Weaning from invasive respiratory support in newborn: is there just one strategy?

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Abstract. Despite a even more frequent use to non-invasive respiratory support, mechanical ventilation is still often necessary for supporting premature infants with lung disease. Protracted mechanical ventilation is associated with increased morbidity and mortality and thus the earliest weaning from invasive respiratory support is desirable. Weaning protocols may be helpful in achieving more rapid reduction in support. However, no consensus has been reached on criteria to identify when patients are ready to wean or how to achieve it. In this article, available evidence is reviewed and reasonable evidence-based recommendations for weaning and extubation are provided. (www.actabiomedica.it)

Key words: weaning, extubation, premature infants

Introduction

Although non-invasive respiratory support is increasingly employed, mechanical ventilation (MV) remains an essential tool in the care of critically ill newborns.

According to the Vermont Oxford Database, about 60% of Very Low Birth Weight Infants (VLBW) and 95% of Extremely Low Birth Weight Infants (ELBW) are subjected to MV during hospitalization (1). Therefore, most of the infants who now receive mechanical ventilation are smaller and more immature than those ventilated only 10 years ago. Particularly, they have serious lung immaturity, inconsistent respiratory drive and a weak respiratory pump.

Moreover, infants who are subjected to MV need an analgosedative therapy to avoid discomfort and pain.

Despite its crucial role in reducing mortality rate, MV is associated with morbidity, risks and complications, including bronchopulmonary dysplasia and periventricular hemorrhage (2-5).

To minimize risks and complications, it is recommended to discontinue MV as soon as infants are able to maintain spontaneous breathing and achieve appropriate gas exchange with minimal respiratory effort.

The ideal time for weaning from MV is frequently established on clinical and laboratory parameters which at least are not very standardised.

The extubation failure may expose to hypoxia and hypercapnia. The subsequent reintubation procedure may exacerbate blood gas alterations with an unknown impact on cerebral function (6). Based on the damage associated with the inappropriate duration of MV in newborns and since the rate of extubation failure is higher the lower the gestational age (30-40% in ELBW) there is necessity to establish objective criteria for extubation (7-9).

Weaning ventilator setting

Conventional Mechanical Ventilation

Weaning is the gradual reduction of ventilatory support and the transfer of respiratory control back to the patient.

The first requirement for weaning is the improve-
Weaning from invasive respiratory support in newborns

Weaning from invasive respiratory support in newborns involves the gradual reduction of mechanical ventilation (MV) and the endotracheal tube. To avoid overdistention, the peak inspiratory pressure (PIP) is carefully monitored. Reduction in PIP is based on chest movement and PaCO₂ levels. When tidal volume (VT) is the primary control variable, reduction in PIP occurs naturally with improved lung compliance and spontaneous inspiratory effort. PIP is adjusted by clinicians to achieve adequate VT in the range of 4-6 mL per kg body weight. Reduction in VT below the normal physiological value increases the work of breathing. On the other hand, VT strategies reduce the duration of MV. Infants treated with MV for a long period need a progressive increase in VT over time as a result of increasing anatomical intrathoracic dead space. Therefore, monitoring of VT facilitates weaning and is helpful for detecting hypoventilation if the reduction in PIP is too large. This is important to prevent a gradual alveolar collapse.

Regardless of the specific modality of ventilation, with triggered ventilation (PTV) VT is a combination of respiratory effort of the newborn (negative intrapleural pressure on inspiration) and the positive pressure generated by ventilator. This results in the transpulmonary pressure which determines VT. Frequency is not usually changed during weaning although Venegas et al. speculated that improvements in respiratory compliance require a lower optimal frequency.

Some clinicians switch from HFOV to conventional MV once the acute lung disease has improved and subsequently wean and extubate from this ventilation mode. However, this combined use of HFOV and conventional MV may be less effective compared with a strategy using HFOV alone. Others studies reported that weaning and extubating directly from HFOV might be an alternative approach and can be successful in preterm infants.

Extubation readiness

In the last two decades, many studies have investigated different tools to predict successful extubation in newborns. They have included pulmonary function tests, oxygen saturation, and respiratory rate. However, no single test is perfect and the decision to extubate should be based on clinical judgment.
function testing and the ability to breathe during a period when ventilator cycling is stopped (spontaneous breathing trial, SBT). Although none of these predictive tests has been confirmed in randomized trials some of them are simple and associated with earlier extubation (25, 26).

Postextubation management

Preterm infants that are not supported after extubation by continuous distending pressure are more prone to failure. This is mainly due to the inability of the immature rib cage to maintain adequate functional residual capacity and also to the edema of vocal cords unable to sustain effective grunting, a mechanism normally used by preterms to maintain internal distending pressure.

Currently the gold standard is nasal continuous positive airway pressure (nCPAP); this approach reduces the deterioration that frequently occurs in these infants after extubation and reduces the need for reintubation.

Although nasal CPAP has been used for many years, there are no data on the most effective level of pressure to use. At present, a level of 4-6 cm H2O is the gold standard (27), although a recent study indicates that higher pressures (7-9 cm H2O) reduce extubation failure, especially in more immature newborns who are still oxygen dependent (28).

Nasal intermittent positive pressure ventilation (NIPPV or SNIPPV if synchronized) was proposed as alternative strategy but only in small trials.

Heated humidified high flow nasal cannula (HH-HFNC) has recently been introduced as an effective alternative to nCPAP after extubation (29). nCPAP is certainly an effective mode of NIV but traumatic nasal complications and intolerance of the nasal interface are common. HHHFNC could allow better access to the baby’s face, which may improve nursing, feeding and bonding. However, further larger randomized trials are required before being able to recommend HH-HFNC as first line therapy during weaning from MV.

More recently, nasal high frequency oscillatory ventilation (NHFOV) has been proposed to overcome the problem that high pressure, normally used in NIPPV, can lead to an active, inspiratory laryngeal closure that limits lung ventilation and diverts gas into the digestive system (30). If this strategy will be confirmed, it could be a valuable tool during weaning, especially when glottis is particularly fragile and sensitive.

Drug therapies during the process of ‘weaning’

A recent Cochrane review has indicated that infants exposed to methylxantine have a lower risk of failed extubation (31). Caffeine is generally preferred for its longer half-life and fewer side effect. The optimal dose to prevent extubation failure could be higher than that normally used to treat apnea of prematurity (32).

Systemic steroids were also suggested to facilitate weaning from the ventilator but their administration is associated with many complications. Nevertheless, Doyle et al., reported that use of systemic steroids is not recommend in infants with mild disease but the risk/benefit ratio is favourable in more immature and severely ill newborns (33).

In addiction, inhaled dexamethasone or racemic epinephrine to prevent post-extubation stridor have also been used but data on effectiveness are not conclusive enough to recommend their routine use (34, 35).

Conclusions

In summary, weaning from mechanical ventilation is a complex process that may be characterized as a series of interrelated and codependent steps. Given the range of existing weaning modes and parameters available, these require explanation and clarification in the context of current evidence. As mechanical ventilation is associated with severe complications in premature infants it is important to limit its duration as much as possible. There is frequently some inertia to wean infants from mechanical ventilation; for this reason it is useful to have written criteria to guide weaning from the ventilator and extubation.

An improved ability to predict when a preterm infant has a high likelihood of successful extubation is highly desirable.

This approach could allow to customize weaning from MV by targeting for respiratory strategy and pharmacological therapy.
References


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