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## Perioperative complications increase the risk of venous thromboembolism following bariatric surgery

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### ABSTRACT

**Background:** Morbidly obese patients are at increased risk of venous thromboembolism (VTE) following surgery. This study explores the impact of a perioperative complication on the risk of VTE after bariatric surgery.

**Methods:** Patients who underwent bariatric surgery were identified from the American College of Surgeons National Surgical Quality Improvement Program dataset (2012–2014). The 17 most common perioperative complications were analyzed by multivariate regression analysis to determine the effect of complications on the risk of VTE.

**Results:** The postoperative incidence of VTE was 0.5% (n = 59,424 bariatric surgeries). The average time to diagnosis of VTE was 11.6 days. 80% of VTE events occurred after discharge. A major complication occurred prior to VTE in 22.6% of patients. The more complications experienced by an individual patient, the more likely they were to experience VTE. Unadjusted thirty-day mortality increased 13.89-fold following VTE (p < 0.0001).

**Conclusions:** Postoperative complications significantly increase the risk of VTE following bariatric surgery.

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### 1. Introduction

Venous thromboembolism (VTE) includes deep venous thrombosis (DVT) and pulmonary embolus (PE). Prior to the widespread use of VTE prophylaxis, PE occurred in approximately 5% of all general surgery patients, with 0.1–0.8% mortality related to these events.<sup>1–4</sup> VTE leads to more than 250,000 hospitalizations annually in the United States and is implicated in over 100,000 deaths each year.<sup>5</sup> About one third of all deaths related to VTE occur after surgical procedures.<sup>6</sup> VTE has the potential to result in significant morbidity and mortality, particularly when the event occurs outside of the hospital and potentially life-saving interventions are delayed.

With the rate of obesity in the United States increasing, bariatric surgical procedures have become commonplace. In 2013 alone, an estimated 180,000 bariatric procedures took place in the United States.<sup>7</sup> PE is the second leading cause of mortality in perioperative bariatric surgery patients and is the likely cause of 40% of all deaths

within the first 30 days after surgery. It has long been reported that morbidly obese patients are at an increased risk of VTE following bariatric surgery. In a recent study, Finks et al. found that every 10-unit increase in body mass index (BMI) resulted in a 37% increase in a patient's risk of developing a VTE following bariatric surgery.<sup>8</sup>

Most bariatric surgery programs in the current era have VTE prophylaxis protocols in place. A recent position statement on prophylactic measures to decrease the risk of VTE in bariatric surgery patients published by the American Society of Metabolic and Bariatric Surgery (ASMBS) cites an incidence of PE between 0 and 6.4%.<sup>9</sup> There are certain patient-specific factors that are associated with a higher risk for a perioperative VTE event. The risk factors identified in the ASMBS position statement are for the most part not easily modifiable prior to surgery (high BMI, advanced age, immobility, prior VTE, known hypercoagulable condition, obesity hypoventilation syndrome, pulmonary hypertension, venous stasis disease, hormonal therapy, expected long operative time or open approach, and male gender). In patients deemed to be high risk prior to surgery, tactics such as more aggressive chemoprophylaxis and extended chemoprophylaxis after discharge are commonly employed. The relationship of a postsurgical complication (other than VTE) on a patient's risk for a subsequent VTE is unknown.

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Using a large national database, we sought to determine the association between perioperative complications and subsequent VTE events after bariatric surgery.

## 2. Methods

The American College of Surgeons (ACS) National Surgical Quality Improvement Program (NSQIP) participant use file datasets from 2012, 2013, and 2014 were queried for patients with a BMI greater than or equal to 30 kg/m<sup>2</sup> who underwent the following bariatric procedures: Roux-en-Y gastric bypass (CPT 43644, 43645, or 43846), sleeve gastrectomy (CPT 43775 or 43843), biliopancreatic diversion (BPD) (CPT 43845), and bariatric revision surgery (CPT 43848, 43860, or 43865). The ACS NSQIP datasets contain prospective risk-stratified data with information on patient demographics, operative information, and postoperative complications through 30-days after surgery. Information is entered in NSQIP by a certified clinical nurse reviewer and audited for accuracy.

Within the NSQIP datasets there were 1,945,772 total cases present, of which 61,512 cases were identified as meeting initial inclusion criteria based on the primary procedure's CPT code (Fig. 1). Patients were excluded from analysis if they presented with any of the following: age greater than or equal to 90 years (n = 4), BMI <30 kg/m<sup>2</sup> (n = 985), disseminated cancer (n = 22), primary surgery classified as an emergency (n = 184), primary procedure classified as non-elective (n = 688), unrelated concurrent surgery (n = 51), previous operation within the past 30-days (n = 7), American Society of Anesthesiologists (ASA) Class V (n = 1), or diagnosis of preoperative sepsis or systemic inflammatory response syndrome (SIRS) (n = 150). Our final study cohort included 59,424 patients. Only the cases in which sufficient information related to the timing of a thrombosis event in relation to a patient's hospital stay were used in these calculations. Five patients were excluded from analyses due to insufficient information.

All included VTE events took place within 30-days of the initial bariatric procedure and involved a PE, DVT, or both. The diagnosis of DVT in NSQIP requires the patient be diagnosed with a 'new' DVT that is confirmed by a definitive imaging modality such as a CT scan, venogram, or duplex ultrasonography. The DVT must also be treated with a vena cava filter, anticoagulation, or both. Patients who refuse warranted treatment are also classified in NSQIP as having been diagnosed with a DVT. PE was defined as the lodging of a new blood clot in the pulmonary artery that results in obstruction of blood supply to the lung parenchyma within 30-days of the initial bariatric procedure. The patient must have also had a V-Q scan interpreted as "high probability of PE" or positive *trans-esophageal* echocardiogram, CT-scan, pulmonary arteriogram, CT-angiogram, or other definitive imaging modality which includes direct pathology examination (i.e. autopsy). The total number of days from the initial bariatric procedure to the DVT or PE event were recorded and subgroup analyses, grouping the timing of the VTE event based on whether it occurred prior to discharge or after discharge from the initial hospital stay were performed to assess factors contributing to early versus late VTE. In instances where the hospital length of stay or post-operative day of thrombotic event was unavailable, the case was removed from subgroup analyses (n = 5).

Seventeen of the most common perioperative complications were examined including: wound dehiscence, superficial, deep incisional and organ space surgical site infection (SSI), reintubation within 48-h of surgery, failure to wean from the ventilator, pneumonia, sepsis, septic shock, blood transfusion, cardiac arrest, myocardial infarction, ischemic stroke, reoperation, progressive renal insufficiency, acute renal failure, and urinary tract infection. Gastrointestinal or anastomotic leak is not a specific complication that is tracked in NSQIP, but these patients likely experience a combination of events including deep organ space infection, sepsis/septic shock, and/or reoperation. Descriptive statistics were calculated for demographic information including BMI, age, sex, race, presence of metabolic syndrome, current steroid use, history of a bleeding disorder, chronic obstructive pulmonary disease, congestive heart failure, diabetes, and smoking status. Metabolic syndrome was defined as the presence of diabetes and hypertension in patients with a BMI >30 kg/m<sup>2</sup>. Perioperative details analyzed included ASA classification, the specific bariatric procedure performed, total operating time, postoperative length of stay, and whether the patient had a blood transfusion while in the operating room or within 72-h following the end of the procedure. To assess the impact of perioperative bleeding on the development of a VTE, we assessed the ACS NSQIP variable for blood transfusions, which is defined as the administration of one unit of packed, or whole red blood cells from the time of surgical incision through 72-h following the end of the procedure.

This study was approved by the Medical College of Wisconsin Institutional Review Board (Milwaukee, Wisconsin). SPSS, version 21 (IBM Corp) was used for all statistical analyses. Descriptive statistics for all categorical data was analyzed with Chi-square or Fisher's exact tests, while a Student's *t*-test or Mann-Whitney *U* test were used for the analysis of continuous data. Univariate and multivariate regression analyses were used to determine the effect of postoperative complications on the risk of VTE. The only exception was mortality, in which the degree to which VTE was predictive of 30-day mortality was calculated. All analyses were 2-sided and a p-value of 0.05 was considered significant.

## 3. Results

Of 59,424 included patients, the VTE incidence was 0.5% (PE 0.2%, DVT 0.3%, n = 284). The average time to diagnosis of DVT was

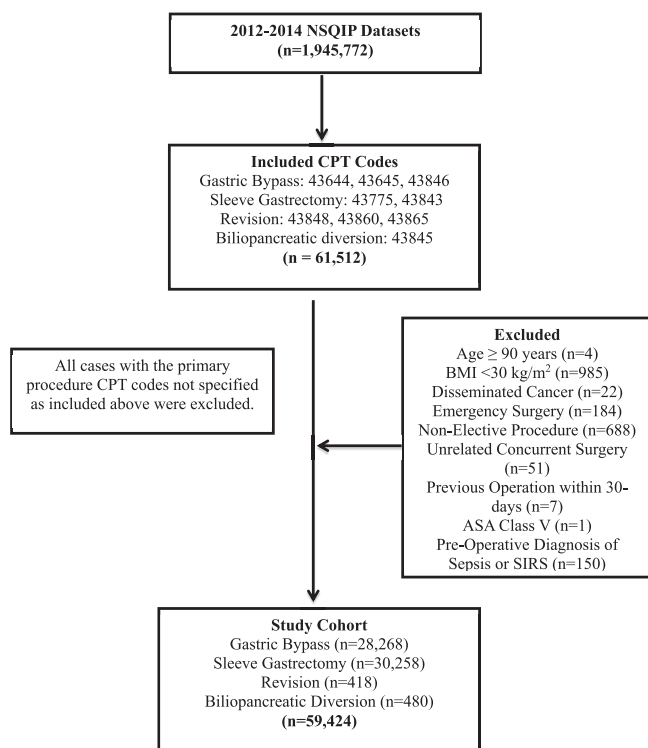


Fig. 1. Flow diagram of case selection.

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