

COMMENTARY

What is the optimal rate of failed extubation?

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Abstract

Failed extubation (FE), defined as reintubation 48 or 72 hours after planned extubation, occurs in a significant percentage of patients and is associated with a substantial burden of morbidity and mortality. This commentary reviews the literature describing FE rates and the clinical consequences of FE and proposes an 'optimal' rate of FE as well as avenues for future research.

Introduction

In patients presenting with right lower abdominal pain, fever, and leukocytosis, surgery is frequently performed for suspected appendicitis. However, in a large contemporary series, 6.4% of patients with suspected appendicitis had a normal appendix removed [1]. Surgeons with a significantly higher 'negative appendix' rate are likely operating too frequently, and those with rates approaching zero are almost certainly not operating on enough patients.

The decision regarding when to liberate patients from mechanical ventilation faces intensive care unit (ICU) clinicians regularly. While this decision is typically based on a variety of data, there is often considerable uncertainty about the success of extubation.

The decision of whether to operate on a suspected appendicitis has, as we shall see, some similarities with the decision of when to extubate. Failed extubation (FE), defined as the need for reintubation within 48 or 72 hours of planned extubation, occurring in 0% of patients would suggest that mechanical ventilation was continued for an unnecessarily long duration, and FE occurring in 50% would suggest that too many patients were liberated from mechanical ventilation prematurely.

What, then, is the optimal rate of FE? Moreover, does it matter? To help answer these questions, this commentary

will review some of the literature on ventilator weaning trials to ascertain the reported range of FE as well as the more limited literature describing the clinical consequences of FE. Finally, we will attempt to answer the question posed by the title of this commentary and propose avenues for future investigation.

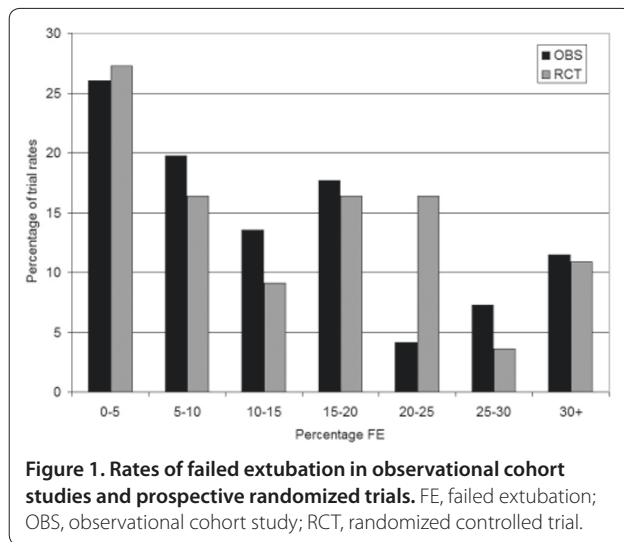
What is the reported rate of failed extubation in the literature?

Figure 1 displays the range of FE rates reported in interventional trials of weaning strategies and observational cohort studies. The mean (standard deviation) rates in interventional and observational studies are 15.7 (15.6) (n = 55) and 15.0 (14.0) (n = 96), respectively. (References are listed in the Supplemental file.) The rates vary widely in part because of differences in the diagnostic categories of the patients studied, the duration of mechanical ventilation prior to planned extubation, and the interventions that were assessed. An investigation by Esteban and colleagues [2] is perhaps the best known of the randomized trials. This multicenter study evaluated four methods of weaning patients from mechanical ventilation: intermittent mandatory ventilation, pressure support ventilation, intermittent spontaneous breathing trials throughout the day, and single spontaneous breathing trials. FE occurred in 13.8%, 18.9%, 15.2%, and 22.6% of the patients, respectively [2]. More recently, Bien and colleagues [3] evaluated the predictive power of three contemporary methods of weaning: T-piece, automatic tube compensation, and pressure support ventilation in 68 consecutive medical ICU patients. The rate of FE for the cohort was 33.8%.

Clinical consequences of failed extubation

A more limited literature describes the clinical consequences of FE. Thille and colleagues [4] prospectively evaluated all patients with planned extubation over the course of a year in a single medical ICU; FE occurred in 15.5%. Patients with FE were older, had a more significant underlying cardiac disease, and were ventilated longer before planned extubation than were patients with successful extubation. Patients with FE sustained far higher rates of pneumonia within 72 hours after extubation (27% versus 0%) and of death (50% versus 5%) than did those with successful extubation.

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We recently completed a case control study of FE [5]. Over a 5-year period, 2,012 patients received mechanical ventilation in our 16-bed medical-surgical ICU; 1,294 had a planned extubation. Eighty-five (6.6%) sustained FE. The patients with FE were matched 1:3 with 255 control patients who were successfully extubated. Matching parameters included duration of ventilation before planned extubation, age, Acute Physiology Score, and admitting diagnosis to the ICU. Ventilator-associated pneumonia developed in 7.1% of the index patients with FE versus 0.8% of the controls with FE ($P = 0.0043$). ICU length of stay was considerably longer in patients with FE: 11.8 (7.7 to 17.5) versus 3.8 (2.1 to 7.5) days ($P < 0.001$). Mortality was more than twice as high: 23.5% versus 10.2% ($P = 0.0052$); multivariate analysis determined that FE was independently associated with increased risk of mortality: odds ratio of 2.64 (95% confidence interval of 1.35 to 5.14) ($P = 0.0044$). These data suggest that, far from being inconsequential, FE is associated with a substantial burden of morbidity and mortality.

Is there an optimal rate of failed extubation?

The diversity of patient populations, study settings, and interventions evaluated precludes a clear-cut answer to this question on the basis of a review of the literature. Nevertheless, we believe that an FE rate of 14%, the median rate observed in the interventional and observational studies described above, is inappropriately high.

A singular focus on lung mechanics characterizes the literature reporting FE rates. Typically, patients are deemed ready for liberation from mechanical ventilation when they have successfully passed a test, such as a spontaneous breathing trial with a low rapid shallow breathing index (expressed as the ratio of respiratory rate

to tidal volume, or RR/Vt) [6]. In fact, the original study describing the use of this index reported an FE rate of 22% [6].

Perhaps the systematic inclusion of parameters not related to lung mechanics would yield lower rates of FE. In particular, these might include factors associated with the patient's general medical status, such as vital signs, neurologic status, nutritional status, and laboratory findings such as electrolyte abnormalities and anemia. In addition, greater attention to airway issues – secretion volume, purulence, viscosity, and the patient's ability to both 'clear' and 'protect' the airway if extubated – may further reduce the FE rate [7].

In fact, a systematic awareness of all three 'domains' of readiness for liberation from mechanical ventilation – good 'performance' on the ventilator (positive end-expiratory pressure or continuous positive airway pressure of not more than 5, good lung mechanics during spontaneous breathing trials or low level of pressure support ventilation, and ability to tolerate a fraction of inspired oxygen (FiO₂) of not more than 0.5), good overall medical status, and the perceived ability of the patient to clear and defend the airway after extubation – by a small group of intensivists practicing in a protocol-driven environment in our mixed medical-surgical ICU has led to the 6.6% rate of FE and relatively short duration of intensive care noted above [5]. This number is remarkably close to the 6.4% rate of 'negative' appendectomies cited at the beginning of this commentary. Accordingly, while differences in patient populations and clinical practices undoubtedly complicate the choice of a single number, we choose the range of 5% to 10% as our proposed 'optimal' rate of FE.

Conclusions

FE occurs in a significant percentage of patients after planned extubation and is associated with significant morbidity and mortality. Efforts to evaluate, in a more systematic manner, factors beyond those related to pulmonary mechanics may lead to lower rates of FE without unnecessarily increasing the duration of mechanical ventilation. Future research exploring the differences in the 'three domains' of readiness for liberation from mechanical ventilation that distinguish patients who sustain FE from those who are successfully extubated may yield models that will assist clinicians in improving the outcomes of mechanical ventilation.

Abbreviations

FE, failed extubation; ICU, intensive care unit.

Competing interests

The authors declare that they have no competing interests.

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