Prolonged Mechanical Ventilation, Weaning, and the Role of Tracheostomy

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KEYWORDS

• Prolonged mechanical ventilation • Difficult weaning • Chronic critical illness
• Rehabilitation • Tracheostomy • Nutrition • Occupational therapy
• Psychological services

KEY POINTS

- Depending on the definitional criteria used, approximately 5% to 10% of critically adults will require PMV with longer-term outcomes that are worse than those ventilated for a shorter duration.
- Outcomes are affected by patient characteristics before critical illness and its severity but also by organizational characteristics and care models.
- Definitive trials of interventions to inform care activities, such as ventilator weaning, upper airway management, rehabilitation, and nutrition specific to the PMV patient population, are lacking.
- Given the heterogeneity in this patient population a structured and individualized approach developed by the multiprofessional team in discussion with the patient and their family is warranted.

INTRODUCTION

Given the aging population with increasing morbidity but also importantly scientific and technological advances that prolong the ability to support survival in intensive care, the number of patients that require prolonged mechanical ventilation (PMV) is rising. This has consequences to health care systems. In the United States, the cost of PMV patients are estimated to be $25 billion annually.[1] Furthermore, hospital and longer term mortality remain high for these patients with many patients unable to return home.[2,3] Patient burden is substantial because of an uncertain disease trajectory; numerous symptoms causing discomfort; and profound physical, neuropsychological,

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and cognitive deficits.[4,5] Patients requiring PMV require a change in clinical management with a greater focus on rehabilitation, symptom relief, and discharge planning.[6]

In this review we outline definitional considerations for PMV and difficult weaning in the setting of acute respiratory failure and patient prevalence, important factors to understanding the epidemiology of these patients. We then discuss the evidence around processes of care important to these patients including weaning methods, managing the upper airway (tracheostomy timing; cuff deflation and its role in weaning, as a communication adjunct, and for dysphagia management; secretion management), the role of physiotherapy in weaning (mobilization and rehabilitation, airway clearance, management of respiratory muscle dysfunction), the role of nutrition in weaning, the role of other therapies including occupational therapy and psychological services, and the role of specialized weaning centers (SWC).

DEFINITION OF PROLONGED MECHANICAL VENTILATION

The way PMV is defined in the current evidence base varies, which is problematic in terms of understanding the epidemiology and designing research to inform optimal care delivery. Commonly a definition of PMV includes mechanical ventilation (MV) duration. Yet the reported MV duration within this definition ranges from 5 hours in a surgical population to up to 1 year.[7] A consensus conference held more than 18 years ago by the US Association for Medical Direction of Respiratory Care defined PMV as greater than or equal to 21 consecutive days of MV for greater than or equal to 6 hours.[8] However, given the average duration of MV is between 4 to 5 days depending on case mix and region, MV greater than or equal to 7 days could be considered to represent a patient requiring PMV. The terms persistent or chronic critical illness may also be applied to this patient cohort given that most require PMV and tracheostomy.[1]

Frequently MV is prolonged because of failure to wean. Using the Joint Task Force on Weaning from Mechanical Ventilation definition,[9] prolonged weaning is the need for more than 7 days of weaning after the first spontaneous breathing trial (SBT). The WIND (Weaning according to a New Definition) classification[10] further extends this definition to weaning that is not achieved (either by successful separation or death) by 7 days after the first separation attempt.

PREVALENCE

The prevalence of PMV in any intensive care unit (ICU) patient cohort is dependent on the definition used, but generally ranges between 5% and 10%. For example, in the recently published WEANSAFE study enrolling 5869 patients from 481 ICUs in 50 countries, 433 (9.6%) of the 4523 patients that underwent at least one attempt to separate from the ventilator required prolonged weaning that is, greater than or equal to 7 days.[11] Previous population based studies report PMV prevalence as 5.4% (1594/11,594; Canada)[12] and 6.3% (349/5552; UK)[13] when defined as greater than or equal to 21 days of MV. In the United States, the prevalence of chronically critically ill patients defined as greater than or equal to 8 days in ICU plus one of five eligible conditions (MV for >96 hours, tracheostomy, sepsis, severe wounds, and multiple organ failure or neurologic injury) was 7.6% (246,151/3,235,741).[1] In Japan, using a similar definition, prevalence was 9.0% (216,434/2,395,016).[14]

FACTORS ASSOCIATED WITH DEVELOPING PROLONGED MECHANICAL VENTILATION

Numerous factors contributing to the development of a requirement for PMV have been investigated and factors associated with the longer-term mortality in this patient group. A recent single-center observational study of 195 patients found predictors of prolonged weaning were MV duration before SBTs were commenced, tracheostomy, Pa_{O_2}/FiO_2 ratio, and requirement for renal-replacement therapy.[15] A systematic review examining risk factors for PMV, weaning failure, and prolonged weaning identified 23 studies recruiting a total of 23,418 patients.[16] Of these, the 14 studies investigating risk factors for developing PMV had substantial heterogeneity in terms definitions for PMV and weaning failure as described previously. Risk factors for PMV included markers of severity of critical illness reflecting acute organ dysfunction, such as the SOFA score. Comorbid factors, such as age, body mass index (high and low), chronic obstructive pulmonary disease (COPD), neuromuscular disease, and previous requirement for home ventilation, were more predictive of weaning failure than markers of severity of acute illness.

Development of PMV may not just be caused by patient characteristics. Two studies from the United States suggest organizational factors may contribute to the development of PMV and subsequent risk-adjusted mortality. Using the Veteran Affairs database containing data from 100 US hospitals, Viglianti and colleagues[17] found higher number of patients developing PMV in hospitals with higher risk- and reliability-adjusted 30-day mortality rates. An ethnographic study of eight US long-term acute care hospitals (LTACH) found care delivery and organizational processes that actively promoted interdisciplinary communication and coordination differentiated high versus low performing hospitals in terms of risk-adjusted mortality.[18] Therefore care processes and structures are important to consider when optimizing the management of this patient group.

OUTCOMES

In a review of long-term survival of patients requiring PMV among cohort studies (124 studies representing 16 countries), pooled 1-year mortality was approximately 60%.[3] Furthermore, the proportion of patients able to return home after PMV was only 19%.[3] In a Canadian administrative database study identifying 11,594 patients who underwent PMV for more than 21 days, 1- and 5-year mortality was higher for PMV patients versus patients who required a shorter MV duration (17% vs 11% and 42% vs 30%, respectively).[12] A recent retrospective Taiwanese single-center study of 296 patients requiring PMV (>21 days) admitted to a weaning center demonstrated 1- and 5-year mortality of 80% and 89%, respectively. Five-year survival was associated with the absence of comorbidities, age younger than 75 years, and successful weaning.[19] Another recent retrospective study of 80 patients requiring PMV and undergoing tracheostomy found that hospital mortality or hospital discharge with a tracheostomy still in situ were associated with older age and higher body mass index.[20] Before this, a 2017 systematic review of patients receiving PMV for greater than 14 days identified 14 studies investigating 19 factors associated with 6-month mortality. As with variables associated with the need for PMV, those associated with 6-month mortality commonly reflected the severity of acute critical illness including thrombocytopenia, acute kidney injury, and vasopressor dependence with other risk factors being advanced age, preexisting kidney injury, and failure to wean.[21]

WEANING METHODS

There is limited empiric evidence for the optimal weaning method evaluated specifically for patients requiring PMV. An early multicenter randomized controlled trial (RCT) enrolling patients with COPD experiencing weaning difficulty compared tracheostomy mask trials with low-level pressure support ventilation (PSV) and found no difference in weaning duration or success.[22] A subsequent seminal RCT recruiting 316 patients from a single US LTACH demonstrated increased weaning success and a shorter weaning time using a once-daily tracheostomy mask trial, with progressive extension based on tolerance, compared with PSV.[23] Of note, 37% of the patients referred to the LTACH for weaning and screened for trial inclusion were excluded. This was because of successful weaning in the 5-day screening window during which unassisted breathing with humidified oxygen was delivered through a tracheostomy collar. This finding emphasizes the need for a daily focused assessment of weaning and extubation readiness, whichever weaning method is used.

More recently Wu and colleagues[24] report a retrospective cohort study of 403 patients receiving MV greater than 21 days admitted to an SWC in Taiwan. Because of concerns around virus transmission during the COVID-19 pandemic, this SWC switched from a 5-day weaning screen comprising unassisted breathing as used in the previously mentioned trial to the use of 5 days of automatic tube compensation. Automatic tube compensation is designed to compensate for tube-related additional work of breathing. It uses closed loop monitoring of the nonlinear flow-dependent pressure drop during inspiration and expiration.[25] When comparing outcomes of patients who received an automatic tube compensation 5-day screen compared with the former usual screening method, those screened using automatic tube compensation had better predictive ability for weaning success and in-hospital survival.[24]

Neurally adjusted ventilatory assist delivers inspiratory pressures proportional to diaphragm electrical activity detected via a specialized nasogastric feeding catheter (Getinge, Solna, Sweden).[26] Three RCTs that compared neurally adjusted ventilatory assist with PSV in patients at risk of PMV demonstrate reduced dyssynchrony[27] and MV duration.[28,29] Therefore neurally adjusted ventilatory assist may have a role in preventing PMV or shortening its overall duration; however, further trials are needed.

Although not specifically recruiting a PMV patient population there is evidence to suggest noninvasive ventilatory strategies following extubation may reduce the risk of developing PMV. In a multicenter RCT of 641 patients conducted by Thille and colleagues[30] a combination of high-flow nasal oxygen alternating with noninvasive ventilation was found to decrease reintubation rates compared with high-flow nasal oxygen alone in patients at high risk for extubation failure (ie, >65 years or any underlying chronic cardiac or lung disease).

A recent systematic review[31] of 28 trials (2066 participants) compared early extubation with noninvasive ventilation for patients who failed or were not ready for an SBT with ongoing invasive ventilation. This review found early extubation to noninvasive ventilation improved in mortality, ventilator-associated pneumonia (VAP) incidence, hospital and ICU length of stay, and MV duration. Improved outcomes were particularly seen for patients with COPD who accounted for almost half of the trial participants.

Despite evidence of effectiveness in patients with an overall shorter MV duration,[32] to-date there are no studies of weaning protocols specific to PMV patients. Furthermore, current guidelines for weaning and ventilator liberation provide little guidance on the management of this patient population.[33,34] However, PMV patients are most likely to benefit from a structured approach to weaning incorporating trials of unsupported weaning with adequate support during periods of ventilation, and consideration of strategies to manage the upper airway that are discussed next.[8,23] Furthermore an individualized weaning plan should be developed by the interprofessional team in discussion with the patient and their family, with regular review and update as required.[35]

MANAGING THE UPPER AIRWAY

Tracheostomy Timing

Tracheostomy insertion is frequently undertaken in intensive care with the main advantages being enabling the ability to vocalize, allowing oral intake, improving comfort[36] with reduced sedation, and improving oral hygiene.[37] TracMan was the largest RCT published to-date investigating early versus late tracheostomy, recruiting 909 patients from 72 hospital in the United Kingdom.[38] This trial did not demonstrate a mortality advantage of early (within 4 days) compared with late (after 10 days) tracheostomy at any measurement time point (30 days up to 2 years). Of note, more than half of the patients randomized to late tracheostomy did not require a tracheostomy, primarily because of discharge from intensive care or no longer requiring MV.[38]

Three recent systematic reviews[39–41] support the lack of effect on mortality finding of the TracMan trial. However, the effect on other patient outcomes of early tracheostomy (defined as insertion within 10 days after intubation) compared with prolonged intubation is less certain. Chorath and colleagues[40] conducted a systematic review including 17 trials recruiting 3145 participants. Early tracheostomy was defined as no more than 7 days after MV initiation and late as placement after 7 days or no tracheostomy. Their meta-analyses identified a reduction in VAP, and ICU length of stay with more ventilator-free days with early tracheostomy. Similarly Deng and colleagues[39] reported a shorter ICU length of stay and reduced MV duration but no effect on VAP rates (15 trials, 3003 participants with early tracheostomy defined using the original study definition). The most recent systematic review by Villemure-Poliquin and collegues[41] defining early tracheostomy as within 10 days of intubation (9 trials, 2457 patients) found no differences in ICU length of stay, MV duration, or VAP rates. Despite also identifying no mortality difference, these authors cautioned that their analyses were likely underpowered with only moderate certainty evidence. Conversely, a fourth review (19 trials, 3508 patients)[42] using a Bayesian analysis suggests early tracheostomy demonstrates benefit on all clinical outcomes including mortality. Importantly, the RCTs included in all meta-analyses that we describe excluded patients with neurologic disease who have a different prognosis and different reasons for tracheostomy (ie, airway protection) compared with other patient groups requiring PMV.

Although the evidence surrounding the effect of early tracheostomy on the previously mentioned outcomes remains somewhat uncertain, tracheostomy is a commonly undertaken procedure and appropriate tracheostomy management has important implications for weaning from PMV. Earlier tracheostomy benefits other patient-centric outcomes, such as participation in activities important to rehabilitation at an earlier timepoint. These include talking, out-of-bed mobility, and eating/drinking.[43] These benefits are caused by important features of tracheostomy management that include cuff deflation and the use of a one-way speaking valve (**Fig. 1**). However, the decision to perform earlier tracheostomy needs to be carefully considered on an individual basis to avoid the possibility of an unnecessary tracheostomy in some cases.

Tracheostomy Cuff Deflation and Its Role in Weaning

Tracheostomy cuff deflation and tracheostomy downsizing facilitates an increased airway diameter leading to reduced airway resistance and work of breathing. This can improve airflows and end-expiratory lung volume.[44] Use of a one-way speaking valve in conjunction with cuff deflation also improves lung recruitment during weaning.[45,46] Cuff deflation may reduce complications associated with prolonged use of an endotracheal tube and improve patient outcomes including reducing weaning and MV duration, although the evidence base is limited.[47] One RCT recruiting 195

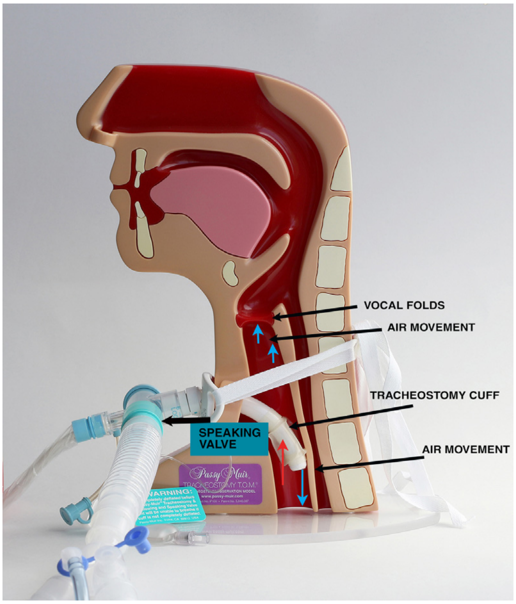

Fig. 1. Passy Muir one-way speaking valve. (Image courtesy of Passy Muir, Inc. Irvine, CA.)

patients using tracheostomy cuff deflation during T-piece SBTs reported a reduced weaning duration with fewer respiratory infections and improved swallow compared with T-piece SBTs with an inflated cuff.[48]

Few studies report predictors of successful cuff deflation to guide patient selection criteria; however, one retrospective cohort found 95% of patients tolerated cuff deflation on the first attempt.[49] Medical and respiratory stability and above-cuff secretions of less than 1 mL/h are predictive of success. There are no published evidenced-based protocols or guidelines on how best to perform early cuff deflation and establish use of a one-way speaking valve, although specialized services use locally developed protocols and decision tools.[50]

Cuff Deflation as a Communication Adjunct

Early cuff deflation helps to promote vocalization alleviating patient distress and frustration associated with inability to communicate.[51] ICU survivors frequently identify the inability to communicate using speech because of an advanced airway as one of the most negative experiences of an ICU admission.[52] Cuff deflation, combined with a one-way speaking valve, directs expiratory gas flow through the vocal cords to restore phonation. Importantly, it is used safely during invasive MV, thereby restoring phonation more quickly compared with use only when a patient is self-ventilating.[53] If cuff deflation and use of a speaking valve is not feasible (eg, in the presence of excessive oral secretions[54]) as assessed by a speech and language therapist, other communication options that include above-cuff vocalization can be explored.[55]

Cuff Deflation for Dysphagia Management

Dysphagia is highly prevalent in the critically ill and associated with PMV and tracheostomy.[56] Indeed, the incidence of swallowing dysfunction in patients requiring PMV and receiving a tracheostomy is estimated at 40%.[57] Breathing and swallowing are interdependent processes with shared anatomy and neurophysiologic regulation.[58] Early tracheostomy cuff deflation and use of a one-way speaking valve may reduce the frequency of aspiration events during swallowing.[59]

Secretion Management

Excessive oral secretions are the result of dysphagia or sialorrhea, common in patients with neurologic disease and brain injury.[60] Excess oral secretions/saliva is associated with adverse outcomes including aspiration pneumonia and delayed weaning.[61] Secretions may be managed via upright positioning; oral suctioning; and subglottic suctioning and pharmacotherapy, such as sublingual atropine, glycopyrronium, hyoscine, and intrasalivary gland botulinum toxin injections.[54] Few studies describe management of sialorrhea in patients requiring PMV. Evidence is limited to cohort studies in other settings, such as home and long-term ventilation centers.[62]

Other reasons for excessive secretions common to patients requiring PMV include bronchorrhea, VAP, and ventilator-associated tracheobronchitis. Potential pharmacotherapies include mucolytics, prophylactic antibiotics, and nebulized antibiotics. However, a systematic review of 13 RCTs recruiting 1712 patients investigating mucolytics including *N*-acetylcysteine, nebulized heparin, and nebulized hypertonic saline found no effect on mortality, MV duration, ventilator-free days, or duration of hospital stay, but a reduction in ICU length of stay (very low evidence certainty).[63] As a prophylactic antibiotic with anti-inflammatory properties, azithromycin may also have a role in the management of bronchorrhea. It has been investigated extensively in patients with COPD, with one RCT recruiting 1142 patients demonstrating a 27% reduction in exacerbation frequency.[64] However, as yet, no studies have investigated its use for managing bronchorrhea in patients requiring PMV. A meta-analysis of azithromycin use in an outpatient setting demonstrated an increase in macrolide resistance. However, it is unclear whether this has an adverse effect on any clinical outcomes particularly when used for short time periods, such as during weaning.[65]

Prophylactic nebulized colistin has been investigated as a potential intervention for VAP prevention. One RCT recruiting 168 patients compared nebulized colistin of 0.5 million units three times daily with nebulized normal saline but did not show a reduction in VAP incidence.[66] However, further definitive RCTs are required. Nebulized antibiotics have also been investigated for VAP. A systematic review with a Bayesian meta-analysis demonstrated that nebulized tobramycin and colistin were associated with high rates of recovery and also microbiologic eradication.[67]

PHYSIOTHERAPY AND ITS ROLE IN WEANING

Mobilization and Rehabilitation

Loss of muscle mass and muscle function occurs early in critical illness with resultant loss of functional capacity in patients requiring PMV.[68] ICU-acquired muscle weakness is highly prevalent, with maintenance of bed rest an important contributor.[69] Mobilization, incorporating functional training and exercise, promotes recovery through improved muscle strength. It also reduces limitations to movements that are required to perform functional activities of daily living important for returning home.[70] It may also reduce the overall duration of MV.[71] Professional society endorsed practice guidelines advocate for mobilization commencing 24 hours after ICU admission, if safe to do so.[33,71,72] In most cases, mobilization would be safe well before the patient meets criteria for PMV. RCTs informing these guidelines advocate for an interprofessional team approach to mobilization and a protocolized, standardized, or structured approach.[72]

Fig. 2. Cycle ergometer (With permission from Reck-Technik, Gmbh & Co. Kg, Betzenweiler, Germany.)

Other interventions that may reduce loss of muscle mass and improve muscle strength are neuromuscular electrical stimulation and cycle ergometry (Fig. 2). Neuromuscular electrical stimulation involves application of local surface electrodes to deliver an electrical impulse that generates muscle contraction.[73,74] One RCT of neuromuscular electrical stimulation used in conjunction with an early mobilization protocol recruiting 74 patients with a median MV duration of 12 days demonstrated improved short-term functional outcomes as compared with the early mobilization protocol alone.[30] Cycle ergometry enables mobilization of the upper and lower extremities that can be individualized to a patient's needs and has been shown to be feasible and safe to deliver in the ICU setting.[75]

As with ventilator weaning, few trials of rehabilitation interventions focus specifically on the PMV patient population. A small number of observation studies[76–79] demonstrate improvements in functional outcomes when examining the effect of various rehabilitation interventions in patients ventilated for greater than 21 days. One German cohort[80] described 150 patients who received an intensive rehabilitation intervention comprising physiotherapy and occupational therapy (?60 minutes each, five times per week) based on individualized goal-driven treatment plans with better mobilization outcomes in those patients spending longer periods practicing walking. Verceles and colleagues[81] conducted a 33-participant RCT that evaluated a progressive and patient-specific multimodal rehabilitation program combining muscular strength and endurance training with functional retraining compared with usual rehabilitation practice. They reported greater weaning success and discharge to home in those patients receiving this multimodal approach.

More recently, an RCT recruiting PMV patients (inclusion criterion of >72 hours of ventilation with mean intubation duration of >8 days) found improved diaphragmatic function and reduced MV duration with a progressive six-stage rehabilitative exercise program compared with usual care.[82] Therefore as with optimal strategies for weaning patients requiring PMV, a strategy that mostly likely is of benefit is an individualized and structured approach with a rehabilitation plan developed by the interprofessional team in collaboration with the patient and their family members as appropriate.

Airway Clearance

Patients requiring PMV often experience airway secretion retention because of ineffective cough, reduced mucociliary transport, and respiratory muscle weakness.[83] Retained secretions can lead to atelectasis, VAP, and can prolong weaning. Airway clearance techniques include manually assisted cough, lung volume recruitment maneuvers, and mechanically assisted cough using a mechanical insufflation-exsufflation device. Manually assisted cough consists of a cough that is timed with an abdominal or lateral costal compression. Mechanical insufflation-exsufflation uses a positive insufflation pressure to expand the lungs to approximately 90% of capacity[84] rapidly alternated with a negative exsufflation pressure. This rapid alternation between positive and negative pressures promotes air flow rates, improves sputum mobilization, and stimulates a cough.[85] Mechanical insufflation-exsufflation is used as a noninvasive technique using a mask or is delivered via an endotracheal or tracheostomy tube as an adjunct to ventilator weaning. Although limited, the evidence in the critically ill patient population suggests these techniques are safe with few adverse events.[86,87] Further studies are required to ascertain their effect when used to promote ventilator weaning in patients requiring PMV.

Treatment of Respiratory Muscle Dysfunction

Respiratory muscle weakness is a consequence of PMV. Rapid atrophy of the diaphragm and other respiratory muscles results in an imbalance between the respiratory load and reduced muscle capacity.[88] Strategies that promote spontaneous breathing

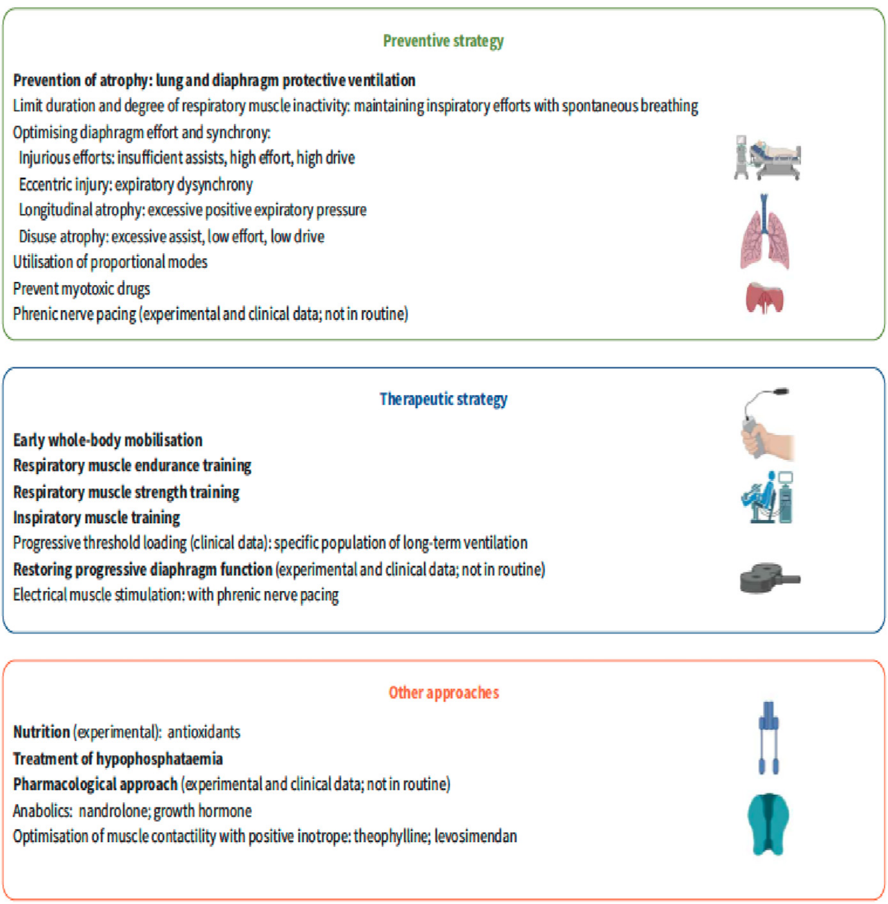

Fig. 3. Intervention to manage respiratory muscle weakness.

early in patients with PMV are key to preserving respiratory muscle activity.[89] Such strategies are seen as preventative or therapeutic (**Fig. 3**).

Inspiratory muscle training is designed to improve strength and endurance of the diaphragm and accessory inspiratory muscles through the application of resistance during inspiration. Inspiratory muscle training includes either strength or endurance training using resistive and threshold loading. Resistive loading involves placement of a resistor that increases the pressure for respiratory muscles to generate a given flow. Threshold loading uses a valve that requires a certain pressure to be generated by the respiratory muscles before it opens to allowing inspiratory flow. Threshold loading is not dependent on patient effort and therefore more commonly used in ventilated patients.[90] A 2018 systematic review and meta-analysis identified a total of 28 studies of inspiratory muscle training with 14 conducted in difficult-to-wean patients. Although subgroup analyses were not performed on these 14 studies, overall improvements in maximal inspiratory pressure and maximal expiratory pressure were found with an uncertain effect on patient outcomes, such as MV and weaning duration.[91]

NUTRITION AND ITS ROLE IN WEANING

Although multifactorial, catabolism is a contributing mechanism of respiratory and other muscle weakness and therefore associated with PMV and weaning failure.[89,92] Patients can lose up to 30% of their quadriceps skeletal muscle mass within 10 days of MV.[68] Malnutrition and insufficient food intake are common, and have been associated with worse patient outcomes.[93] International clinical nutrition guidelines define phases of metabolism as (1) acute-early (days 1–2), (2) acute-late (days 3–7), and (3) recovery (>7) days.[94] In the acute phases, metabolism is catabolic and in the adaptive stress state. At this time nutrient metabolism is likely to be impaired.[93] In the later phases, which coincides with the definition of PMV, metabolism switches to anabolism and is likely a more appropriate time for nutritional interventions used in combination with rehabilitation activities.

Recommendations for feeding in guidelines for the provision of nutrition support therapy in the critically ill,[94,95] although not specific to PMV patients, are shown in **Box 1**. Importantly, although early feeding is recommended, harm is likely to be associated with feeding to full estimated energy expenditure.[96] PMV are likely to benefit most from an individualized and personalized approach to nutrition.[97,98]

OTHER THERAPIES AND THEIR ROLE IN WEANING

Occupational Therapy

Occupational therapy includes assessments and provision of interventions to treat physical, cognitive, emotional, or psychological domains targeting impairments, activity limitations, and participation restrictions (**Fig. 4**).[99] Given the loss of functional and

Box 1
Guidance for feeding patients requiring PMV

- Target feed between 12 and 25 kcal/kg in the first 7 to 10 days of the ICU stay
- Target protein intake of 1.2 to 2.0 g/kg/day
- Commence feeding early with either enteral or if not feasible with parenteral nutrition
- Do not start supplemental parenteral nutrition before Day 7 of ICU admission
- Use either mixed-oil or 100% soybean oil intravenous lipid emulsions or fish-oil or non–fish oil intravenous lipid emulsions for patients requiring parenteral nutrition

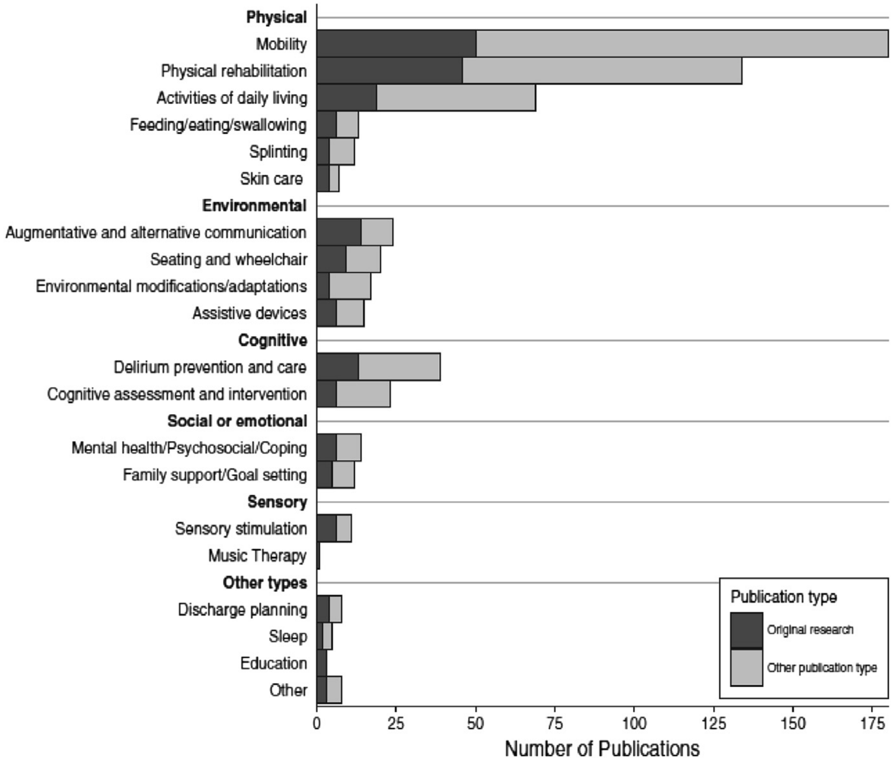

Fig. 4. Role of occupational therapy in intensive care.

cognitive capacity resulting in inability to perform activities of daily living common to patients requiring PMV, occupational therapy can assist with helping to achieve rehabilitation and basic self-care goals.[100] Furthermore, occupational therapists can provide cognitive interventions that prevent delirium, again highly prevalent in PMV patients, and to improve attention and concentration, memory, executive functioning, processing speed, and language skills.[101] As such, occupational therapists are important members of the ICU interprofessional team contributing to the planning and delivery of a range of rehabilitative interventions. However, the inclusion of occupational therapists in the ICU team is highly variable within and across regions internationally.[100,102,103]

Psychology Services

Patients experiencing PMV and difficulty weaning experience several psychological symptoms that warrant psychology input. Fear and anxiety are commonly reported and may be exacerbated with repeated failure of weaning attempts or SBTs.[104] Anxiety may be compounded into panic-like symptoms caused by increased sympathetic arousal and accompanying dyspnea, ultimately resulting in SBT failure.[105] Agitation is also common and may contribute to the need for PMV and to weaning failure.[106] Cognitive behavioral therapy for acute stress may be a useful tool for managing profound anxiety and agitation in difficult-to-wean patients.[105] Dexmedetomidine, a central α_2-receptor agonist, may have a role in promoting weaning success in PMV patients experiencing delirium, agitation, or anxiety.[107,108] Undiagnosed depression or delirium may be other reasons for lack of engagement in rehabilitation interventions that promote weaning, which may benefit from input from psychological services.[109]

ROLE OF SPECIALIZED WEANING CENTERS

Care location has been demonstrated to improve outcomes for several patient populations. Improvement in outcomes related to location of care has been demonstrated in coronary care units,[110] stroke units,[111] and respiratory support units for COPD exacerbation.[112] Volume-outcome relationships have also been demonstrated in major trauma systems,[113] critical care,[114] and surgical specialties.[115] Therefore care located within an SWC also may be important for patients with PMV experiencing difficult weaning. In the United States, an SWC may be colocated in an LTACH. In the systematic review we refer to earlier reporting outcomes of patients requiring PMV from 16 countries, 12-month mortality of patients admitted to a SWCs was better than those remaining in an ICU (48% vs 59%).[3] Mortality outcomes were worse in US hospitals compared with other countries (12-month mortality, 73% vs 47%). Outcomes in UK SWUs compare favorably with the international data presented previously. A single-center cohort study published in 2017 recruiting 458 patients demonstrated hospital and 12-month mortality of 9% and 35%, respectively, with 82% returning home, which is substantially higher than the aforementioned 19% reported in a systematic review of cohort studies.[116]

In the United Kingdom, professional society–endorsed guidance has been recently published to guide the SWU development and care models.[117] This guidance discusses governance structures, patient pathways, service models, and the multiprofessional staffing required to deliver high-quality care to patients requiring PMV. Importantly, there is the recommendation that SWUs be colocated with complex long-term ventilation centers because in the United Kingdom up to 60% of patients are discharged on long-term ventilation (either invasive or noninvasive).[116]

SUMMARY

Depending on the definitional criteria used, approximately 5% to 10% of critically adults will require PMV with longer-term outcomes that are worse than those ventilated for a shorter duration. Outcomes are affected by patient characteristics before critical illness and its severity but also by organizational characteristics and care models. Definitive trials of interventions to inform care activities, such as ventilator weaning, upper airway management, rehabilitation, and nutrition specific to the PMV patient population, are lacking. However, given the heterogeneity in this patient population a structured and individualized approach developed by the interprofessional team in discussion with the patient and their family is warranted.

CLINICS CARE POINTS

- A standardized yet individualized approach is required for weaning for PMV patients comprising progressive lengthening of tracheostomy collar trials with adequate ventilatory support developed by the interprofessional team with the patient and family members involved.
- Management of the upper airway involves consideration of tracheostomy timing and early cuff deflation to promote weaning, enable vocalization, and restore oral intake.
- Interventions focused on rehabilitation, mobilization, and nutrition are important to the recovery of patients requiring PMV.
- Speech language therapists, physiotherapists, dieticians, occupational therapists, psychologists, and pharmacists have important roles in the recovery of this patient group.

DISCLOSURE

The authors have no potential conflicts of interest to declare relevant to this publication.

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