

Association Between Perioperative Glycemic Variability and Wound Healing Following Major Abdominal Surgery

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Background: Perioperative glycemic control is increasingly recognized as an important determinant of postoperative recovery. While sustained hyperglycemia has been linked to surgical site infections and delayed wound healing, the effect of glycemic variability (GV) remains inadequately investigated. This study evaluated the association between perioperative glycemic variability and wound healing outcomes following major abdominal surgery.

Methods: A retrospective observational study was conducted among 312 adult patients undergoing elective major abdominal surgery between January 2023 and December 2025. Blood glucose levels were measured preoperatively and during the first 72 postoperative hours. Glycemic variability was quantified using the coefficient of variation (CV), standard deviation (SD), and mean amplitude of glycemic excursions (MAGE). Patients were categorized into low- and high-variability groups according to the median CV. Primary outcome was delayed wound healing within 30 postoperative days. Secondary outcomes included surgical site infection (SSI), hospital stay, and readmission.

Results: High glycemic variability was observed in 154 patients (49.4%). Delayed wound healing occurred significantly more frequently in the high-variability group (24.7%) than in the low-variability group (11.0%, $p < 0.001$). Surgical site infection developed in 18.2% versus 8.4% of patients, respectively ($p = 0.013$). Median hospital stay was longer among patients with elevated GV (10 vs. 7 days, $p = 0.002$). Multivariate logistic regression demonstrated that high GV independently predicted delayed wound healing (OR 2.48; 95% CI 1.39–4.42; $p = 0.002$).

Conclusion: Perioperative glycemic variability is independently associated with impaired wound healing and increased postoperative complications following major abdominal surgery. Strategies targeting stable glucose control may improve surgical recovery.

Key Words: Glycemic variability, abdominal surgery, wound healing, surgical site infection, perioperative glucose, postoperative outcomes

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Introduction

Postoperative wound healing remains one of the most important determinants of successful recovery after abdominal surgery. Delayed wound healing contributes to prolonged hospitalization, increased healthcare costs, patient discomfort, and higher readmission rates.

Hyperglycemia impairs leukocyte function, collagen synthesis, angiogenesis, and fibroblast proliferation. While perioperative glucose targets have been incorporated into enhanced recovery protocols, recent evidence suggests that fluctuations in blood glucose may be more harmful than isolated episodes of hyperglycemia.

Glycemic variability generates oxidative stress and inflammatory responses that damage endothelial cells and impair tissue regeneration. Experimental studies have demonstrated that oscillating glucose concentrations induce greater cellular injury than persistent hyperglycemia.

Few clinical studies have evaluated the impact of perioperative glucose fluctuations on wound healing after major abdominal procedures. This study therefore investigated whether increased glycemic variability independently predicts delayed wound healing and postoperative complications.

Materials and Methods

Study Design

A retrospective cohort study was performed at a tertiary referral center after institutional approval.

Patient Population

Adult patients (≥ 18 years) undergoing elective:

- Colorectal resection
- Gastrectomy
- Hepatectomy
- Pancreatectomy
- Small bowel resection

were included.

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Exclusion Criteria

- Emergency surgery
- Minor procedures
- Pregnancy
- Chronic steroid therapy
- Missing glucose data
- Death within 30 postoperative days

Data Collection

Clinical variables included:

- Age
- Sex
- BMI
- Diabetes mellitus
- Smoking history
- ASA classification
- Operative duration
- Estimated blood loss
- Surgical approach
- Albumin level

Glycemic Assessment

Blood glucose was recorded:

- Preoperatively
- Every 6 hours during the first 72 postoperative hours

Glycemic variability was assessed using:

- Standard deviation (SD)
- Coefficient of variation (CV)
- Mean amplitude of glycemic excursions (MAGE)

Patients were divided according to the median CV.

Outcome Measures

Primary Outcome:

Delayed wound healing within 30 days.

Secondary Outcomes:

- Surgical site infection
- Hospital stay
- Reoperation
- Readmission
- Overall complications

Statistical Analysis

Continuous variables were analyzed using Student's t-test or Mann–Whitney U test. Categorical variables were compared using Chi-square testing. Independent predictors were evaluated using

multivariate logistic regression. Statistical significance was defined as $p < 0.05$.

Results

Baseline Characteristics

A total of 312 patients met inclusion criteria.

Mean age was 61.3 ± 12.4 years.

Diabetes mellitus was present in 38%.

Baseline demographic characteristics were comparable between groups.

Glycemic Variability

Median coefficient of variation:

18.5%

Patients with higher variability demonstrated:

- Higher postoperative glucose peaks
- Greater insulin requirements
- Longer ICU observation

Wound Healing Outcomes

Delayed wound healing occurred in:

- High GV: 38 patients (24.7%)
- Low GV: 17 patients (11.0%)

$p < 0.001$

Surgical Site Infection

SSI developed in:

- High GV: 18.2%
- Low GV: 8.4%

$p = 0.013$

Length of Stay

Median stay:

- High GV: 10 days
- Low GV: 7 days

$p = 0.002$

Multivariate Analysis

Independent predictors of delayed wound healing included:

Variable	Odds Ratio	95% CI	p-value
High Glycemic Variability	2.48	1.39–4.42	0.002
Diabetes Mellitus	1.82	1.05–3.15	0.031
Albumin <3.5 g/dL	2.15	1.18–3.94	0.014
Operative Time >240 min	1.74	1.01–3.01	0.047

Discussion

The findings indicate that perioperative glycemic variability is a stronger predictor of impaired wound healing than average glucose levels alone. Patients with greater glucose fluctuations experienced significantly higher rates of delayed wound healing, surgical site infection, and prolonged hospitalization.

Oscillating glucose concentrations are believed to induce oxidative stress through repeated activation of inflammatory pathways. This process impairs fibroblast migration, collagen deposition, and angiogenesis, all of which are essential for normal wound repair. The observed association remained significant after adjusting for diabetes, nutritional status, and operative duration.

These results support previous investigations demonstrating that stable glucose management may be more beneficial than simply maintaining acceptable mean glucose values. Continuous glucose monitoring and protocol-driven insulin therapy may reduce glucose excursions during the perioperative period.

Limitations include the retrospective design, single-center setting, and absence of continuous glucose monitoring in all participants. Prospective multicenter studies are required to establish optimal glycemic variability thresholds for surgical patients.

Conclusion

Perioperative glycemic variability is independently associated with delayed wound healing, increased surgical site infections, and prolonged hospitalization following major abdominal surgery. Monitoring glucose fluctuations in addition to mean glucose levels may enhance perioperative risk stratification and improve postoperative outcomes. Interventions aimed at minimizing glycemic variability should be considered in enhanced recovery protocols.

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Conflict of Interest

The authors declare no conflict of interest.

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Data Availability

The datasets generated during the current study are available from the corresponding author upon reasonable request.

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