Variation in transfusion rates within a single institution: Exploring the effect of differing practice patterns on the likelihood of blood product transfusion in patients undergoing cardiac surgery

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Objectives: Rates of perioperative transfusion vary widely among patients undergoing cardiac surgery. Few studies have examined factors beyond the clinical characteristics of the patients that may be responsible for such variation. The purpose of this study was to determine whether differing practice patterns had an impact on variation in perioperative transfusion at a single center.

Methods: Patients who underwent cardiac surgery at a single center between 2004 and 2011 were considered. Comparisons were made between patients who had received a perioperative transfusion and those who had not from the clinical factors at baseline, intraoperative variables, and differing practice patterns, as defined by the surgeon, anesthesiologist, perfusionist, and the year in which the procedure was performed. The risk-adjusted effect of these factors on perioperative transfusion rates was determined using multivariable regression modeling techniques.

Results: The study population comprised 4823 patients, of whom 1929 (40.0%) received a perioperative transfusion. Significant variation in perioperative transfusion rates was noted between surgeons (from 32.4% to 51.5%, $P < .0001$), anesthesiologists (from 34.4% to 51.9%, $P < .0001$) and across year (from 28.2% in 2004 to 48.8% in 2008, $P < .0001$). After adjustment for baseline and intraoperative variables, surgeon, anesthesiologist, and year of procedure were each found to be independent predictors of perioperative transfusion.

Conclusions: Differing practice patterns contribute to significant variation in rates of perioperative transfusion within a single center. Strategies aimed at reducing overall transfusion rates must take into account such variability in practice patterns and account for nonclinical factors as well as known clinical predictors of blood transfusions. (J Thorac Cardiovasc Surg 2015;149:297-302)

See related commentary on pages 303-4.

Transfusion of blood products among patients undergoing cardiac surgery has been associated with increased short- and long-term morbidity including incision infection,[1,2] pneumonia,[2,3] renal dysfunction,[4-6] severe sepsis,[2,6] and mortality.[7,8] Efforts to better understand predictors of transfusion and to reduce rates of perioperative transfusion have resulted in the development of several quality improvement initiatives,[9-11] Many of these initiatives have focused on patient-specific predictors of transfusion, including increased age, female sex, lower body mass index (BMI), reduced preoperative hematocrit, use of platelet-inhibiting drugs, and surgical acuity.[9,12]

Despite these efforts, studies have shown that significant interinstitutional variability in blood transfusion practices persists,[13-15] suggesting that factors other than patient-specific variables are at play in determining rates of transfusion. Jin and colleagues[16] demonstrated that after adjusting for differences in patient risk factors, there was a significant effect of hospital culture on transfusion rates at an institution.

To date, few studies have examined the effect that differing individual practice patterns have on variation in transfusion rates, especially within a single institution.[16-18] A more thorough understanding of these practice pattern differences may lead to strategies that can reduce rates of transfusion within an institution and thus limit interinstitutional variability. The purpose of this study was to determine the effect of differing practice patterns on variation in perioperative transfusion rates at a single institution.

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Abbreviations and Acronyms

ASA = acetyl salicylic acid
BMI = body mass index
CABG = coronary artery bypass graft
CPB = cardiopulmonary bypass
CryoPPT = cryoprecipitate
FEIBA = factor 8 inhibitor bypassing activity
FFP = fresh frozen plasma
MI = myocardial infarction
NYHA = New York Heart Association
PLT = platelets

PATIENTS AND METHODS

Patient Population

All patients who underwent cardiac surgery at the Saint John Regional Hospital, Saint John, New Brunswick (Canada) from April 1, 2004, to September 30, 2011, were included in this study. Patients who underwent an emergency or off-pump procedure were excluded from the final study sample. No strict intraoperative transfusion protocol was implemented for the duration of the study. Postoperatively, the only guideline in place was for administration of packed red blood cells (pRBC) for a hemoglobin concentration less than 70 g/L. The number of units to be given or the target hemoglobin level was not specified in these guidelines. With respect to transfusion of coagulation products, these were administered subjectively depending on the amount of blood loss experienced or the perception that a coagulopathy was responsible for this blood loss.

Ethics approval was obtained from the Horizon Health Network Ethics Review Board with a waiver of patient consent as the study was retrospective in nature and identification of patients was not necessary.

Data Sources

Patients were identified from the New Brunswick Heart Centre Cardiac Surgery database, a detailed observational clinical registry that prospectively collects information on pre-, intra-, and postoperative characteristics for all patients undergoing cardiac surgery at the Saint John Regional Hospital. Detailed transfusion data were obtained from the institutional laboratory information system, which tracks the date, time, amount, and location of all transfusions of pRBC and coagulant products.

Variable Definitions

The following baseline clinical characteristics were taken into consideration: age, sex, BMI, smoking history, diabetes, hypercholesterolemia, renal failure (defined as serum creatinine >176 μmol/L), hypertension, chronic obstructive pulmonary disease, peripheral vascular disease, cerebrovascular disease, previous cardiac surgery, recent myocardial infarction (MI) ($\leq$21 days), congestive heart failure, unstable angina, atrial fibrillation, preoperative medications (acetyl salicylic acid [ASA], angiotensin-converting enzyme inhibitors, anticoagulants, β-blockers, cholesterol-lowering agents), New York Heart Association (NYHA) functional class (IV vs I/II/III), ejection fraction less than 40%, and urgency status (urgent vs elective). Data on the use of non-ASA antiplatelet medications, including clopidogrel, ticlodipine, and abciximab, were not available for the entire study duration and were thus not included in the analysis.

Intraoperative variables of interest included procedure type (isolated coronary artery bypass graft [CABG], isolated valve, CABG + valve, or other $\pm$ CABG $\pm$ valve), cardiopulmonary bypass (CPB) time, baseline hematocrit less than 40% before initiating CPB, insertion of an intra-aortic balloon pump, and administration of inotropes on transfer from the operating room to the intensive care unit.

Practice patterns were characterized by the attending surgeon, anesthesiologist, and perfusionist as well as the year in which the procedure was performed. Although our institution follows an open intensive care unit model, dedicated intensivists were not involved in the postoperative management of patients and were therefore not included in the analysis. Furthermore, the assignment of surgeon and anesthesiologist at our institution is random, and therefore no surgeon-anesthesiologist teams existed, indicating the relative independence of these variables. The year was chosen as a variable to reflect the changes in transfusion practices that may have existed over time but could not be attributed to differences in patient-specific clinical factors or individual practice patterns. Examples of such changes could include a mandated change in transfusion culture within an institution through the adoption of strict transfusion protocols or new onset shortages of blood products resulting from changes in blood bank supply.

The primary outcome of interest, perioperative transfusion, was defined as the administration of 1 or more units of pRBC, fresh frozen plasma (FFP), platelets (PLT), cryoprecipitate (CryoPPT), and/or factor 8 inhibitor bypassing activity (FEIBA) intraoperatively or during the first 24 hours after surgery. Transfusion of recombinant factor VIIa was not considered because 2 of the 5 surgeons included in the study did not use this product during the study period.

Statistical Analysis

Patients who received a perioperative transfusion were compared with those who did not based on the baseline characteristics, intraoperative factors, and practice pattern variables. The χ^2 test was used to compare categorical variables as well as transfusion rates by surgeon, anesthesiologist, perfusionist, and year. A multivariable logistic regression model was constructed from the baseline and intraoperative characteristics using perioperative transfusion as the outcome of interest. The nonparsimonious risk-adjusted predictive model identified those clinical and nonclinical variables that best predicted whether or not a patient was likely to receive a perioperative transfusion.

All statistical analyses were performed using SAS v 9.3 (SAS Institute, Inc, Cary, NC).

RESULTS

The final study population included 4823 patients, of whom 1929 (40.0%) received a perioperative transfusion. Of the 1929 patients who received a transfusion, 1685 (87.4%) received pRBCs and 889 (46.1%) received 1 or more coagulation products in the form of FFP, PLT, CryoPPT, or FEIBA.

Baseline Characteristics

Patients who received a perioperative transfusion were more likely to be older and female, have a BMI less than 25 kg/m^2, have more comorbid illnesses, have been on anticoagulants, have had NYHA class IV symptoms, have experienced a recent MI, have undergone previous cardiac surgery, and have presented with greater surgical acuity (Table 1).

Intraoperative Variables

Intraoperatively, patients who had undergone more complex procedures, had experienced prolonged bypass

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