complicate glycemic management.¹¹ When a patient's home insulin regimen is not decreased to reflect the decreased caloric or carbohydrate intake, hypoglycemia frequently results.

Many comorbid conditions predispose hospitalized patients to hypoglycemia. These conditions include cirrhosis, congestive heart failure, chronic kidney disease, sepsis, malnutrition, critical or terminal illness, and malignancy. Previous episodes of hypoglycemia also place patients at increased risk of recurrent hypoglycemia.

The participation of multiple teams in patient care can lead to duplication of insulin orders and failure to discontinue oral diabetic medications, especially when communication between teams is lacking. As many as one-third of the medical errors in hospitalized patients that cause death within 48 hours of the error involve insulin therapy or administration.¹⁰

Monotherapy with sliding scale insulin (SSI) is a major obstacle to appropriate glycemic control in the inpatient setting. Despite multiple studies demonstrating that SSI monotherapy fails to adequately control hyperglycemia and increases the frequency of hypoglycemic events, SSI monotherapy remains ingrained in the practice climates of many hospitals.⁹ Physician unfamiliarity with prescribing or adjusting insulin regimens to include basal, nutritional, and correctional dose components has proven to be a barrier to elimination of SSI as monotherapy.¹¹ Providers may cling to SSI because of the complexity of writing insulin orders that require daily adjustments because the insulin needs of some inpatients are highly unpredictable.¹¹

The U.S. Department of Health and Human Services recommends a reduction in sliding scale variation (or the elimination of sliding scales), limits on high-dose insulin orders, and coordination of meal and insulin times as safeguards against hypoglycemia.

DEVELOPMENT OF THE HYPOGLYCEMIA COMMITTEE

Multidisciplinary teams are established to improve inpatient glycemic control for many reasons. One medical center's multidisciplinary diabetes inpatient safety committee gathered data on the frequency of hypoglycemic events in the institution and found the number of severe events (BG <40 mg/dL) to be 5.5 per 1,000 patient days. This discovery led to development of a standardized hypoglycemia treatment protocol and insulin order sets.¹¹ Another glucose control task force was commissioned in response to a sentinel event that occurred because of hypoglycemia in the institution.¹²

Ochsner Medical Center–New Orleans (OMC) is a 473-bed, tertiary acute care hospital with 80 specialties and subspecialties represented. It is the academic center of the Ochsner Health System that includes 8 hospitals and more than 38 health centers throughout southeast Louisiana. In 2006, an interdisciplinary committee was assembled to improve inpatient glycemic management, increase the safety of insulin administration, and pursue The Joint Commission's Certificate of Distinction in Inpatient Diabetes Care. This glycemic management committee's monitoring of BG values revealed that episodes of severe hypoglycemia were occurring, but the specific causes remained unclear despite attempts to trend the data. In response, the Hypoglycemia Committee was created in 2008.

The goal of the Hypoglycemia Committee is to reduce the frequency of hypoglycemic events in the hospital, especially severe events (defined as those with a documented BG <40 mg/dL). The committee comprises all endocrinology fellows currently at OMC, endocrinologists, a hospitalist, endocrine nurse practitioners, a clinical pharmacist specializing in diabetes, a performance improvement coordinator, and the clinical coordinator of the inpatient diabetes management program.

ANALYSIS OF HYPOGLYCEMIC EVENTS

The initial aim of the Hypoglycemia Committee was to develop a systematic way to analyze all episodes of severe hypoglycemia occurring at OMC. Patients meeting the criteria for severe hypoglycemia are identified by point-of-care testing. The nurse places all glucometers used for point-of-care BG monitoring on a docking station after capillary BG testing. Each BG is automatically transferred to the electronic health record and the glucometer manufacturer's server; the performance improvement coordinator searches these resources for BG values <40 mg/dL. The endocrinology fellows receive a report of severe hypoglycemic episodes every month.

The fellows then perform retrospective, focused reviews by examining the details of each case to identify causes of the hypoglycemic episode. The data collected for each patient include admission/discharge dates, admission diagnosis, past medical history, provider service, diabetes type, hospital diet, home insulin regimen, recent hemoglobin A1c, the BG recorded at the time of the event, the frequency of BG monitoring in the hospital, the in-hospital insulin regimen, the use (or lack of use) of an insulin order set, appropriate documentation of an occurrence report, adjustments made to the insulin regimen after the event, and any treatments given in response to the episode.

Once the fellows retrospectively review the cases, the committee meets monthly to review the reports individually and ascertain the probable causes for each case of severe hypoglycemia. The committee developed several individual and system-related probable-cause categories (Table) and assigned each case one or more numbers to characterize the causes of severe hypoglycemia.

The data obtained for each case were used to identify opportunities for improvement. Interventions resulting from the Hypoglycemia Committee's case reviews include preliminary development of a prediction model based on the most frequently identified causes of hypoglycemia (Table) to be used to identify patients at high risk for hypoglycemia, creation of a standalone hypoglycemia treatment protocol, education of staff physicians and house staff on common errors and specific risk factors, and revision of insulin order sets based on national guidelines and OMC best practices to reduce hypoglycemia.

DEVELOPMENT OF A STANDALONE HYPOLYCEMIA PROTOCOL

Prior to intervention by the Hypoglycemia Committee, hospitalized patients with hypoglycemia were treated by a nurse-driven protocol that was incorporated into all insulin order sets. The limitation of this approach was that the hypoglycemia treatment protocol was initiated only in those patients who were being treated with insulin. The lack of a standalone hypoglycemia treatment protocol resulted in delayed identification and treatment of hypoglycemia from causes other than insulin therapy. This approach made the need for a standalone hypoglycemia treatment protocol obvious.

A standalone hypoglycemia treatment protocol is preferred to hypoglycemia treatment orders that are incorporated into insulin order sets in several clinical situations. Critically ill patients often have hypoglycemia in the absence of insulin therapy. In the

intensive care unit before the development of a hypoglycemia treatment protocol, the standardized treatment for hypoglycemia in critically ill patients was appended to an intravenous insulin infusion pathway with BG testing hourly or involved a subcutaneous insulin order set with BG monitoring every 4 to 6 hours. However, if hypoglycemia developed without insulin dosing, these order sets did not specify whether or not the insulin should be discontinued after a hypoglycemic event. Therefore, a patient might receive therapy to increase his or her BG after a hypoglycemic event and then receive insulin in response to transient hyperglycemia, triggering the administration of a correction dose of insulin.

As previously stated, some patients without diabetes are at high risk for hypoglycemia, such as patients with malnutrition, those receiving parenteral or enteral feeding, and those with predisposing comorbid conditions such as chronic kidney disease, adrenal insufficiency, or sepsis. Patients with hypoglycemia secondary to sulfonylurea or long-acting insulin therapy can remain hypoglycemic for 24 hours or more depending on the clinical scenario. These patients may not develop hyperglycemia or require insulin but do require frequent BG monitoring and a treatment regimen for hypoglycemia.

The first step in developing the standalone hypoglycemia treatment protocol was to define the BG level that should prompt treatment. A consensus statement from the ADA and American Association of Clinical Endocrinologists (AACE) defines hypoglycemia as a BG level <70 mg/dL.⁶ This level is based on a study showing that the initiation of counter-regulatory hormone responses occurs when BG is 65-70 mg/dL in nondiabetic individuals.^{11,13} The ADA and AACE define severe hypoglycemia as a BG level <40 mg/dL.⁶ The level at which nondiabetic patients begin to develop cognitive impairment is 50 mg/dL.^{11,13} Therefore, the Hypoglycemia Committee defined the values for commencing therapy as BG levels of 70 mg/dL and 50 mg/dL.

The first step in the hypoglycemia treatment protocol is to discontinue all previous insulin orders, if present. The options in the protocol for the frequency of BG monitoring are every 1, 2, 3, 4, or 6 hours. For any BG <70 mg/dL, patients are given 16 g oral glucose. If the BG level is <50 mg/dL, patients are given 24 g oral glucose. If patients cannot take medications orally but have intravenous access, they are given a 25 mL dextrose 50% in water (D50W) intravenous push. If the patient is obtunded, without intravenous access, glucagon 1 mg is administered intramuscularly. The nurses are instructed to recheck the BG 15 minutes after treatment. If the BG remains

Table. Causes of Hypoglycemia

Prescriber Error

- 1 – Ordered inappropriate SSI
- 2 – Kept patient on SSI longer than recommended
- 3 – Inappropriate order set used
- 4 – Inappropriate type/dose/timing of insulin ordered
- 5 – Mismanagement of hypoglycemia
- 6 – Inappropriate ordering of sulfonylurea
- 7 – Treated patient with same therapy as home

Nursing Error

- 8 – Improper monitoring of BG
- 9 – Medication administration error
- 10 – Called wrong physician about low BG reading
- 11 – IV insulin mismanaged
- 12 – Omission of treatment for hypoglycemia
- 13 – Improperly followed orders
- 14 – Previous hypoglycemia: admitted with hypoglycemia and developed subsequent hypoglycemia
- 15 – Previous hypoglycemia: other hypoglycemic events during the same admission

NPO Patients

- 16 – In preparation for procedure
- 17 – Not able to take or tolerate food
- 18 – Poor appetite/food consumption
- 19 – Too much insulin because of increased insulin sensitivity
- 20 – Medication reconciliation not done

Comorbid Conditions

- 21.1 – Multiorgan failure
- 21.2 – End-stage renal disease/chronic kidney disease
- 21.3 – End-stage liver disease/chronic liver disease
- 21.4 – Acute renal failure
- 21.5 – Congestive heart failure
- 21.6 – Sepsis
- 21.7 – Malnutrition
- 21.8 – Other cardiac conditions
- 21.9 – Cancer/history of cancer
- 22 – Age
- 23 – Patient refused BG check
- 24 – Unable to determine, occurred despite appropriate treatment
- 25 – Imminent death
- 26 – Patient noncompliance
- 27 – Pharmacy error

BG, blood glucose; IV, intravenous; NPO, nil per os; SSI, sliding scale insulin.

<70 mg/dL, the nurses will re-treat the patient and call the physician.

In the future, the Hypoglycemia Committee plans to add an intravenous dextrose infusion to the

hypoglycemia treatment protocol. This infusion would be particularly useful in patients with recurrent hypoglycemia secondary to sulfonylurea or long-acting insulin and in patients without diabetes at high risk of recurrent hypoglycemia. A dextrose infusion could be substituted for D50W in some patients, thus decreasing our demand for D50W when it is in short supply.

DISCONTINUATION OF SSI MONOTHERAPY

SSI therapy has been in existence since 1934.⁹ Despite an abundance of evidence demonstrating no significant benefit and increased episodes of hypoglycemia, SSI remains a mainstay of glycemic control in many hospitals.⁹ A Medline search of 52 trials from 1966 to 2003 found that no clinical trials showed benefit from SSI.^{9,14} A prospective cohort study determined that SSI did not control hyperglycemia and resulted in more frequent episodes of hypoglycemia.^{9,15} SSI does not consider weight, nutritional status, insulin sensitivity, or need for basal insulin.⁹ Insulin stacking may occur with SSI being given every 6 hours.¹⁶ A result of insulin stacking is a high risk of hypoglycemia, and the risk increases with high doses of SSI.

The Hypoglycemia Committee noted a trend in severe hypoglycemia and related many of the episodes to SSI. Through communication with the interdisciplinary glycemic management committee, insulin order sets were changed based on the Hypoglycemia Committee's observations and a review of the current literature.

The first enhancement was the elimination of SSI as monotherapy. The solitary SSI order set was made unavailable, thus encouraging the use of available basal, prandial, and correction dose insulin order sets. Studies have shown that a safe and effective insulin regimen for non-intensive care inpatients should include basal, prandial, and correction dose insulin.¹⁷ The regimen should be adjusted based on a patient's weight, previous insulin needs, and diet. Adjustments in insulin regimens often need to be made daily.

In addition, the high-dose correction insulin option was removed from all subcutaneous insulin order sets because the adverse effects related to SSI are compounded at higher doses. The risk of insulin stacking is increased when patients are temporarily allowed nothing by mouth or have decreased oral intake. In these situations, a high dose of insulin can be excessive, leading to severe hypoglycemia. As a result of eliminating the SSI order set and high-dose correction scale insulin at OMC, hypoglycemic events related to SSI have decreased.

PHYSICIAN EDUCATION

Two studies have shown that case-based learning sessions and provider lectures decreased the use of SSI, increased the use of basal-bolus correction insulin, and improved glycemic control.^{18,19} At OMC, the endocrinology fellows and staff educate physicians and house staff on the importance of not relying on the sliding scale for glucose management by pointing out the dangers of SSI and teaching them how to order and dose-adjust insulin. The forums through which the endocrine fellows educate staff physicians and house officers include morning reports and noon conferences. Physician education and changes in the practice climate at OMC as it relates to SSI have helped to reduce its use.

Another study found that modules on inpatient management of diabetes and hyperglycemia were well accepted by providers.²⁰ Online prescriber modules are one of several ways to educate physicians on how to appropriately prescribe insulin and correctly use order sets and protocols.

CONCLUSIONS

With the development of the subspecialty Hypoglycemia Committee, OMC established a systematic way to investigate and characterize all events of severe hypoglycemia. The committee is unique in that every case of severe hypoglycemia is reviewed by physicians, endocrinologists, and diabetes specialists. Since its inception, the Hypoglycemia Committee has helped to decrease hypoglycemic events by establishing a standalone hypoglycemia treatment protocol, reducing the use of SSI as monotherapy, eliminating high-dose insulin correction scales, and developing ways to educate staff physicians and house staff on proper insulin prescribing practices and the use of best-practice order sets. In the future, the Hypoglycemia Committee and endocrine fellows hope to pursue additional quality improvement projects with the data gathered and to demonstrate that the steps taken by the committee continue to show measurable decreases in preventable hypoglycemic episodes. With strong institutional support, the Hypoglycemia Committee will continue to improve patient safety by further reducing the incidence of hypoglycemia in the hospital.

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