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EDITORIAL

So You Think You Can Safely Extubate Your Patient?

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Intubation and mechanical ventilation are necessary in one-third of patients who are critically ill. While life-saving, these interventions are coupled with increased acid–base disturbances, infections and organ failure [1]. In addition, both early extubation leading to reintubation and deferred extubation correlate with higher morbidity and morality and longer stays in the intensive care unit (ICU) [2, 3]. Physicians strive to determine the most appropriate time to extubate a patient with efforts to predict this dating to the earliest research in critical care [4]; however, patients still have a significant extubation failure rate, now estimated to be 13–18% of the time [5, 6].

Extubation and discontinuation of mechanical ventilation should be considered once the cause of the respiratory failure has been remedied if the patient is oxygenating without difficulty and not hemodynamically compromised. The patient should also be evaluated for ability to tolerate a spontaneous breathing trial [7]. While these recommendations guide the physician in liberating a patient from the ventilator, they do not assess if the patient's airway is adequate to tolerate extubation. A weak cough and copious secretions are associated with an unsatisfactory airway and extubation failure [6].

Accurately judging ability to protect the airway is paramount in patients intubated solely for neurologic reasons. This unique population of critically ill patients frequently does not have respiratory failure and otherwise meet criteria for extubation. Uncertainty of a brain-injured patient's airway can delay extubation, perhaps unnecessarily. Coplin et al. [3] followed a prospective observational cohort of 136 brain-injured patients. Twenty-seven percent of patients experienced extubation delay after meeting criteria for extubation readiness. These patients had worse neurologic status as measured by the Glasgow Coma Scale (GCS) and increased airway care requirements. Extubation delay was not necessarily associated with improvement in neurologic status. In fact, 43% of the patients who had a delayed extubation had no change or a worsening of their neurologic condition at time of extubation. A physician may choose to keep a comatose patient intubated for airway protection and prevention of pneumonia. However, 54% of pneumonias occurred after patients met criteria for extubation delay ($P = 0.05$). Coplin and colleagues also underscored the costs associated with extubation delay, including increased lengths of ICU and hospital stays and increased mortality.

Given physicians' trepidation in safely extubating brain-injured patients, several studies have attempted to identify predictors of extubation outcome in these patients. Weaning parameters (including respiratory rate, tidal volume, rapid shallow breathing index, minute ventilation, negative inspiratory force, and the PaO_2/FiO_2 ratio) are not prognostic of extubation failure in patients intubated for neurologic reasons [8]. These findings are not unsurprising given these parameters evaluate pulmonary status in patients without primary pulmonary dysfunction. Neurologic status as a predictor of extubation failure has produced contradictory results. Coplin et al. [3] demonstrated that comatose patients could be extubated successfully (80 and 91% of patients with GCS ≤ 8 and ≤ 4, respectively). Ko

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et al. [8] attempted to use the Four Scale score to distinguish those at risk for extubation failure, but did not find a specific score that separated those who failed extubation from those who successfully extubated. However, others have found that a GCS score > 7 and the ability to follow commands correlate with extubation success [9, 10]. Clearly, further study in this area is warranted.

In this issue of *Neurocritical Care*, Karanjia et al. [11] describe patient characteristics that led to extubation failure in patients requiring intubation because of primary neurological injury. This manuscript takes an important step in illustrating why brain-injured patients might fail extubation. In this retrospective review, the authors identify 1265 patients in their neurocritical care unit (NCCU) whose need for intubation was neurological rather than pulmonary or post-anesthesia. The authors describe outcomes regarding successful and failed extubation attempts, need for reintubation and need for tracheostomy. The incidence of extubation failure in this study was 6.1%. This rate is much lower than previously reported assessments of 13–18% in the general critical care population [5, 6] and 17–38% in the neurological population [8–10]. Unfortunately, the difficulty with comparing the rate of extubation failure across studies is the lack of a uniform definition for this variable. Karanjia and colleagues chose to define extubation failure as need for reintubation within 72 h of extubation. Others have used both a shorter time interval of 48 h [8] and any need for reintubation without a clear time interval [9] to define extubation failure. The latter definition by Namen et al. [9] may explain the high rate of extubation failure (38%) in this study. Additionally, the denominator used to calculate extubation failure is not the same in all studies. Karanjia et al. compute extubation failure using the total intubated population as the denominator. This method gives a falsely low incidence of extubation failure compared to using patients who had an extubation attempt as the denominator. Regardless, the authors make interesting observations in those patients who required reintubation.

Of the 1265 patients reviewed by Karanjia et al., 129 patients required reintubation. Ninety-nine of these patients had primary brain injury; the others had spinal cord, peripheral nerve or neuromuscular disorders. The majority of brain-injured patients (63 patients) failed for neurologic respiratory insufficiency characterized by a decreased respiratory rate and radiographic evidence of atelectasis later leading to respiratory distress involving tachypnea, increased work of breathing and air hunger. Hypoxemia was not universal in this population. Importantly, patients failing for neurologic reasons did not have a diagnosis of aspiration or pneumonia contributing to their respiratory failure. All patients were reported to have an intact gag and cough; however, ability to handle secretions is not included. A spontaneous cough and suctioning frequency have been associated with extubation success in brain-injured patients [3]. Corroborating these findings in this most recent study by Karanjia et al. could have further characterized brain-injured patients at risk for extubation failure. Also, while the authors comment on the GCS score at time of extubation, they do not comment on the GCS score at time of reintubation. The association between mental status and neurologic respiratory insufficiency could be an important finding given the inconclusive data available thus far. Twenty-two brain-injured patients required reintubation for primary pulmonary reasons. Ten patients had nosocomial pneumonia, six patients aspirated, and six patients developed stridor. The remaining patients were intubated for either neurologic complications related to herniation or seizures or for various medical complications.

The timing of reintubation in this retrospective review is also of interest. Most of the brain-injured patients (51 patients) failed extubation within the first 24 h. The next largest group of patients (25 patients) required reintubation >72 h post-extubation. This latter population of patients is typically not defined as failed extubation, but it may be important to look beyond 48 or 72 h in patients with neurologic injury to assess need for reintubation. One would want to know if those who fail early versus late do so for different reasons and if any factors can predict early versus late need for reintubation.

A population of patients not adequately characterized by Karanjia and colleagues are those patients who went on to direct tracheostomy without extubation attempt. In their study, these patients are defined as successful extubations. While patients who have direct tracheostomy may be successfully weaned from the ventilator, they are not successfully extubated. Importantly, successfully liberating a patient from the ventilator is not the dilemma in neurologically impaired patients given a lack of primary pulmonary pathology in these patients. The quandary physicians face relates to ability to protect airway despite an impaired mental status. One could argue that patients who have direct tracheostomy in essence failed extubation based on physician judgment. Reasons for failure to attempt extubation in this population would be enlightening.

Overall, Karanjia and colleagues make a significant observation that a majority of brain-injured patients seem to require reintubation based on neurologic respiratory insufficiency. This syndrome is essentially characterized by hypoventilation, and in the discussion section, the authors further attempt to define neurologic respiratory insufficiency using the following four criteria: respiratory rate < 8 breaths per minute, tidal volumes below those for age-specific norms, $PaCO_2 > 48$ mm Hg, and $PaO_2 <$ 60 mm Hg or $SaO_2 < 90\%$. From the text, it is not clear how many of the four criteria were fulfilled by each patient labeled as having neurologic respiratory insufficiency. Further prospective study refining the definition of neurologic respiratory insufficiency and identifying brain-injured patients at risk could be key to accurately predicting extubation outcome in this population. As neurointensivists wait for future research to yield a more refined quantitative assessment to predict extubation outcome, we are left to rely on imprecise guidelines and physician judgment to determine if a patient can extubate safely. Often, the answer to the question of extubating is not a resounding, "Yes!", but a halfhearted, "Yes, I think so. Well, maybe?".

Disclosures None.

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