Variation in extubation failure rates after neonatal congenital heart surgery across Pediatric Cardiac Critical Care Consortium hospitals

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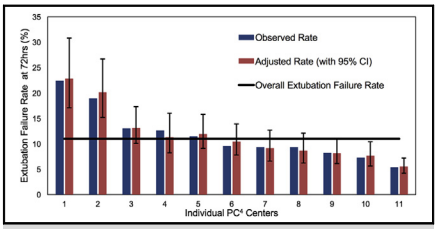
ABSTRACT

Objective: In a multicenter cohort of neonates recovering from cardiac surgery, we sought to describe the epidemiology of extubation failure and its variability across centers, identify risk factors, and determine its impact on outcomes.

Methods: We analyzed prospectively collected clinical registry data on all neonates undergoing cardiac surgery in the Pediatric Cardiac Critical Care Consortium database from October 2013 to July 2015. Extubation failure was defined as reintubation less than 72 hours after the first planned extubation. Risk factors were identified using multivariable logistic regression with generalized estimating equations to account for within-center correlation.

Results: The cohort included 899 neonates from 14 Pediatric Cardiac Critical Care Consortium centers; 14% were premature, 20% had genetic abnormalities, 18% had major extracardiac anomalies, and 74% underwent surgery with cardiopulmonary bypass. Extubation failure occurred in 103 neonates (11%), within 24 hours in 61%. Unadjusted rates of extubation failure ranged from 5% to 22% across centers; this variability was unchanged after adjusting for procedural complexity and airway anomaly. After multivariable analysis, only airway anomaly was identified as an independent risk factor for extubation failure (odds ratio, 3.1; 95% confidence interval, 1.4-6.7; $P = .01$). Neonates who failed extubation had a greater median postoperative length of stay (33 vs 23 days, $P < .001$) and in-hospital mortality (8% vs 2%, $P = .002$).

Conclusions: This multicenter study showed that 11% of neonates recovering from cardiac surgery fail initial postoperative extubation. Only congenital airway anomaly was independently associated with extubation failure. We observed a 4-fold variation in extubation failure rates across hospitals, suggesting a role for collaborative quality improvement to optimize outcomes. (J Thorac Cardiovasc Surg 2017;■:1-8)



Observed and adjusted rates of extubation failure for neonates after cardiac surgery.

Central Message

Extubation failure occurs in 11% of neonates after cardiac surgery, with 4-fold variation across centers that may be modifiable.

Perspective

Extubation failure is common in neonates after cardiac surgery; considerable variation in these rates exists across centers. Airway anomaly was the only identified risk factor in this multicenter cohort, suggesting that center practices might underlie the observed variation. Collaboratives, including the Pediatric Cardiac Critical Care Consortium, are suited to identify best practices and improve outcomes.

CONG

Pediatric cardiac critical care providers often are challenged with the equally important but often conflicting goals of minimizing patients' exposure to mechanical ventilation and preventing extubation failure.[1-3] Although early extubation protocols may improve outcomes for certain populations in pediatric cardiac intensive care units (ICUs), extubation failures have been associated with adverse outcomes, including increased duration of

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Abbreviations and Acronyms
GEE = generalized estimating equation
ICU = intensive care unit
IRB = institutional review board
LOS = length of stay
PC^4 = Pediatric Cardiac Critical Care Consortium

Scanning this QR code will take you to a supplemental video for the article.

hospital stay, cardiac arrest, and mortality.[4,5] Although these outcomes in part reflect overall illness severity and are not exclusively the result of extubation failure, patients may experience downstream complications of extubation failure, such as airway injury, prolonged mechanical ventilation, and the numerous consequences of prolonged exposure to critical care therapies. As such, collaborative efforts to reduce extubation failure events comprising all members of a congenital cardiac surgical program, including surgeons, anesthesiologists, intensivists, and cardiologists, can lead to great benefits for patients. A recent study conducted by the Pediatric Heart Network aimed at optimizing mechanical ventilation practices is a notable example of the importance of multidisciplinary collaboration when addressing issues related to surgery for congenital heart disease.[6]

Reliable measures of extubation readiness, although validated in adult patients, remain elusive in pediatric and neonatal intensive care. Among pediatric patients of all ages in the cardiac ICU included in 2 multi-institutional registries, risk factors for extubation failure have included young age, genetic syndromes, surgical complexity, delayed sternal closure, postoperative infections or complications, and duration of mechanical ventilation.[4,5] Neonates in the cardiac ICU consistently have demonstrated an increased risk of extubation failure relative to their pediatric counterparts; previous investigation focusing on these patients consistently report extubation failure rates from 17.5% to 22.0% of patients compared with overall rates of approximately 6% in all patients in the cardiac ICU.[4,7,8] These studies also suggest worse clinical outcomes associated with extubation failure in neonates.[7-9]

To date, extubation failure after neonatal congenital heart surgery has been studied only in single-center populations or as part of the larger pediatric population. It is possible that the epidemiology and risk factors for extubation failure in neonates vary differently across hospitals. As such, studies exploring this life-threatening complication using large multicenter datasets are sorely needed to design interventions aimed at minimizing its occurrence. We sought to use the data available within the Pediatric Cardiac Critical Care Consortium (PC^4) registry to describe the epidemiology of extubation failure in neonates recovering from congenital heart surgery across multiple centers and identify risk factors for its occurrence.

MATERIALS AND METHODS

Data Infrastructure

The PC^4 is a quality improvement collaborative currently including hospitals from North America that participate voluntarily.[10] The registry contains data on patients with primary cardiac disease admitted to an ICU under the care of a cardiac critical care attending. For this data analysis, data from 14 hospitals actively submitting cases between October 1, 2013, and July 31, 2015, were included. The registry collects patient demographics, cardiac ICU encounter characteristics, surgical data, critical care practices, and outcomes. For each episode of mechanical ventilation, the date and time of initiation, the date and time of extubation, and whether an extubation is planned or unplanned were recorded. PC^4 data entry for surgical variables uses common data definitions and terminology and is integrated with the site's local data collection for the Society of Thoracic Surgery Congenital Heart Surgery Database as previously described.[10]

Trained data managers who pass an annual certification examination enter data into the registry. All data fields are defined according to standardized definitions. PC^4 conducts weekly data-collection team teleconferences to review variable definitions and resolve questions related to data entry. Cases cannot be submitted to the registry unless all mandatory data fields are complete, and approximately 90% of fields are required for submission. There were no missing data in the study cohort on variables necessary for the analysis. The PC^4 Data Coordinating Center audits every participating center on a regular schedule using a combined method of blind chart abstraction by auditors and source data verification including cardiac ICU census review. The results of auditing processes indicated an aggregate overall accuracy of 99.1%, a major discrepancy rate of 0.62%, and no evidence of selective case omission.[11] Participation in PC^4 is considered quality improvement by the local institutional review board (IRB) at each site that participated in this study, and as such, the local IRB waived the need for approval. The University of Michigan IRB provides oversight for the PC^4 data coordinating center; this study was reviewed and approved with waiver of informed consent.

Patient Population

All neonates who underwent cardiac surgery at age 30 days or less, who had a cardiac ICU encounter between October 1, 2013, and July 31, 2015, and who had data submitted to the PC^4 registry were included in the analysis. Only the neonate's index surgical encounter that resulted in postoperative mechanical ventilation was included. Neonates were excluded if they weighed less than 2.5 kg and were undergoing isolated closure of patent ductus arteriosus, were extubated before arrival to the cardiac ICU, had a tracheostomy before cardiac surgery, died before a planned extubation attempt, or were extubated with the intention of withdrawal of life-sustaining therapy.

Data Variables and Outcomes

Patient, preoperative, operative, and postoperative clinical variables were chosen a priori as potential risk factors for extubation failure.