Sex- and age-based variation in transfusion practices among patients undergoing major surgery

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Background. *Data on hemoglobin (Hb) threshold levels for "appropriate" packed red blood cell (PRBC) transfusions have not taken into account patient-specific variables such as sex and age. We sought to define differences in perioperative transfusion practices based on patient sex and age among patients undergoing complex gastrointestinal (GI) and cardiothoracic-vascular (CT-V) surgical procedures.*
Methods. *All patients undergoing any major GI or CT-V procedures between January 2010 and April 2014 at the Johns Hopkins Hospital were identified. Data on sex, age, as well as other clinicopathologic and procedures were collected and analyzed relative to transfusion practices (restrictive: transfusion at blood Hb $<$ 7 vs liberal transfusion at Hb $\geq$ 7 g/dL).*
Results. *Among the 10,772 patients included in the study cohort, 4,689 (44.0%) were transfused with $\geq$1 PRBC. Median preoperative Hb was lower among women (12.3 vs 13.4 g/dL in men) and the aged ($<$65 years, 13.1 vs $\geq$ 65 years, 12.7 g/dL) patients (both P $<$ .05). On adjusted analysis, male sex (odds ratio [OR], 1.13; 95% CI, 1.02–1.26;* P = *.03) and age $\geq$65 (OR, 1.77; 95% CI, 1.35–2.33;* P $<$ *.001) were associated independently with an increased odds of receipt of $\geq$1 PRBC. Although sex did not seem to impact transfusion strategy, patient age did impact the relative trigger used by providers for a transfusion. Specifically, patients 65–74 years (OR, 2.87; 95% CI, 1.93–4.26) and those $\geq$74 years (OR, 3.42; 95% CI, 2.28–5.14) were at a much greater odds of being transfused liberally compared with patients $<$65 years old (both* P $<$ *.05). The proportion of patients who had a potentially avoidable transfusion (ie, both trigger $\geq$7 and target $\geq$9 g/dL) was greater among aged patients (50%) compared with nonaged patients (41%;* P $<$ *.001). Of note, a restrictive transfusion strategy did not increase the risk of overall morbidity among women (OR, 0.76; 95% CI, 0.59–0.99;* P = *.04) or aged (OR, 1.13; 95% CI, 0.87–1.47;* P = *.37) patients.*
Conclusion. *Sex and age were associated with receipt of transfusion and, in the case of older patients, transfusion strategy. Given the lack of evidence to support a higher Hb level in older patients, emphasis should be placed on aligning transfusion practices with current evidence to employ a more restrictive transfusion strategy to decrease overuse of blood resources. (Surgery 2015;158:1372-81.)*

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The transfusion of packed red blood cells (PRBC) is the most common and cost intensive procedure performed in US hospitals.[1] Despite recommendations for the restrictive use of PRBC, the number of perioperative transfusions is still growing.[2] Furthermore, there is considerable variation among providers with regard to the use of transfusions in the perioperative period.[2-15] Hemoglobin (Hb) "triggers" and "targets," namely, the Hb level that prompts a transfusion and the target level for transfusion goals, have been proposed to optimize patient care and transfusion practices.[16] Although the "optimal" transfusion strategy may still be a matter of some debate, recent studies have noted that a restrictive transfusion strategy (Hb trigger of $<$7–8 g/dL) is preferable to a liberal strategy (Hb target level of $\geq$7–8 g/dL).[15,17-19] Specifically, data from several prospective studies have

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noted that a restrictive transfusion strategy not only avoids unnecessary use of a limited resource, but can also be associated with comparable, if not better, perioperative outcomes.[15,18,19] Interestingly, data on Hb triggers and targets, as well as the proposed Hb threshold level for "appropriate" transfusion, have not taken into account important patient-specific variables such as sex and age.

Despite reported important differences in Hb concentration based on sex and age, prior reports on Hb transfusion strategy have not examined these factors specifically. Furthermore, the average age of patients in several randomized trials such as the Transfusion Requirements after Cardiac Surgery (TRACS) and Functional Outcomes in Cardiovascular Patients Undergoing Surgical Hip Fracture Repair (FOCUS) trials ranged broadly from 61 and 81, respectively.[5,13] In addition, prior randomized transfusion trials that evaluated a liberal versus restrictive transfusion strategy failed to analyze whether respective triggers and targets were different in women versus men or nonaged versus aged patients.[13,18,20,21] In fact, current guidelines do not mention sex or age in the recommendations about transfusion strategies. Given the lack of a detailed analysis on the relationship between different sex and age strata and transfusion practices, the objective of the current study was to examine variation in Hb triggers and targets and overall utilization of blood transfusion among patients undergoing complex gastrointestinal (GI) and cardiothoracic-vascular (CT-V) operative procedures. In particular, this study sought to define differences in perioperative transfusion practices based on patient sex and age, as well as examining outcomes among patients based on sex, age, and transfusion strategy.

METHODS

Study population. All patients undergoing any major GI or CT-V procedures between January 2010 and April 2014 at the Johns Hopkins Hospital, Baltimore, Maryland, were identified using the appropriate International Classification of Diseases (ICD-9) procedure codes. ICD codes for GI procedures included gastrectomy (43.5–43.9), pancreatectomy (52.5–52.7, 52.96), hepatectomy (50.3), or colorectal resections (17.32–17.36, 17.39, 45.7, 45.8, 48.5, and 48.6); ICD codes for CT-V procedures included coronary artery bypass graft (36.1–36.3), aortic valve replacement (35.21 and 35.22), carotid endarterectomy (38.12), pulmonary resection (32.30, 32.39–32.41, 32.49, 32.50, and 32.59), esophagectomy (42.4 and 43.99), and abdominal aortic aneurism repair (38.34, 38.44, 38.64, 39.25, 39.71, and 39.73). These procedures were selected because of their nontrivial risk of transfusion compared with other general surgery cases (eg, cholecystectomy, appendectomy).

Baseline patient characteristics and demographic data were collected, including sex, age, Charlson comorbidity index scores, American Society of Anesthesiologists (ASA) classification, preoperative comorbidities, and duration of stay. Age groups were categorized according to the recommendations of the American Society of Cardiology (nonaged <65 years of age vs aged ≥65 years of age).[22] Perioperative complications were identified using ICD-9 diagnosis codes and included stroke, transient ischemic attack, myocardial infarction, ventilator-associated pneumonia, deep vein thrombosis, drug-resistant infection, surgical site infection, urinary tract infection, *Clostridium difficile* infection, and sepsis.[8-10] Cerebrovascular accidents, transient ischemic attack, and myocardial infarction were defined as ischemic events.[23]

As previously described, transfusion and Hb data were obtained via a web-based blood management intelligence portal (IMPACT Online, Haemonetics, Inc., Braintree, MA).[4,8-10,12,16] The IMPACT system links the Johns Hopkins Hospital's electronic medical record with the blood bank information system, thereby integrating patient- and procedure-specific clinicopathologic, operative, and laboratory data. The data in the anesthesia management system and perioperative blood management system are collected prospectively and routinely undergo quality audits to verify data accuracy.[4,8-10,12,16] For the purposes of the present study, only PRBC transfusions were analyzed. Consistent with previous reports, Hb trigger was defined as the lowest measured Hb that preceded a blood transfusion; Hb target was defined as the final measured Hb level following a blood transfusion before discharge.[4,8-10,12,16] The definition of a liberal transfusion practice was a Hb trigger of ≥7 g/dL, whereas a restrictive transfusion practice was defined as a Hb trigger of <7 g/dL.[12] A discharge Hb of ≥9 g/dL was considered an "overdose," because it exceeds the established recommended target for transfusion.[13,15,20,21]

Statistical analysis. Categorical variables were presented as whole numbers with respective percentages. Continuous variables were noted as median and interquartile range (IQR). Categorical variables were compared using the Chi-square and Fisher's exact tests, where appropriate. The Wilcoxon test was used to compare continuous data variables, as well as to assess parametric and nonparametric data. Logistic regression, in both univariable