Commentary

Extubation failure: an outcome to be avoided

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Related to *Research* by Seymour *et al*., see page 395

Abstract

Extubation failure is an outcome of increasing importance but nearly all studies have been conducted in academic settings. The article by Seymour and colleagues demonstrates that extubation failure is an outcome to be avoided in the community hospital setting as well. Patients failing extubation experience longer lengths of stay, experience higher intensive care unit mortality, and incur greater hospital costs. Investigators have identified tools for predicting extubated patients at highest risk for reintubation. The predictors focus on detecting upper airway obstruction, inadequate cough, excess respiratory secretions, and abnormal mental status. Systematic application of these predictors has the potential to improve outcome.

Keywords extubation failure, intensive care unit mortality, mechanical ventilation, reintubation

The art and science of discontinuing patients from invasive mechanical ventilation continues to attract attention. The discontinuation process consists of two components: weaning (assessing the need for ventilatory support) and extubation (assessing the need for an airway). Investigators have increasingly focused on the latter component, where 5–20% of extubations may fail and require reintubation.

Both unnecessarily delayed extubation and 'premature' extubation are associated with adverse outcomes. Delayed extubation is associated with increased length of stay, increased risk for ventilator-associated pneumonia, and increased mortality in brain-injured patients [1]. Conversely, reintubation (extubation failure) after planned extubation is associated with adverse outcomes including increased hospital mortality, prolonged hospital stay, higher costs, and greater need for tracheotomy and transfer to postacute care [2–4]. Although the adverse effects of reintubation could reflect the severity of underlying illness or could result from complications during reintubation, this has not been demonstrated with multivariate analysis [2–4]. Rather, delayed timely reinstitution of ventilatory support may allow for deterioration and new organ failure, ultimately contributing to increased mortality and increased costs [5].

In response to this observation, investigators have examined whether postextubation application of noninvasive ventilation (NIV) can improve outcome. Unfortunately, NIV did not improve outcome for established postextubation respiratory failure [6] and was actually associated with increased intensive care unit (ICU) mortality when used in a large cohort with early signs of extubation failure (only 10% of whom had chronic obstructive pulmonary disease) [7].

Studies of extubation failure have been almost exclusively performed in academic medical centers. Hence the relevance of the study by Seymour and colleagues, who extend previous work by finding that extubation failure (in a 16-bed medical–surgical ICU) also exacts a devastating toll in the community setting [8]. Using a retrospective methodology, these investigators noted that both postextubation ICU length of stay and hospital length of stay were significantly longer in patients requiring reintubation (9 days and 11 days longer, respectively). Both ICU mortality and hospital

 ICU = intensive care unit; NIV = noninvasive ventilation.

mortality were also higher for reintubated patients, although the latter did not achieve statistical significance. Using estimates from direct and indirect charges, Seymour and colleagues found that total hospital costs increased by an average of nearly $34,000 for reintubated patients.

Although the results of Seymour and colleagues' study are enticing, several issues with the study design will need to be addressed when future investigators examine this issue. A classic case–control methodology should ideally be employed, matching controls for sex, age, case type (e.g. surgical versus medical), severity of illness (or organ failure score), etiology of respiratory failure, and duration of mechanical ventilation prior to extubation. In addition, several groups have noted that patients reintubated for airway problems or upper airway obstruction and those patients reintubated more rapidly have a better prognosis than other reintubated patients [5,9]. With so many potential factors impacting outcome for reintubated patients, multivariate analyses to determine the independent effect of extubation failure are mandatory.

How should the results of this study and other studies conducted in tertiary care academic centers affect how we care for ventilated patients? Given the poor outcome of patients failing extubation and the inconsistent benefit for NIV to prevent reintubation, clinicians should be more vigilant in identifying who is at high risk for extubation failure.

Predictors developed to predict weaning outcome have not faired well in accurately predicting extubation outcome [10]. This is not unexpected as extubation failure often occurs for reasons other than an imbalance between work of breathing and the load on the respiratory system, the typical reason for weaning failure. Patients often fail extubation because of upper airway obstruction, inadequate cough, excess respiratory secretions, abnormal mental status, or a combination of more than one of these factors [11].

The quantitative cuff leak test (the difference between inspired and expired tidal volumes during assist-control ventilation with the endotracheal tube cuff deflated) can identify a cohort at increased risk for postextubation stridor [12–14]. Objective, quantitative assessments of cough strength and secretion volume can similarly predict postextubation failure [15]. Indeed, decreased peak expiratory flow rates using a calibrated flow meter ($<$60 l/min) and increased sputum volume ($>$2.5 ml/hour in the 2–3 hours prior to extubation) were associated with relative risks for reintubation of 4.8 and 3, respectively [16]. The same investigators noted a relative risk of extubation failure of 4.3 in patients unable to complete four simple neurological tasks (open eyes, follow with eyes, grasp hand, stick out tongue). Combining the three risk factors of decreased peak cough flow, increased sputum volume, and abnormal neurological assessment had a synergistic effect. Only 3% of patients without risk factors required reintubation, compared with 100% of patients with all three risk factors.

Based on these studies, one can recommend delaying extubation if the risk factor (e.g. excess secretions, abnormal mental status) can be substantially corrected in 1–3 days. Intuitively, little is gained by waiting for extubation if risk factors are irreversible or would take more than a few days to correct. In the latter instance, the benefits of waiting are offset by the risks of significantly prolonging invasive ventilation. Whether the latter group should be extubated despite the elevated risk for reintubation or alternatively be considered for tracheotomy is unclear. A preliminary report suggests that immediate application of NIV in such a high-risk cohort may be effective in improving outcome [17].

In conclusion, the study of Seymour and colleagues further supports the notion that extubation failure is an outcome to be avoided, wherever it occurs. We now have the tools to predict who is at risk for extubation failure. The effective application of those tools at the bedside requires further investigation.

Competing interests

The author declares that he has no competing interests.

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