Commentary

Protocol-directed weaning: a process of continuous performance improvement

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Abstract

The use of a nursing-directed and/or respiratory therapist-directed protocol in many intensive care units for weaning from mechanical ventilation is associated with a shorter duration of ventilation and length of stay in the ICU. Most protocols have two formal components: the daily screening of a set of simple observations or interventions to identify readiness to proceed, followed by a spontaneous breathing trial that tests the patient's ability to breathe independently. The daily screen is designed to identify potential barriers regarding medical stability, level of consciousness, oxygenation, ventilation, and airway patency and protection. However, one must avoid selecting criteria that are too restrictive, potentially delaying the discontinuation of ventilation.

In this issue of *Critical Care*, Tonnelier and colleagues [1] report beneficial effects of a nurses' protocol-directed weaning strategy to discontinue mechanical ventilation (MV) in patients requiring ventilatory support for greater than 48 hours. Whereas many controlled trials conducted in North America have demonstrated the effectiveness of nursing-based and respiratory therapist-based protocols in the early discontinuation of MV and reducing the length of stay in the intensive care unit (ICU) [2–5], weaning from MV in Europe has generally been physician-directed [1]. The study by Tonnelier and colleagues [1] was undertaken to test whether the French Intensive Care Society (SRLF) 2001 consensus recommendations [6] to use a nurses' protocol-directed approach to weaning would be effective. When their results were compared with historical controls, the authors showed a shorter duration of MV and a shorter length of stay in the ICU, with no difference in extubation failure (reintubation) or incidence of ventilator-associated pneumonia [1].

Over the past decade, the approach to discontinuation of MV has changed from one of gradual reductions in the level of artificial ventilatory support until independence is achieved, namely 'weaning', to that of timely recognition of the patient's ability to breathe independently followed by rapid discontinuation [7]. Ely and colleagues [2] first showed that a combination of a daily screening checklist of easily measured parameters, followed by a demonstration of tolerance of spontaneous independent breathing was highly predictive of extubation success. Importantly, this technique [2] emphasizes a multidisciplinary approach that relies on nursing and respiratory therapist assessments of objective criteria, and has served as the basis for weaning protocols in many ICUs.

Tonnelier and colleagues' [1] approach is similar, with a daily screen of weaning parameters, then a 90-minute spontaneous breathing trial (SBT) conducted with a T piece if the screen was passed. It is noteworthy that, as in other studies [2–5], performance of the screen and SBT is independent of physician input, potentially streamlining the process. The decision to extubate is made by a physician after the patient has demonstrated a good cough, and a leak test has been passed [1]. Achieving independence from the ventilator and from the artificial airway generally requires the patient to have significant improvement in the indication for MV, adequate medical stability, evidence of sufficient ventilator-independent gas exchange to achieve acceptable ventilation and oxygenation after discontinuation, adequate cough, and good airway patency and protection.

Because both longer duration of ventilation and higher rates of extubation failure have been linked to medical factors unrelated to adequacy of ventilation [8], most screening tools include factors related to medical stability, typically hemodynamic stability reflected by an absence of vasopressor support for shock [1,2,5,7]. The patient should

FiO2 = fraction of inspired oxygen; ICU = intensive care unit; MV = mechanical ventilation; PaO2 = arterial oxygen partial pressure; PEEP = positive end-expiratory pressure; RSBI = rapid shallow breathing index; SBT = spontaneous breathing trial.

also be sufficiently awake to protect the airway, cough, and ventilate. Although Tonnelier and colleagues [1], as well as others [2], use the absence of continuous infusion sedatives as a surrogate marker, more directly examining the patient's level of arousal may be preferred because many patients on sedative infusions are sufficiently awake for extubation [1,5,9,10]. The relationship between sedative medications, level of consciousness, and ventilator discontinuation is important. Daily cessation of sedative infusion has been linked to earlier extubation [11], perhaps through reduced drug accumulation or because of more timely weaning [12].

Progressive hypoxemia after extubation is a common cause of failed extubation [8] and might be predicted by a high fraction of inspired oxygen (FiO2) and/or positive end-expiratory pressure (PEEP) requirement, or a reduced arterial oxygen partial pressure (PaO2):FiO2 ratio [7]. Whereas Tonnelier and colleagues [1], and others [10], selected a rather conservative threshold of FiO2 < 0.5 and PEEP ≤ 5 cmH_2O, other protocols use PaO2:FiO2 > 200 mmHg [2–4,13], PaO2:FiO2 > 150 mmHg [5], or PaO2:FiO2 > 120 mmHg [9]. The use of a conservative FiO2 and PEEP threshold might delay patients from progressing to the SBT unless FiO2 and PEEP are routinely reduced to the lowest acceptable levels. Similarly, a conservative PaO2:FiO2 threshold (that is, more than 200 mmHg) might delay progress – this was the most common reason for screening failure in patients who eventually achieved ventilator independence without ever passing a daily screen in one observational study [13].

Ventilatory insufficiency leading to hypercapnia and/or increased work of breathing is another frequent contributing factor for extubation failure. Although the SBT is usually the final test of adequate patient ventilation, other measures, such as the ratio of frequency to tidal volume (rapid shallow breathing index; RSBI) are incorporated into some screening criteria. An RSBI of less than 105 breaths per litre per minute is required to proceed with SBT testing in some protocols [2,10]. However, because of concerns that this test and/or threshold might delay weaning [7,8], some groups use a higher threshold, such as 125 breaths per litre per minute [5], or omit RSBI altogether [1,4]. There are many variations on the actual process of conducting an SBT, such as the following: first, a duration ranging from 30 to 120 min; second, the level of mechanical support intended to overcome the work of breathing through the endotracheal tube varying among T-piece, automatic tube compensation, continuous positive airway pressure, or pressure support ventilation; and third, the criteria to identify SBT failure and stop the trial. Any of these factors might influence the outcome of the trial. Tonnelier and colleagues used a 90-minute T-piece SBT with conventional failure criteria. More work is needed to confirm the adequacy of shorter SBTs [14] and to compare various ventilatory support methods for SBT.

Although cough adequacy, secretion clearance, and airway patency have long been recognized as important factors for successful weaning and extubation, testing has been largely subjective. Similar to other approaches, 'efficient' cough and subjective air leak were required before extubation of Tonnelier and colleagues' patients. Recent research confirms the importance of respiratory secretion volume, cough strength, and measured leak with cuff deflation of the endotracheal tube as predictors of successful extubation [9,15].

In sum, the work by Tonnelier and colleagues [1] confirms the value of a structured nursing-driven (and/or respiratory therapy-driven) weaning protocol noted by most [2-5] but not all [10] investigators to reduce duration of MV without increasing reintubation rates. Their results may be influenced by study design (historical control rather than randomized), populations studied (different results for medicine and surgery patients), and the pre-existing approach to weaning. It is noteworthy that their duration of MV was longer and reintubation rates were higher than in other reports [2–5,10], despite similar severity of illness. This implies that further reductions in MV duration might be attainable, perhaps by fine-tuning the screening criteria as discussed above, or by instituting a daily strategy for the cessation of sedation. Finally, the long-term success of such protocols requires continued multidisciplinary attention and support, along with periodic evaluation and revision if necessary.

Competing interests

The author(s) declare that they have no competing interests.

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