



Original contribution

# Decisional practices and patterns of intraoperative glucose management in an academic medical center<sup>☆, ☆ ☆</sup>



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## Abstract

**Objective:** To understand the decisional practices of anesthesia providers in managing intraoperative glucose levels.

**Design:** This is a retrospective cohort study.

**Setting:** Operating rooms in an academic medical center.

**Patients:** Adult patients undergoing surgery.

**Intervention:** Intraoperative blood glucose management based on an institutional protocol.

**Measurements:** Glucose management data was extracted from electronic medical records to determine compliance to institutional glucose management protocol that prescribes hourly glucose measurements and insulin doses to maintain glucose levels between 100 to 140 mg/dL. Effect of patient and surgery specific factors on compliance to glucose management protocol was explored.

**Main results:** In 1903 adult patients compliance to hourly glucose measurements was 72.5% and correct insulin adjustments was 12.4%. Insulin was under-dosed compared to the prescribed value by a mean of 0.85 U/h (95% CI 0.76-0.95). Multivariate analysis showed that compliance to hourly glucose measurements decreased with increasing length of the procedure (OR = 0.92 per hour, 95% CI 0.89-0.95) but increased with ASA status codes (OR = 1.25 per ASA unit, 95% CI = 1.06-1.49). Greater compliance to correct insulin adjustment was found in diabetic patients compared with non-diabetic patients (OR = 1.31, 95% CI 1.09-1.55). On average, providers administered progressively more insulin with an additional 0.11 U/h (95% CI = 0.00-0.21] for every additional 10 kg/m<sup>2</sup> of BMI and 0.20 U/h (95%

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CI = 0.01-0.39) less in diabetic patients than in non-diabetic patients. With the above practice pattern, the mean  $\pm$  SD of glucose level was  $158 \pm 36$  mg/dL. Hypoglycemic (<60 mg/dL) incident rate was 0.1% (9/8301 measurements) while hyperglycemic (>180 mg/dL) incident rate was 28%. Glucose levels were within the target range (100-140 mg/dL) only 28% of the time.

**Conclusions:** Low compliance and considerable variability in initiating and following institutional glucose management protocol were observed.

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## 1. Introduction

Studies on perioperative glucose management have primarily focused on the postoperative phase [1–6]. However, the factors affecting blood glucose levels and insulin action are possibly different during the intraoperative phase when compared with the postoperative phase. Hence, the glycemic management considerations suggested by the postoperative studies may not be directly applicable to the intraoperative phase without modifications. Nevertheless, many institutions have generally extended glucose management strategies to the intraoperative phase due to the consideration that adequate glucose management in the operating room leads to better glucose management during the postoperative phase. Commonly, the same protocol that is used for postoperative or ICU glucose management is used during the intraoperative period as well [7,8].

Glucose management in the operative room is almost exclusively performed by anesthesia providers. With no clear and specific guidelines for optimal blood glucose control and a desired target range, the decisional practice of the anesthesia provider in initiating and adhering to a blood glucose management protocol is unclear. Contributing to this is the variability of surgical stress that a patient encounters for different types of procedures and its influence on the anesthesia provider in managing blood glucose levels. Additionally, in a busy operating room in which the anesthesia provider multitasks various patient care steps, keeping vigilance and closely following a glucose management protocol becomes difficult. With these factors under consideration, we undertook an observational study to understand the decisional practices of the anesthesia provider in initiating and following an institutional glucose management protocol during the intraoperative period. Specifically, we explored when the anesthesia providers initiated glucose management protocol and which patient and procedure specific factors influenced their decision. We also explored the compliance of the anesthesia providers in closely following the institutional glucose management protocol.

## 2. Materials and methods

### 2.1. Study setting

We performed a retrospective cohort study of surgical patients that required intraoperative glucose management at the

University of Washington Medical Center (UWMC) during the 2011 calendar year. UWMC performs approximately 17,000 adult surgical procedures every year and includes general, neurosurgical, cardiac and liver transplant cases. Anesthesia providers practicing at UWMC include attending anesthesiologists, residents and Certified Registered Nurse Anesthetists (CRNAs). The study was approved by the University of Washington's Institutional Review Board (IRB).

#### 2.1.1. Glucose management protocol

Based on patient and surgery characteristics the anesthesia providers initiate and follow an institutional glucose management protocol. The University of Washington protocol (UW protocol), shown in Figure, recommends hourly blood glucose measurements and insulin infusion adjustments based on a table that translates glucose measurements to corresponding insulin infusion rates. The target range for glucose management used by the algorithm is 100 to 140 mg/dL. Intraoperative glucose measurements are performed by the anesthesia provider either as part of arterial blood gas analysis performed by a central laboratory or through a point of care glucose meter (Accu-Chek, Roche Inc, Indianapolis, IN).

#### 2.1.2. Inclusion criteria

Surgical procedures on adult patients (18 years or older) that had glucose management recommended by the UW protocol were included. These included diabetic patients (both type 1 and 2), and non-diabetic patients who had at least one intraoperative blood glucose measurement greater than 140 mg/dL. Additionally, major cardiac and liver transplant surgical patients who normally have blood glucose managed intraoperatively were included in the study. For analyzing compliance to UW protocol, only cases that had intraoperative glucose measured were considered.

## 2.2. Data preparation

### 2.2.1. Data sources

Intraoperative anesthesia care at UWMC is documented through an Anesthesia Information Management System (AIMS). AIMS automatically acquires and documents blood glucose measurements performed by both the central laboratory and the point of care glucose meters. The insulin infusion doses used to manage blood glucose levels are documented manually by the anesthesia provider in AIMS. Patient characteristics such

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