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REVIEW

Prolonged Weaning and Respiratory Intensive Care Units. A Narrative Review

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ABSTRACT

Progress in management, while improving hospital survival of critically ill individuals in intensive care units (ICU), has also increased the prevalence of individuals needing prolonged weaning from mechanical ventilation (PMV). Respiratory intensive care units (RICUs) may provide an environment also for these individuals. A narrative review searching literature was performed in PubMed and Scopus databases of publications between 1990 and 2022 using the keywords "chronic critical illness", "non-invasive mechanical ventilation", "physiotherapy and ICU", "RICU", "tracheostomy", "ventilator assisted individuals", "weaning mechanical ventilation". Results show that there are recent developments in ventilatory strategies, protocols, physiotherapy, and location for individuals needing PMV to be managed also in RICU. In conclusion, present medical training of clinicians and locations like ICU do not appear to be enough to face problems posed by PMV. RICU may be helpful.

Keywords: Critical illness. Intensive care unit. Mobilisation. Noninvasive ventilation. Tracheostomy. Weaning units.

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INTRODUCTION

One side effect of increasing worldwide life expectancy is the high prevalence of chronic diseases and related "chronic critical illness"[1] with up to twenty million people annually requiring admission to intensive care units (ICUs). Progres in management has improved the short-term survival of these individuals at the price of a growing prevalence of individuals needing partial or complete dependence on mechanical ventilation with clinical and organizational problems as well as high human and health resource consumption. In order to minimize the prevalence of long-term ventilator-assisted individuals (VAIs) we must better manage those needing weaning from prolonged mechanical ventilation (PMV)[2].

Among other activities, respiratory intensive care units (RICU) may provide an environment for the management of individuals with severe acute respiratory failure (ARF) avoiding the dangerous "underassistance" in the ward and the unnecessary "overassistance" in the ICU. Activities in RICU may include non-invasive respiratory support for ARF, weaning from PMV, tracheostomy care and decannulation and discharge planning for VAIs[3]. Their usefulness has been shown in the recent COVID-19 pandemic[4-7]. This narrative review analyses the use of RICU in weaning individuals needing PMV.

METHODS

Literature search of randomized controlled trials (RCTs), observational studies, systematic reviews, and meta-analyses published between 1990 and 2022 in English, in PubMed, and Scopus databases using the keywords "chronic critical illness", "non-invasive ventilation (NIV)", "PMV", "physiotherapy and ICU", "RICU", "tracheostomy", "VAIs", "weaning mechanical ventilation". In this review we will use the terms "prolonged weaning" and "prolonged mechanical ventilation" with the same meaning.

Factors associated with PMV are summarised in table 1[2].

DEFINITIONS AND EPIDEMIOLOGY

Prolonged mechanical ventilation/prolonged weaning

There is great variability in terminology and definitions:

- National Association for Medical Direction of Respiratory Care: "the need for more than 21 consecutive days of mechanical ventilation for more than six hours/day"[8].
- European Respiratory Society (ERS) Task Force: "the need of more than seven days of weaning after the first spontaneous breathing trial": up to 14% of individuals admitted to ICU for mechanical ventilation[9,10].
- Weaning according to a New Definition (WIND) study: "successful extubation after more than three spontaneous breathing trials or taking more than seven days": 10% of individuals receiving mechanical ventilation with a 29.8% mortality[11].

A systematic review on the long-term survival of PMV individuals reported a 59–62% one-year mortality. Pooled mortality at hospital discharge was 29%. However, only 19% were

Table 1. Factors associated with PMV

Systemic – Chronic diseases, comorbidities, – Nutrition and metabolic problems – Severity of illness – Sepsis
Cardio-vascular function
Critical illness neuromyopathy
Respiratory – Unresolved respiratory causes of ARF – Diaphragm weakness or dysfunction – Imbalance between WOB and respiratory muscle reserve – Tracheo-bronchial obstruction – Ineffective cough and secretion retention
Complications of therapy – Ventilator-associated pneumonia, infection – Length and modalities of mechanical ventilation – Tracheostomy – Sedation – Lack of early mobilisation
Conitive – Sleep deprivation – Anxiety/depression

ARF: acute respiratory failure; WOB: work of breathing.

discharged home and only 50% were successfully weaned from mechanical ventilation[12].

Strategies for successful weaning

There has been recent progress in weaning from mechanical ventilation, to be used also in RICUs: ventilatory strategies, weaning protocols, early mobilisation and physiotherapy, specialised weaning units.

Ventilatory strategies

The most used ventilatory strategies to shorten weaning from mechanical ventilation are progressive reduction in the level of pressure support ventilation (PSV) and progressive longer periods of spontaneous breathing trials through the tube[13]. Multicentric comparative studies in the ICUs gave conflicting results, reporting advantages with either one, or other, or equivalent results[14].

Synchronized intermittent mandatory ventilation (the patient can breathe spontaneously between ventilator-delivered breaths), neurally adjusted ventilatory assist (NAVA), NIV and high-flow oxygen (HFO) have also been used.

NAVA[15] has been used during weaning from mechanichal ventilation in ICU and, compared to PSV, resulted in reduced patient-ventilator asynchronies, and in a breathing pattern more similar to spontaneous ventilation[16].

Nava et al.[17] were the first to use NIV in an RICU to shorten time of weaning from and avoid the complications of invasive mechanical ventilation in individuals with acute exacerbations of chronic obstructive pulmonary disease (COPD). Noninvasive mechanical ventilation during weaning was as effective as invasive mechanical ventilation in improving the breathing pattern, reducing the work of breathing with adequate gas exchange[18]. The recent ERS/American Thoracic Society (ATS) guidelines[19] suggest that NIV should be used to facilitate weaning from mechanical ventilation in individuals with hypercapnic ARF only in centres with adequate experience using NIV in this setting[19].

More recently, the use of HFO[20] compared with conventional oxygen therapy reduced the risk of re-intubation within 72 hours in extubated patients at low risk for reintubation[21]. Among high-risk extubated adults, HFO was not inferior to NIV in preventing reintubation

and post-extubation ARF[21]. The sequential use of NIV and HFO has also been suggested[22].

Ventilatory strategies in PMV

In RICUs with clinicians trained to manage PMV, a prospective multicenter RCT in individuals with COPD requiring mechanical ventilation for more than 15 days found that progressive reduction in the level of PSV or progressive longer periods of spontaneous breathing through the tube were equally effective in weaning success and hospital mortality rate, duration of ventilatory assistance and length of stay[23]. Another study found that the use of the spontaneous breating trial protocol with a tracheostomy collar resulted in shorter median weaning time, without any effect on six- and twelve- month survival[24].

Neurally adjusted ventilatory assist. A study performed in an RICU/weaning unit confirmed that NAVA eliminates the risk of overassistance. However, it also indicated that the advantages of NAVA over PSV were smaller when PSV was carefully set avoiding excessive support[25]. A systematic review suggests that the NAVA mode may improve the rate of weaning success compared with other partial support modes for difficult-to-wean individuals[26].

Non invasive ventilation. A prospective study included chronically critically ill individuals admitted to Spanish RICUs[27]. The weaning method consisted of progressive periods of spontaneous breathing trials. Patients were transferred to NIV when it was impossible to increase the time of spontaneous breathing trial beyond 18 hours. 86% of patients were successfully weaned, out of whom 21% needed NIV during the weaning process[27]. In another study performed in a RICU-weaning unit, NIV applied to individuals failing weaning from PMV was feasible and could facilitate the decannulation process. Individuals successfully completing this process showed good survival rates and few complications[28].

Weaning protocols

Trials have demonstrated that application of the protocol or guidelines for the weaning process may lead to a decrease in weaning time irrespective of the mode used and are suggested by official guidelines[29,30].

Early mobilization and physiotherapy

Overall, about 25% of individuals needing PMV develop generalized and persistent muscle weakness (critical illness neuromyopathy)[31]. Muscle deconditioning occurs very early with bed rest, involving more calf and other antigravity than other muscles, such as those involved in grip strength. Muscle atrophy is associated with decline in muscle mass, strength and aerobic efficiency, and the predominant muscle composition changes from type IIa, with higher aerobic capacity, to type IIb fibres[32-34].

Evidence of benefits from early mobilisation and physiotherapy has progressed during the past 15 years with recommendations including mobilization and muscle electrical stimulation[35,36]. For adults mechanically ventilated for > 24 h, the ATS/CHEST guidelines suggest using protocols of early mobilisation, without any

superiority of a protocol over another[30]. Early physiotherapy in RICU has also been proposed in the recent Covid-19 pandemic[37].

Physiotherapy techniques commonly used for early mobilization and airway clearance are shown below[2]:

Muscle weakness

– Passive and active-assisted mobilisation.

– Continuous rotational therapy.

– Postures.

– Active limb exercise.

– Peripheral muscle training.

– Neuromuscular electrical stimulation.

– Respiratory muscle training.

Cough augmentation techniques

– Manual hyperinflation.

– Percussion and vibrations.

– Mechanical in-exsufflation.

– Percussive ventilation.

Specialised weaning unit

To take care of difficult-to-wean patients, recently the problem of appropriate ICUs utilisation has been faced by proposing different locations and modalities of assistance[2,38]:

– Respiratory intensive care units within acute care hospitals[39], less expensive than ICUs, but usually offering adequate levels of assistance, may also provide multidisciplinary rehabilitation, using non invasive evaluation tools[7,40-41]. Some of these RICUs may work also as "step down" units for PMV and as a bridge to home-care programs or long-term care facilities[42].

– Alternatively, individuals needing PMV may be transferred from acute care hospitals to specialised regional long-term weaning units (LWUs), often located within rehabilitation hospitals with trained teams (e.g., nurses, respiratory therapists, nutritionists, psychologists, speech and occupational therapists). Variable mortality and weaning success rates have been reported[39,42-44].

More recently, modalities of tele-monitoring have been proposed as a means to manage difficult-to-wean patients and VAIs[45,46].

LONG-TERM OUTCOMES

There are few published data on discharge home rates, use of NIV, or long-term survival in RICUs or specialized LWUs[39,42,47-49].

TRACHEOSTOMY AND DECANNULATION

Respiratory intensive care units should also deal with tracheostomy, which seems to

increase in individuals needing PMV with conflicting results[50-52].

Decannulation is the final step of liberation from PMV. Although there exist several protocols, universally accepted ones are lacking as well as RCTs on this critical issue[53]. Training in pulmonological techniques may help[54]. There is a need for accepted protocols for time and modalities of decannulation, also in the view that lack of decannulation of conscious tracheostomized patients before ICU discharge to the general ward was associated with higher mortality[55].

CONCLUSION

Moving from widespread use of NIV, the complexity of the interventions performed in RICUs has increased significantly over the last 15 years. These locations may provide specialized environment also for the weaning from PMV, tracheostomy care, and decannulation and discharge planning for VAIs.

DISCLOSURES

The authors have nothing to disclose.

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