Journal of Clinical Anesthesia 36 (2017) 184–188

Contents lists available at ScienceDirect

Journal of Clinical Anesthesia

Original contribution

Effect of basal insulin dosage on blood glucose concentration in ambulatory surgery patients with type 2 diabetes☆

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ARTICLE INFO

Article history:
Received 1 May 2016
Accepted 27 October 2016
Available online xxxx

Keywords:
Diabetes mellitus
Blood glucose
Glucose management
Hyperglycemia
Hypoglycemia
Perioperative glycemic control
Glargine insulin
Perioperative insulin management

ABSTRACT

Study objective: Among patients with type 2 diabetes treated with insulin, perioperative hyperglycemia and hypoglycemia may cause undesirable symptoms, surgery delay or cancellation, or unexpected hospitalization. Our objective was to compare preoperative glargine dosing regimens on perioperative glycemic control in patients undergoing ambulatory surgery.
Design: Observational study.
Setting: Pre- and postoperative holding areas.
Patients: One hundred fifty patients with type 2 diabetes using a once daily, evening insulin glargine regimen undergoing ambulatory surgery were included.
Interventions: None.
Measurements: To conduct the analysis, patients were divided into four groups based on the percentage of normal evening glargine dose taken. Group 1 took no glargine. Group 2 took 33%-57%. Group 3 took 60%-87% and Group 4 took 100% of their normal dose. The primary outcome was the proportion of patients in each group with blood glucose in the target range (100-180 mg/dL), and the incidence of hypoglycemia (defined as BG <70 mg/dL or symptomatic, requiring glucose).
Main results: Group 3 had the highest proportion (78%) of patients within target range ($P < .001$) and Group 4 had the highest proportion of patients with hypoglycemia ($P = .01$). Patients in Group 3 were significantly more likely to achieve target blood glucose than patients in either Group 1 ($P = .001$) or Group 4 ($P = .002$).
Conclusions: Our study shows that the percent of normal insulin dose given the evening before surgery directly impacts perioperative glucose levels in ambulatory surgery patients. Patients taking 60%-87% of their usual dose the evening before surgery were likely to arrive in target blood glucose range with decreased risk for hypoglycemia. The mean and mode dose taken in Group 3 were 73% and 75%, respectively, suggesting that the optimal dose may be 75% of normal dose.

1. Introduction

The American Diabetes Association estimates that 29 million Americans suffer from diabetes, affecting approximately 9.3% of the total population [1]. From 1980-2011, the number of Americans with a diagnosis of diabetes has tripled [2] and patients with diabetes are more likely to need surgery [3]. Perioperative hyperglycemia is associated with an increased rate of surgical complications, surgical delays, metabolic decompensation, and prolonged hospital length of stay [4-6]. Similarly, avoidance of hypoglycemia during preprocedural fasting is

☆ Funding/Disclosure: Department of Anesthesiology, Emory University School of Medicine. Statistical expertise provided by John Hanfelt, PhD, Professor of Biostatistics and Bioinformatics. Dr Hanfelt is supported by the National Center for Advancing Translational Sciences of the National Institutes of Health under Award Number UL1TR000454.

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http://dx.doi.org/10.1016/j.jclinane.2016.10.003
0952-8180/

necessary to prevent undesirable symptoms, surgery delay or cancellation, or unexpected hospitalization. The growing recognition of case delays and complications due to hyperglycemia and hypoglycemia is increasingly compelling anesthesiologists to seek best practice methods to manage patients with diabetes undergoing ambulatory surgery.

The Society for Ambulatory Anesthesia (SAMBA) published consensus guidelines in 2010 for the "perioperative management of diabetic patients undergoing ambulatory surgery" [7] as means to provide evidence-based recommendations for glycemic control. Before this publication, there was no consensus and ambulatory surgery patients received no insulin to 100% of their normal daily dose [7-9]. The SAMBA recommends that plans for preoperative insulin treatment should include an evaluation of the preoperative glycemic control, history and risk of hypoglycemia, timing of surgery, and duration of fasting state before surgery. Despite the lack of solid evidence from prospective randomized trials, SAMBA recommended that patients should be instructed to take 100% of their daily basal insulin dose the day before surgery. They did comment that patients should reduce their nighttime dose if they had a history of nocturnal or morning hypoglycemia.

The use of basal insulin (glargine and detemir) alone or as part of a basal bolus regimen has been shown to be effective in improving glucose control, but is associated with a rate of hypoglycemia between 5% and 32% in a noncritical care setting [10-13]. There is concern, however, that some patients receiving basal insulin may be at high risk of developing hypoglycemia in the absence of meals and prolonged fasting [14]. The ideal glargine dose needed to achieve safe perioperative blood glucose levels is not known. Accordingly, to determine optimal basal insulin dosing for ambulatory surgery, we determined differences in glycemic control among patients receiving different percentages of total daily glargine dose the evening before ambulatory surgery. We hypothesized that taking 100% of insulin dose would increase the risk for perioperative hypoglycemia, particularly later in the day, and taking no insulin the night prior may predispose to perioperative hyperglycemia. We aimed to find the percent of normal dose that would provide the best perioperative glycemic control.

2. Methods

2.1. Study population

The study was conducted at the Ambulatory Surgery Center (ASC) at The Emory Clinic, Atlanta, Georgia, and was approved by the Emory University institutional review board. The ASC cares for approximately 5500 patients per year and provides general anesthetics and anesthesia-directed sedation for ambulatory surgical procedures. From March 2010 to May 2015, adult patients presenting for elective surgery, with a history of type 2 diabetes and using insulin glargine dosed once daily in the evening, were eligible for the study. Insulin changes were determined by the patient, preoperative nursing staff, anesthesiologist, endocrinologist, or surgeon, and were not controlled for. All patients were confirmed nil per os (NPO) after midnight, but the duration of NPO status was not controlled for. Adjunct oral and bolus insulin regimens were also not controlled for. Exclusion criteria included patients with type 1 diabetes, those receiving twice daily dosing of glargine, and end-stage renal disease patients on dialysis. Patients were recruited to participate in the study in the morning of surgery, and written informed consent was obtained from all patients.

The number of units of insulin glargine taken the evening before surgery, the patient's usual daily dose, age, weight, and body mass index was documented. Fasting blood glucose (FBG) (BG1) was recorded on arrival to the ASC. An additional blood glucose (BG2) check was recorded for 85% of patients on arrival to recovery unit. Additional interventions needed to manage glucose in the perioperative period were documented. Blood glucose was measured using a point of care meter (Accu-Chek; Roche Diagnostics, USA) on venous blood during the IV placement or capillary blood from finger stick.

2.2. Measurements

The patients were divided into four groups based on the percentage of normal glargine dose taken. Groups were empirically delineated post hoc based on the frequency of patients taking a specific percent of normal insulin dose (see Fig. 1). Specifically, Group 1 took no glargine. Group 2 took 33%-57%. Group 3 took 60%-87% and Group 4 took 100% of their normal dose. In addition, we considered clinical feasibility for these groupings; for example, we felt that recommending 0%, 50%, 75%, or 100% of normal insulin dose was clinically relevant options. Although Group 1 only had five patients, we felt it was important to leave it as a separate group to show that holding glargine completely the evening before surgery was clearly not appropriate. The primary outcome was achievement of target blood glucose levels between 100-180 mg/dL on arrival to the ASC [14-17]. The safety end point was the incidence of hypoglycemia, defined as a BG ≤70 mg/dL and/or symptomatic hypoglycemia requiring intervention at any point during the perioperative course.

2.3. Analytic methods

Exact Pearson χ^2 analyses were used to compare the percentages of patients within, above, or below target for each group. P values <.05 were considered statistically significant; in this exploratory observational study, no adjustment was made for multiple comparisons. Trends between groups were analyzed with the Jonkheere-Terpstra test. All statistical analysis was conducted using SAS version 9.3, Cary, North Carolina.

3. Results

One hundred fifty ambulatory surgery patients were included in the study. All patients remained in the study to completion, which was defined as discharge from the ASC. Daily insulin doses ranged from 3 to 100 units (median, 32.6 units) the evening before surgery. Demographic and clinical characteristics of the four groups are shown in Table 1. Age, sex, body mass index, and daily dose of insulin glargine did not vary significantly among groups.

Achievement of target blood glucose between 100 and180 mg/dL was examined across groups. The admission blood glucose for the entire cohort was 141.2 ± 48 mg/dL. The mean BG1 for each group is shown in Table 1 and a scatter plot of BG1 vs percent of normal dose taken is shown in Fig. 1. The BG1 decreased as percent of daily insulin dose increased and this decreasing trend in BG1 across the four groups was statistically significant ($P < .001$).

There were significant differences among the four groups with respect to the proportions of patients with BG1 in the target range and the proportions presenting with hypoglycemia. Specifically, Group 3 had the highest proportion (78%) of patients with BG1 in target range ($P < .001$) and Group 4 had the highest proportion of patients with hypoglycemia ($P = .01$). Patients in Group 3 were significantly more likely to achieve BG1 in the target range than patients in either Group 1 ($P = .001$) or Group 4 ($P = .002$); the difference between Groups 2 and 3 was not significant ($P = .56$). The risk of hypoglycemia was significantly higher in Group 4 than in Group 3 ($P = .03$). The group with the highest proportion in target range and a minimum number of hypoglycemic events was Group 3.

Postoperative blood glucose value (BG2) was recorded on arrival to the postanesthesia care unit. The mean BG2 for each group is shown in Table 1 and a scatter plot of BG2 vs percent of normal dose taken is shown in Fig. 2. Twenty-two patients did not have a repeat blood glucose check before discharge. The lack of a repeat second blood glucose check was evenly distributed among the four groups ($P = .49$). Among patients in Group 3, 94% (31/33) of BG2 values were in target (Fig. 2), compared with 65% (13/20) of Group 2, 50% (32/64) of Group 4, and 20% (1/5) of Group 1. Group 3 had significantly more patients