Rate of Major Anesthetic-Related Outcomes in the Intraoperative and Immediate Postoperative Period After Cardiac Surgery

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Objectives: To examine anesthesia-centered outcomes in a large cohort of patients undergoing coronary artery bypass grafting (CABG) or valvular heart surgery.

Design: A retrospective study with univariate and multivariate logistic regression to identify independent predictors for mortality.

Setting: Diverse setting including university, small, medium, and large community hospitals.

Participants: All patients undergoing CABG or valve surgery in the National Anesthesia Clinical Outcomes Registry (NACOR) from the Anesthesia Quality Institute.

Interventions: None.

Measurements and Main Results: Common anesthesia-centered outcomes including arrhythmia, cardiac arrest, death, hemodynamic instability, hypotension, inadequate pain control, nausea/vomiting, seizure, stroke, reintubation and transfusion were reported. All outcomes, consistent with NACOR data entry, were defined as occurring intraoperatively or during phase I or II recovery in the PACU. Death occurred in 0.15% of CABGs and 0.23% of valve surgeries. Age less than 18, American Society of Anesthesiologists physical status (ASA PS) classification of 5, and mean case duration greater than 6 hours were associated with increased mortality (p < 0.05). The presence of a board-certified anesthesiologist was associated with decreased odds for mortality.

Conclusions: Death was a rare outcome in this cohort, reflecting the infrequent occurrence of intraoperative or immediate postoperative death. The presence of a board-certified anesthesiologist represented a modifiable risk factor for reducing mortality risk.

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KEY WORD: CABG, valve surgery, outcomes, anesthesiology, mortality, cardiac surgery

CORONARY ARTERY BYPASS GRAFTING (CABG) and open surgical repair or replacement of heart valves remain common, effective procedures for multivessel coronary artery disease and moderate-to-severe valvulopathy in appropriate surgical patients. While the number of CABGs in the United States has been decreasing over the past 15 years, more than 395,000 procedures still were being performed annually as of 2010.[1–3] Indeed, CABG remains the procedure of choice for patients with multivessel disease, left main disease, diabetes, and those patients who are not candidates for percutaneous coronary interventions.[4–7] Similarly, despite growing advances in transcatheter approaches to valvular heart disease, open surgical repair or replacement of diseased valves remains the standard of care for most patients; at present, only patients deemed to be a prohibitive surgical risk are FDA-approved candidates for transcatheter valve replacement.[8] Outcomes in cardiac surgery have been assessed previously by a variety of methodologies, including cohort studies, retrospective observational studies, and randomized controlled trials. A diverse array of outcomes has been reported across these studies, including neurologic, cardiovascular, and mortality outcomes. The largest existing datasets primarily have reported on mortality after cardiac surgery.[9–12] However, many of these studies predated more recent guidelines and advances in noninvasive

and medical management of coronary artery disease. Additionally, many focused on limited groups of patients in specific practice settings and environments that may not represent the array of patients seen in wider clinical practice outside the university hospital environment.

Cardiac anesthesiologists play a critical role in cardiac surgery.[13] Similar to medical management, cardiac anesthesia has changed significantly in recent years, with a growing awareness of the value of transesophageal echocardiography and less reliance on pulmonary artery catheterization. Additionally, evolving guidelines have led to more restrictive transfusion strategies in cardiac surgery.[14] Little is known how these evolving practices have affected the current practice of cardiac anesthesia in the United States. Further, most existing datasets define "operative mortality" as mortality during the index hospitalization or within 30 days.[15–18] No existing data examine immediate perioperative mortality and morbidity as influenced by the anesthesiologist.

Given the limited literature on the variability of anesthesia practices nationwide, as well as outcomes across a more recent cohort of cardiac surgery patients, this study sought to examine the variability of patient acuity, surgery types, and anesthetic practices. The National Anesthesia Clinical Outcomes Registry (NACOR) of the Anesthesia Quality Institute (AQI) is a database containing administrative and clinical information for every case performed at more than 300 practices and 3,500 facilities across the United States. The dataset includes patients undergoing procedures in a variety of hospital sizes and from all regions of the United States, reflecting the variations in populations both regionally and in different hospital settings. While the dataset contains somewhat limited information regarding underlying comorbidities, it contains a wealth of information regarding anesthetic care and practices as well as clinical outcomes captured by an increasing percentage of practices nationwide. Using the NACOR data, the authors performed a retrospective analysis on patients undergoing CABG and heart valve procedures, with the goal of identifying the rate of major outcomes in the immediate perioperative period.

METHODS

Data Source

Data were collected by AQI from January 2010 to December 2014, and consisted of 23,341,130 records accumulated through the NACOR from more than 100 heterogeneous sources.[19] Because the database is de-identified, it meets the criteria of the Health Insurance Portability and Accountability Act to protect personal information and was exempt from the consent requirement by the authors' institutional review board. NACOR is a voluntary submission registry with institutions that participate in the sharing of anesthesia-related data and outcomes in order to evaluate the quality of care both nationally and locally. NACOR participants are a diverse group of private and academic practices from across the United States, and NACOR data increasingly are used to describe the scope of American anesthesia care. The AQI database contains de-identified patient information and various data related to patient demographics, billing, procedural, diagnostic, and provider information, as well as reported adverse events in all cases from a percentage of practices.

Study Sample

NACOR provides a Clinical Classifications Software (CCS) label for each case—this label gives a generic description of the surgery. CABGs and heart valve surgeries were identified using a CCS label of 43 (for valve surgeries) or 44 (for CABGs). All cases assigned an American Society of Anesthesiologists Physical Status (ASA PS) class VI and who had missing data for ASA PS class, age, sex, and case duration were removed from the study. Figure 1 illustrates the exclusion methodology applied to this study. For both valve surgeries and CABG from 2010 to 2014, data were collected for age, age group (under 18, 19-49, 50-64, 65-79, and greater than 80 years old), ASA PS classification (ASA PS class I and II were combined), sex, case duration, case duration group (less than 4, 4-6, and greater than 6 hours), presence of residents, presence of certified nurse anesthetists (CRNA), and board certification status of anesthesiologists (board certified versus not board certified). Data were collected for year of surgery, facility type, and United States (US) region location. Facility types included university hospitals, large-sized community hospitals (more than 500 beds), medium-sized community hospitals (100-500 beds), and small-sized community hospitals (fewer than 100 beds). NACOR contains data for other types of facilities, including attached surgery centers, freestanding surgery centers, and surgery clinics, but the authors do not report these data here. US regions included Northeast, Midwest, South, and West.

NACOR provides outcomes data for about 20% of all cases in the database. Outcomes are included in the available research data file if they are reported consistently (yes or no) for all cases from a given facility. Because outcome reporting relies on secondary use of local quality improvement data, definitions of specific outcomes may be inconsistent among sites. The AQI promulgates standard definitions for outcomes of interest, and these have been widely, but not universally, adopted by practices and their information technology vendors. Some reported outcomes (eg, perioperative mortality) are consistent in definition and reporting, whereas others (eg, hemodynamic instability) may vary in definition and reporting rigor from practice to practice or even from provider to provider within the same institution. There exist 47 different reported outcomes. For this study, the authors chose to report 13 different outcomes, as they were pertinent to cardiac cases. Outcomes were reported as percentages, with the numerator defined as the absolute count reporting that particular outcome, and the denominator defined as the total number of cases reported from all facilities reporting that outcome.

Statistical Analysis

R Project for Statistical Computing (R version 3.1.2) was used to perform all statistical analysis. Because death was of particular interest, the authors fitted a logistic regression model to the data to determine which patient characteristics were associated with increased death. They grouped CABG and valve data together for the analysis. Death in NACOR was defined as occurring intraoperatively or during Phase I and Phase II of the recovery phase.[20] Therefore, any death occurring after transfer to the intensive care unit was not reported. Additionally, the registry does not differentiate between patients who went directly to the intensive care unit versus via the PACU. Cases with missing data as described above also were excluded from the analysis. After univariate analysis, a multivariate analysis was applied to test for independent predictors. In determining association of age to death, covariates included ASA PS class and sex. For association of ASA PS class and death, age and sex were covariates. For analyzing association of sex with death, ASA PS class and age were covariates. Finally, for analyzing association of death with case duration or provider status, ASA PS class, age, and sex were covariates. For the logistic regression, odds ratios (OR) were reported with their associated 95% confidence intervals (CI). OR not including 1.00 in their 95% CI were considered statistically significant.

RESULTS

The complete NACOR database query contained 23,341,130 records, of which 77,927 were identified as CABG, and 54,575 as valve surgery after exclusion criteria. Table 1 displays patient-related demographics for those undergoing CABG and valve surgery. The patient population, as has been
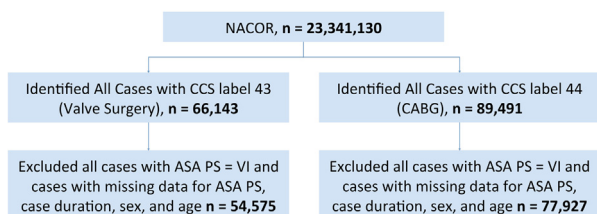

Fig 1. Coronary artery bypass graft (CABG) and valve surgery study population from the National Anesthesia Clinical Outcomes Registry (NACOR). CCS, clinical classifications software; ASA PS, American Society of Anesthesiologists Physical Status.