

# Implementation of a Standardized Preoperative Diabetes Medication Guideline and its Effect on Day of Procedure Blood Glucose Levels

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**Purpose:** *The purpose of this project was to determine the effect of implementation of a preoperative diabetes medication management guideline on day of procedure blood glucose (BG) levels.*

**Design:** *This project was designed as pre- and postimplementation process improvement project based on the Iowa Model of evidence-based practice.*

**Methods:** *Anesthesia providers were surveyed for knowledge and confidence before and following education. Surgical patients with diabetes were provided instructions for all classes of prescribed diabetes medications. Day of procedure BG levels were compared prior to and following the guideline implementation.*

**Findings:** *Provider knowledge scores increased 4.5 points (95% confidence interval [CI] 3.2, 5.8) and confidence improved 31.3 percentage points (95% CI 20.8, 41.7). Mean BG level was 132.3 (SD 37.5) before implementation and 130.4 (SD 44.7) after implementation.*

**Conclusions:** *The project resulted in significant gains in provider knowledge and confidence, but no significant difference in preoperative BG levels following implementation of the guideline.*

**Keywords:** *preoperative diabetes management, anesthesia preoperative evaluation.*

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**THE INCIDENCE OF DIABETES MELLITUS** (DM) continues to increase to epidemic levels in the United States.<sup>1</sup> Uncontrolled DM in the surgical patient can result in undesirable outcomes such as increased morbidity and mortality, additional inpatient days, and expanded cost related to hospital care.<sup>2,3</sup> It is imperative that anesthesia providers deliver current evidence-based preoperative diabetes medication instructions to patients before surgery to improve patient outcomes and satisfaction scores through reduction in surgical delays, cancellations, or both. The purpose of this project was to determine the effect of implementation of a standardized evidence-based preoperative diabetes medication management guideline on day of procedure blood glucose (BG) levels in adult patients undergoing elective ambulatory surgical procedures.

## Background

In 2014, the Centers for Disease Control and Prevention released its National Diabetes Statistics Report stating that 29.1 million Americans had been diagnosed with DM as of 2012, and further predicted an additional 1.7 million new diagnoses each year.<sup>1</sup> Uncontrolled DM in the perioperative period poses significant implications for the patient, including labile blood pressure and silent myocardial ischemia related to autonomic neuropathy, fluid and electrolyte imbalance as a result of osmotic diuresis, increased risk of aspiration secondary to gastroparesis, and difficult airway issues related to glycosylation of the atlanto-occipital and temporomandibular joints. Furthermore, chronically uncontrolled BG levels can contribute to clinically significant neurologic, cardiovascular, renal, and musculoskeletal comorbidities.<sup>4</sup> Several recommendations have been made with regards to optimal BG levels, including 90 to 130 mg/dL for outpatient management,<sup>2</sup> less than 200 mg/dL in noncardiac surgical patients,<sup>5</sup> and 140 to 180 mg/dL in critically ill patients.<sup>6</sup> Hyperglycemia on the day of procedure has been shown to contribute to the delay or cancellation of surgical cases, with cancellation rates reported as high as 11.6%.<sup>7</sup> Campbell et al<sup>8</sup> estimated the average cost associated with a single case cancellation is \$4,550.

Patients diagnosed with DM are routinely prescribed at least one, or a combination of insulins, noninsulin injectables, and oral diabetes medications. These medications may have profound anesthetic and perioperative implications. Therefore, patients should receive clear instructions to continue, hold, or adjust the dosages of these medications to circumvent fluctuation in BG levels as a result of nil per os status and perioperative stress responses. Inappropriate administration of diabetes medications could lead to perioperative hypoglycemia or hyperglycemia, which may ultimately cause unexpected surgical delays or case cancellations.

The Military Health System is charged with caring for military retirees and dependents of active duty and retired members, many of whom present for surgical care with systemic diseases such as DM. Military service personnel and their dependents are participating in the Military Health System more frequently, and predictions indicate annual health care spending by the Department of Defense will increase from \$51 billion in 2013 to \$65 billion by 2017, and as high as \$90 billion by 2030.<sup>9</sup> Federal health care spending has been identified as one of the significant contributors to the current financial crisis facing the United States government. Therefore, it is in the interest of military health care professionals and researchers to investigate methods for reducing costs associated with canceled surgical cases, including optimizing day of procedure BG levels.

Clinical practice guidelines (CPGs) have become a common instrument used by many federal and state government health care facilities, as well as privatized organizations to improve the quality and cost-effectiveness of patient care. Over the past decade, implementation of nationally recognized CPGs has been used in process improvement projects to address clinical challenges such as central line and urinary catheter infections, ventilator-associated pneumonia, and deep vein thrombosis prophylaxis. These guidelines are standardized approaches to medical prevention, diagnosis, and treatment, which are based on current available evidence, and often developed or adopted for dissemination by professional nursing and medical associations.

## Problem

In the anesthesia department of our medium-sized military treatment facility, a standardized guideline was not used to direct the preoperative management of diabetes medications. Patients received variable provider-specific instructions, some of which were not based on the most current literature available. Our team developed a preimplementation and postimplementation process improvement project to determine the effect of implementing an evidence-based standardized diabetes medication management guideline on day of procedure BG levels.

### *Project Design: Modified Iowa Model*

This project was designed as a preimplementation and postimplementation process improvement project based on the Iowa Model of evidence-based practice to promote quality care. Through the use of this framework, we sought to identify a relevant issue within our institution, organize a team of primary stakeholders, conduct a review of the current literature, pilot a change in practice based on the available evidence, and ultimately evaluate the effect of the new process on day of procedure BG levels. The clinical issue we identified was the absence of a standardized guideline for preoperative management of patients' diabetes medications within our anesthesia department. We classified this issue as a clinical priority at both organizational and federal government levels, considering its potential impact on patient outcomes and cost implications. Our team of primary stakeholders included clinical leaders from the anesthesia, preoperative, and same-day surgery departments, in addition to an electronic medical record database liaison.

We conducted a thorough review of the current literature to either (1) identify an existing vetted CPG for preoperative diabetes medication management or (2) create such a guideline from the available evidence. Accepted articles were published in or translated to English from October 2004 to October 2014 and included only human subjects. Databases searched included PubMed, CINAHL, EMBASE, JAMA Evidence, and Google Scholar. In addition, we searched for current guidelines within the Society for Ambulatory Anesthesia

(SAMBA), American Diabetes Association (ADA), and Agency for Healthcare Research and Quality Web sites. Search terms included: "preoperative," "perioperative," "pre-procedure," "pre-anesthesia," "diabetes," "DM," "diabetic," "glycemic control," "glycaemic," "blood glucose," "insulin," "guidelines," "protocol," "management," and "program." All articles were appraised individually by three associate investigators through a systematic review according to the process developed by Melnyk and Fineout-Overholt.<sup>10</sup>

Our initial search yielded 24 articles, of which only 17 made specific recommendations for preoperative diabetes medication management. Only one article's recommendations were based on the highest level of evidence: a systematic review. The remaining 16 articles consisted of expert opinions or nonsystematic evidence-based reviews. Ultimately, we chose the SAMBA Consensus Statement<sup>2</sup> as the basis for our standardized guideline, which will be hereafter referred to as the SAMBA guidelines. The authors described the process by which they conducted a systematic literature review following the recommended protocol of the Cochrane Collaboration. It is because of this due diligence that our team chose this specific set of guidelines to implement for our project. One additional strength of the SAMBA guideline is that its recommendations were consistent with most other articles. The SAMBA guidelines were formatted into a carbon copy patient instruction form (Figure 1, Pt Instruction Form) available for anesthesia providers to complete and provide to the patient during the preoperative interview before the day of surgery.

### *Project Implementation*

Our team created an interactive education program that outlined the specific components of the SAMBA guidelines. The education also included pharmacology of the most common classes of diabetes medications including oral diabetes medications, noninsulin injectables, and various types of insulin. Finally, the presentation outlined the details regarding the project implementation process and specific expectations for each participating department. Efficacy of the education was measured via a pre-education and posteducation provider knowledge and confidence survey. The survey consisted of 11 multiple choice questions

on specific components of the chosen clinical guideline with corresponding Likert-scale items to evaluate each provider's confidence that they chose the correct answer.

Working in conjunction with the preoperative clinic, patients with diabetes were directed to the anesthesia department for evaluation before their scheduled day of procedure. Patients included in the preimplementation arm of the study received the current practice of nonstandardized, provider-specific preoperative diabetes medication management instructions provided to them during their preoperative anesthesia interview. The postimplementation arm received instructions based on the implemented standardized guideline. The carbon copy patient instruction form (Figure 1) was filled out in the presence of the patient, clearly identifying the patient's specific medications and their corresponding instructions. The patient received the original copy of the completed instruction form, whereas the carbon copy was collected in a designated area in the anesthesia department for later data collection. Day of procedure BG levels were mined from the electronic medical record for equal periods of time: 3 months before and after the implementation of the standardized preoperative diabetes medication management guideline. To assess the provider compliance with the newly implemented process, the collected patient instruction forms were counted and compared with the number of postimplementation day of procedure BG levels mined from the electronic medical record.

## Methods

For provider responses in the pre-education and posteducation surveys, the number of correct responses to knowledge-based questions was summed to arrive at a total score (range 0 to 11). Likert-type assessments of confidence in having the correct answer to a knowledge-based question were summed and divided by the number of responses to arrive at an average confidence score (range 0 to 100). For both provider and patient outcomes, frequencies and means (SD) were calculated to describe the responses of the sample. Data were assessed for missingness and normality. BG values were categorized to reflect compliance with 2007 ADA guidelines<sup>2</sup>

(BG 90 to 130 mg/dL), compliance with target values recommended<sup>6</sup> (BG less than 181 mg/dL), and compliance with target values recommended<sup>5</sup> (BG less than 201 mg/dL). Differences in preimplementation versus postimplementation categorical data were assessed by computing odds ratios (ORs; 95% confidence interval [CI]). Differences in preimplementation versus postimplementation continuous data were assessed by computing the difference in means (95% CI).

## Results

Fourteen providers responded to the knowledge-based questions and 13 responded to the assessment of confidence. At baseline 8 of 14 providers agreed, 4 of 14 neither agreed nor disagreed, and 2 of 14 disagreed or strongly disagreed that their practice when caring for patients with diabetes was evidence based. Mean score on the knowledge test was 5.1 (SD 2.0) before training and 9.6 (SD 1.0) after training, an increase of 4.5 points (95% CI 3.2, 5.8). Average confidence across responses was 58.3 (SD 15.4) before training and 89.6 (SD 9.1) after training, a gain of 31.3 points (95% CI 20.8, 41.7).

Data were available for 85 patients before implementation and 87 patients after implementation. Values for age, sex, and BG were available for all patients. Values for body mass index (BMI) were available for 93% (n = 79) of subjects before implementation and 90% (n = 78) after implementation; odds of the missing BMI were not significantly different before and after implementation (OR 1.46; 95% CI 0.55, 3.94). Mean age was 55.9 years (SD 11.8) before implementation and 56.8 years (SD 13.5) after implementation (difference 0.96; 95% CI -2.9, 4.8). Mean BMI was 34.4 kg/m (SD 7.3) and 31.8 kg/m (SD 6.4) preimplementation and postimplementation, respectively (difference 2.7; 95% CI 0.5, 4.8). Females made up 61% (n = 52) of the preimplementation cohort and 54% (n = 47) of the postimplementation cohort, with similar odds of being female in each cohort (OR 1.3, 95% CI 0.7, 2.5). Mean plasma glucose was 132.3 (SD 37.5) before implementation and 130.4 (SD 44.7) after implementation, a difference of 1.9 mg/dL (95% CI -10.6, 14.3).

Before implementation, 47% (n = 40) of patients were compliant with 2007 ADA recommendations,

**Preoperative Diabetes Medication Management Patient Instructions\***

**Metformin:** (Glucophage)

Does patient have an elevated Cr level or will they be receiving IV contrast for the procedure?

If YES,  Hold Metformin (Glucophage) for 2 days prior to procedure

If NO,  Hold Metformin (Glucophage) on morning of procedure

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**Other Oral Diabetes Medications:** (Acarbose, Actose, Amaryl, Avandia, Chlorpropamide, Diabinese, Diabeta, Glimepiride, Glipizide, Glucotrol, Glyburide, Glyset, Januvia, Micronase, Miglitol, Nateglinide, Onglyza, Orinase, Pioglitazone, Prandin, Precose, Repaglinide, Rosiglitazone, Saxagliptin, Sitagliptin, Starlix, Tolbutamide)

**Non-Insulin Injectables:** (Byetta, Exenatide, Pramlintide, Symlin)

**Short-Acting Insulins:** (Apidra, Aspart, Glulisine, Humulin R, Humalog, Lispro, Novolin R, Novolog)

Does patient take any oral diabetes medication (other than Metformin), non-insulin injectable or short-acting insulin?

If YES,  Hold all oral diabetes medications, non-insulin injectables and/or short-acting insulins on the morning of surgery and resume when you start eating normal meals after surgery.

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**Intermediate-Acting Insulins:** (Humulin N-NF, Lente, Novolin N, NPH, Ultralente)

Does patient experience nocturnal or morning hypoglycemia (BG<70)?

If YES,  Take 75% of regular dose the night before surgery and bring your intermediate-acting insulin with you on the morning of surgery (Hold the morning dose until you check into the preoperative clinic)

If NO,  Take 75% of regular dose the night before surgery and take 50% of regular dose on the morning of Surgery

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**Long-Acting Insulins:** (Detemir, Glargine, Lantus, Levemir)

Does patient experience nocturnal or morning hypoglycemia (BG<70)?

If YES,  Take 75% of regular dose the night before surgery and bring your long-acting insulin with you on the morning of surgery (Hold the morning dose until you check into the preoperative clinic)

If NO,  Take your regular dose the night before or morning of surgery (as prescribed)

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**Mixed Insulins:** (Humalog Mix 50/50, Humalog Mix 75/25, Humulin 50/50, Humulin 70/30, Novolin 70/30, Novolog Mix 70/30)

Does patient's mixed insulin include Lispro-Protamine?

If YES,  Take 50% of morning dose, but use NPH instead (Lispro-Protamine only available as a mix)

If NO,  Take 50% of morning dose of intermediate-acting component ONLY (NPH or Aspart Protamine)

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If you experience symptoms of hypoglycemia (sweating, heart racing, weakness, fatigue, confusion, or behavioral changes) or have a blood glucose less than 70 on the morning of surgery, drink 6 ounces of a clear fruit juice, electrolyte drink, or soda (**MUST BE A CLEAR LIQUID**)

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\*These guidelines were adopted from Joshi, G.P., Chung, F., Vann, M.A., Ahmad, S., Gan, T.J., Goulson, D.T.,..... and Twersky, R. (2010). Society for ambulatory anesthesia consensus statement on perioperative blood glucose management in diabetic patients undergoing ambulatory surgery. *Anesthesia & Analgesia*, 111:6, 1378-87

Figure 1. Preoperative diabetes medication patient education sheet. This figure is available in color online at [www.japan.org](http://www.japan.org).

89% (n = 76) patients demonstrated preoperative BG less than 181, and 93% (n = 79) demonstrated preoperative BG less than 201. After implementation, 48% (n = 42) of patients were compliant with 2007 ADA recommendations, 91% (n = 79) patients demonstrated preoperative BG less than 181, and 92% (n = 80) patients demonstrated preoperative BG less than 201. The odds of being compliant with 2007 ADA recommendations (OR 1.03; 95% CI 0.75, 1.40), presenting with BG less than 181 (OR 1.02; 95%

CI 0.92, 1.12), and presenting with BG less than 201 (OR 0.99; 95% CI 0.91, 1.08) were not significantly different for patients who presented for surgery before implementation and after implementation.

The number of patient instruction forms (n = 87) collected during the postimplementation period was the same as the number of day of procedure BG levels collected (n = 87) during the same period of time.

## Conclusions

The project resulted in significant gains in knowledge and confidence but little change in patient preoperative BG measurements. At baseline, a slight majority of providers felt that their practice was evidence based, despite answering an average of less than half of questions correctly. After training, the number of correct responses per provider nearly doubled. Similar effects were seen for confidence in knowledge. In contrast to the large effect of the training on knowledge and confidence, implementation of standardized medication teaching did not result in significant changes in plasma glucose on the morning of surgery, odds of being compliant with 2007 ADA recommendations, odds of presenting with BG less than 181, or odds of presenting with BG less than 201.

## Discussion

The purpose of this process improvement project was to evaluate the effectiveness of a standardized preoperative medication management guideline on day of procedure BG levels in patients with diabetes undergoing elective surgical procedures. In addition, we evaluated the effectiveness of a diabetes medication education program on anesthesia provider knowledge and confidence in providing evidence-based preoperative diabetes medication instructions.

The implementation did not yield a significant reduction in day of procedure BG levels, which may be because of the population at our hospital having regular access to health care and prescription benefits at no cost. Outcomes may have differed if the project was implemented in a facility where the patient population's access to health care was limited. Despite a lack of significant reductions in day of procedure BG levels, the use of a CPG ensures that each patient is provided consistent preoperative education, and also ensures that current evidence-based instructions are used.

Although not the primary goal of our project, the significant improvement in anesthesia provider knowledge and confidence levels was identified as a major influence in promoting the implementation to departmental leadership.

The increases in provider knowledge and confidence by 40% and 30%, respectively, show how a department can benefit from having a diabetes medication education program in their practice. We recommend the use of the evidence-based patient instruction tool during all preoperative anesthesia interviews and incorporation of the education program into departmental orientation for new anesthesia staff members.

In addition, we received positive feedback from anesthesia providers in the department regarding the usefulness of having a standardized form for the management of preoperative diabetes medications, and to consider expanding it to include medications for diagnosis' such as high blood pressure and conditions requiring anticoagulation. It reportedly increased the efficiency of providing preoperative education and appeared to improve patient understanding and satisfaction with the process. On the basis of the findings of our project, we recommend that institutions consider the use of a standardized diabetes medication management guideline to improve provider and patient knowledge, increase efficiency of preoperative education, improve patient satisfaction, and ultimately improve patient outcomes.

## Limitations

This process improvement project was designed to meet Institutional Review Board exempt status to meet academic deadlines. This design lends itself to multiple limitations including the inability to access patient records to compare long-term control status of the patients' diabetes through glycosylated hemoglobin levels, a relatively small sample size ( $n = 172$ ), and the absence of a control group. We were unable to compare the number of case cancellations or delays that resulted from uncontrolled BG levels on the morning of procedure because the hospital only records the number of case cancellations and not the cause for such events. In addition, we were unable to determine patient compliance. Each patient was given a standardized set of instructions based on the written form during their preoperative anesthesia interview, but because we did not specifically identify these

patients, we could not assess if the patient actually followed instructions the night before surgery. Furthermore, despite the matching number of patient instruction forms and day of procedure BG levels collected during the postimplementation period, our inability to identify individual patients and thus track them on the day of procedure hindered our ability to accurately measure provider compliance with the newly implemented process. With respect to the educational component of the project, a priming or practice effect cannot be ruled out. With respect to the clinical implementation component of the project, historical changes in hospital practice cannot be ruled out.

### Summary

Preoperative diabetes medication management is important for the optimization and safety of surgical patients with diabetes. It can be complicated for anesthesia providers who counsel these patients preoperatively, given the number and combinations of medications that make up

current diabetes treatment regimens. Diabetes medications may have profound anesthetic and perioperative implications, making it important for patients to receive clear instructions regarding whether to continue, hold, or adjust the dosages of these medications to avoid wide swings in BG levels due to nil per os status and perioperative stress. Uncontrolled BG levels can contribute to perioperative morbidity and mortality, surgical case delays, and cancellations. These outcomes have a profound negative effect on both patient satisfaction and cost of health care. Optimization of preoperative BG levels can improve patient outcomes, reduce cost, and improve patient satisfaction scores. Although our implementation was unable to produce a significant change in day of procedure BG levels, we did accomplish a significant improvement in provider knowledge and confidence levels in managing preoperative diabetes medications through our evidence-based education initiative. We also produced a tangible tool for providers to use in the preoperative interview to guide diabetes medication instructions and then give to the patient for easy reference to promote patient compliance.

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