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The association of perioperative transfusion with 30-day morbidity and mortality in patients undergoing major vascular surgery

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Objective: **Blood transfusions are common among patients undergoing major vascular surgery. Prior studies suggest an association between blood transfusion and increased morbidity and mortality among patients undergoing cardiac surgery. The predictors of perioperative transfusion and its impact on patients undergoing vascular surgery have been poorly defined.**

Methods: **We examined data from a large multicenter quality improvement vascular surgical registry of all patients undergoing elective or urgent open peripheral arterial disease procedures, endovascular aneurysm repair, or open abdominal aortic aneurysm (AAA) repair between January 2012 and December 2013. Emergency cases, carotid endarterectomy, and carotid artery stenting were excluded. Univariate and multivariate logistic regression modeling was used to identify predictors of transfusion and association of transfusion with outcomes. All regression models had Hosmer-Lemeshow $P > .05$ and area under the receiver operating characteristic curve of >0.8, confirming excellent goodness of fit and discrimination.**

Results: **Our study population comprised 2946 patients who underwent open peripheral arterial disease procedures (n = 1744), open AAA repair (n = 175), or endovascular aneurysm repair (n = 1027) at 22 hospitals. The overall transfusion rate was 25%, at a median nadir hemoglobin level of 7.7 g/dL. Independent factors predicting transfusion included female gender (odds ratio [OR], 2.6; 95% confidence interval [CI], 2.1-3.2), nonwhite race (OR, 2.7; 95% CI, 1.4-5.2), preoperative admission status (ie, acute care hospital) (OR, 2.6; 95% CI, 1.3-5.3), preoperative anemia (OR, 4.2; 95% CI, 3.3-5.1), congestive heart failure (OR, 1.4; 95% CI, 1.1-1.9), prior myocardial infarction (OR, 1.3; 95% CI, 1.01-1.6), clopidogrel (OR, 1.4; 95% CI, 1.2-1.8), open AAA repair (OR, 25; 95% CI, 17-39), open bypass (OR, 3.5; 95% CI, 2.7-4.6), and urgent procedures (OR, 1.4; 95% CI, 1.1-1.8). With adjustment for major covariates, perioperative transfusion was independently associated with death (OR, 6.9; 95% CI, 3.2-15), myocardial infarction (OR, 8; 95% CI, 3.7-17), and pneumonia (OR, 7.4; 95% CI, 3.3-17).**

Conclusions: **Perioperative transfusion in vascular surgical patients is independently associated with increased 30-day morbidity and mortality. Given indeterminate causation, these data suggest the need for a prospective transfusion threshold study in vascular surgical patients. (J Vasc Surg 2015;61:1000-9.)**

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Intraoperative blood loss, perioperative anemia, and postoperative blood transfusion are all common occurrences in patients undergoing major vascular surgery.[1] The same atherosclerotic disease process that mandates operative intervention in this population also increases risk for postoperative mortality and other adverse cardiac and vascular events.[2] The factors predictive of a transfusion administration are difficult to quantify, given variability in patients, symptoms, and physician preferences and thresholds. A study of percutaneous coronary interventions found that patients who were older, women, hypertension, diabetes, and renal insufficiency were associated with transfusions.[3]

Blood transfusions are associated with considerable expense[4] and may contribute to major morbidity, such as surgical site infections and other infections, such as pneumonia and sepsis.[5-7] Some data suggest that patients with coronary artery disease have improved outcomes with restrictive transfusion[8] and that vascular surgery patients

may benefit from limiting of transfusions.[9] Other populations of patients at high cardiovascular risk have experienced similar reduced morbidity and mortality with restrictive transfusion guidelines,[8,10-12] calling into question the wisdom of liberal perioperative blood transfusions for vascular surgery patients.

Conversely, maintaining a more physiologic hemoglobin (Hgb) level may decrease myocardial stress secondary to tachycardia required to maintain tissue oxygenation, possibly reducing perioperative myocardial morbidity. In some studies, lower triggers for blood transfusion in "at-risk" populations, such as those with preoperative anemia,[13] reduced cardiac reserve,[14] and >500 mL of blood loss,[15] have been associated with improved outcomes, including reduced mortality. Thus, these divergent results suggest that anemia and subsequent transfusion may benefit some medical populations and harm others.

This study was undertaken to evaluate among a broad, modern, real-world population of patients undergoing major vascular surgery (1) preoperative predictors of perioperative transfusion and (2) the effect of perioperative blood transfusion on postoperative morbidity and mortality.

METHODS

Study design. A large multicenter statewide quality improvement registry served as the data source for this study. Patient demographic, diagnostic, operative, and transfusion data were collected prospectively by trained nurse abstractors. The Blue Cross Blue Shield of Michigan Cardiovascular Consortium Vascular Intervention Collaborative (BMC2 VIC) registry and waiver of patient consent either have been approved by or the need for approval waived by the Institutional Review Board at each of the participating hospitals. The University of Michigan has waived the need for Institutional Review Board approval on all data analysis, given that all data are anonymous and no patient identifiers are collected.

Patient population. A 22-hospital consortium in Michigan collected prospective data on patients undergoing elective vascular surgical procedures with 30-day outcomes. The details of the BMC2 VIC program have been described previously.[16-18] Supported by Blue Cross Blue Shield of Michigan, BMC2 VIC is a prospective, multicenter observational registry designed to collect information on patients undergoing vascular surgery procedures in an effort to evaluate outcomes and to improve quality.

All patients undergoing elective or urgent open peripheral arterial disease bypass procedures, endovascular aneurysm repair (EVAR), or open abdominal aortic aneurysm (AAA) repair between January 2012 and December 2013 were included in the study. Patients undergoing emergency procedures or carotid endarterectomy and carotid artery stenting were excluded, given variability in cases and associated low transfusion rates, respectively. Other exclusion criteria included age <18 years; body mass index (BMI) <10 or >80; and critical missing variables, such as missing nadir Hgb level, medications, or basic demographics. The first hospitalization was studied for patients with multiple hospital admissions.

A data form was compiled for each patient, including demographic information; past medical history; standard blood and chemistry laboratory test results before and after the procedure; patient history, including preoperative location (skilled nursing facility, acute care hospital, or home), procedural indications (claudication and critical limb ischemia), and types (bypasses for peripheral arterial disease, AAA repair); procedural urgency; medication types (eg, statins, antiplatelet therapies, anticoagulants, antihypertensives); technical details of procedures; and associated complications, if they occurred. Coronary artery disease was defined as a history of myocardial infarction, percutaneous coronary intervention, or coronary artery bypass graft. Cerebrovascular disease was defined as a history of stroke or transient ischemic attack (TIA). Primary outcomes included mortality and morbidity. Specific morbidities included surgical site infection, defined as a documented wound infection requiring antibiotics and culture-positive results; myocardial infarction, defined according to the universal definition[19]; pneumonia, defined as an infiltrate on the chest radiograph, hypoxemia, elevated leukocyte count, and productive sputum; and TIA or stroke. All outcomes were within 30 days after surgery. Perioperative blood transfusion was the exposure variable.

Data quality and the inclusion of consecutive procedures are ensured by ad hoc queries, random chart review, and a series of diagnostic routines included in the database conducted by the coordinating center. Twice yearly, sites are audited by a nurse monitor from the coordinating center. All cases associated with severe complications and a randomly selected 5% of cases are audited for accuracy.

Statistical analysis. Unadjusted comparisons between patients who received perioperative transfusion and patients who did not receive perioperative transfusion were performed by the χ^2 or Fisher exact test for categorical variables and the two-tailed *t*-test for continuous variables (log transformation was applied to variables with skewed distribution). We further categorized the patient by the time of receiving transfusion—no transfusion, received it only postoperatively, received it only intraoperatively, and received it both postoperatively and intraoperatively. The 30-day adverse outcomes (death, myocardial infarction, TIA or stroke, surgical site infection, and pneumonia) were compared between no transfusion and each transfusion category by Fisher exact test. Note that pneumonia is not up to 30 days. The relationship between nadir Hgb and albumin levels was assessed by the Pearson correlation.

Two different logistic regression models were constructed to assess (1) the relationship between preoperative variables and perioperative transfusion and (2) the association between perioperative transfusion and other adverse outcomes. In the logistic regression model for perioperative transfusion, we considered variables such as baseline characteristics (patient information and history), preoperative medicines, and other clinically relevant variables. See the Supplementary Table (online only) for