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Key Words: mechanical ventilation, pediatric cardiac surgery, reintubation, surgical complexity, center volume

EDITORIAL COMMENTARY

Can multicenter registries determine the optimal timing of extubation after congenital heart surgery?

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Central Message

A large registry is used to assess the effect of the timing of mechanical ventilation extubation after congenital heart surgery.

See Article page 451.

The length of time that a patient is on mechanical ventilation has been shown to be associated with both intensive care unit (ICU) and hospital length of stay after congenital heart surgery, including surgery involving complex palliations, such as the Norwood procedure.^{1,2} Although this relationship is not always causal, experts recommend that extubation be performed as early as reasonably possible,^{3,4} to limit exposure to morbidities associated with prolonged ventilation, as well as therapies required with ventilation, such as analgesia, sedation, and use of invasive catheters.

Questions remain as to which patients can be safely extubated early in the postoperative course and what factors might predict subsequent failure of unassisted respiration. Although only a small percentage of patients require reintubation, the associated morbidity should be avoided.

Gupta and colleagues⁵ conducted a retrospective analysis of prospectively collected data to determine factors

that affect ICU mechanical ventilation and reintubation after pediatric congenital heart surgery, using the Virtual PICU Systems (pediatric ICU; Los Angeles, Calif) database. This analysis represents a sizable number of patients (27,298) from a large number of centers (62). Independent patient risk factors identified for mechanical ventilation in the ICU included: younger age; lower weight; genetic disorder; pulmonary hypertension; complex operations for patients in congenital heart surgery mortality categories 4 or 5 (Society of Thoracic

Surgeons and the European Association for Cardio-Thoracic Surgery; STAT mortality categories); reoperation; acute lung injury; and increased Pediatric Index of Mortality-2 score. By contrast, a dedicated cardiac ICU was found to be protective. Additional independent risk factors for reintubation included: cardiac arrest, chylothorax, phrenic nerve injury, seizures, sepsis, high-frequency oscillatory ventilation, extubation in the operating room, and longer duration of ventilation.

DO WE HAVE THE DATA TO ANSWER THE QUESTION?

A limitation of registries is that their data fields are often not well designed to answer post-hoc research questions. In this particular study, additional important data fields regarding the decision to extubate in the operating room might include: airway anomaly, preoperative intubation, pulmonary pathology (upper respiratory infection, reactive airway disease, increased secretions), anesthetic strategy, bleeding, arrhythmia, length of case, open sternum, operating room turnover time, time of day, and expertise of anesthesiologist. Similarly, additional data impacting timing of extubation might include open sternum, extracorporeal life support, fluid balance, inotropic support, airway edema, level of consciousness, arrhythmia, and bleeding. Center-specific practice patterns impacting timing of extubation might include centers with out-of-house attending coverage may prefer not to extubate borderline patients at night and institutional threshold for use of noninvasive ventilation or high-flow nasal cannula.

ARE THE REGISTRY DATA ACCURATE, AND TYPICAL OF A CARDIAC SURGERY COHORT?

Gupta and colleagues⁵ report that of 40,903 surgical patients, 32% were excluded overall: 4224 because the index operation was not documented; 8921 because they were not assigned a STAT risk stratification. Reports from the Society of Thoracic Surgeons⁶ and the Pediatric Cardiac Critical Care Consortium¹ show that $\geq 97\%$ of patients should be classified into an index operation and a STAT category.

Whether systematic misclassification occurred, in the sense of bias toward excluding complex versus simple procedures, is impossible to know. In addition, Gupta and colleagues⁵ report that 26 patients were extubated in the operating room after a Norwood procedure. This is a surprising finding, leaving open the question of whether the Norwood procedure was appropriately coded.

COMPARING APPLES TO ORANGES

What are we to make of the authors' primary conclusion⁵ that "the prevalence of extubation in the operating room is

low and it is associated with a low complication rate"? If one mixes all the fruit in 1 basket, correct; if one examines the individual types of fruits, incorrect. For the overall cohort, 25% of patients were extubated in the operating room and only 6% of those required reintubation. However, for certain lesions, extubation in the operating room, compared with the ICU, resulted in a high incidence of reintubation. Following the Norwood procedure, 26 patients were extubated in the operating room, and 50% of those required reintubation, compared with 27% of those extubated in the ICU. Similarly, following the arterial switch operation, 22 patients were extubated in the operating room, and 36% required reintubation, compared with 7% of those extubated in the ICU. Therefore, perhaps a more appropriate conclusion would be that extubation in the operating room is safe in well-selected patients, particularly those undergoing low-complexity operations.

CONCLUSIONS

Gupta and colleagues⁵ provide an excellent statistical analysis of a high volume of patients using the Virtual PICU Systems registry to help determine how the timing of extubation affects the need for reintubation after pediatric congenital heart surgery. Unfortunately, due to the nature of registry data, many subtleties of reasoning for the timing of extubation and need for reintubation are not captured. Nearly one third of the potential patients were omitted due to incomplete data entry. Interestingly and intuitively, although not previously reported, there may be a dramatic difference in success of extubation in the operating room across surgical subtypes. The article by Gupta and colleagues⁵ sets the foundation for further work needed to determine the relevant details that would predict successful extubation in the operating room.

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