

Reassessing Glycemic Index: Data-Driven HbA1c and Same Day Glucose Strata that Maximize the Likelihood of 90-Day Major Complications following Lumbar Fusion

Ivan Z Liu¹, Chloe Pontier Farnham¹, Amil Raj Agarwal, Philip M Parel, Theodore Quan², Wesley Michael Durand³, Micheal Raad, Amit Jain

¹Medical College of Georgia, ²George Washington University, ³Johns Hopkins Hospital
INTRODUCTION:

Diabetes mellitus (DM) is a known risk factor for wound complications and major complications following lumbar fusion surgery (LF). HbA1c is the gold-standard marker to understand preoperative glycemic control; whereas same-day serum glucose (SDG) levels are utilized as an important perioperative marker. Thresholds for undergoing surgery have been created based on these values, but established thresholds are either non-specific for lumbar fusion or have low power in predicting complications. As the prevalence of DM in LF patients increases, it is important to reassess the relationship of glycemic index and lumbar fusion. Therefore, the purpose of this study was to generate data-driven strata for preoperative HbA1c and SDG measures that maximize the likelihood of 90-day major complications and wound complications following LF.

METHODS:

Patients who underwent LF from 2013 to 2022 were identified using a national database. Patients were included if they had both a HbA1c level taken within 3 months before surgery and an SDG level. Distinct data-driven strata for HbA1c and same-day glucose levels were established using stratum specific likelihood ratio (SSLR) analysis. SSLR is a modified approach to analyzing Receiver Operating Characteristics (ROC) curves that identified data-driven thresholds that maximizes the likelihood of an outcome. The outcomes in this study included 90-day major complications and wound complications following LF. The incidence for each of these complications was recorded for all identified strata. To control for confounding variables, each stratum was then propensity-score matched to the lowest strata based on age, sex, hypertension, heart failure, chronic obstructive pulmonary disease, and obesity. The risk ratio (RR) for each stratum with respect to the lowest matched stratum was observed. A significance level was set at a p-value threshold of <0.05.

RESULTS:

In total, 12,026 patients were identified who underwent LF. SSLR identified three data-driven HbA1c strata (4.5-5.4, 5.5-7.9, and 8.0+) and three SDG strata (60-159, 160-239, and 240+) that maximized the likelihood of 90-day major complications. SSLR was unable to identify any data-driven strata for 90-day wound complication rates. For HbA1c, when propensity-matched to the lowest strata (4.5-5.4), the risk of 90-day major complications sequentially increased as the HbA1c strata increased: 5.5-7.9 (1.689; p=0.001; 95% CI 1.242, 2.296), 8.0+ (2.313; p<0.0001; 95% CI 1.558, 3.433). For SDG, when compared to the propensity-matched lowest strata (60-159), the risk of 90-day major complications also sequentially increased as the SDG strata increased: 160-239 (1.343; p<0.0001; 95% CI 1.175, 1.535), 240+ (1.636; p<0.0001; 95% CI 1.305, 2.049).

DISCUSSION AND CONCLUSION:

We were successful in identifying data-driven strata for HbA1c and SDG that maximized the difference in risks for 90-day major complications but not 90-day wound complications in LF patients. In the preoperative setting, the identified HbA1c strata can be incorporated into risk calculators and utilized to risk-stratify patients with other known variables rather than be used as a threshold for undergoing surgery. In the perioperative setting, strict glycemic control of preventing an SDG from exceeding 160 can also help reduce the risk of major complications following LF. The multiple strata identified for HbA1c and SDG levels demonstrate that a single cut-off value as identified in prior literature may not be ideal for preoperative patient management. Rather, risk stratification incorporating our multiple HbA1c and SDG strata with other parameters may be a better approach to preoperative risk stratification and counseling for 90-day major complications following LF.

Table 1. Patient Demographics, Unadjusted Rates, and Risk Ratios for 90-Day Major Complications Based on HbA1c and Same-Day Serum Glucose

| Demographic | HbA1c Stratification | | Same-Day Serum Glucose Stratification | |
|------------------------------|----------------------|-------------|---------------------------------------|-------------|
| | 4.5-5.4 (%) | 5.5-7.9 (%) | 60-159 (%) | 160-239 (%) |
| Unadjusted Rate (%) | 4.0 | 4.5 | 4.5 | 4.5 |
| Adjusted Rate (%) | 4.0 | 4.5 | 4.5 | 4.5 |
| Adjusted Risk Ratio (95% CI) | 1.0 | 1.1 | 1.0 | 1.0 |

Table 2. Total Demographics

| Demographic Category | Number | Percentage (%) |
|----------------------|-------------|----------------|
| Total Population | 12,026 | - |
| Average Age | 61.9 ± 13.1 | - |
| Sex | | |
| Male | 5,616 | 45 |
| Female | 6,410 | 55 |
| Hypertension | 7,000 | 60 |
| Heart Failure | 655 | 7 |
| Obesity | 4,526 | 36 |
| COOP | 2,878 | 24 |

Table 3. Unadjusted 90-Day Major Complications by HbA1c Stratification

| HbA1c Stratum | Number | Percentage (%) |
|---------------|--------|----------------|
| 4.5-5.4 | 484 | 4.0 |
| 5.5-7.9 | 504 | 4.5 |
| 8.0+ | 530 | 4.5 |

Table 4. Matched 90-Day Major Complications by HbA1c Stratification

| HbA1c Stratum | Number | Percentage (%) |
|---------------|--------|----------------|
| 4.5-5.4 | 484 | 4.0 |
| 5.5-7.9 | 484 | 4.0 |
| 8.0+ | 484 | 4.0 |

Table 5. Matched 90-Day Major Complications by Same-Day Serum Glucose Stratification

| Same-Day Serum Glucose Stratum | Number | Percentage (%) |
|--------------------------------|--------|----------------|
| 60-159 | 4,000 | 33 |
| 160-239 | 4,000 | 33 |
| 240+ | 4,000 | 33 |

Table 6. Unadjusted 90-Day Major Complications by Same-Day Serum Glucose Stratification

| Same-Day Serum Glucose Stratum | Number | Percentage (%) |
|--------------------------------|--------|----------------|
| 60-159 | 4,000 | 33 |
| 160-239 | 4,000 | 33 |
| 240+ | 4,000 | 33 |