Is Female Sex an Independent Risk Factor for Perioperative Transfusion in Coronary Artery Bypass Graft Surgery?

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BACKGROUND: Perioperative red blood cell transfusion is a risk factor for postoperative mortality and morbidity in coronary artery bypass grafting (CABG). Females have a higher risk of red blood cell transfusion, but few previous studies have accounted for preoperative hematocrit and female sex together as risk factors for red blood cell transfusion. We evaluated female sex as an independent risk factor for red blood cell transfusion in CABG, while accounting for hematocrit.

STUDY DESIGN: A cardiac surgery database was reviewed for isolated, primary, first-time CABG operations from a single center from January 2005 to June 2009. Demographic and clinical variables were evaluated as risk factors of red blood cell transfusion using univariate (Student *t*-test and chi-square test) and multivariate (logistic regression) analyses.

RESULTS: Of 2,107 patients (ALL-patients) reviewed, 640 had known hematocrit (KNOWN-Hct). Women had lower hematocrit (35.77% ± 4.07% vs 40.06% ± 4.79% for men). On multivariate analysis of ALL-patients, older age, smaller body surface area, and female sex were risk factors; higher ejection fraction and off-pump surgery were associated with less red blood cell transfusion. On multivariate analysis of KNOWN-Hct, older age, lower hematocrit, smaller body surface area, and lower ejection fraction were risk factors of red blood cell transfusion and sex was not a significant risk factor in this group.

CONCLUSIONS: Female sex is not an independent risk factor for red blood cell transfusion in CABG when preoperative hematocrit is included as a covariate in a multivariable model. A lower hematocrit could explain some of the sex-specific disparities in outcomes after CABG and should be included in future analyses. (J Am Coll Surg 2011;212:362–366. © 2011 by the American College of Surgeons)

Cardiac surgery consumes more blood components than any other surgical discipline. In the United States, cardiac surgery accounts for the use of 20% of all blood products.[1] Blood transfusion is associated with adverse outcomes. Specifically, perioperative red blood cell transfusion in cardiac surgery is associated with increased short-term and long-term mortality as well as morbidity, including infections, neurologic and cardiac morbidities, renal dysfunction, increased ventilator and ICU hours, and hospital length of stay.[2-5] Despite Society of Thoracic Surgeons (STS) guidelines and other widely published reports, significant institutional variability exists in perioperative blood transfusion practices.[6-9]

Previous studies have shown female sex as a risk factor for perioperative blood transfusion in CABG.[9-13] Female sex has also been associated with increased perioperative mortality and morbidity in CABG.[14-16] We sought to evaluate female sex as an independent risk factor for perioperative transfusion in CABG while accounting for preoperative hematocrit using a cardiac surgery database from a single center.

METHODS

This is a retrospective observational study conducted in accordance to Institutional Review Board (IRB) standards and federal regulations. With IRB approval, consent was waived. The adult cardiac surgery database of Jewish Hospital, Louisville, KY was used to obtain the data necessary

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Abbreviations and Acronyms

BSA = body surface area
CABG = coronary artery bypass grafting
CHF = congestive heart failure
DM = diabetes mellitus
EF = ejection fraction
HTN = hypertension
OR = odds ratio

to conduct the study. The data is captured and stored in an electronic format at the time of operation and was accessed at a later point in a Health Insurance Portability and Privacy Act (HIPPA) compliant manner.

The adult cardiac surgery database of Jewish Hospital was reviewed for patients undergoing consecutive, isolated, primary, first-time CABG surgery from January 1, 2005 to June 30, 2009. Patients identified by these selection criteria were enrolled in the study for further evaluation.

For all on-pump operations, standard practice was to use retrograde autologous priming unless the patients could not tolerate this hemodynamically. The degree of systemic cooling was variable, but only rarely were the patients cooled any lower than 32°F. Aortic clamping and cold blood cardioplegia were used with few exceptions in pump cases.

Data

After completion of patient selection and enrollment, further demographic and clinical information (preoperative, operative, and postoperative) was obtained from the institutional adult cardiac surgery database. In addition to standard demographic and clinical characteristics, study-specific data points included diabetes mellitus (DM), hypertension (HTN), congestive heart failure (CHF), preoperative hematocrit, operative and postoperative transfusion data, cardiopulmonary bypass use, and mortality. Preoperative hematocrit data were measured closest to the time of surgery. The vast majority of patients had a preoperative measurement in the 48 hours before operation. We used a categorical outcome of transfusion of 2 or more packed red blood cell transfusions received operatively and/or postoperatively during the hospitalization. The decision to transfuse packed red blood cells was based on patients' clinical condition and the treating physician's judgment.

Statistical analysis

We began collecting preoperative hematocrit data in January 2008, making it available for a subset of patients analyzed in our study. Statistical analyses were performed on all patients and separately on the smaller group of patients with known preoperative hematocrit (KNOWN-Hct group). Demographic and preoperative characteristics such as age, body surface area (BSA), ejection fraction (EF), cardiopulmonary bypass (CPB) use, history of CHF, DM, and HTN, preoperative hematocrit (only in KNOWN-Hct group) were stratified by gender and studied using univariate analyses. Student *t*-test (numeric variables) and chi-squared test (categorical variables) were applied for univariate analyses. A multivariate logistic regression model was used to evaluate age, sex, BSA, EF, CPB use, history of CHF, DM, and HTN for their association with perioperative red blood cell transfusion. In the KNOWN-Hct group, preoperative hematocrit was added as a variable. All statistical analyses were performed using SAS software (SAS Inc) at statistical significance level of $\alpha = 0.05$. Numerical variables (age, BSA, EF, Hct.) were measured using mean ± standard deviation (mean ± SD).

RESULTS

Patient characteristics

Based on selection criteria (consecutive, primary, isolated, first time CABG surgery), there were 2,107 patients enrolled in the study. Preoperative hematocrit data were available in 640 of these patients (KNOWN-Hct group). Thirty-nine of 2,107 (1.85%) patients had no EF data available and were excluded from analysis; this included 17 of 640 patients in the KNOWN-Hct group.

Of 2,107 patients, 28.33% (n = 597) were women, and in the KNOWN-Hct group (640 patients) 29.69% (n = 190) were women. Women were, on average, older in both groups (Table 1). Women had a higher prevalence of comorbid conditions including DM (43.70% vs 36.60%, p = 0.002), HTN (90.10% vs 85.60%, p = 0.005), and CHF (24.60% vs 19.30%, p = 0.007) (Table 1). In the KNOWN-Hct group, women had a higher prevalence of DM (46.80% vs 37.60%, p = 0.028), but the prevalence of CHF (43.20% vs 42.70%, p = 0.908) and HTN (91.60% vs 86.60%, p = 0.091) was similar (Table 1). In the all patients groups, women had higher EF (52.8% ± 11.6% vs 50.5% ± 11.3%, p < 0.0001) than men. In the KNOWN-Hct group, EF (53.9 ± 11.7 vs 52.05 ± 11.1, p = 0.06) was comparable between men and women.

Operative and transfusion characteristics

Among all patients, the rate of perioperative red blood cell transfusion was 22.59% (476 of 2,107 patients) and was higher in women (37.86% vs 16.56%, p < 0.0001). In the KNOWN-Hct group, the rate of perioperative red blood cell transfusion was 24.69% (158 of 640) and also higher in women (41.05% vs 17.78%, p = 0.0006). Table 2 defines the transfusion characteristics stratified by sex. In the all