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# Insulin dependence as an independent predictor of perioperative morbidity after ventral hernia repair: a National Surgical Quality Improvement Program analysis of 45,759 patients

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## Abstract

**BACKGROUND:** Although diabetes mellitus has been identified as a predictor of perioperative morbidity after ventral hernia repair (VHR), it is unclear whether insulin-dependent diabetes mellitus (IDDM) and non–insulin-dependent diabetes mellitus (NIDDM) confer the same degree of risk. We examined the variable effect of IDDM and NIDDM on 30-day medical and surgical complications after VHR.

**METHODS:** We performed a retrospective analysis of patients in the National Surgical Quality Improvement Program database from 2005 to 2012 undergoing VHR. After perioperative variable comparison, regression analysis was performed to determine whether IDDM and/or NIDDM independently predicted increased complications after proper risk adjustment.

**RESULTS:** A total of 45,759 patients were identified to have undergone VHR. Of these, 38,026 patients (83.1%) were not diabetic, 5,252 (11.5%) were NIDDM patients, and 2,481 (5.4%) were IDDM patients. After controlling for other risk factors, we found that IDDM independently predicted increased rates of overall, surgical, and medical complications (odds ratio, 1.284, 1.251, 1.263, respectively) in open repair. IDDM independently predicted increased overall and medical complications (odds ratio, 1.997, 1.889, respectively) but not surgical complications in laparoscopic repair. NIDDM was not significantly associated with any complication type in either procedure type.

**CONCLUSIONS:** Our present study suggests that much of the perioperative risk associated with diabetes is attributable to IDDM. The effect of IDDM on laparoscopic and open repair is subtly different. IDDM demonstrates increased overall and medical complications in laparoscopic repair and increased

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Ethical approval: De-identified patient information is freely available to all institutional members who comply with the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Data Use Agreement. The Data Use Agreement implements the protections afforded by the Health Insurance Portability and Accountability Act of 1996 and the ACS-NSQIP Hospital Participation Agreement and conforms to the Declaration of Helsinki.

Disclaimer: The NSQIP and the hospitals participating in the NSQIP are the source of the data used herein; they have not been verified and are not responsible for the statistical validity of the data analysis, or the conclusions derived by the authors of this study.

The authors declare no conflicts of interest.

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overall, medical, and surgical complications in open repair. Of note, IDDM does not independently predict increased risk for surgical complications in laparoscopic repair.
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Ventral hernia repair (VHR) is a high-volume surgery that can be accomplished through an open or laparoscopic approach. The outcomes of VHR have been well documented.[1–5] In 2010, the Ventral Hernia Working Group (VHWG) published a tool that aimed to stratify patients undergoing incisional VHR into 4 classes based on their risk of surgical site infections (SSIs) and surgical site occurrence (SSO).[6] Diabetes mellitus (DM) was one of the several comorbidities implicated by the VHWG to be associated with increased risk of postoperative SSI or SSO based on previous reports linking DM to increased SSI.[7–9] Given the high prevalence of this procedure, the recent emphasis on preoperative risk stratification, and new tools available to assist with outcomes-based decision-making, re-evaluation of previously established risk factors is possible. Such evolving analysis is necessary to advance efforts to reduce patient morbidity and its associated economic burden to hospitals.

The underlying disease etiology of DM has been attributed to increased surgical risk in other fields. For example, hematologic and wound healing abnormalities have been previously documented in diabetic patients.[10,11] DM, as captured by the National Surgical Quality Improvement Program (NSQIP) database by the American College of Surgeons (ACS), is categorized into insulin-dependent DM (IDDM) and non–insulin-dependent DM (NIDDM). We propose that NIDDM and IDDM should be interpreted as a marker of type 2 DM disease severity. Given that only 5% of all diabetic patients are type 1, the IDDM cohort is likely to predominantly reflect sicker type 2 diabetes with a few type 1 diabetes, whereas the NIDDM cohort comprises type 2 diabetes only with lesser disease severity.

The previous literature implicating DM as a risk factor for VHR is limited by small sample sizes or an inability to differentiate between IDDM and NIDDM. To our knowledge, no one has performed a robust, retrospective analysis on the variable effect of IDDM and NIDDM on outcomes after open and laparoscopic VHR. To this end, we have performed a risk-adjusted analysis on data acquired from the ACS-NSQIP to determine whether insulin dependence and disease severity of DM, as indicated by the surrogate labels of NIDDM and IDDM, independently predict increased risk of perioperative morbidity after VHR.

## Methods

### Population

We performed a retrospective analysis of patients in the NSQIP database, which was instituted by the ACS in 2004 and provides comprehensive information for major surgical procedures at more than 240 institutions across the United States. The details of the ACS-NSQIP data collection methods have previously been described in detail and validated.[12,13] Data files from 2005 to 2012 were reviewed to collect data on all patients undergoing VHR during that period. All patients who underwent ventral or incisional hernia repair were selected from the database based on primary *Current Procedural Terminology* (CPT) codes and postoperative *International Classification of Diseases, Ninth Revision* (ICD-9) diagnoses codes. The following primary CPT codes were included: 49560, 49561, 49565, 49566, 49568, 49570, 49572, 49580, 49582, 49585, 49587, 49590, 49652, 49653, 49654, 49655, 49656, 49657, and 49659. Patients who underwent multiple procedures, identified by the presence of other or concurrent CPT codes 15734 (component separation) or 49568 (use of mesh), were included. Finally, the following ICD-9 codes were used to select only those patients whose postoperative diagnosis was a ventral or incisional hernia: 551.2, 551.21, 551.29, 552.2, 552.21, 552.29, 553.2, 553.21, and 553.29. Any patient with an ICD-9 other than those listed was excluded. Patients with a primary CPT code of 49652, 49653, 49654, 49655, 49656, 49657, or 49659 were considered to have undergone a laparoscopic procedure. Patients were initially grouped by the procedure type (open vs laparoscopic) and then stratified according to diabetic status (not diabetic, NIDDM, and IDDM) for comparison of perioperative variables and covariate screening.

### Variables

NSQIP-defined preoperative variables were compared among the respective cohorts. They included demographic variables (eg, age, body mass index class); lifestyle variables (eg, smoking) and medical comorbidities (eg, diabetes, dyspnea, hypertension, chronic obstructive pulmonary disease, congestive heart failure, bleeding disorders, prior angioplasty or cardiac surgery, previous stroke or transient ischemic attack, radiotherapy within 90 days of operation, chemotherapy within 30 days of operation, previous operations within 30 days of operation). Tracked outcomes were categorized as surgical complications, medical complications, and overall complications. Surgical complications included superficial, deep, or organ-space SSI and wound disruption. Medical complications included deep venous thrombosis, pulmonary embolism, unplanned reintubation, ventilator dependence greater than 48 hours, progressive renal insufficiency, acute renal failure, coma, stroke, cardiac arrest, myocardial infarction, peripheral nerve injury, pneumonia, urinary tract infection, blood transfusions, graft prosthesis, flap failure, and sepsis septic shock. All morbidities were used as defined in the