Gynecologic Oncology 136 (2015) 71–76

Contents lists available at ScienceDirect

Gynecologic Oncology

journal homepage: www.elsevier.com/locate/ygyno

# Intensive postoperative glucose control reduces the surgical site infection rates in gynecologic oncology patients

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## HIGHLIGHTS

- Patients with DM in gynecologic oncology can have an SSI rate up to 45%.
- We adopted a quality improvement protocol to start postoperative insulin infusion for target blood glucose <139 mg/dL.
- SSI was lowered by 35%.

## ARTICLE INFO

*Article history:*
Received 26 August 2014
Accepted 19 September 2014
Available online 28 September 2014

*Keywords:*
Surgical site infection
Gynecologic oncology surgery
Diabetes mellitus
Intensive glycemic control
Post operative morbidity
Surgical outcome

## ABSTRACT

*Objective.* SSI rates after gynecologic oncology surgery vary from 5% to 35%, but are up to 45% in patients with diabetes mellitus (DM). Strict postoperative glucose control by insulin infusion has been shown to lower morbidity, but not specifically SSI rates. Our project studied continuous postoperative insulin infusion for 24 h for gynecologic oncology patients with DM and hyperglycemia with a target blood glucose of <139 mL/dL and a primary outcome of the protocol's impact on SSI rates.

*Methods.* We compared SSI rates retrospectively among three groups. Group 1 was composed of patients with DM whose blood glucose was controlled with intermittent subcutaneous insulin injections. Group 2 was composed of patients with DM and postoperative hyperglycemia whose blood glucose was controlled by insulin infusion. Group 3 was composed of patients with neither DM nor hyperglycemia. We controlled for all relevant factors associated with SSI.

*Results.* We studied a total of 372 patients. Patients in Group 2 had an SSI rate of 26/135 (19%), similar to patients in Group 3 whose rate was 19/89 (21%). Both were significantly lower than the SSI rate (43/148, 29%) of patients in Group 1. This reduction of 35% is significant ($p = 0.02$). Multivariate analysis showed an odd ratio = 0.5 (0.28–0.91) in reducing SSI rates after instituting this protocol.

*Conclusions.* Initiating intensive glycemic control for 24 h after gynecologic oncology surgery in patients with DM and postoperative hyperglycemia lowers the SSI rate by 35% (OR = 0.5) compared to patients receiving intermittent sliding scale insulin and to a rate equivalent to non-diabetics.



## Introduction

Surgical site infection (SSI), a surgical complication, is defined as infection(s) occurring after surgical procedures. It is the third most common (17%) [1] of all nosocomial infections in hospitalized patients, and is a significant cause of postoperative morbidity, mortality, and healthcare costs [2–4].

Data from the National Healthcare Safety Network show that SSI rates vary by type of surgical procedure [5,6]. SSI rates are estimated to be 1.7% for abdominal hysterectomy and 0.9% for vaginal hysterectomy [6]. However, in gynecologic oncology this rate ranges from 5% to 35% [2]. This variation depends on numerous factors including: high body mass index (BMI), low socio-economic status, poor nutritional status, high intraoperative blood loss, prolonged operative time, performance of bowel resection, perioperative blood transfusion, and patients' other medical co-morbidities [2].

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http://dx.doi.org/10.1016/j.ygyno.2014.09.013
0090-8258/

Preventing SSI is vitally important and several interventions have been shown to reduce infection rates. The most important intervention is using perioperative prophylactic antibiotics [6,7]; others include improving antiseptic techniques and maintaining perioperative normal body temperature. Despite the [2] above measures, SSI remains a challenge due to the propensity of patients' medical co-morbidities, including the perioperative management of diabetes mellitus (DM).

Diabetes mellitus has been recognized as a risk factor for SSI in many surgical specialties, including cardiothoracic, hepato-biliary, and colorectal [4,8–12]. A recent study reported that the rate of SSI was an alarming 44.8% in gynecologic oncology patients with DM [2]. Fortunately, multiple studies have indicated that lowering postoperative blood glucose can reduce SSI rates [4,10–12]. Most of these studies support keeping a target postoperative blood glucose <200 mg/dL in patients with DM [13,14]. Van den Berghe et al. showed a better outcome (decreased morbidity and mortality) in surgical patients in an intensive care unit with more intensive postoperative glucose control (<139 mg/dL) [15]. A recently published study, NICE-SUGAR, had a contradictory outcome, showing that intensive glucose control among adults in the ICU to a blood glucose target of <180 mg/dL resulted in lower mortality than did a target of 81 to 108 mg/dL [16]. It is important to note that this study looked only at death rates. Nonetheless, SSI rates were not the primary outcome of both of these studies.

Considering the above studies, we hypothesize that a strict postoperative glucose control (<139 mg/dL) will lower SSI rates in gynecologic oncology patients. On March 1, 2008 our group adopted a quality improvement (QI) project at our institution. This entailed a strict postoperative blood glucose control (<139 mg/dL) by continuous intravenous insulin infusion for 24 h after surgery for patients with DM and postoperative hyperglycemia (PH) on the general surgical floor, as well as in the ICU. We utilized this QI project not only to improve morbidity and mortality outcomes, but also to hopefully lower surgical site infection rates.

Two years after adopting the QI project, we evaluated the impact of our protocol on SSI rates. To achieve that, we compared the SSI rates of our patients in three groups: Group 1, patients with DM who were managed by subcutaneous intermittent insulin injections before the QI project adoption; Group 2, patients with DM and PH managed with continuous intravenous insulin infusion after the QI project adoption; and Group 3, patients who had neither DM nor PH after the QI project adoption.

The objective of this study is to examine the effects of our protocol of an intensive postoperative glucose control regimen on SSI rates in gynecologic oncology patients.

## Methods

Prior to the beginning of our QI project on March 1, 2008, patients with gynecologic malignancies at our institution with known DM had their blood glucose controlled postoperatively by intermittent subcutaneous (SC) insulin injections (traditionally known as a sliding scale). This was accomplished by using short acting regular insulin given SC every 6 h according to a set algorithm. The target blood glucose was <200 mg/dL.

After March 1, 2008, as part of our QI project, we instituted an intense postoperative blood glucose control. This strict control was achieved by initiating a continuous intravenous (IV) insulin infusion for 24 h after surgery, with a target finger stick glucose range of 90–139 mg/dL. The targeted patients were those with known DM and patients who were not diabetic but had postoperative blood glucose levels >= 150 mg/dL (or >= 200 mg/dL if they received steroids during surgery), who were labeled patients with postoperative hyperglycemia (PH).

Insulin was infused in 250 mL of normal saline at a concentration of 1 Unit/mL. The dose of insulin varied from 1 to 12 Units/h according to the patient's starting blood glucose. Once infusion began, blood glucose was checked every hour (using AccuCheck® machines) and the insulin infusion rate changed according to a defined algorithm adopted by the American College of Endocrinology [17].

After 24 h of insulin infusion, patients with pre-existing DM were restarted on their preoperative regimens of either subcutaneous (SC) insulin or oral hypoglycemic agent (OHA) when they resumed bowel function. Patients with PH without preexisting DM had no further treatment unless their blood glucose continued >150 mg/dL; at that point, they were managed by SC insulin until discharge. Since all PH patients are at risk of having undiagnosed DM, they were also advised to follow up with their primary care physicians for further management and/or diagnosis of DM.

Our QI project protocol allowed us to study our primary outcome, SSI rates, in three different groups. Group 1 included patients with DM who were managed by subcutaneous intermittent insulin injections before the QI project adoption prior to March 2008. Group 2 included patients with DM and PH managed with continuous intravenous insulin infusion after the QI project adoption from March 2008 through March 2010. Group 3 included consecutive patients who had neither DM nor PH after the QI project adoption; we collected data from these patients from January 1, 2009 through December 31, 2009 for simplicity and convenience reasons. These groups can be seen in Fig. 1.

After we obtained Institution Review Board approval, we retrospectively collected data. The inclusion criteria were: women undergoing major surgery for gynecologic malignancies and above 18 years of age. We excluded patients with incomplete medical records (those with missing or inconsistent data) and incarcerated patients. We also excluded those who underwent minimally invasive surgery (MIS), recognizing the lower rates of SSI with this surgical approach.

Demographic and surgical data collected from the electronic medical records included: age, body mass index (BMI), American Society of Anesthesiology scoring system (ASA), medical co-morbidities including DM (both types), hypertension, current smoking status, chronic renal or hepatic disease, immune deficiency, perioperative antibiotic use, length of surgery (LOS: defined from surgical incision to closure) and estimated operative blood loss (EBL). SSI was defined according to NHSN/CDC criteria [1]. The follow up time for each patient also followed the CDC criteria of 30 days after surgery.

Comparisons of patient characteristics among the three groups were performed using Fisher's exact test for dichotomous variables or t-tests for continuous variables. Univariate logistic regression was used to determine the effect of each variable on SSI. Multivariate logistic regression was conducted to examine the association between SSI in the three groups by blood glucose control methods after controlling for covariates. Results were quantified in terms of odds ratios (ORs) with corresponding 95% confidence intervals (CIs). All statistical analyses were performed using SAS 9.1 software (SAS Institute Inc. Cary, NC). Statistical significance was defined as a two-tailed p-value <0.05.

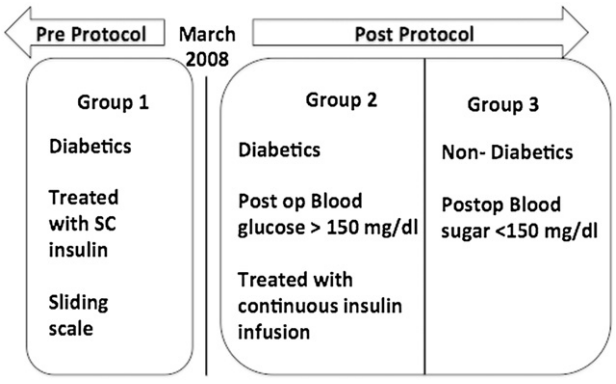


**Fig. 1.** The three groups of patients.