From the Society for Clinical Vascular Surgery

Index complications predict secondary complications after infrainguinal lower extremity bypass for critical limb ischemia

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ABSTRACT

Objective: Patients undergoing lower extremity bypass (LEB) are at high risk of perioperative complications that can lead to a cascade of secondary complications. Our goal was to understand the association of index complications with secondary complications after LEB.

Methods: The American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database from 2005 to 2012 was used to analyze secondary complications after five index complications after LEB: deep/organ space surgical site infection, urinary tract infection (UTI), myocardial infarction (MI), pneumonia, and acute renal failure (ARF). Index cohorts were developed with 5:1 propensity matching for comparison. This score was based on preoperative variables and event-free days.

Results: We evaluated 20,230 LEB patients. Postoperative index surgical site infection increased the risk of secondary ARF (odds ratio [OR], 4.0; 95% confidence interval [CI], 1.1-15.0), pneumonia (OR, 2.7; 95% CI, 1.0-7.4), UTI (OR, 3.1; 95% CI, 1.3-7.5), cardiac arrest (OR, 4.4; 95% CI, 1.6-12.2), wound disruption (OR, 10.5; 95% CI, 6.7-16.6), unplanned intubation (OR, 5.1; 95% CI, 2.0-12.8), prolonged ventilation (OR, 5.9; 95% CI, 2.0-17.6), sepsis (OR, 16.2; 95% CI, 10.2-25.6), and mortality (OR, 3.5; 95% CI, 1.7-7.1). Postoperative index UTI was associated with pneumonia (OR, 5.6; 95% CI, 2.7-11.6), sepsis (OR, 7.8; 95% CI, 5.1-11.8), and mortality (OR, 2.7; 95% CI, 1.3-5.3). Postoperative index MI was associated with secondary ARF (OR, 8.7; 95% CI, 3.8-20.1), pneumonia (OR, 4.9; 95% CI, 2.7-8.8), cardiac arrest (OR; 7.4; 95% CI; 4.0-13.5), deep venous thrombosis (OR, 3.9; 95% CI, 1.7-9.1), unplanned intubation (OR, 12.2; 95% CI, 7.3-20.3), prolonged intubation (OR, 12.2; 95% CI, 6.4-23.2), sepsis (OR, 2.2; 95% CI, 1.2-3.8), and mortality (OR, 5.6; 95% CI, 3.6-8.5). Postoperative index pneumonia was associated with secondary ARF (OR, 25.5; 95% CI, 3.0-219.3), MI (OR, 7.6; 95% CI, 3.2-18.0), UTI (OR, 4.3; 95% CI, 2.0-9.0), cardiac arrest (OR, 5.2; 95% CI, 2.0-13.2), deep venous thrombosis (OR, 7.7; 95% CI, 2.1-27.4), unplanned intubation (OR, 14.7; 95% CI, 8.3-26.1), prolonged ventilation (OR, 26.0; 95% CI, 11.8-56.9), sepsis (OR, 7.2; 95% CI, 4.0-12.8), and mortality (OR, 6.0; 95% CI, 3.7-10.0). Last, postoperative index ARF was associated with increased risk of secondary pneumonia (OR, 7.16; 95% CI, 2.6-20.0), cardiac arrest (OR, 15.5; 95% CI, 1.6-150.9), unplanned intubation (OR, 6.2; 95% CI, 2.3-16.8), prolonged ventilation (OR, 8.8; 95% CI, 3.4-22.4), and mortality (OR, 8.8; 95% CI, 3.4-22.4).

Conclusions: A postoperative index complication after LEB is significantly more likely to lead to serious secondary complications. Prevention and early identification of index complications and subsequent secondary complications could decrease morbidity and mortality. (J Vasc Surg 2016;■:1-10.)

Postoperative morbidity and mortality depend on the occurrence of not only an index complication but also the potential subsequent secondary complications.[1,2] Index complications have been shown to increase secondary complications, leading to increased morbidity and mortality.[3,4] Previous analysis from many different surgical specialties of patients undergoing elective inpatient surgical procedures have identified index complications linked to secondary complications in a general surgical population.[5] Identifying potential secondary complications associated with an index complication could allow earlier recognition and intervention, thereby decreasing morbidity and mortality.[6]

Patients with critical limb ischemia undergoing lower extremity bypass (LEB) are at high risk for morbidity and mortality.[7,8] These patients can be difficult to rescue after an initial complication because it can lead to a cascade of subsequent complications. Evaluation of secondary complications has not been examined in patients undergoing vascular surgery operations. Establishing how index complications affect the pattern and risk of secondary

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Author conflict of interest: none.

Presented as a Plenary Presentation at the Forty-fourth Annual Symposium of the Society for Clinical Vascular Surgery, Las Vegas, Nev, March 12-16, 2016.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the JVS policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

0741-5214

http://dx.doi.org/10.1016/j.jvs.2016.10.096

complications in this high-risk population can potentially help with their earlier identification and treatment.

We queried the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) to analyze the associations of secondary complications with five index complications: surgical site infection (SSI), urinary tract infection (UTI), myocardial infarction (MI), pneumonia, and acute renal failure (ARF). The goal of this study was to identify the pattern of secondary complications associated with index complications after LEB to establish baseline rates for quality improvement and to provide objective data for patients, their families, and surgeons.

ARTICLE HIGHLIGHTS

- **Significance:** This study investigated the association of index complications with secondary complications after lower extremity bypass procedures.
- **Type of Research:** Retrospective analysis of prospectively collected data of the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) registry
- **Take Home Message:** In patients undergoing infrainguinal bypass, the occurrence of surgical site infection, myocardial infarction, pneumonia, urinary tract infection, or acute renal failure predicts a high incidence of secondary complications and mortality.
- **Recommendation:** The authors' data suggest that protocols to decrease index complications should be developed because these will likely decrease secondary complications after lower extremity bypass procedures.
- **Strength of Recommendation:** 2. Weak
- **Level of Evidence:** B. Moderate

METHODS

Selection of patients. The ACS NSQIP database is a clinical registry that uses trained reviewers to provide a multicenter database of prospective data. It includes risk-adjusted outcomes using standardized definitions for surgical quality improvement. Details relating to data gathering have been well described.[9,10] The NSQIP data include patient demographics, preoperative risk factors, operative details, length of stay, and 30-day postoperative morbidity and mortality for specified surgical procedures. We identified patients undergoing infrainguinal LEB from 2005 to 2012 in the ACS NSQIP Participant Use Data files. Current Procedural Terminology (American Medical Association, Chicago, Ill) coding for the primary procedure was used to identify LEB procedures for critical limb ischemia, including 35556, 35566, 35570, 35571, 35583, 35585, 35587, 35656, 35666, and 35671. Patients without complete variable data were excluded from the analysis. Index SSI, UTI, MI, pneumonia, and ARF were chosen as common postoperative LEB complications as they have previously been used for analyses on secondary complications.[5] The outcomes used in this study were complications that occur after an index complication; 13 complications occurring after the day of the index complication were analyzed. The secondary complications included MI, cardiac arrest, pneumonia, deep venous thrombosis (DVT), pulmonary embolism, unplanned intubation, being on a ventilator longer than 48 hours, wound disruption, deep/organ space SSI, sepsis, UTI, ARF, and mortality. Institutional Review Board approval from Boston University was obtained and patient consent was waived. The ACS NSQIP and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

Statistical analysis. An index event was defined as the first postoperative complication to occur; a secondary complication was defined as a complication that occurred after the index complication. The NSQIP has time to event data that we used to determine the timing of index and secondary complications. We identified five cohorts of patients with corresponding index complications as index cohorts. To analyze the risk of subsequent secondary complications after an index event, the outcomes of patients with similar demographics and comorbidities with and without index events were compared. To that end, a matched cohort was created for each index event cohort. Our matching strategy was similar to one described by Wakeam et al, but with several modifications.[5] First, a propensity score was calculated for each patient in the original sample for the propensity to experience each of the five index complications in this study. The score was based on the demographic and comorbidity data available in the NSQIP (Table I). Second, time of the first complication was considered for each patient to ensure complication-free follow-up until the date of the index event for the pull of the possible index event-free matches. Therefore, matching was based on both the propensity score to have the index complication and the event-free days. Matched cohorts were created for each index event cohort in a 5:1 ratio. The comorbidity and demographics of the matched cohorts were compared to analyze the success of matching (Table I). For each type of index complication, patients with the other four index complications were considered potential controls as long as time to their index complication was longer than the time to the index complication of interest in the corresponding case.

The unadjusted rates of complications between the matched cohorts for each index complication were compared using logistic regression. The effects of index events were expressed as odds ratios (ORs) with