Impact of retained blood requiring reintervention on outcomes after cardiac surgery

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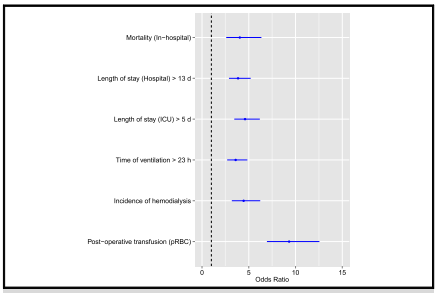
ABSTRACT

Objectives: Evacuation of shed blood from around the heart and lungs is a critical requirement for patients in early recovery after cardiac surgery. Incomplete evacuation of shed blood can result in retained blood, which may require subsequent reinterventions to facilitate recovery. The purpose of this study was to determine the incidence of retained blood requiring reintervention and examine the impact on outcomes.

Methods: We performed a cross-sectional, observational study of all adult patients undergoing cardiac surgery between 2006 and 2013. Subjects who required an intervention to remove blood, blood clot, or bloodily fluid were attributed to the retained blood group. These patients were compared with those not presenting with any of the defined criteria for retained blood. Multivariate regression was performed to account for confounders.

Results: Of 6909 adult patients who underwent cardiac surgery, 1316 (19%) presented with a retained blood-related condition. Retained blood was associated with increased in-hospital mortality (odds ratio [OR], 4.041; 95% confidence interval [CI], 2.589-6.351, $P < .001$) and a length of stay more than 13 days in the hospital (OR, 3.853; 95% CI, 2.882-5.206; $P < .001$) and 5 days in the intensive care unit (OR, 4.602; 95% CI, 3.449-6.183; $P < .001$). The OR for a time of ventilation greater than 23 hours was 3.596 (95% CI, 2.690-4.851; $P < .001$) and for incidence of renal replacement therapy was 4.449 (95% CI, 3.188-6.226; $P < .001$).

Conclusions: Postoperative retained blood is a common outcome and associated with higher in-hospital mortality, longer intensive care unit and hospital stay, and higher incidence of renal replacement therapy. Further research is needed to validate these results and explore interventions to reduce these complications. (J Thorac Cardiovasc Surg 2016;152:595-601)



Graphical presentation of OR of selected outcome parameters with respect to retained blood.

Central Message

Postoperative retained blood is a common complication after cardiac surgery and associated with compromised outcomes.

Perspective

For patients recovering from cardiac surgery, incomplete evacuation of shed blood can result in retained blood around the heart and lungs and impaired outcomes. However, this is a potentially readily addressable problem, because methods to actively clear drains of obstructions may be targeted through protocols for quality-improvement initiatives in the ICU.

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Postoperative hemorrhage is one of the most common complications in patients after heart surgery.[1] Existing studies identify a wide range of risk factors for bleeding, including advanced age, nonelective surgery, low body surface area, prolonged cardiopulmonary bypass time (>150 minutes), complex procedures, number of bypass grafts (>5), and preoperative use of antiplatelet agents.[2-5] Bleeding is associated with worse outcomes, including higher 30-day mortality, higher incidence of stroke, intensive care unit (ICU) stay more than 72 hours, mechanical ventilation

Scanning this QR code will take you to supplemental tables for this article.

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Abbreviations and Acronyms
CABG = coronary artery bypass grafting
CI = confidence interval
ICU = intensive care unit
OR = odds ratio

more than 24 hours, and significantly increased costs.[5,6] The exact cause of the higher mortality and complications related to bleeding has not been elucidated completely. In theory, bleeding, as measured by output of chest tubes, should be adequately addressed in the ICU with blood transfusions, treatment with factor concentrates, and fluid resuscitation until the bleeding is treated and resolves or is corrected surgically. Yet, numerous studies demonstrate that outcomes are considerably worse in patients who are transfused with blood, leading to speculation that the poor outcomes could be related directly to the negative biologic impact of transfusions and anemia.[7-9] However, several recent studies have shown that adverse clinical results and mortality due to bleeding is independent of the need for transfusions or that limiting transfusions has no beneficial effect or may even be harmful.[10,11] These findings raise the possibility that there may be other mechanisms that contribute to poor outcomes in patients bleeding after heart surgery.[6,12,13]

One mechanism by which patients' bleeding may have worse outcomes could be related to incomplete evacuation of shed blood from around the heart and lungs in the early hours after heart surgery. There are potentially several causes of incomplete evacuation of shed blood. Recent surveys and a prospective observational study demonstrated that chest tube clogging is more common than previously appreciated, suggesting that inadequate blood evacuation leading to retained blood from around the heart and lungs also may be affecting outcomes in patients who bleed after heart surgery.[14,15] Furthermore, chest tubes might be positioned inefficiently, may be removed too early, or may become kinked or bent when needed for drainage. If shed blood is incompletely evacuated, blood can be retained around the heart and lungs, which could adversely affect outcomes. To explore this hypothesis further, the objective of this study was to determine the incidence of interventions for retained blood in a large cardiac surgery database and examine, using logistic regression analysis, whether this is an independent variable contributing to adverse clinical outcomes in patients recovering after heart surgery.

MATERIALS AND METHODS

This was a cross-sectional, observational study derived from our institutional clinical databases. With the written consent of the federal data protection officer and the hospital ethics commission (EA1/034/13), clinical routine data from all patients who underwent cardiac surgery between 2006 and 2013 were extracted from the 2 electronic patient data management systems at our hospital (COPRA System, Sasbachwalden, Germany, and SAP, Walldorf, Germany) into an anonymized study database. Because of the study's retrospective design, the ethics commission waived the need for informed consent for this study. Cardiac surgery was defined as a documented procedure on valves or vessels in proximity to the heart or coronary vessels. All patients received 30F chest tubes. Pleural tubes were placed when the pleural space was opened. On rare occasions, Jackson-Pratt drains were used. The average number of chest tubes per patient was 1.71. Anticoagulation after surgery is managed per institutional protocol. Six hours after ICU admission, aspirin (100 mg) and low-dose heparin (250 IE/h) are given when the patient is judged hemodynamically stable with no signs of bleeding (<100 mL/h drainage output) and when laboratory results do not suggest coagulation disturbance. To capture the most clinically significant patient population with the primary end point, retained blood was defined as any intervention to remove blood, blood clot, or bloody fluid, such as interventions for tamponade or pericardial effusion, hemothorax, or pleural effusion during the index hospitalization. This included any re-exploration for bleeding (which uniformly requires washout of retained blood), any pericardial window or pericardiocentesis, or any placement of a chest tube in the pleural space or thoracentesis. Excluded were reoperations after the index cardiac surgery procedure when bleeding and washout were not managed. When one of these prerequisites was present, the patient was attributed to the "retained blood" group and compared with patients not presenting with any of the defined criteria. Primary end points were in-hospital mortality and length of hospital stay. Time to extubation, incidence of any renal replacement therapy (ie, hemofiltration or hemodialysis), and postoperative transfusion of packed red blood cells were defined as secondary end points. Institutional transfusion triggers follow written, standard operating procedures whereby patients receive transfusion at a trigger of 7 g/dL after revascularization. For those who are not completely revascularized, we use a trigger of 8 g/dL. In case of massive transfusion, we aim for a hemoglobin level of 7 to 9 g/dL. These policies did not change during the 7-year study period.[16]

In addition to basic patient characteristics, type, priority, and duration of surgery as markers of its complexity and preoperative risk (Age, Creatinine, and Ejection Fraction[17]), and postoperative Acute Physiology and Chronic Health Evaluation II admission score were assessed to characterize the study population and to identify possible confounders. Preexisting medical conditions were derived from International Classification of Diseases, 10th Revision–coded diagnoses available from the patient data management systems or paper-based patient records. Hemostatic disorder was defined as prothrombin time ratio less than 60%, partial thromboplastin time greater than 45 seconds, or thrombocytes less than 100,000/μL.

Statistical Analysis

Descriptive analyses and statistical testing were performed using the R Project of Statistical Computing 3.0.1. When normal distribution was ruled out using the Kolmogorov–Smirnov test, results were given as medians and interquartile ranges, and otherwise as mean $\pm$ standard deviation. Qualitative observations were characterized by numbers with percentage. Statistical significance among groups was analyzed univariately by the exact nonparametric Kruskal–Wallis test and (pairwise) with the exact Mann–Whitney *U* test. Exact chi-square tests were used for qualitative data. Separate multivariate logistic regressions were performed for any of the defined study end points, adjusted for possible preoperative and perioperative confounding factors with stepwise backward selection. Whenever the response variable was continuous (eg, length of hospital stay), the median of the study population served as cutoff point. Odds ratios (ORs) with 95% confidence intervals (CIs) were determined and used for graphical presentation. In addition, continuous variables were analyzed using robust regression with Huber function. All regression models are reported in Tables E1 and E2. Logistic regression analyses were completed by a

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