Continuous Quality Improvement: Hypoglycemia Prevention in the Postoperative Surgical Population

Christina Munoz, Crystal Lowry, and Catherine Smith

A continuous quality improvement project for decreasing hypoglycemia on a surgical unit at a major university medical center in Chicago was successful in reducing hypoglycemic episodes and increasing overall patient safety. A secondary root cause analysis of hypoglycemic episodes is discussed for use in planning future hypoglycemia prevention strategies.

The estimated prevalence of diabetes mellitus (DM) is greatest in persons age 60 and older, making the disease a significant problem in hospitals. In 2007, people age 65 and older represented 13% of the population and 33% of all hospitalizations (Agency for Healthcare Research and Quality [AHRQ], 2007). In 2004, nearly 6.3 million hospitalizations occurred for persons with DM, indicating 428 hospital stays for every 1,000 persons with the disease in the United States (AHRQ, 2006). Both hyperglycemia and hypoglycemia have been linked to inpatient morbidity and mortality (Turchin et al., 2009; Turina, Fry, & Polk, 2005; Van den Berghe et al., 2001, 2006).

In the perioperative setting specifically, studies have shown that even mild-to-moderate hyperglycemia increases the risk for postoperative ileus, sternal wound infection, joint infection, and thrombotic events; therefore it is imperative to achieve glycemic targets (Lipshutz & Gropper, 2009; Marchant, Viens, Cook, Vail, & Bolognesi, 2009). Recent studies have been completed on a general medical-surgical unit to identify a safe, beneficial BG target, although experts recommend pre-meal targets less than 140 mg/dl and all random BG values less than 180 mg/dl (Moghissi et al., 2009).

In October 2008, the unit director recognized an increasing number of hypoglycemic events in electronically documented unusual occurrence (UO) reports. UO reports track events that place patients or employees at risk for harm. These reports can be filed by any medical center employee and are then sent to his or her manager. In 2008, all medical-surgical units in the hospital were tracking hypoglycemia through these reports as part of a nursing systems project. Therefore, authors incidentally found UO reports of hypoglycemia dispro-

Background

Rush University Medical Center (Chicago, IL) is an academic medical center that includes a 671-bed hospital serving adults and children. The described intervention occurred on a 26-bed acute medical-surgical unit with services for general surgical, oncology, and telemetry patients. The surgical population is distributed among gynecology, general surgery, otolaryngology, and urology. About 60% of the patients have gynecological-oncology procedures. Among these subsets, the management of medical-surgical patients can be complex due to factors such as postoperative stress and subsequent postoperative complications. In addition, patients frequently require parenteral or enteral nutrition. Glycemic control thus can be challenging. Many surgical patients with a history of DM depend on safe glycemic management from surgical residents with limited experience in DM management.

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portionately occurred in the gynecological and gynecological-oncology population. The unit director enlisted a team to manage this emerging problem, convening a meeting with the involved surgeons and the section director of endocrinology. A continuous quality improvement project was designed based on this clinical outcomes review. The endocrine consult team was to be consulted to see all gynecological and gynecological-oncology patients with blood glucose greater than 140 mg/dl.

**Purpose**

The first objective of this project was to improve patient safety by optimizing glycemic control and decreasing the rate of hypoglycemia. The second objective was to identify the root cause of increasing occurrence of hypoglycemia and improve the glycemic control process. Third, this project offered the opportunity to improve interdisciplinary communication and serve as an educational experience for nurses and physicians.

**Methods**

Nurse leaders at Rush University Medical Center use the FOCUS PDCA methodology (see Table 1) for continuous quality improvement activities (Langley, Nolan, & Nolan, 1992). Use of the process to guide the intervention is described below:

**Find**

Nurses identified the problem of increased incidence of hypoglycemic events through the number of UO reports.

**Organize**

Key team members who organized and participated in this intervention were unit director, physicians, nurse practitioner, clinical nurse coordinator (CNC), and staff registered nurses (RNs).

**Clarify**

The current knowledge of managing inpatient DM was lacking as evidenced by unusual occurrences of hypoglycemia in gynecological-oncology patients. Nurses and physicians clearly had knowledge deficits regarding access and interpretation of the hypoglycemia protocol, DM resources, and current glycemic guidelines.

**Understand**

Variation existed in the therapeutic approach to DM management in many patient cases. Records review and subjective comments from RNs corroborated knowledge deficits and deviation from the recommended inpatient DM management guidelines.

**Select**

The clinical glycemic guidelines from the ADA/AACE, The Rush Medical Center Inpatient DM Management Guidelines (including insulin order set and hypoglycemia protocol developed by endocrinology department and available as a hospital resource), and the endocrine consult team were selected to guide the improvement process.

**Plan**

The goal was to decrease rates of hypoglycemia and improve patient safety. RNs were directed to document episodes of BG less than 70 mg/dl electronically for 1 year. The next step of the plan was to develop in-services and educational materials for direct-care RNs. The key intervention included a consult by the resident physician from the gynecology team to the endocrine consult team for any inpatients on the service with DM, and instructions to page the endocrine service with any questions regarding DM management. All BG outcomes data were collected electronically.

**Do**

As part of the education process, the nurse practitioner, unit director, and CNC provided one-to-one training of RNs and residents regarding the hypoglycemia protocol. This included access and ordering of the protocol in the computer system (EPIC). The NP completed two in-services in December 2008 and February 2009 regarding management of inpatient diabetes, diabetes medications, and postoperative considerations for patients with DM and hypoglycemia. She created bulletin boards regarding hypoglycemia prevention and current hospital protocols. The unit director and CNC reinforced this information through RN completion of a mandatory computer training module and test. Unit leaders also reinforced this education through staff meeting reminders and emails to the direct-care RNs with information regarding DM and hypoglycemia. Physician gynecology teams consulted the NP to manage blood glucose through insulin titration for any patient with DM, starting in late December 2008. The NP initiated a consult if a patient was hyperglycemic and needed insulin management. If the patient was not hyperglycemic, he or she should
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<table>
<thead>
<tr>
<th></th>
<th>Hypoglycemia Events</th>
<th>Pre-Intervention % of Hypoglycemia</th>
<th>Hypoglycemic Events</th>
<th>Post-Intervention % of Hypoglycemia</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire Unit</td>
<td>60/3,209</td>
<td>1.9%</td>
<td>58/3,884</td>
<td>1.5%</td>
<td></td>
</tr>
<tr>
<td>Target GYN Population</td>
<td>32/1,376</td>
<td>2.3%</td>
<td>29/1,846</td>
<td>1.5%</td>
<td>0.12</td>
</tr>
<tr>
<td>Non-GYN Population</td>
<td>28/1,833</td>
<td>1.5%</td>
<td>29/2,038</td>
<td>1.4%</td>
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Results

In the 6 months prior to the intervention, 32 hypoglycemic events were recorded in the gynecological and gynecological-oncology service; 29 events were recorded in the 6 months during and after the intervention (January 1-June 30, 2009). The rate of hypoglycemia in the target population declined from 2.3% to 1.5%. A chi-square analysis of findings did not find statistical significance (p=0.12). However, these data were clinically significant because patient safety was improved and quality of care maximized despite the seemingly minimal reduction in hypoglycemia.

A review of all hypoglycemic events, including all surgical services, on the unit during the 6 months pre-intervention identified 60 events in 3,209 glucose assessments. A review during and after intervention revealed 58 events in 3,884 glucose assessments. Two less hypoglycemic events occurred, although the total rate of hypoglycemia was decreased from 1.9% to 1.5%. These data also were clinically significant because the rate of hypoglycemia decreased even in the group that did not receive the full intervention. This group, which did not receive an automatic endocrine consult, may have benefited only from nursing education.

Results of the chart review for a root cause analysis were limited by RN failure to document hypoglycemia as a UO July 1-June 30, 2009 (see Table 2). Nurses reported only 44/118 hypoglycemic events on that unit as recorded by the hospital’s laboratory software (Precision Web Data Management System, 2001). The secondary root cause analysis of each of the 44 UOs reported as hypoglycemic events on the unit July 2008-June 2009 showed 34 of the events in order of frequency were related to poor oral intake, insulin-food mismatch, renal insufficiency, home therapy with a thiazolidinedione (TZD), oral sulfonylureas given in the hospital, and age over 80. Ten hypoglycemic events occurred in patients who had not received any oral diabetes management or insulin during their hospital stays. Reasons for the hypoglycemia experienced by these patients can be speculated by chart review to be linked to sulfonylurea use at home, kidney or liver disease, and/or gastric bypass. The endocrine service was involved and managed the insulin in 11 of the 44 cases of hypoglycemia documented in unusual occurrence reports.

Take no oral DM medications throughout the admission. The NP rounded with the attending endocrinologist daily on all new consults. The orders placed by the endocrine NP included the hypoglycemia protocol, pertinent laboratory tests, subcutaneous insulin doses, and BG parameters. The NP adjusted the insulin doses based on four point-of-care (POC) BG measures daily. RNs were to page the endocrine team for any BG less than 70 mg/dl or greater than 180 mg/dl. A physician or NP from the endocrine team was available to manage the glucose around the clock. Selected 6-month periods before intervention (July 1-December 31, 2008) and after/during intervention (January 1-June 30, 2009) allowed comparison of hypoglycemic episodes and evaluation of the intervention. A root cause analysis of the documented hypoglycemic episodes was completed through chart reviews in the EPIC electronic medical record system.

Check: Sustained improvement can be assessed by tracking BG data with the hospital’s Precision Web Data Management System (© 2001, version 1.044). This browser-based software application allows use of POC glucose data to generate specific or general reports for evidence-based care. This system collects BG values from the POC glucometers on every unit when they are downloaded every 8 hours. RNs no longer electronically complete an unusual occurrence report to document all hypoglycemic episodes.

Act: Endocrine consults are main-
Discussion

Educating nurses and physicians about glycemic control and having a specialized team to manage the glucose in postoperative gynecological surgery patients could lower rates of hypoglycemia in the hospital setting. A NP-led team called the Glucose Management Service has been utilized to manage patient blood glucose on the surgical units in another Chicago teaching hospital with much success (DeSantis et al., 2006). An evaluation of the methodology revealed improved glycemic control and a reduced frequency of hypoglycemia on surgical units where the teams were utilized.

The unit lowered the rate of hypoglycemia overall by 0.4%, while the rate of hypoglycemia in the target population decreased by 0.8%. All staff received education, but only gynecological surgery patients were recommended to have an endocrine consult. Management by the endocrine consult team may have had the greatest influence in decreasing rates of hypoglycemia in the target population. It is clinically significant to note that in other non-gynecological surgical services, the decline in the rate of hypoglycemia only may be attributed to RN education because endocrine team consult was not mandated. One limitation of the intervention was a failure to remind the nursing staff to continue to document all the hypoglycemic episodes (not just among gyn-oncology patients) as unusual occurrences for the review of root cause. A longer period of data collection following rather than during the intervention also may have been helpful in creating a larger impact. Because the protocol for consults was new, it is also possible that the gynecology team did not call to consult on some patients; this failure could have reduced the effect. Also of importance is the fact that 675 more POC glucose measurements were completed in the post-intervention period; this greater attention to glucose control with likely more intensive insulin management did not cause hypoglycemic events to increase as could be speculated with tighter glycemic control.

However, a root cause analysis of the hypoglycemic episodes accessible for chart review provided some educational opportunities for the unit and the consult team. Many patients who received insulin developed hypoglycemia due to poor oral intake, insulin-food mismatch, or use of TZD/sulfonylurea prior to arrival or sulfonylurea use without insulin while in the hospital. These findings suggest the importance of reinforcing the hospital’s insulin protocols to the nurses, in particular holding mealtime insulin if the patient eats less than 50% or the patient is NPO. Mealtime insulin also should be given within 20 minutes after the patient eats to avoid insulin-food mismatch. Reinforcement is needed for residents to refrain from ordering oral DM agents for patients after surgery because the patients may not have consistent food intake. Insulin is the only DM therapy that can be adjusted multiple times a day based on amount of oral intake or NPO status. Prior use of a TZD at home also was linked to more frequent hypoglycemia. Up to 8 weeks of therapy may be needed for this class of medication to be effective; when discontinued, its impact on glycemic values tends to last a few days. This clinical situation suggests the need for conservative insulin dosing for patients who take TZDs at home.

Renal insufficiency was a key contributor to hypoglycemia, especially when patients took a sulfonylurea at home. In addition, some hypoglycemic events were due to the stacking of insulin doses in patients with renal diagnoses; insulin dosing needs to be more conservative in those patients. RNs and physicians need to be taught that patients with renal failure and DM taking sulfonylureas at home may not need insulin for the first few days after hospital admission. When the sulfonylurea is discontinued in the hospital, drug blood levels may remain therapeutic due to slower renal clearance; administration of insulin can compound hypoglycemia risk.

Of 44 cases of hypoglycemia, 10 occurred without any insulin or oral anti-diabetic pills taken. Six patients (four with a history of DM) had severe liver or kidney disease and/or were less than age 80. These events may be explained by decreased creatinine clearance, DM therapy taken prior to hospital arrival, or inadequate hepatic glucose output and inappropriate response to glucagon. Nurses have been taught to evaluate patterns of BG in patients with kidney disease, and to think critically about any medication and its impact on blood glucose values. They should question appropriateness of the medication dose when they identify declining glucose values or if they know a patient has taken oral therapy prior to arrival.

Two patients were admitted for surgery and made NPO on arrival, but took their sulfonylurea or TZD within the last 24 hours. They became hypoglycemic the day of or after admission. One patient had been receiving steroids in the days previous and became hypoglycemic when a dose of steroids was missed without any insulin given. Patients with a history of diabetes receiving steroids in the hospital require management by the endocrine team due to risk of hypoglycemia during titration of steroids.

One patient with DM had gastric bypass surgery and did not receive any insulin or pills following surgery. However, BG was still less than 70 mg/dl. This patient did not have kidney or liver disease, and was taking small amounts of fluids. The best explanation for this may be increased incretin effect. Studies in humans and rats have shown an early amplified release of incretins after Roux-en-Y gastric bypass, causing increased insulin secretion for a short period of time postoperatively. This is believed to be a result of gastrointestinal bypass, causing an increased and speedier release of incretins GIP and GLP-1 (Laferriere et al., 2007). These results should prompt observation of patients for 24-48 hours after surgery for improved glucose control and only conservative treatment with insulin if needed at all. If hypoglycemia is a repeated pattern, a new protocol can be implemented to start dextrose 5%
TABLE 3.
Nursing Education

<table>
<thead>
<tr>
<th>Hypoglycemia Prevention Tips</th>
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<tbody>
<tr>
<td><strong>1. Who Is at Risk?</strong></td>
</tr>
<tr>
<td>Patients to monitor closely for hypoglycemia:</td>
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<tr>
<td>- Patient with acute or chronic kidney failure</td>
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<td>- Patient improving from a “stressed state”</td>
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<tr>
<td>- Sympathomimetic agent withdrawal: phenylephrine, ephrine, dopamine, norepinephrine</td>
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<tr>
<td>- Patient post-infection of a large amount of alcohol</td>
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<td>- Inadequate nutrition</td>
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<td>- History of severe hypoglycemia</td>
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<td>- New NPO status</td>
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<tr>
<td>- Reduction in rate of dextrose intravenous (IV) fluids</td>
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<td>- Cortisol deficiency/adrenal or pituitary insufficiency</td>
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<tr>
<td><strong>2. Oral DM Agents</strong></td>
</tr>
<tr>
<td>No sulfonylurea or glitazones in NPO or postoperative patients</td>
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<tr>
<td><strong>3. Tube Feedings</strong></td>
</tr>
<tr>
<td>Never let the tube feeding bag run empty. Never stop tube feeding for more than 30 minutes without hanging dextrose 10% at the same rate if the patient has received any insulin.</td>
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<tr>
<td><strong>4. Steroids</strong></td>
</tr>
<tr>
<td>Be aware that a patient who is receiving steroids that are being tapered or undergoing dose change in any way will likely need adjustment to the insulin dose. Be wary of downward trends in blood glucose (BG); monitor patient closely for symptoms of hypoglycemia and notify service.</td>
</tr>
<tr>
<td><strong>5. Look at Patterns</strong></td>
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<tr>
<td>Check patient’s BG more frequently if you are concerned, give insulin on time with meals, suggest an endocrine consult if uncontrolled, document BG promptly, notify service if downward trends or BG 70-80 mg/dl and the patient is NPO.</td>
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<tr>
<td><strong>6. Bedtime Snacks</strong></td>
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<tr>
<td>Give any patient with diabetes (not NPO) a bedtime snack (HS): sandwich, or milk and crackers, regular Jell-O®, or cereal if the HS fingerstick glucose is &lt; 130 mg/dl. If patient is NPO and fingerstick glucose at HS &lt; 100 mg/dl, page service.</td>
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<tr>
<td><strong>7. Hypoglycemia Unawareness</strong></td>
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<tr>
<td>Keep snacks at the bedside; all patients should have IV access. Be knowledgeable of BG in the last 24 hours to alert service if values show downward trend.</td>
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<tr>
<td><strong>8. Meal-time Insulin</strong></td>
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<tr>
<td>Hold the mealtime insulin if patient is NPO or eats less than 50% of the meal.</td>
</tr>
<tr>
<td><strong>9. Patient Transfer</strong></td>
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<tr>
<td>Never let patient leave the unit without known BG within 2 hours. Page service if fingerstick glucose &lt; 90 mg/dl and NPO because patient may need to leave with IV fluids with dextrose.</td>
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Sources: Adapted from ADA, 2012; McCullough & Inzucchi, 2012; Turchin et al., 2009

intravenously instead of lactated ringsers in this population; however, no trend toward this has been noted at Rush University Medical Center. See Table 3 for hypoglycemia prevention recommendations used in educating staff nurses.

Conclusion
Successful management of diabetes in hospitalized patients requires close monitoring and assessment of many factors that can contribute to hyperglycemia and hypoglycemia. The complicated nature of an acute care hospital stay can make insulin titration challenging, even though insulin is recognized as the most appropriate therapy for hospitalized patients with DM (ADA, 2012). Nursing and medical staff who work with specialized medical-surgical populations require basic

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Objectives
This continuing nursing educational (CNE) activity is designed for nurses and other health care professionals who care for and educate patients and their families regarding hypoglycemia prevention. After studying the information presented in this article, the nurse will be able to:
1. Discuss hypoglycemia in the postoperative setting.
2. Describe a continuous quality improvement project to improve patient safety, identify the root cause of the increasing occurrence of hypoglycemia and improve the glycemic control process, and improve interdisciplinary communication.

Note: The authors, editor, and education director reported no actual or potential conflict of interest in relation to this continuing nursing education article.

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education about the importance of managing hypoglycemia and hyperglycemia in an inpatient setting. Hospitals may benefit from formation of specialist teams of physicians, advanced practice nurses, and nurse educators to manage conditions such as DM in the hospital because incidence of hyperglycemia and hypoglycemia has been linked to poor quality care as well as decreased reimbursement. The Institute for Safe Medication Practices (2012) identified insulin as one of five high-alert medications and The Joint Commission incorporated this into their safe practice initiatives, making insulin safety a priority for all hospitals (Cohen & Kilo, 1999). Authors found an NP/physician team was effective in managing BG and minimizing hypoglycemia in gynecologic surgery patients. This nurse-led continuing education effort helped physicians and nurses to utilize their resources, think critically about patients who are at high risk for hypoglycemia, and apply knowledge of current protocols to maintain safe practice. MAN

REFERENCES

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