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Strategies for weaning from mechanical ventilation: A state of the art review

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Summary Identification and adoption of strategies to promote timely and successful weaning from mechanical ventilation remain a research and quality improvement priority. The most important steps in the weaning process to prevent unnecessary prolongation of mechanical ventilation are timely recognition of both readiness to wean and readiness to extubate. Strategies shown to be effective in promoting timely weaning include weaning protocols and use of spontaneous breathing trials. This review explores various other strategies that also may promote timely and successful weaning including bundling of spontaneous breathing trials with sedation and delirium monitoring/management as well as early mobility, the use of automated weaning systems and modes that improve patient—ventilator interaction, mechanical insufflation—exsufflation as a weaning adjunct, early extubation to non-invasive ventilation and high flow humidified oxygen. As most critically ill patients requiring mechanical ventilation will tolerate extubation with minimal weaning, identification of strategies to improve management of those patients experiencing difficult and prolonged weaning should be a priority for clinical practice, quality improvement initiatives and weaning research.

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Implications for Clinical Practice

- Clinicians should seek to identify strategies to promote timely recognition of weaning and extubation readiness appropriate to their clinical environment and the needs of individual patients.
- Patients experiencing difficult and prolonged weaning require careful consideration with a graduated, consistent approach using a tracheostomy mask recommended for tracheostomised patients.
- Strategies such as early extubation to non-invasive ventilation and cough augmentation using mechanical insufflation—exsufflation may be effective in certain subpopulations.

Introduction

What is known about weaning from mechanical ventilation?

It is undisputed that mechanical ventilation, though lifesaving is associated with complications resulting in risk to the critically ill patient (Adamides et al., 2009; Boles et al., 2007; MacIntyre, 2001). Therefore weaning from mechanical ventilation has been a long-standing priority in terms of research to identify the most effective and efficient methods and quality improvement initiatives designed to implement evidence and best practices. Existing data indicate the most important steps in the weaning process to prevent unnecessary prolongation of mechanical ventilation are timely recognition of both readiness to wean and readiness to extubate (Brochard et al., 1994; Esteban et al., 1995). Inappropriate decision making regarding weaning and extubation readiness also is not without risk. Patients may experience respiratory and cardiac failure associated with increased work of breathing during the reduction of ventilatory support for weaning (Jeganathan et al., 2015; Vagheggini et al., 2015). Reintubation due to post-extubation respiratory failure has been shown to increase mortality from 2.5 to 10 times compared to patients that do not require reintubation (Rothaar and Epstein, 2003). However, despite numerous studies attempting to identify predictors of weaning and extubation readiness that have high levels of sensitivity and specificity, no one predictor or combination of predictor variables, either objective or subjective, has been shown to be particularly accurate (Meade et al., 2001). In some contexts weaning protocols that provide structured guidance to weaning and incorporate timely assessment of weaning and extubation readiness may reduce the time to wean and overall duration of ventilation (Blackwood et al., 2014).

A spontaneous breathing test (SBT) or weaning test (Perren and Brochard, 2013) that comprises a focused assessment of a patient's capacity to breathe, currently is advocated as the best method to ascertain extubation readiness (Boles et al., 2007). A SBT generally comprises 30—60 minutes on either low levels of pressure support or continuous positive airway pressure (CPAP) via the ventilator, or using a T-piece attached to the endotracheal tube. A recent Cochrane systematic review and meta-analysis confirms the results of earlier studies that report no difference in terms of weaning success based on the SBT method (Ladeira et al., 2014). Most patients, approximately 60—70%, will require minimal to no weaning of ventilatory support and are extubated without difficulty after the first SBT (Boles et al., 2007). These patients may be classified as simple weaning (Boles et al., 2007). The remaining 30—40% may be classified as difficult weaning, defined as requiring up to three SBTs and seven days to achieve weaning success or prolonged weaning defined as requiring more than three SBTs and more than seven days of weaning (Boles et al., 2007). These patients require a more graduated approach to reducing the amount of support provided by the ventilator or prolonging the time spent off the ventilator using a T-piece or tracheostomy mask (Boles et al., 2007).

This state of the art review of weaning from mechanical ventilation will discuss recent evidence for strategies to promote weaning success including the bundling of SBTs with other complex interventions including sedation and delirium monitoring and management and early exercise; automated weaning systems and ventilator modes that promote improved patient—ventilator interaction; management of difficult and prolonged weaning; use of mechanical insufflation—exsufflation (MI-E) as a weaning adjunct; early extubation to non-invasive ventilation; and the role of high flow humidified oxygen in weaning.

Spontaneous breathing trials, spontaneous awakening trials and the rest of the alphabet

As discussed earlier, a SBT or a weaning test is considered the best method to ascertain extubation readiness. In 2008, Girard and colleagues (Girard et al., 2008) published a multi-centre randomised controlled trial (the ABC trial) that paired a SBT with a spontaneous awakening trial (SAT), also referred to as sedation interruption. Duration of mechanical ventilation, intensive care unit (ICU) and hospital length of stay were reduced with the study intervention when compared to the usual sedation and weaning practices prevalent in the participating units at that time. A key feature of studies evaluating the effectiveness of SBTs, SATs and those evaluating weaning and sedation protocols is the shifting of responsibility from physicians to nurses and other allied health professionals such as physiotherapists and respiratory therapists (Ely et al., 1999). More recently, Klompas and colleagues (2015) in a surveillance study of 3425 ventilation episodes, reported that the pairing of an SBT with an SAT resulted in a reduction in ventilator associated events (VAEs) as well as reductions in the duration of mechanical ventilation, ICU and hospital length of stay. In 2013 VAEs replaced ventilator associated pneumonia (VAP) as the surveillance target for mechanical ventilation recommended by the Centers for Disease Control and Prevention (CDC) (Magill et al., 2013). A VAE is defined as two days or