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Editorial

Weaning from Mechanical Ventilator

Mechanical ventilation (MV) is a life-supporting modality that is used in a significant proportion of patients in intensive care units (ICUs). Weaning from MV has been described as either a gradual decrease of ventilator support to allow liberation from the ventilator or determining when the patients will have the ability to be separated from the ventilator safely. Around 20% of mechanically ventilated patients will fail their first attempt at weaning process.[1,2] Prolonged MV is associated with various complications, like infection, gastro-intestinal bleeding, and deep vein thrombosis. On the other hand, premature extubation followed by re-intubation is associated with increased mortality and morbidity.[3] Thus, choosing the right time for weaning remains a challenge to the clinicians.

Weaning from MV depends on the strength of respiratory muscles, the load applied to those muscles, and the respiratory drive to breathe. Respiratory failure may occur because of any of these. The aetiology of unsuccessful weaning is the imbalance between the respiratory muscle pump and the respiratory muscle load. This could happen secondary to inadequate resolution of the initial problem that rendered the patient on MV, a rise of a new problem, a ventilator-associated complication, or a combination of these factors. The key elements to optimise weaning are: *(i)* to determine cause of ventilator dependency, *(ii)* rectify correctible problems like pulmonary gas exchange, fluid balance, mental status, acid-base status, electrolyte disturbance, *(iii)* to consider psychological factors, and *(iv)* to optimise posture and provide ambulation. It is imperative to correct these elements for a successful weaning.

An extubation failure may occur secondary to upper airway obstruction or respiratory secretions that could not be managed by the patient. These factors do not manifest themselves until the removal of the translaryngeal tube. Significant trauma to the airway from translaryngeal intubation is more common in females and increases with increasing duration of intubation. Another potential reason for extubation failure is the loss of positive pressure in the thorax after extubation in pressure support ventilation (PSV)-weaned patients. It is important to remember that the extubation failure that requires re-intubation is associated with an increase in the duration of MV, ICU and length of hospital stay.[4] There is also a significant increase in hospital mortality, especially in the case of delayed re-intubation.

Recognising and treating the process that caused the patient to go on the ventilator is the first goal in liberating him from MV. The complete resolution of the inciting event that led to respiratory failure does not need to be accomplished to start the process of weaning. Partial resolution of the cause of the respiratory failure may be enough to be able to discontinue MV.

Conventional criteria for readiness to wean are relatively easy to use, but their sensitivity and specificity are relatively poor. These criteria include tidal volume (5 to 8 mL/kg), minute ventilation (6L/min), vital capacity (10-15 mL/kg), maximum voluntary ventilation (50 to 200 L/min),[5] respiratory frequency, maximum inspiratory pressure (<-20cm H_2O is associated with inability to maintain spontaneous breathing) as well as integrative indexes (rapid shallow breathing index).[6] Yang and Tobin[6] showed that this rapid shallow breathing index, reflected by the ratio of frequency (breaths/min) to tidal volume (liters), is an accurate predictor of weaning outcome. Using a threshold of less than 105, this ratio had a positive predictive value of 0.78 and a negative predictive value of 0.95. However, it is important to understand that no index has proven to be ideal and highly predictive of weaning.

Various techniques have been proposed to facilitate the transition to spontaneous ventilation. The studies that have addressed this issue have conflicting results. Nevertheless, the commonly used techniques of weaning are T-piece, synchronised intermittent mandatory ventilation (SIMV), or PSV. Unfortunately, the optimal mode of MV used during weaning remains controversial. The SIMV weaning, prolongs the duration of MV. Daily T-piece trials consistently have been superior to the SIMV mode in weaning, and at least equivalent to PSV weaning. More than once daily T-piece trials have not been shown to be superior to daily trials.[7]

With recent advances in technology new features, like automatic tube compensation (ATC) and proportional-assist ventilation (PAV), have been developed.[8,9] The initial step in any protocol-driven ventilator weaning is daily screening for readiness to wean using several weaning parameters. Every appropriate patient in ICU should also undergo a daily interruption of sedation to be in optimal neurological condition for the screening.[10] Most of the guidelines start by identifying potential candidates for the daily screening. Candidates for such a protocol are patients with adequate oxygenation (PaO_2>60 mmHg with $FIO_2 \leq 0.5$, PEEP≤8 cm of H_2O. The spontaneous breathing trial (SBT) is terminated if the patient successfully tolerates SBT from 30 minutes to 2 hours or starts showing signs and symptoms of failing (respiratory rate>35 for >5 minutes, SaO_2<90% for >30 seconds, 20% increase or decrease in heart rate for >5 minutes, systolic blood pressure >180 OR

<90 for one minute with repeated measurements, agitation, anxiety or diaphoresis as a change from the baseline).

To conclude, MV is a life-sustaining therapy fraught with side-effects. The successful removal of MV at any time is associated with a higher survival rate. Therefore, removing the patient from the ventilator as soon as possible is in the patient's best interest. The best approach to wean patients from MV involves a team approach of all care givers including physicians, nurses, respiratory therapist and nutritionists.

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