From the Society for Vascular Surgery

Contributions of planned readmissions and patient comorbidities to high readmission rates in vascular surgery patients

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Objective: **Administrative data show that among surgical patients, readmission rates are highest in vascular surgery. Herein we analyze the contribution of planned readmissions and patient comorbidities to high readmission rates in vascular surgery.**

Methods: **The 2012 to 2014 American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) data set was analyzed for overall and unplanned readmissions. Bivariable and multivariable risk adjustment analyses were performed using patient comorbidities to compare risks of overall and unplanned readmissions in vascular surgery compared with other specialties.**

Results: **Among 1,164,421 surgical patients, 86,403 underwent a vascular operation (other specialties included general surgery, 587,829 [51%]; orthopedic surgery, 211,507 [18%]; gynecology, 82,771 [7%]; urology, 62,153 [5%]; neurosurgery, 55,030 [4.7%]; plastic surgery, 32,318 [3%]; otolaryngology, 31,070 [2.6%]; and thoracic surgery, 15,340 [1%]). Incidence of 30-day readmission was 10.2% for vascular and 5.5% for other specialties ($P < .0001$). Planned readmissions were more frequent for vascular than for other specialties (8.8% vs 5.4%; $P < .0001$). In unadjusted analysis, vascular patients had significantly greater risk for overall readmission (odds ratio [OR], 1.97; 95% confidence interval [CI], 1.93-2.02; $P < .0001$) and unplanned readmission (OR, 1.89; 95% CI, 1.84-1.93; $P < .0001$) compared with other specialties. In bivariable analysis, vascular patients were older (67 ± 13 vs 56 ± 17 years) and had more comorbidities such as diabetes (31% vs 14%), dialysis dependence (6.3% vs 0.9%), American Society of Anesthesiology class III/IV status (84% vs 41%), and many others (all $P < .0001$). After risk adjustment for baseline differences between groups, vascular patients had a marginally greater overall risk of readmission compared with other specialties (OR, 1.04; 95% CI, 1.01-1.07; $P < .0001$), but the risk of unplanned readmission was not significantly different (OR, 0.98; 95% CI, 0.95-1.01; $P = .13$).**

Conclusions: **Incidence of 30-day readmission after vascular surgery appears high, but after account for planned readmissions and risk adjustment, the risk of unplanned readmission is similar to that in other surgical patients. Thus, the use of readmission rate as a quality measure must account for more frequent planned vascular readmissions and patient-specific differences between vascular surgery and other specialties. (J Vasc Surg 2016;63:746-55.)**

Hospital readmissions are increasingly used as a health care quality metric. The Patient Protection and Affordable Care Act of 2010 established the Hospital Readmissions Reduction Program, which requires the Centers for Medicare and Medicaid Services (CMS) to penalize hospitals for excessive readmission.[1] In 2013, the CMS began to penalize hospitals for excess readmissions for three medical conditions: acute myocardial infarction, heart failure, and pneumonia. In 2015, the list of conditions expanded to include readmissions in surgical patients after total knee and hip arthroplasties.[2] In 2017, the CMS plans to target readmissions after coronary artery bypass surgery.[3] This penalty list now includes five of the seven conditions associated with the most frequent and highest cost readmissions reported to the United States Congress by the Medicare Payment Advisory Commission in 2007.[4] The remaining two conditions not yet penalized are percutaneous transluminal coronary angioplasty and a category labeled "other vascular" procedures.[4]

Thus, vascular surgical procedures might soon be included in hospital penalties for excess readmissions. Vascular surgery patients have been found to have some of the highest readmission rates recorded in administrative databases. For example, in the Medicare population, the overall 30-day readmission rate for vascular surgical patients is quite high at 24%,[5] and these readmissions cost

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more on a per readmission basis than any other condition studied, including coronary artery bypass surgery.[4] However, such statistics on the basis of administrative data might not be accurate because they do not account for planned readmissions and readmissions not related to the index procedure.[6] Furthermore, some studies have found that administrative data are inaccurate in recording true readmission rates.[6,7]

It would be imperative to determine accurate rates of readmission in vascular surgery patients and examine the reasons for the published high readmission rates. Although critical to appropriate policy-making, investigation of readmissions in vascular surgery might also provide an opportunity to improve the quality of care delivered by vascular surgeons because readmissions in surgical patients have been thought to reflect inferior quality of care.[8] In this report, we examine readmissions in vascular surgery patients in the large clinical American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database and investigate the reasons behind increased readmission rates in vascular surgery patients.

METHODS

Data source. We used data from the ACS NSQIP Participant User File (PUF) on all procedures recorded for the years 2012 to 2014. The ACS NSQIP is a national surgical quality improvement program that collects preoperative patient variables, operative data, and 30-day postoperative outcomes (including readmissions) for patients who undergo major surgeries at participating hospitals.[9-12] Dedicated, trained personnel at each participating center collect the data. Postoperative outcomes are determined through chart review and mail or telephone contact with patients and families 30 days after the index operation. Hospitals are audited to ensure quality of data collection.[13] Academic medical centers and community hospitals participate in the ACS NSQIP, although the specific distribution of provider types and case volume is not available for analysis. Data are collected on surgeries performed by surgeons in nine different specialties: general, vascular, orthopedic, thoracic, plastic, urology, otolaryngology, gynecology, and neurosurgery. The frequency distribution of surgical specialty patients in the ACS NSQIP was as follows: general surgery, 587,829 (51%); orthopedic surgery, 211,507 (18%); vascular surgery, 86,403 (7%); gynecology, 82,771 (7%); urology, 62,153 (5%); neurosurgery, 55,030 (4.7%); plastic surgery, 32,318 (3%); otolaryngology, 31,070 (2.6%); and thoracic surgery, 15,340 (1%). The frequency distribution of vascular surgical procedures is shown in Supplementary Table I (online only).

The ACS NSQIP subdivides readmissions into planned or unplanned. The ACS NSQIP defines planned readmission as a readmission that is planned at the time of the index procedure. The specific reasons for such planned readmission are not recorded in the database. The ability of the ACS NSQIP to differentiate between planned and unplanned readmissions has been previously validated.[14] Unplanned readmissions are further subdivided into unplanned readmissions related to the principal procedure and unplanned readmissions unrelated to the principal procedure. There are no planned readmissions unrelated to the principal procedure in the ACS NSQIP.

The ACS NSQIP and participating hospitals are the source of these data; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors. Our research protocol was reviewed by the Colorado Multiple Institutional Review Board, who determined that it was not human subject research because of the use of a completely deidentified database. Requirement for patient consent was waived because this was a retrospective review of a completely deidentified national database.

Primary outcome. The primary outcome variable was hospital readmission to the same or another hospital that was unplanned at the time of the index procedure and occurred within 30 days of the index procedure. We also analyzed all readmissions and unplanned readmissions related to the principal procedure as coded in the database.

Statistical analyses. We used our research experience and clinical judgement on the basis of existing literature regarding risk factors for readmission to select the preoperative variables considered as potential predictors for 30-day postoperative unplanned hospital readmission in ACS NSQIP.[15-17] These included three demographic variables (sex, age, race and/or ethnicity), 18 preoperative comorbidities, three variables related to the surgery (emergency, inpatient vs outpatient status, and work relative value unit [RVU]), and three other variables (American Society of Anesthesiology [ASA] physical status classification, functional health status, and transfer status). We excluded laboratory values from our analysis, because they have not been shown to be risk factors for readmission, and we had previously found that inclusion of laboratory values did not improve the predictive ability of a preoperative model for unplanned readmission (Glebova et al, unpublished data). We did not include postoperative complications because we specifically wanted to examine patient characteristics as risk factors for readmission.

We excluded 1.8% of patients because of missing values for some of the predictor variables, or for data quality issues with the primary outcome variable (patients reported with an unplanned readmission >30 days after the index procedure, or having a second readmission but not a first readmission; Fig). Two important preoperative variables (race and/or ethnicity and body mass index) had significant percentages of missing values. Therefore, a category labeled "missing" was created for these variables along with the given categories of these variables. We also excluded 0.8% patients who died before discharge on the basis of the "destination: expired" variable and date of death recorded as previous to the date of discharge from the hospital.

The bivariable association between each of these 27 preoperative variables and 30-day unplanned readmissions was tested using a χ^2 test for categorical predictor variables and an unpaired *t*-test for continuous variables. Multivariable risk-adjusted regression analysis was performed to