

WHAT'S NEW IN INTENSIVE CARE



What's new in management and clearing of airway secretions in ICU patients? It is time to focus on cough augmentation

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Introduction

An effective clearing of the airways requires a balance between production and removal of respiratory secretions through the muco-ciliary escalator. In ICU patients, both sides of the balance can be impaired. The amount of respiratory secretions can be increased from infection, aspiration, or swallowing disorders. The removal of respiratory secretions can be reduced by upper airway dysfunction and/or respiratory muscle weakness. Many pre-existing or ICU-acquired situations, like chronic neuromuscular disease (NMD), ICU-acquired neuromuscular weakness, sepsis, delirium or conscious level decline due to brain damage may compromise optimal glottis functioning or respiratory muscle strength [1] and, hence, promote unbalance between production and removal of respiratory secretions. Important pathophysiological consequences of this unbalance include increased airway resistance and work of breathing, hypoxemia, atelectasis, and superinfection. Any caregiver in the ICU, whether he/she is a physician, physiotherapist, respiratory therapist, or nurse, has been used to facing the need of tracheal intubation and invasive mechanical ventilation (after a failing attempt of noninvasive ventilation or high oxygen flow) or extubation failure due to copious respiratory secretions.

The amount of respiratory secretions is a primary cause of extubation failure in the ICU [2] and is likely to delay extubation. Both extubation failure [2] and prolonged invasive mechanical ventilation [3] increase the

risk of poor patient outcome. The need of instrumental techniques and close monitoring from respiratory physiotherapists to manage secretions in specific ICU patients is a reason that prolongs ICU stay with the subsequent increasing costs and hazards. It follows from the above that clearing airway secretions is of utmost importance in the ICU. The optimization of the management of clearing airways in the ICU includes detection of a weak cough and carrying out methods that aim at enhancing the efficacy of coughing.

Cough strength assessment and augmentation

For the intensivists facing a weaning failure, making the difference between extubation failure from airway issues and weaning failure from mechanical ventilation support need is important and risk factors for each mechanism have been recently investigated [4]. Identifying patients at high risk of post-extubation failure requiring respiratory or cough assistance remains challenging. Several factors may contribute to extubation failure, including cough impairment and presence of thick and/or excessive mucus, in addition to hypoventilation. [5].

Cough assistance and non-invasive mechanical ventilation (NIV) can prevent post-extubation respiratory failure. As these techniques are time-consuming, criteria for selecting those patients most likely to benefit are useful. Previous studies evaluating cough efficiency before extubation focused on peak cough flow (PCF). However, the PCF cut-offs varied widely [6, 7], perhaps due to differences in study populations and mechanical ventilation durations. Moreover, diversity of devices used to measure PCF, presence of a cannula used to bypass the upper airway, and differences in the degree of patient coordination and cooperation during measurements may influence

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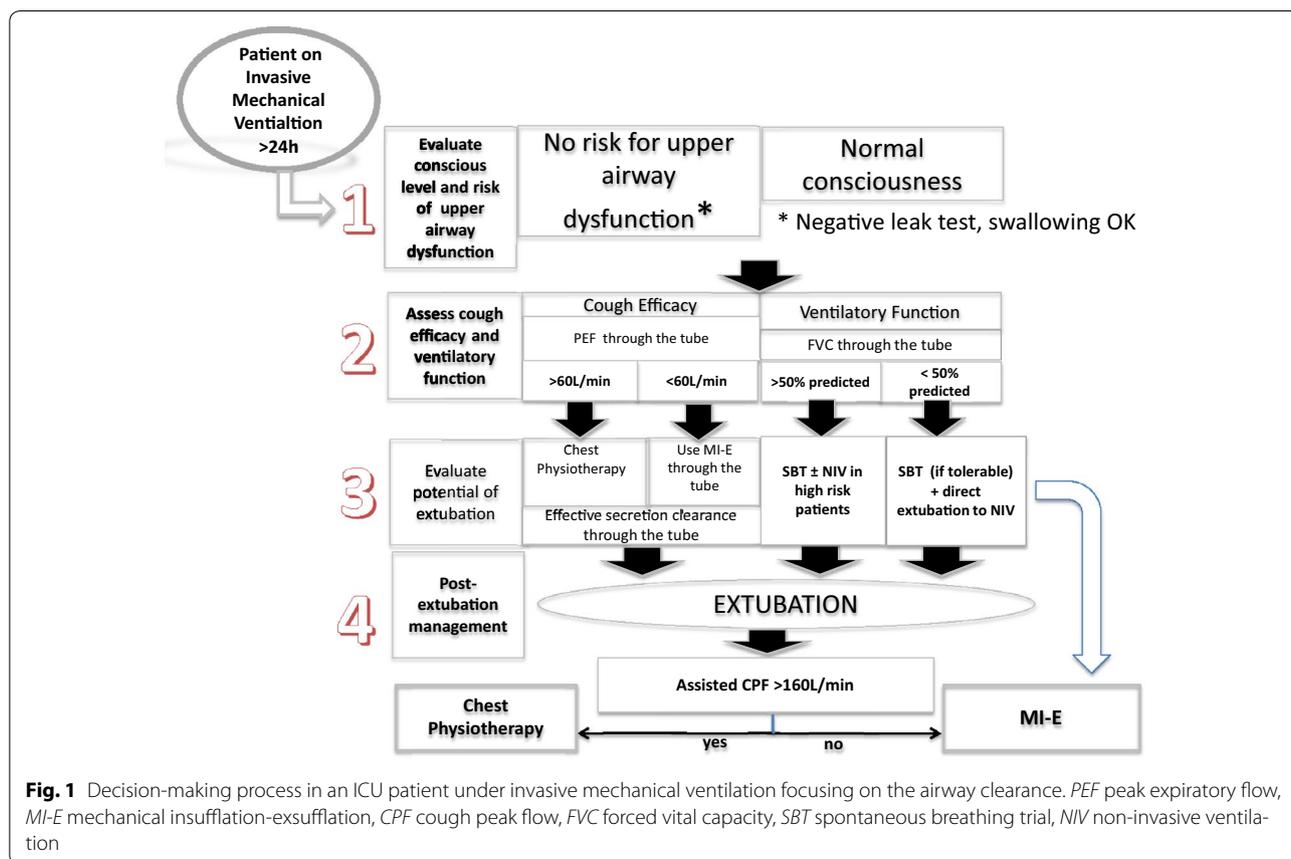
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the results [7–9]. Recently Terzi et al. [10] assessed cough performance and other easily collected respiratory parameters obtained before and after extubation, with the goal of determining which parameters and measurement conditions best identified patients who would require mechanical assistance after extubation. They found that pre- and post-extubation PCF weakly correlated. Several hypotheses can be suggested to explain this finding. The lack of glottis closure in intubated patients may limit the pressure generated during coughing and, hence, the generated PCF would be less compared to PCF without the tube. Airflow resistance is higher with than without an endotracheal tube. However, forced vital capacity (FVC) measurements before and after extubation are well correlated [10]. FVC may serve as an objective predictor of post-extubation respiratory failure requiring NIV and/or mechanical cough assistance and/or re-intubation in heterogeneous populations of medical ICU patients. As such, FVC could be used in combination with easily identified risk factors for assessing patients after a successful spontaneous breathing trial (SBT), with the goal to identify those likely to require prophylactic pre- and post-extubation mechanical cough assistance (Fig. 1). Gobert et al. [11] found that PCF can be measured using

the built-in ventilator flow meter without disconnecting the patient from the ventilator to estimate cough performance. However, PCF alone performed less than combination of PCF and tidal volume to predict post-extubation failure, as demonstrated using FVC.

Airway clearance refers to two separate, but connected, mechanisms: muco-ciliary clearance and cough augmentation. Approaches to prevent airway secretion retention in critically ill patients with mechanical ventilation include pharmacotherapy to reduce mucus production or to liquefy secretions, and chest physiotherapy techniques (CPT). Intratracheal saline or sodium bicarbonate or inhaled β_2 -agonists are unproven but frequently used pharmacological interventions. CPT can be very effective in preventing pulmonary complications in adult critically ill patients with broncho-pulmonary secretion accumulation. The principles of manual CPT consist of application of manual or mechanical external forces in the thoracic cage that have direct effect on expiratory flow and mucus mobilization. Conventional CPT for secretion management failed to increase weaning and extubation success in one trial [12], which had some limitations [13], but improved patient outcomes in a prospective cohort study [14].



The process of discontinuing mechanical ventilation must balance the risk of complications due to unnecessary delay in extubation with the risk of complications due to early discontinuation and the need for re-intubation. Extubation failure occurs in 10–20% of patients who meet all weaning criteria and is associated with a higher mortality rate [2]. Therefore, following extubation, all patients should be closely monitored and an early airway secretion clearance must be performed in order to prevent re-intubation.

Mechanical insufflation-exsufflation (MI-E) is a cough assistance therapy in which the device gradually inflates the lungs followed by an immediate change to negative pressure, which produces a rapid exhalation aimed at stimulating the airflow changes that occur during a cough, thereby assisting sputum clearance [15]. MI-E can be provided via an oronasal mask, a simple mouthpiece, or through an endotracheal tube. With the latter, the cuff, when present, should be inflated. The risk of MI-E is baro/volutrauma and hypotension. Intermittent percussive positive ventilation is another means by which to increase secretion clearance.

Although evidence supporting use of MI-E in critically ill patients is lacking [16], Goncalves et al. found that secretion management with MI-E is an useful complementary technique to prevent re-intubation in patients in whom acute respiratory failure develops in the first 48 h after extubation. In this study, the re-intubation rate related to NIV failure was significantly lower in the MI-E group than in controls [17].

The use of MI-E can avoid intubation in or quickly extubate NMD patients in acute ventilatory failure with no breathing tolerance and profuse airway secretions due to concurrent chest infections. Successful extubation was reported to occur in 155 of 157 unweanable patients with NMD to NIV and MI-E in two centers using a specific goal-directed protocol [18].

Cough strength assessment remains a challenge in ICU patients and its assistance has strong impact on efficient secretion clearance as it may reduce the incidence of post-extubation respiratory failure and contribute to early extubation and, thereby, avert tracheotomy provided that glottic function is sufficient to avoid secretion aspiration. Thus, a different evaluation and treatment paradigm is required for the optimal management of these patients in the ICU.

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Compliance with ethical standards

Conflicts of interest

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