Impact of Anesthetic Handover on Mortality and Morbidity in Cardiac Surgery: A Cohort Study

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Objective: **Clinical handover is a critical moment in patient care. The authors tested the hypothesis that handover of anesthesia care is associated with increased mortality and morbidity in patients undergoing cardiac surgery.**

Design: **This was a single-center, retrospective cohort study of prospectively collected data.**

Setting: **The study was conducted in a quaternary care cardiac surgery center and university research hospital.**

Participants: **All patients undergoing cardiac surgical procedures between April 1, 1999 and October 31, 2009 were included in the study.**

Interventions: **Propensity-score matching was used to adjust for differences between patients who received intraoperative handover of anesthesia care and those who did not, and in-hospital mortality and morbidity were compared using multivariate logistic modeling.**

Measurements and Main Results: **14,421 patients met the inclusion criteria for this study; handover occurred in 966 cases (6.7%). After propensity-score matching, 7,137 patients were included for analysis. In-hospital mortality was 5.4% in the handover group and 4.0% in the non-handover group (match-adjusted odds ratio, 1.425; 95% confidence interval, 1.013-2.006; p = 0.0422); the incidence of major morbidity was 18.5% in the handover group and 15.6% in the non-handover group (match-adjusted odds ratio, 1.274; 95% confidence interval, 1.037-1.564; p = 0.0212).**

Conclusions: **Handover of anesthetic care during cardiac surgery is associated with a 43% greater risk of in-hospital mortality and 27% greater risk of major morbidity. Further studies are required to explore this relationship and to systematically evaluate and improve the process of handover.**

KEY WORDS: handover, patient safety, anesthesiology, cardiac surgery

HANDOVER IS constant in today's healthcare, affecting all professions and care settings.[1] Although necessary, clinical handover remains vulnerable to lapses in communication, which may compromise patient safety. The World Health Organization has included communication during patient care handovers among its top 5 patient safety initiatives.[2] Furthermore, the Joint Commission found that "communication failures" during handover were the root cause in more than 30% of sentinel events—unexpected incidents involving death or serious morbidities—leading to the requirement for all American hospitals to develop a standardized approach to handover of care.[3]

In the study of critical events, communication failures during handover frequently are identified as a contributing factor to patient harm.[4–6] The complex environment of the modern operating room is no exception.[7–11] Most previous research has studied communication errors during the handover process, rather than identifying their impact on patient outcomes. Patients undergoing cardiac surgery are at a higher risk for adverse outcomes compared with other surgical populations[12,13] and are more likely to have intraoperative anesthetic handover. For these reasons, a recent American Heart Association Scientific Statement has recommended the implementation of formal handover protocols during transfer of care among medical personnel.[14] The authors, therefore, tested the hypothesis that handover of anesthesia care is associated with increased mortality and morbidity in patients undergoing cardiac surgery.

METHODS

The study was approved by the Ottawa Hospital Human Research Ethics Board, with a waiver of informed consent, and conducted in accordance to the ethical standards described in the 1964 Declaration of Helsinki and its amendments. Written consent from individual study participants was not required because the study represented a secondary use of nonidentifiable data (TCPS Article 5.5).[15]

Study Population and Data Collection

This was a single-center, retrospective cohort study of prospectively collected data, which included all patients undergoing major cardiac surgical procedures at the University of Ottawa Heart Institute (UOHI) between April 1, 1999 and October 31, 2009. The UOHI is a quaternary care referral center providing all adult cardiac surgical and postoperative care to a population of approximately 2 million persons.

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The UOHI perioperative database is a comprehensive, prospectively collected database, documenting more than 400 variables for every surgical patient during the preoperative, intraoperative, and postoperative periods. All information in the database was collected by a dedicated research team and was validated for completeness and accuracy.[16,17]

Definition of Exposure Variable

Handover was defined as transfer of patient care from one attending cardiac anesthesiologist to another at any point during the intraoperative period and was captured as a distinct variable in the database. During the study period, there was no formalized manner (ie, electronic or paper checklist) by which handover was conducted; handover was primarily a verbal exchange summarizing pertinent clinical information. In the authors' institution, there are 14 attending cardiac anesthesiologists who provide all intraoperative anesthesia care on a one-to-one basis and all postoperative intensive care in the closed intensive care unit. When senior residents or fellows are present, they are supervised closely by the attending anesthesiologist. The most common indication for handover was change of shift from day to on-call or vice versa. Handover may occur in the morning from an overnight case or in the evening from a day case, from Monday to Friday. No intraoperative handover occurs on weekends.

Definition of Outcome Variables

The prospectively defined primary endpoint for this study was in-hospital mortality. The secondary endpoint was a composite index of major postoperative morbidity, which included postoperative myocardial infarction (MI), cerebral vascular accident, prolonged mechanical ventilation (>48 hours), and acute kidney injury requiring renal replacement therapy (continuous or intermittent hemodialysis). Postoperative MI was defined clinically using a combination of electrocardiographic (new Q-wave) and enzymatic criteria (elevation of CK-MB or troponin T > 5 times the upper limit of normal). Cerebral vascular accident was defined as a new central neurologic deficit with focal or lateralizing signs on physical examination and confirmed on brain imaging or by a neurologist.

Other Variables

Most variables used in this study are standardized to medically accepted definitions;[18] only those that may vary from institution to institution will be described in greater detail. History of diabetes mellitus, chronic obstructive pulmonary disease, peripheral vascular disease, and infective endocarditis was determined by preoperative history obtained from each patient; operative priority was defined as elective, urgent (diagnosis and surgery during same admission), emergent (surgery within 24 hours of diagnosis), or immediately emergent (surgery as soon as possible); critical state was defined as preoperative intra-aortic balloon pump therapy, ongoing cardiopulmonary resuscitation, or preoperative cardiac arrest. The logistic EuroSCORE was used for preoperative risk adjustment.[19]

To adjust for variation during the intraoperative period, 7 variables were used. Type of surgery was divided into simple and complex procedures. Simple surgery was defined as either isolated coronary artery bypass grafting, with or without cardiopulmonary bypass (CPB), or a single valve intervention (repair or replacement). Complex surgery included coronary artery bypass grafting combined with 1 or more valve interventions, multiple valve interventions, aortic surgery, cardiac transplant, left ventricular assist device insertion, pulmonary thromboendarterectomy, repair of congenital cardiac defects, reoperative cardiac surgery, and extracorporeal membrane oxygenation. In addition, aortic cross-clamp time, inotrope usage, need to return to CPB before leaving the operating room, need for mediastinal reexploration before leaving the operating room, and need for intraoperative transfusions were documented.

Statistical Analysis

Assuming a baseline mortality rate of 3.5% in the surgical population, it was estimated that the sample size would have statistical power of 80% to detect an absolute increase in mortality of 2%.

Continuous, normally distributed variables were analyzed using two-tailed *t* tests and are described as means (± standard deviation). Categoric variables were analyzed using chi-square tests and are presented as counts (proportions).

It was anticipated that the handover and non-handover groups might differ with respect to preoperative and intraoperative characteristics. Therefore, a propensity score was generated by creating a nonparsimonious multivariate logistic regression model, modeling the probability of handover as a function of the preoperative and intraoperative variables that were different between groups. This propensity score then was used to match cases (handover) to controls (non-handover) using a greedy 1-to-8 matching algorithm.

The propensity score-matched cohort was assessed for differences between the handover and non-handover groups for each of the potential confounders, and conditional logistic regression was used to assess the effect of handover on mortality. Based on a priori analysis of risk factors associated with mortality, the following baseline variables were included in the model: Age, gender, preoperative creatinine, EuroScore, aortic cross-clamp time, history of peripheral vascular disease, previous cardiac surgery, left ventricular class, operative priority, unstable angina, recent myocardial infarction, chronic obstructive pulmonary disease, active endocarditis, transfusions, return to CPB, reopening before leaving the operating room, surgery type, and atrial fibrillation.

Using both the propensity score-matched cohort and the entire study cohort, the association between handover of anesthesia care and mortality was evaluated, as well as the secondary endpoint, a composite index of major postoperative morbidity. Stratified analysis based on likely confounders also was performed. All p values of less than 0.05 were considered to indicate statistical significance. No imputations were performed for missing data, and the sample size was allowed to float with the analysis. All analyses were conducted in SAS v9.2 (SAS Institute, Cary, NC) and GraphPad 5.0 (GraphPad Software Inc, La Jolla, CA).

RESULTS

A total of 14,421 patients met the inclusion criteria for this study. Handover of anesthetic care occurred in 966 cases (6.7%). Baseline demographic, preoperative, and intraoperative characteristics of the study population are shown in Table 1. Preoperatively, the 2 groups were significantly different with regard to EuroSCORE, operative priority, critical preoperative state, left ventricular function, recent MI, angina, atrial fibrillation, previous cardiac surgery, and chronic obstructive pulmonary disease. Intraoperatively, the 2 groups were significantly different with regard to surgery type, aortic cross-clamp time, use of inotropes, need to return to CPB, need to re-open the chest before leaving the operating room, and intraoperative transfusion. After propensity score matching, there remained a total of 7,137 patients, with 6,344 in the non-handover group and 793 in the handover group. All baseline demographic, preoperative, and intraoperative characteristics were similar between the 2 matched groups (Table 1).

After propensity score matching, in-hospital mortality was 5.4% in the handover group and 4.0% in the non-handover