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UNDERSTANDING THE DISEASE

Ten tips to optimize weaning and extubation success in the critically ill

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Prolonged mechanical ventilation (MV) is associated with complications and prolonged intensive care unit (ICU) stay [1, 2]. Weaning time (referring to the first attempt to separate the patient from the ventilator, whatever its modality) accounts for up to 50% of the duration of MV. In this short review, we set out what we consider to be the ten most important tips for accelerating the weaning and extubation process.

1. *Less is more: avoid unnecessary sedation*

One cannot conceive of weaning without optimizing sedation and limiting the use of paralytics. Sedation protocols (nursing-protocolized targeted sedation or daily sedative interruption) have been associated with shorter duration of MV in both medical and surgical patients [3, 4] in comparison with no protocols, and are currently recommended by international guidelines [1, 4].

2. *Diaphragm-protective ventilation to prevent respiratory muscle complications of MV*

Prolonged controlled mode ventilation is associated with numerous complications including respiratory muscle dysfunction/atrophy, also called ventilator-induced diaphragm dysfunction [2], and with poor outcome. High tidal volumes, excessive inspiratory efforts and patient-ventilator asynchronies are associated with both lung and diaphragm injuries. The effort-dependent lung injury has been termed "patient self-inflicted lung injury" (PSILI) [5].

3. *Daily screen for spontaneous breathing trial (SBT)*

To be eligible for an SBT under the European guidelines, the condition that led to the patient's intubation must be improving and the patient's vitals must be within physiological ranges with low or no organ support, or within acceptable limits for specific patients [6]. Whether some of these items should be reconsidered remains to be tested in future studies (e.g. should we revise the classical respiratory criteria: $PaO_2/FiO_2 > 150$ mmHg, $FiO_2 < 40\%$, PEEP $< 8 cmH_2O$) ?

4. *Which SBT?*

Choosing the best SBT at the bedside is not an easy task and no large study has ever compared different trials considering different clinical vignettes and respiratory physiology patterns. The T-Tube trial is the SBT that closely reflects post-extubation inspiratory effort. However, the goal of the SBT should be, rather, to answer the question "can I wean and extubate my patient with a low risk of reintubation based on this SBT?". When choosing an SBT, it is important to remember that an "easy" trial, characterized by high assistance (e.g. pressure support $7 cmH_2O$ with PEEP $5 cmH_20$) and short duration (30 min), is associated with a higher risk of post-extubation respiratory failure than a tougher test (60–120 min of T-Tube), which is associated with a higher rate of SBT failure and subsequent delayed extubation [7]. This is the reason why the most recent guidelines suggest that the SBT may be performed if it has a low level of assistance and a short duration (pressure support $7 cmH_2O$, PEEP $0 cmH_20$, 30 min) [1].

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5. *Protocolized or semi-automated weaning strategy*

Daily and systematic use of a checklist in a ventilator liberation protocol is associated with 25 more ventilator-free hours and one more ICU-free day compared with no protocol. Whether automated and semi-automated algorithms available on modern ventilators could further increase the ventilator-free days remains uncertain and may be further explored in difficult-to-wean patients. Similarly, proportional modes of ventilation which assist the patient by adapting to his/her effort could be considered in selected patients [8].

6. *Quickly intervene when an SBT fails*

Performing an SBT as soon as the patient becomes "eligible" should be considered as a "stress test", both because it may shorten the duration of invasive MV and because it may unmask one or several undiagnosed conditions (with positive pressure) that should be addressed and treated before the next trial.

7. *Inspiratory muscle load/force generation ratio*

SBT failure reflects an imbalance between inspiratory muscle load and neuromuscular efficiency. Because of specific muscle characteristics and load discrepancies between respiratory and limb muscle groups, the respiratory load/efficiency balance cannot be extrapolated from the examination of limb muscles [9]. In patients in whom the load/efficiency balance is altered, expiratory muscles are recruited, and a better understanding of their function during acute respiratory failure has recently been highlighted [10].

8. *Weaning vs extubation failure risk factors*

Difficult-to-wean patients make up 20% of the mechanically ventilated critically ill population; being older than 65 years and being affected by cardiopulmonary comorbidities are the main known risk factors [11]. Besides weaning risk factors, Jaber et al. compared the risk of airway-related vs non-airway-related risk factors for reintubation within 48 h following extubation (defined extubation failure) and reported that three risk factors were specific to airway failure (female sex, duration of ventilation > 7 days, copious secretions) and two others (non-obese status, SOFA score ≥ 8) to non-airway failure [12].

9. *Post-extubation respiratory support*

Ten to 15% of patients will need to be reintubated within 48 to 72 h post extubation [12]. Standard oxygen therapy should probably be used only in easy-to-wean patients with no or few extubation failure risk factors. On the other hand, in high-risk patients, the combination of high-dose non-invasive ventilation (NIV) (at least 12 h per day for 48 h following extubation) with high-flow nasal oxygen (HFNO) is associated with less reintubation in comparison with HFNO alone [11]. In low- to moderate-risk patients, prophylactic HFNO has been associated with a lower rate of reintubation than standard oxygen therapy in medical but not surgical patients [13–15]. Likewise, HFNO is probably not inferior to NIV alone in preventing post-extubation respiratory failure [14] and may be considered as a first-line prophylactic respiratory support option in patients with a moderate risk of weaning failure. In expert centers, NIV may also be used as a weaning strategy in patients who failed the SBT, as a way to provide positive pressure without the side effects of the tracheal tube and sedation [16–18].

10. *Tracheostomy*

Early vs late tracheostomy has not been associated with a better prognosis in the general ICU population versus the neurocritically ill population. Patients who may be considered eligible for a late tracheotomy (> 10 days of MV) are those that maybenefit, for instance, from gradual weaning and constant airway/mucus plugging control.

Weaning and extubation success depends on careful monitoring, especially in high-risk patients, of adequate pain/sedation management, patient/ventilator interaction, and respiratory load/neuromuscular efficiency. A low pressure spontaneous breathing trial of short duration represents the best compromise between unnecessary prolonged MV and hazardous reintubation. Finally, the association between HFNO and NIV may be considered as a post-extubation respiratory support option in selected high-risk patients.

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Compliance with ethical standards

Conflicts of interest

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