VENTILATOR WEANING

Overview

This Coverage Policy addresses ventilator weaning, also referred to as discontinuation or liberation from mechanical ventilation.

Coverage Policy

Mechanical ventilation weaning is considered medically necessary in the least intensive, clinically appropriate setting. This may include a skilled nursing facility, subacute facility, regional weaning center, long-term acute hospital, step-down unit or respiratory care unit. An intensive care unit level of care is considered not medically necessary for weaning from mechanical ventilation in the absence of other medical conditions requiring an intensive care unit level of care.

General Background

Mechanical ventilation is a method that uses a device to help patients breathe when they are unable to breathe sufficiently on their own. It is indicated for acute or chronic respiratory failure, which is defined as insufficient oxygenation, insufficient alveolar ventilation, or both. Mechanical ventilation is also called positive pressure ventilation and can fully or partially replace spontaneous breathing. Mechanical ventilation is indicated as a measure to control ventilation in critically ill patients and as prophylaxis for impending collapse of other
physiologic functions. The desired effect of mechanical ventilation is to maintain appropriate levels of Po₂ and Pco₂ in arterial blood while unloading the ventilatory muscles. Endotracheal intubation is usually performed to facilitate mechanical ventilation.

Common modes of mechanical ventilation include:

- Intermittent mandatory ventilation (IMV): allows the patient to breathe spontaneously, and the ventilator delivers a number of machine breaths at a preset rate and volume.
- Assist control ventilation (ACV): allows the patient to breathe at their own rate, and the ventilator senses the inspiratory effort and delivers a preset tidal volume with each patient effort.
- Controlled mechanical ventilation (CMV): does not allow the patient to breathe spontaneously; therefore, the ventilator assumes the respiratory work by delivering a preset volume of gas at a preset rate.
- Synchronized intermittent mandatory ventilation (SIMV): delivers synchronized ventilator breaths with the patient’s respiratory efforts (a combination of ACV and IMV).
- Pressure control ventilation (PCV): the inspiratory pressure, respiratory rate, and inspiratory time are determined by ventilator settings.
- Pressure support ventilation (PSV): the patient’s inspiratory effort is supported by a set level of inspiratory pressure.
- Inverse ratio ventilation (IRV): the inspiratory to expiratory ratio is prolonged to 1:1 or greater.
- Noninvasive positive pressure ventilation (NPPV): ventilatory support is delivered by using a mechanical ventilator connected to a mouthpiece or mask instead of an endotracheal tube. NPPV is used in patients with chronic respiratory failure caused by neuromuscular disease or thoracic deformities and in patients with idiopathic hypoventilation. It may eliminate the need for tracheostomies.

Mechanical ventilation is the most common treatment plan in intensive care units (ICU) and is used in approximately 25% of hospital admissions. Prolonged ICU stays and mechanical ventilation may predispose patients to a greater risk of nosocomial infection, pneumonia and death. Some of the potential major complications associated with mechanical ventilation include:

- pulmonary barotraumas (e.g., pneumothorax, subcutaneous emphysema, pneumomediastinum), which are generally secondary to high levels of positive end-expiratory pressure (PEEP), excessive tidal volumes, high peak airway pressures, and coexistence of lung disease
- pulmonary thromboemboli, which can be prevented by leg care, antiembolic stockings, and low dose heparin
- gastrointestinal bleeding, which can be prevented with prophylactic treatment
- accumulation of large amount of secretions, which requires frequent respiratory toilet
- arrhythmias, nosocomial infections, laryngotracheal injury, malnutrition, hypophosphatemia, oxygen toxicity, psychosis

**Ventilator Weaning**

Ventilator weaning is used to describe the process of gradually removing the patient from the ventilator and restoring spontaneous breathing after a period of mechanical ventilation. This process has also been referred to as discontinuation or liberation from mechanical ventilation. Traditional methods of weaning include spontaneous breathing trials (SBTs), progressive decreases in the level of pressure support during pressure support ventilation (PSV), and progressive decreases in the number of ventilator-assisted breaths during intermittent mandatory ventilation (IMV). Newer weaning methods include computer-driven automated PSV weaning and early extubation with immediate use of post-extubation noninvasive positive pressure ventilation (NPPV).

Physicians and the ICU respiratory care specialists help patients to wean from ventilatory support when it is determined to be medically appropriate. The team decision to wean or discontinue mechanical ventilation is based on the patient’s current illness and past medical history, complete medical assessment, tests of daytime and nighttime breathing efficiency, and ability to breathe without assistance. Long-term mechanical ventilation is for patients whose medical conditions become unstable without mechanical ventilation. While the majority of patients with some conditions can be weaned from mechanical ventilation after a few days to a week in the ICU, patients with other conditions cannot or should not be taken off the ventilator. In the minority of patients, probably
10% to 20% overall, mechanical ventilation is more difficult to discontinue. This group is largely composed of patients receiving mechanical ventilation for longer than 21 days. Patients with stable chronic medical conditions are more likely to require long-term mechanical ventilation, (e.g., patients with neuromuscular disorders or chest wall deformities). Conditions such as stroke and spinal cord injury damage the nerves that control breathing and make spontaneous breathing impossible for an extended period or for life. Chronic illness that requires recurrent ICU hospitalization may require frequent repeated treatments with mechanical ventilation and repeated attempts to wean from mechanical ventilation. Aggressive removal of ventilatory support is balanced against the risks of premature withdrawal of ventilatory support, including difficulty in re-establishing the artificial airway, compromised gas exchange, and ventilatory muscle fatigue.

Data from observational studies has proven that 34–60% of patients who are discharged from the ICU, as being ventilator dependent, can be successfully weaned when they are transferred to units dedicated to ventilator weaning. Various types of facilities may be considered for patients who require ongoing mechanical ventilation. Those patients who leave the ICU but require hospitalization can receive care in a specialized respiratory care unit of the hospital or a general medical/surgical unit in the hospital. For patients with special medical needs who can be discharged from the hospital, care can be given in a subacute care unit of the hospital, a long-term hospital or a rehabilitation hospital. If the patient is capable of independent living, they can be discharged to a skilled nursing facility or home.

The most favorable discontinuation outcomes are most likely achieved by protocol-directed ventilator management teams that adhere to their protocols. These programs can improve the quality of care of patients on mechanical ventilation and decrease their length of ICU stay especially when the ventilator management program has built into it the active search for, and correction of, medical barriers that allow for the persistence of inspiratory respiratory muscle fatigue or weakness.

**Literature Review – Adults**

Subirà et al. (2019) conducted a randomized trial to evaluate the effect of a daily spontaneous breathing trial (SBT) consisting of 30 minutes of pressure support ventilation (an approach that is less demanding for patients) vs an SBT consisting of two hours of T-piece ventilation (an approach that is more demanding for patients) on rates of successful extubation. After evaluating 1153 patients, the authors concluded that a spontaneous breathing trial consisting of 30 minutes of pressure support ventilation, compared with 2 hours of T-piece ventilation, led to significantly higher rates of successful extubation. These findings support the use of a shorter, less demanding ventilation strategy for spontaneous breathing trials.

In a randomized trial, Perkins et al. (2018) compared weaning with early extubation to noninvasive ventilation with invasive weaning. A total of 364 adults who received invasive mechanical ventilation for more than 48 hours and in whom a spontaneous breathing trial failed were randomized to receive either protocolized weaning via early extubation to noninvasive ventilation (n = 182) or protocolized standard weaning (continued invasive ventilation until successful spontaneous breathing trial, followed by extubation) (n = 182). Primary endpoint was time from randomization to successful liberation from all forms of mechanical ventilation. The median time to liberation was 4.3 days in the noninvasive group vs 4.5 days in the invasive group. The authors concluded that early extubation to noninvasive ventilation did not shorten time to liberation from any ventilation.

A prospective, observational trial including 2469 critically ill patients on mechanical ventilation >24 hours was completed by Borges et al. (2017). The authors investigated the effectiveness of a multifaceted strategy to implement a protocol to wean patients from mechanical ventilation (MV) and to evaluate the weaning success rate as well as practitioner adherence to the protocol. A total of 1,943 subjects (78.7%) experienced weaning success during the study years, the weaning success of all subjects increased (from 73.1% to 85.4%, p<0.001). When the weaning protocol was evaluated step-by-step, we found high adherence for noninvasive ventilation use (95%) and weaning predictor measurement (91%) and lower adherence for control of fluid balance (57%) and daily interruption of sedation (24%). Weaning success was higher in patients who had undergone the weaning protocol compared to those who had undergone weaning based in clinical practice (85.6% vs. 67.7%, p<0.001).

Damuth et al. (2015) conducted a systematic review and meta-analysis to analyze long-term survival of critically ill patients treated with prolonged mechanical ventilation as well as successful liberation from mechanical
ventilation while in hospital. Among the 29 included high-quality studies, the pooled mortality at one year was 62%. Pooled mortality at hospital discharge was 29%. However, only 19% were discharged to home and only 50% were successfully liberated from mechanical ventilation. For studies in post-acute care hospitals, outcomes were worse in the USA than internationally (mortality at one year was 73% in the USA vs 47% in non-USA countries; in-hospital mortality was 31% vs. 18%; and liberation from ventilation was 47% vs. 63%; p<0·0001 for all).

A Cochrane systematic review and meta-analysis (Rose, et al., 2015) compared mechanical ventilator weaning duration for critically ill adults and children when managed with automated systems versus non-automated strategies. Results showed automated systems may result in clinically meaningful reduced durations of weaning, ventilation and ICU stay. The authors stated that overall; these systems appear to be safe and can be considered a reasonable approach in the management of ventilator weaning. These potential reductions are more likely to occur in mixed/medical as opposed to surgical ICU populations and with Smartcare/ PS™ (Dräger Medical). Due to limited evidence on automated systems other than Smartcare/PS™ and Adaptive Support Ventilation (ASV) (Hamilton Medical) no conclusions can be drawn regarding their influence on outcomes. The method of weaning to which automated systems was compared (protocolled or non-protocolled usual care) did not influence the effect on weaning duration.

In a Cochrane systematic review and meta-analysis, Blackwood et al. (2011) investigated the effects of weaning protocols on the total duration of mechanical ventilation, mortality, adverse events, quality of life, weaning duration, and length of stay in the intensive care unit and hospital. They included randomized and quasi-randomized controlled trials of weaning from mechanical ventilation with and without protocols in critically ill adults. Eleven trials that included 1971 patients met the inclusion criteria. The authors reported that there is evidence of a reduction in the duration of mechanical ventilation, weaning, and stay in the intensive care unit when standardized weaning protocols are used, but there is significant heterogeneity among studies and an insufficient number of studies to investigate the source of this heterogeneity.

Tanios et al. (2006) conducted a multicenter, randomized controlled trial to determine the effect of including a weaning predictor (i.e., frequency-tidal volume ratio) in a weaning protocol. Three hundred and four patients were randomized to two groups. All adult patients were eligible once mechanically ventilated for ≥24 hours. One group (n=151) had the frequency-tidal volume ratio measured, but it was not used in the decision to wean. The other group (n=153) had the frequency-tidal volume ratio measured and was used with a threshold of 105 breaths/min/L. The mean duration for weaning time was shorter in the group where the weaning predictor was not used. There was no difference between the two groups with regard to the extubation failure, in hospital mortality rate, tracheostomy, or unexplained extubation. The authors’ state one possible role for weaning predictors is in the evaluation of patients intolerant of SBT with a goal of identifying reversible causes of weaning failure.

In a controlled trial, Krishnan et al. (2004) reported that adults requiring mechanical ventilation for > 24 hours showed no difference in duration of mechanical ventilation, ICU stay, need for reinstitution of mechanical ventilation, or hospital mortality in the group treated with a nursing/respiratory therapist-driven protocol compared with those in whom weaning was managed off protocol by the supervising physician. This study was conducted in a closed, intensivist-run ICU with high levels of staffing with a routine management template that was used daily to encourage the staff to address weaning issues every day.

Vitacca et al. (2001) conducted a multicenter, randomized controlled study in three long-term weaning units to evaluate which protocol, PSV or SBT, is more effective in weaning patients with chronic obstructive pulmonary disease (COPD) requiring mechanical ventilation for more than 15 days. Fifty-two patients were randomly assigned to PSV or SBT. The authors report no significant difference in weaning success rate, mortality rate, and duration of ventilatory assistance, long-term weaning unit, or hospital stay in the PSV and SBT groups. The authors reported that the application of a well-defined protocol, independent of the mode used, may result in better patient outcomes than uncontrolled clinical practice.

**Literature Review – Pediatrics**

Ferreira et al. (2019) conducted a randomized, controlled trial to evaluate the usefulness of a spontaneous breathing trial for predicting extubation success in pediatric patients compared with a physician-led weaning.
A total of 110 pediatric patients on mechanical ventilation for more than 12 hours after cardiac surgery for congenital heart disease were randomized into the two groups. The authors concluded that patients undergoing the spontaneous breathing trial had a significantly higher rate of successful extubation and a shorter PICU length of stay compared with those weaned according to the physician’s clinical judgment.

Bol et al. (2019) performed a systematic review of the literature to obtain all available evidence on the effect of protocolized versus non-protocolized weaning on the duration of invasive mechanical ventilation in critically ill neonates. Three studies met the inclusion criteria. Of 2 of these, the separate neonatal data could not be obtained. Only one retrospective study was included in the review. This reported a decrease in the mean weaning time from 18 to 5 and 6 days, respectively. There is no robust evidence in the literature to support or disprove the use of a weaning protocol in critically ill neonates.

In a review of pediatric ventilation, Turner and Arnold (2007) summarize that mechanical ventilation with pressure limitation and low tidal volumes has become the prevailing practice in pediatric ICUs. Further research is needed regarding the use of high frequency oscillatory ventilation, airway pressure release ventilation, and surfactant to assist pediatric intensivists in the application of these therapies. The authors state that weaning protocols do not appear to be as useful in pediatrics as they are in adults.

In a multicenter, randomized controlled trial, Randolph et al. (2002) compared a weaning protocol with standard of care (no defined protocol) in infants and children with acute illnesses requiring mechanical ventilation. The authors found that, in contrast to adult patients, the majority of children were weaned within two days, and the weaning protocol did not influence the duration of mechanical ventilation.

Professional Societies/Organizations

**American College of Chest Physicians (ACCP) / American Thoracic Society (ATS)**

The ACCP/ATS Clinical Practice Guideline (Schmidt, et al., 2017) titled Liberation From Mechanical Ventilation in Critically Ill Adults was published after comprehensive evidence synthesis to assess the overall certainty of the evidence for six topic groups. Each recommendation was considered strong or conditional and required at least 80% panel consensus for approval. Only one recommendation, extubation to preventive noninvasive mechanical ventilation in high-risk patients, is strongly suggested. All others are considered conditional recommendations.

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>*Strength of Recommendation</th>
<th>Certainty of Evidence (ie, Quality of Evidence)</th>
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<tbody>
<tr>
<td>1 For acutely hospitalized patients ventilated more than 24 hours, ACCP/ATS suggests that the initial SBT be conducted with inspiratory pressure augmentation (5-8 cm H2O) rather than without (T-piece or CPAP)</td>
<td>Conditional</td>
<td>Moderate certainty in the evidence</td>
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<tr>
<td>The evidence suggested that conducting the SBT with pressure augmentation was more likely to be successful, produced a higher rate of extubation success, and was associated with a trend toward lower ICU mortality than SBTs performed without pressure augmentation. This recommendation relates to how to conduct the initial SBT but does not inform how to ventilate patients between unsuccessful SBTs.</td>
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<tr>
<td>2 For acutely hospitalized patients ventilated for more than 24 hours, ACCP/ATS suggests protocols attempting to minimize sedation</td>
<td>Conditional</td>
<td>Low certainty in the evidence</td>
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<tr>
<td>#</td>
<td>Recommendation</td>
<td>Level of Evidence</td>
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<tr>
<td>3</td>
<td>For patients at high risk for extubation failure who have been receiving mechanical ventilation for more than 24 hours and who have passed a SBT, ACCP/ATS recommends extubation to preventive NIV. Studies of preventive NIV found heterogeneity in defining the high-risk patient. Risk factors included older age, comorbidities such as COPD or congestive heart failure, and hypercapnia during the SBT. The evidence synthesis indicated that preventive NIV was superior to no preventive NIV regarding extubation success, ICU length of stay, and both short- and long-term mortality.</td>
<td>Strong</td>
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<tr>
<td>4</td>
<td>For acutely hospitalized patients who have been mechanically ventilated for &gt; 24 hours, ACCP/ATS suggests protocolized rehabilitation directed toward early mobilization. The evidence synthesis demonstrated that patients who received an intervention directed toward early mobilization had a shorter duration of mechanical ventilation and were more likely to be able to walk at hospital discharge. There were no differences in mortality, ICU length of stay, ability to walk at ICU discharge, 6-min walk distance, or ventilator-free days. Low rates of serious adverse events, including arrhythmias, have been reported. There is insufficient evidence to recommend any rehabilitation protocol over another.</td>
<td>Conditional</td>
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<tr>
<td>5</td>
<td>ACCP/ATS suggests managing acutely hospitalized patients who have been mechanically ventilated for &gt; 24 hours with a ventilator liberation protocol. The guideline panel defined a “ventilator liberation protocol” as protocol-guided efforts to identify a patient’s readiness for liberation (ie, extubation) from invasive mechanical ventilation. The evidence demonstrated that patients managed with a ventilator liberation protocol spent fewer hours on mechanical ventilation than did patients managed without a protocol. Additionally, management with a ventilator liberation protocol led to patients being discharged from the ICU earlier than management without a protocol. However, ventilator liberation protocols had no significant effect on mortality or reintubation rates. Adverse events were rarely reported. Subgroup analyses found that compared with management without a ventilator liberation protocol, personnel-driven and computer-driven protocols had similar effects. The ventilator liberation protocol may be either personnel driven or computer driven.</td>
<td>Conditional</td>
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<tr>
<td>6A</td>
<td>ACCP/ATS suggests performing a CLT in mechanically ventilated adults who meet extubation criteria and are deemed at high risk for PES</td>
<td>Conditional</td>
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<tr>
<td>6B</td>
<td>For adults who have failed a CLT but are otherwise ready for extubation, ACCP/ATS suggests administering systemic steroids at least 4 hours before extubation; a repeated CLT is not required</td>
<td>Conditional</td>
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</table>

The evidence suggested that patients with an absent or insufficient cuff leak are at increased risk of postextubation stridor (PES) and unsuccessful extubation. Very low-quality evidence also suggested that the use of a CLT to guide management may decrease the reintubation and PES rate and delay extubation (due to a high false-positive rate). It has no effect on the duration of mechanical ventilation when considering the additional days associated with reintubation. Moderate-quality evidence suggested that administration of systemic steroids to patients failing a CLT may reduce both the reintubation and PES rates. Patients passing a CLT have a low risk of reintubation and PES, although these risks are also low among patients extubated without having a CLT performed.

Risk factors for PES include traumatic intubation, intubation > 6 days, large endotracheal tube, female sex, and reintubation after unplanned extubation. A repeat CLT is not required following the administration of systemic steroids.

*Strength of Recommendation*

**Strong Recommendation:** Most individuals should receive the intervention. Adherence to this recommendation according to the guideline could be used as a quality criterion or performance indicator. The recommendation can be adopted as policy in most situations.

**Conditional Recommendation:** Clinicians should recognize that different choices will be appropriate for individual patients and that one must help each patient arrive at a management decision consistent with his or her values and preferences.

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**American College of Critical Care Medicine (ACCCM) / Society of Critical Care Medicine (SCCM)**

The ACCCM/SCCM ICU Admission, Discharge, and Triage Guidelines (Nates, et al., 2016) updated their 1999 guidelines for ICU admission, discharge, and triage noting evaluation of outcomes comparing care in other units to care in the ICU is incomplete. There is some evidence for success with weaning from mechanical ventilation; however, paucity of data may not reflect ineffectiveness of the step-down unit but rather a large gap in research to validate effectiveness.

**Care in the ICU versus Intensive Care in the Wards Recommendation:**

- We suggest that patients with invasive mechanical ventilation or complex life-threatening conditions, including those with sepsis, be treated in an ICU. Patients should not be weaned from mechanical ventilation on the general ward unless the ward is a high-dependency/intermediate unit (Grade 2C: Weak strength of recommendation; Low certainty of evidence).
American Academy of Pediatrics (AAP)
The AAP Policy Statement Respiratory Support in Preterm Infants at Birth (2014) notes early initiation of CPAP may lead to a reduction in duration of mechanical ventilation and postnatal corticosteroid therapy.

The American Board of Internal Medicine’s (ABIM) Foundation Choosing Wisely® Initiative
No specific relevant information.

Centers for Medicare & Medicaid Services (CMS)
- National Coverage Determinations (NCDs): No applicable NCD found.
- Local Coverage Determinations (LCDs): No applicable LCD found.

Use Outside of the US
No specific relevant information.

Coding/Billing Information

Note: 1) This list of codes may not be all-inclusive.
   2) Deleted codes and codes which are not effective at the time the service is rendered may not be eligible for reimbursement.

Considered Medically Necessary when criteria in the applicable policy statements listed above are met:

<table>
<thead>
<tr>
<th>Revenue Codes†</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0121</td>
<td>Room &amp; Board—Semiprivate (two beds)—Medical/Surgical/GYN</td>
</tr>
<tr>
<td>0131</td>
<td>Room &amp; Board—Three and Four Beds—Medical/Surgical/GYN</td>
</tr>
<tr>
<td>0151</td>
<td>Room &amp; Board—Ward—Medical/Surgical/GYN</td>
</tr>
<tr>
<td>0193</td>
<td>Subacute care—Level III</td>
</tr>
<tr>
<td>0194</td>
<td>Subacute care—Level IV</td>
</tr>
<tr>
<td>0206</td>
<td>Intensive Care Unit—Intermediate ICU</td>
</tr>
<tr>
<td>0209</td>
<td>Intensive Care Unit—Other Intensive Care</td>
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</tbody>
</table>

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<thead>
<tr>
<th>DRG</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>207</td>
<td>Respiratory system diagnosis with ventilator support greater than 96 Hours</td>
</tr>
<tr>
<td>208</td>
<td>Respiratory system diagnosis with ventilator support≤ 96 hours</td>
</tr>
<tr>
<td>951</td>
<td>Other factors influencing health status</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ICD-10-CM Procedure Codes</th>
<th>Description</th>
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<tbody>
<tr>
<td>5A1935Z</td>
<td>Respiratory Ventilation, Less than 24 Consecutive Hours</td>
</tr>
<tr>
<td>5A1945Z</td>
<td>Respiratory Ventilation, 24-96 Consecutive Hours</td>
</tr>
<tr>
<td>5A1955Z</td>
<td>Respiratory Ventilation, Greater than 96 Consecutive Hours</td>
</tr>
</tbody>
</table>

Considered Not Medically Necessary when used to report ventilator weaning:

<table>
<thead>
<tr>
<th>Revenue Codes†</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0202</td>
<td>Intensive Care Unit—Medical</td>
</tr>
</tbody>
</table>

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References


22. MacIntyre NR, Cook DJ, American College of Chest Physicians; American Association for Respiratory Care; American College of Critical Care Medicine, et al. Evidence-based guidelines for weaning and discontinuing ventilatory support: a collective task force facilitated by the American College of Chest Physicians; the American Association for Respiratory Care; and the American College of Critical Care Medicine. Chest. 2001 Dec;120(6 Suppl):375S-95S.


