

Effect of patient age on blood product transfusion after cardiac surgery

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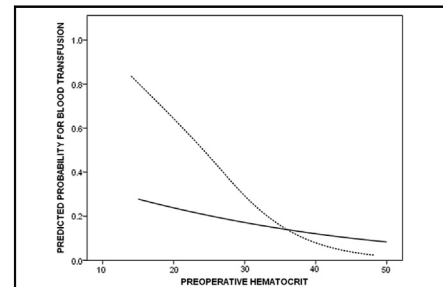
ABSTRACT

Objective: Blood product transfusion after cardiac surgery is associated with increased morbidity and mortality. Transfusion thresholds are often lower for the elderly, despite the lack of clinical evidence for this practice. This study examined the role of age as a predictor for blood transfusion.

Methods: A total of 1898 patients were identified who had nonemergent cardiac surgery, between January 2007 and August 2013, without intra-aortic balloon pumps or reoperations, and with short (<24 hours) intensive care unit stays (age ≥ 75 years; $n = 239$). Patients age ≥ 75 years were propensity-score matched to those age <75 years to balance covariates, resulting in 222 patients per group. Analyses of the matched sample examined age as a continuous variable, scaled in 5-year increments.

Results: After matching, covariates were balanced between older and younger patients. Older age significantly predicted postoperative (odds ratio = 1.39, $P = .028$), but not intraoperative (odds ratio = 0.96, $P = .559$), blood transfusion. Older age predicted longer length of stay ($B = 0.21$, $P < .001$), even after adjustment for blood product transfusion ($B = 0.20$, $P < .001$). As expected, older age was a significant predictor for poorer survival, even with multivariate adjustment (hazard ratio = 1.34, $P = .042$).

Conclusions: In patients with a routine postoperative course, older age was associated with more postoperative blood transfusion. Older age was also predictive of longer length of stay and poorer survival, even after accounting for clinical factors. Continued study into effects of transfusion, particularly in the elderly, should be directed toward hospital transfusion protocols to optimize perioperative care. (*J Thorac Cardiovasc Surg* 2015;150:209-14)



The figure shows spline curves demonstrating the relationship of preoperative hematocrit with odds for blood transfusion, for ages ≥ 75 years (dashed line) and ages <75 years (solid line) in the matched sample.

Central Message

For routine cardiac surgery, older patient age was a robust predictor for postoperative blood product transfusion and was predictive of longer length of stay and poorer survival.

Perspective

This study demonstrates that patient age is associated with a significant surgeon bias regarding blood transfusion thresholds without proven clinical merit. Future studies should focus on specific blood transfusion protocols for older patients to maximize the appropriateness of blood transfusion after cardiac surgery.

See Editorial Commentary page 214.

Cardiac surgery accounts for a substantial proportion of surgical procedures in which blood and blood products are transfused.^{1,2} The risks associated with blood transfusion are difficult to ascribe to clearly delineated risk factors.³ However, cardiac surgery that involves transfusion is associated with a higher risk of infection and ischemic

outcomes,^{2,4} longer length of stay,⁵ and increased perioperative and long-term morbidity and mortality^{6,7} compared with cardiac procedures without transfusion. Recent studies have found that cardiac surgery programs that develop and adhere to a blood conservation protocol succeed in reducing the incidence of blood transfusion, improving outcomes, and minimizing health care costs.⁸⁻¹⁰

In general, when postoperative hemoglobin levels are ≤ 10 g/dL, elderly patients are more likely than younger patients to receive transfusion.^{9,11} Transfusion thresholds are often lower (ie, transfusion occurs at higher hemoglobin levels) in the elderly, despite the scarcity of clinical evidence to support this practice.⁹ Few published studies have examined blood transfusion in elderly (age >75 years) patients undergoing cardiac surgery, and the effects of transfusion after cardiac surgery in a specific subset

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Abbreviations and Acronyms

CI	= confidence interval
EuroSCORE	= European System for Cardiac Operative Risk Evaluation
HR	= hazard ratio
OR	= odds ratio

of elderly patients have not been previously described. In this study, we examined the role of age as a predictor for blood transfusion and the effects of age on postoperative outcomes in elderly patients undergoing cardiac surgery.

METHODS

A total of 1898 consecutive patients who had undergone nonemergent cardiac surgery between January 2007 and August 2013 were identified. These patients did not have placement of an intra-aortic balloon pump or reoperation for bleeding or any other indication, and all had short (<24 hours) stays in the intensive care unit. Most patients (64%) who met these criteria underwent coronary artery bypass graft surgery, either alone or in combination with another cardiac surgical procedure. Of this sample, 239 patients (13%) were age ≥ 75 years.

This study was approved by our local institutional review board (nos. 06.022 and 12.055) and was granted a waiver of consent. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Data were obtained from our local Society of Thoracic Surgeons database and were merged with survival and clinical information collected at our institution. Data on long-term survival were obtained from the National Death Index (closing date: December 31, 2010), the Social Security Death Index (closing date: January 31, 2013), and our institutional follow-up program (ongoing).

Blood Transfusion Protocol

In 2007, we implemented a rigorous, multidisciplinary, criteria-driven algorithm for blood transfusion in cardiac surgery patients at our center. Cardiopulmonary bypass techniques, anesthesia, management of perioperative bleeding, and strict indications for blood transfusion were modified as part of this protocol. Transfusion was approved only by an attending cardiac surgeon in symptomatic patients, and specific criteria were developed for intraoperative and postoperative transfusion (Figure 1). Regardless of this protocol, transfusion can be ordered by the attending surgeon if it is deemed clinically justified.

Statistical Analyses

All analyses were conducted with SPSS, Version 17.0 (SPSS Inc, Chicago, Ill) and R 2.10.1 (R Foundation for Statistical Computing, Vienna, Austria). A 2-sided *P* was computed. Data are presented as mean \pm SD, median (interquartile range), or frequency (percentage). Comparisons involving dichotomous dependent variables were evaluated with χ^2 analysis, Fisher's exact test, or logistic regression; comparisons involving continuous dependent variables were evaluated with Student's *t* test, the Mann-Whitney *U* test, or linear regression.

To improve balance between the 2 groups, patients age <75 years were matched by propensity score to patients age ≥ 75 years, using the MatchIt package for R (R Foundation for Statistical Computing, Vienna, Austria). The propensity for age ≥ 75 years was estimated with a logistic model, using the following covariates: gender; body mass index; ejection fraction;

EuroSCORE II (European System for Cardiac Operative Risk Evaluation); preoperative hematocrit; status (urgent or elective); hypertension; surgery (isolated coronary artery bypass graft or other); chronic pulmonary disease; diabetes; peripheral vascular disease; and cerebrovascular disease. Patients were matched based on propensity score, using a caliper of 0.25 propensity-score SD. After matching, 222 patients remained in each age group, and good covariate balance was achieved between the 2 age groups (Figure 2).

Outcome analyses were conducted exclusively on the matched sample, and age was examined as a continuous variable (scaled by 5 years), unless otherwise noted. Logistic regressions were performed to evaluate the effect of age on the risk for intraoperative and postoperative blood transfusion, as well as on perioperative outcomes. Univariate logistic regressions were run separately within each matched age group to evaluate the effect of preoperative hematocrit on the probability of perioperative blood transfusion and to visualize these relationships using spline curves. In addition, multivariate logistic regression analysis was used to formally test for interaction of age and preoperative hematocrit before the analysis of separate age groups. Cox proportional hazards modeling was conducted to examine the effects of age as a continuous variable (scaled by 5 years) and blood transfusion on long-term survival.

RESULTS

Mean age for the unmatched sample was 61.4 ± 11.6 years, and most patients (79%) were men. Before propensity-score matching, the prevalence of preoperative comorbid conditions, including hypertension, congestive heart failure, history of stroke, and peripheral vascular disease, was higher for patients age ≥ 75 years (Table 1). No difference by age group was found for type of cardiac surgery procedure. After propensity-score matching, all preoperative characteristics of patients age ≥ 75 years ($n = 222$) were similar to those of patients age <75 years ($n = 222$), except age (Table 2). All results that follow were found within the propensity score-matched sample ($N = 444$).

Blood products were transfused in 55 patients (12%). Intraoperative transfusion only was used in 35 patients, postoperative transfusion only in 15 patients, and intraoperative and postoperative transfusion in 5 patients. The incidence of Society of Thoracic Surgeons-defined complications was low in this matched sample. Such complications included: 2 patients with pneumonia (0.5%); 2 with a stroke and/or transient ischemic attack (0.5%); 2 who died within 30 days (0.5%); 4 with major morbidity or mortality (0.9%); and 33 with readmissions within 30 days (7%).

Age and Outcomes

Age as a continuous variable did not predict intraoperative transfusion (odds ratio [OR] = 0.96, 95% confidence interval [CI], 0.85-1.10, $P = .559$), but age was a significant predictor for postoperative transfusion (OR = 1.39, 95% CI, 1.04-1.87, $P = .028$). For every 5-year increase in patient age, the odds of postoperative transfusion were 39% greater. Age remained a significant predictor for postoperative transfusion (OR = 1.40, 95% CI, 1.04-1.88, $P = .027$) after adjustment for preoperative hematocrit.

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