Unplanned Reintubation Following Cardiac Surgery: Incidence, Timing, Risk Factors, and Outcomes

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Objectives: **To determine the incidence, timing, risk factors for, and outcomes after unplanned reintubation following cardiac surgery in adults.**

Design: **Retrospective analysis of admission data from the American College of Surgeons National Surgical Quality Improvement Project Database, 2007-2013, inclusive. Univariate and multivariate analyses of risk factors and outcomes.**

Participants: **A total of 18,571 patients, over 18 years of age, undergoing cardiac surgery.**

Interventions: **Not applicable.**

Measurements and Main Results: **Reintubation incidence was 4.0%. Risk factors included older age, preoperative partial or total dependence, dyspnea at rest or on exertion, chronic kidney disease, chronic obstructive pulmonary disease, previous cardiac surgery, congestive heart failure, emergency surgery, longer duration of surgery, and mitral and tricuspid valve surgery. Patients requiring reintubation after surgery had 7.5 times higher mortality (21.9% *v* 2.9%), longer hospital admissions (22.2 *v* 7.8 days), and were less likely to be discharged home within 30 days (35% *v* 80%). Multivariate analysis demonstrated increased risk of failure to wean from the ventilator, pneumonia, sepsis, pulmonary embolism, deep vein thrombosis, and discharge to skilled care, rehabilitation, or other care.**

Conclusions: **Patients reintubated after cardiac surgery had significantly higher mortality, complication rates, and length of stay. Novel risk factors identified could be used to tailor extubation timing and strategy appropriately. Compared to noncardiac surgery, some risk factors for reintubation differed and risk continued beyond the immediate postoperative period to a greater degree.**

KEY WORDS: cardiac surgery, postoperative, reintubation, risk factors, outcomes, NSQIP

WHILE REINTUBATION AFTER surgery generally is rare, reintubation after cardiac surgery remains a persistent problem.[1–5] Reintubation after surgery is associated with increased morbidity, mortality, and cost.[5] It is therefore important to know its incidence, timing, risk factors, and outcomes, particularly in the era of fast-track cardiac care.[6] The indication and urgency of reintubation range from emergency management of failed extubation in the operating room or intensive care unit (ICU), to urgent or semielective intubation for emerging complications or subsequent clinical deterioration, potentially days or weeks postoperatively.

The American College of Surgeons' National Surgical Quality Improvement Project (NSQIP) database records large quantities of surgical admission data from hospitals across the United States for 30 days or until discharge. From this, incidence and predictors of rare complications can be estimated accurately. An analysis of NSQIP general and vascular surgery data demonstrated 30-day reintubation rates of 3.0%, with associations between reintubation and male gender, smoking status, chronic obstructive pulmonary disease (COPD), and congestive cardiac failure.[7] NSQIP data also have demonstrated that for nonemergency, noncardiac surgical patients, half of unplanned reintubations occurred within 3 days postoperatively.[5]

Analysis of anesthesia outcomes including reintubation, using the National Anesthesia Clinical Outcomes Registry (NACOR), demonstrated reintubation rates of 0.02% after coronary artery bypass grafting (CABG) and 0.04% after cardiac valve surgery.[8] However, this represented anesthesia care in the operating room and postanesthesia care unit (PACU) only, thus failing to capture any events or reintubations occurring in the ICU or on the floor subsequently. There are currently no large multicenter studies of reintubation after cardiac surgery that follow patients beyond PACU discharge. One single-center study of 1,000 cardiac surgery patients reported a reintubation rate of 2.6%, however, length of follow up was not reported.[2] The purpose of this study was to use a large national database (American College of Surgeons [ACS] National Surgical Quality Improvement Program [NSQIP]) to determine current incidence, timing, risk factors, and outcomes for unplanned reintubation after cardiac surgery, until discharge or 30 days postoperatively.

METHODS

The ACS-NSQIP is a well-validated data registry consisting of deidentified cases reported from approximately 400 different participating sites. Institutional Review Board approval was obtained for analysis of the data and was exempted from the consent requirement due to the deidentified nature of the data. The authors retrospectively examined abstracted information for patients undergoing cardiac surgery between January 1, 2007 and December 31, 2013.

NSQIP defines unplanned reintubation as a "placement of an endotracheal tube or other similar breathing tube (laryngeal mask airway, nasotracheal tube, etc) and ventilator support intraoperatively or within 30 days following surgery which was not intended or planned."[9] Included are incidences of reintubation for respiratory or cardiac arrest, unplanned extubation requiring reintubation, or intubation postoperatively for hemodynamic reasons. Excluded in the definition are patients with chronic tracheostomy requiring intermittent ventilator support, reintubation for both planned and unplanned returns to the

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operating room, and intraoperative conversion from anesthesia with an unsecured airway (such as local/regional anesthesia or monitored anesthesia care) to anesthesia with an endotracheal tube or laryngeal mask airway. The primary event in this study was presence and timing of unplanned reintubation in the postoperative period (postoperative days 0-30). The secondary aims were to assess for any patient or surgical risk factors for reintubation and report the outcomes (complications, mortality, and discharge) of reintubated patients.

For this study, the 2007-2013 NSQIP was compiled into a single data file containing 306 variables across 2.8 million cases of all surgical specialties. Excluded from analysis due to exclusion from participation in NSQIP were all cases of trauma or transplant surgery, or surgery on patients under the age of 18 years at the time of surgery. All cases performed by cardiac surgery, defined as "the surgical specialty area that best characterizes the principal operative procedure or the surgeon's self-declared specialty" were included. American Society of Anesthesiologists (ASA) physical status class 6, representing a brain-dead organ donor and cases failing to report an 'unplanned reintubation' response, were excluded from the analysis.

The authors collected data for baseline patient demographics and risk factors (age, gender, ethnicity, body mass index [BMI], functional status, dyspnea, ASA class) and presence of the following comorbidities (diabetes, congestive heart failure, COPD, chronic kidney disease, cerebrovascular accident, transient ischemic attack, current smoker, current alcohol consumption). The authors collected data for procedure characteristics comprising surgical procedure, mean surgical time, and mean anesthetic time. The authors collected data for postoperative events comprising number of days postoperative at time of reintubation, postoperative complications, mortality, length of stay, and discharge destination. For Current Procedural Terminology/CPT codes, see the Appendix Table 1.

Statistical Analysis

The authors conducted a comparison of the cohort requiring unplanned reintubation with the cohort that did not require reoperation. This was performed utilizing the 2-sided student's t-test for continuous variables and Pearson's χ^2-test for categorical variables. All analyses were conducted using R Project for Statistical Computing, v3.2.3 (R Project for Statistical Computing, Vienna, Austria). Statistical significance was calculated as p-value of <0.05. The authors conducted univariate analysis of demographics, functional status, and co-morbidities. Subsequently, the authors created a multivariate model using stepwise selection of variables to analyze patient risk factors, surgical factors, and outcomes including postoperative complications, discharge destination, and mortality.

To create the stepwise regression model, the authors first created a generalized linear model using all variables significant at a p-value of <0.2. The authors then performed a stepwise selection in a bidirectional manner to identify the best-fit model. Variables selected were age, sex, ethnicity, ASA class, BMI, functional status, dyspnea, diabetes, history of congestive cardiac failure, previous cardiac surgery, COPD, chronic kidney disease, cerebrovascular accident, weight loss, and smoking. 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

Having applied the authors' inclusion and exclusion criteria, a total of 18,571 cases were included in their analysis (Fig. 1). Of these 18,571 patients undergoing cardiac surgery, 718 (4.0%) patients required reintubation within the first 30 postoperative days. Table 1 demonstrates the demographic and patient factors associated with reintubation (OR, 95% CI). Patients who were reintubated were significantly more likely to be older and female and less likely to be Hispanic or identify ethnicity as "other". Patients with a BMI of <18.5 were more likely to be reintubated and patients with BMI of 25 to 30 were less likely to be reintubated than patients with normal BMIs (18.5-25).

Reintubated patients were more likely to be partially or totally dependent for activities of daily living, baseline dyspnea at rest or on exertion, and comorbidities including congestive heart failure, chronic obstructive pulmonary disease, chronic kidney disease, and recent weight loss ($p < 0.001$). Multivariate analysis showed that reintubated patients were more likely to have chronic kidney disease, COPD, previous cardiac surgery, and congestive heart failure. Patients from ASA classes 3, 4, and 5 were increasingly likely to undergo reintubation compared to ASA class 2 patients. No significant association was found between smoking status and the incidence of reintubation.

While the average reintubation rate after all cardiac surgery was 4.0%, there were differences in reintubation rates among surgeries (Table 2). For example, the

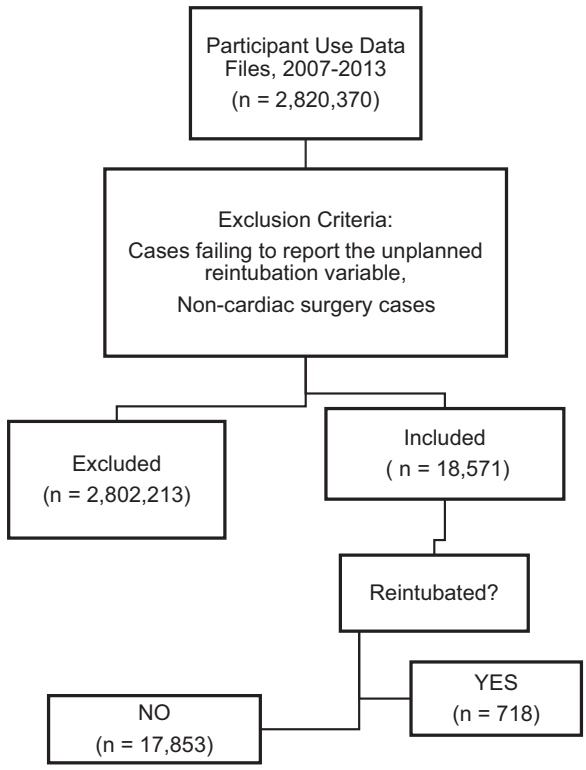

Fig 1. Flow diagram of inclusion criteria yielding study population.