How to Withdraw Mechanical Ventilation

A Systematic Review of the Literature

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ABSTRACT

Eight published accounts about ventilator withdrawal spanning 1992–2004 were selected for review. Articles were selected if they contained data that described the processes comprising the withdrawal of mechanical ventilation as a terminal illness event. The purpose of this article is to synthesize the existing evidence about processes for the compassionate withdrawal of mechanical ventilation from intensive care unit patients, including measures of distress, premedication, medication during withdrawal, withdrawal methods, extubation considerations, duration of survival, and relationship of opioids or benzodiazepines to duration of survival. Practice recommendations will be suggested.

Keywords: dyspnea, dying, life supports, mechanical ventilation, terminal weaning, terminal care, withdrawal

Artificial ventilation has been used for decades to support breathing when patients experienced acute or chronic respiratory failure. Beginning with negative pressure ventilation (iron lungs) during the polio epidemic, clinicians had the means to prolong life. Modern ventilators provide a variety of modes and mechanisms for supporting even patients with the most severe pulmonary impairments.

In 1975, a young woman named Karen Ann Quinlan existed in a persistent vegetative state. Her life was prolonged with mechanical ventilation and enteral feedings. Her parents recognized that her prognosis for functional neurologic recovery was poor, and they requested withdrawal of the ventilator. Karen’s physicians had never faced this type of request and would have found no support in the professional literature for how to respond. The clinicians believed that Karen would die without the ventilator and that by acting to remove it, they would be complicit in her death.

Karen’s condition and her parent’s request were given a great deal of ethical and legal attention. In 1976, the New Jersey Supreme Court ruled in favor of the ventilator withdrawal. To the surprise of her physicians, she was able to sustain herself with spontaneous breathing and lived 10 more years in a vegetative state with enteral feeding and hydration before dying from pneumonia.

The 1970s were characterized by a proliferation of new and improving life-sustaining therapies and the continued evolution of critical care as a specialty. The development of ethical standards and the creation of legal statutes lagged behind the expansion and implementation of life-sustaining therapies. The 1980s featured “right to die” cases resolved in the courts and the formulation of ethical standards to guide this type of care decision.1

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Numerous cases across the country found their way into the courts, providing the basis for case law and eventually statutes to guide clinical decision making. A Presidential Commission to address ethical issues in medicine was formed; one of their reports addressed decisions to forgo life-sustaining treatment. The Commission examined how decisions were made to forgo therapy, clarified the issues, and suggested appropriate procedures for making decisions that are the basis for current practice. By the early 1990s, clinical standards, policies, and procedures about forgoing life-sustaining therapy were in wide use and reflected broad agreement about the underlying principles regarding these decisions. The Patient Self-Determination Act was introduced to provide federal statutory support of the patient’s right to use advance directives.

Currently, decisions are made every day to forgo life-sustaining therapies. In the vast majority of cases, all parties directly involved—patients, families, and clinicians—are in agreement with the decision. Referral to a court or an ethics committee is not necessary, except in cases characterized by dispute.

Before 1990, the critical care literature focused on ethical and legal decision making about forgoing mechanical ventilation. There was little empiric evidence to guide the process; the “ought to” was described but not the “how to.” The earliest article that suggested a method for ventilator withdrawal was published in 1983 on the basis of the processes used in one unit. Grenvik distinguished terminal weaning from conventional weaning because terminal weaning proceeds despite deteriorating vital signs and other variables. He recommended continued evaluation of blood gases during terminal weaning to monitor the patient’s progress toward death or successful weaning. Additionally, he suggested that some patients should remain intubated if airway obstruction and disconcerting airway sounds can be anticipated.

More recently, Rubenfeld and Crawford suggested that ventilator withdrawal be treated similarly to other processes or procedures undertaken in the intensive care unit (ICU). For example, a plan should be developed for the ventilator withdrawal that considers what processes will occur and in what order. Who will be responsible for those processes?

Some critical care units have turned to protocols, standing orders, or algorithms to guide the process of ventilator withdrawal and an ideal protocol should reflect the state of the science. Thus, the purpose of this article is to systematically review and synthesize extant evidence about the processes of ventilator withdrawal, in other words the “how to.” This article does not include a summary of the evidence about communicating to make the decision or caring for families as those topics are presented in other articles in this issue of AACN Advanced Critical Care.

Method
Two electronic databases, MEDLINE (1980 to February 2007) and CINAHL (1982 to February 2007), were searched for studies in English using the keywords mechanical ventilation and withdrawal, life support withdrawal, ventilator withdrawal, and terminal weaning. The search yielded 207 citations, of which 35 articles reflected the purpose of the review and were selected for evaluation for inclusion/exclusion criteria. Studies were included if the target population was mechanically ventilated adults having ventilation withdrawn as a part of terminal illness care. Articles were excluded if the data were collected from a mixed sample of patients having ventilation withdrawn or withheld, if the sample was less than 12 patients, or if the article described one or more case reports.

Table 1 summarizes the 8 articles included in this review.

Data were extracted to predesigned summary tables under the following headings: author(s), year of publication, study design, sample size, measures of distress, premedication or medication during withdrawal, withdrawal method(s), extubation considerations, duration of survival, and correlation of survival with administration of opioids and sedatives. Because of variability in data extracted, it was not possible to combine the findings of different studies and, therefore, summaries of the variables are reported.

How Is Dyspnea or Respiratory Distress Measured?
Dyspnea, also known as “breathlessness,” is a noxious phenomenon defined as “a subjective experience of breathing discomfort that consists of qualitatively distinct sensations that vary in intensity. The experience derives from interactions among multiple physiological, psychological, social and environmental factors, and may induce secondary physiological and
behavioral responses. Dyspnea can be perceived and verified only by the person experiencing it. Many patients who are undergoing ventilator withdrawal are cognitively impaired or unconscious as a result of underlying neurologic lesions or hemodynamic, metabolic, or respiratory dysfunction that produce cognitive impairment or unconsciousness. Respiratory distress has been characterized as an observable (behavioral) corollary to dyspnea; the physical and emotional suffering that results from the experience of asphyxiation that is characterized by behaviors that can be observed and measured. Dyspnea or respiratory distress is anticipated during ventilator withdrawal and should be the focus of patient interventions during the process.

Neuromuscular blocking agents (NMBA) are being used with less frequency in the ICU; however, when in use, it is impossible to assess the patient’s comfort. Thus, NMBA should be discontinued with evidence of patient neuromuscular recovery before ventilator withdrawal. In some cases, the duration of action of these agents is prolonged, such as when the patient has liver or renal failure and impaired clearance. Therefore, although controversial, withdrawal can proceed with careful attention to ensuring patient comfort if an unacceptable delay in withdrawing mechanical ventilation occurs because of protracted effects of NMBA.

Daly et al conducted a chart review and indicated that medications given during ventilator withdrawal were titrated to maintain a respiratory rate less than 30 breaths per minute, or to an unspecified appearance of comfort. Campbell et al used 3 measures for distress in a prospective observation study. The bispectral index of EEG, Bizek agitation scale (BAS), and the COMFORT scale were used simultaneously to assess patients for respiratory distress, and they strongly correlated with each other. The measures used were not specific to respiratory distress: BIS is a measure of wakefulness, BAS is an agitation scale, and the COMFORT scale is intended to measure distress in infants.

Table 1: Studies Included in Review of the Literature

<table>
<thead>
<tr>
<th>Authors</th>
<th>Year</th>
<th>Design</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faber-Langendoen and Bartels</td>
<td>1992</td>
<td>Retrospective, descriptive</td>
<td>14</td>
</tr>
<tr>
<td>Daly et al</td>
<td>1996</td>
<td>Retrospective, descriptive</td>
<td>42</td>
</tr>
<tr>
<td>Campbell et al</td>
<td>1999</td>
<td>Prospective, descriptive, correlation</td>
<td>31</td>
</tr>
<tr>
<td>Mayer and Kossoff</td>
<td>1999</td>
<td>Retrospective, descriptive, correlation</td>
<td>32</td>
</tr>
<tr>
<td>Ankrom et al</td>
<td>2001</td>
<td>Retrospective, descriptive</td>
<td>13</td>
</tr>
<tr>
<td>O'Mahony et al</td>
<td>2003</td>
<td>Retrospective, descriptive</td>
<td>21</td>
</tr>
<tr>
<td>Rocker et al</td>
<td>2004</td>
<td>Prospective, descriptive</td>
<td>155</td>
</tr>
<tr>
<td>Chan et al</td>
<td>2004</td>
<td>Retrospective, descriptive</td>
<td>75</td>
</tr>
</tbody>
</table>

Abbreviation: N, study sample size.
when patients are unable to reliably provide a self-report about their experience. Recent investigation of the reliability and validity of a Respiratory Distress Observation Scale suggests that there may be common behaviors displayed by patients in response to hypercarbia, hypoxemia, or inspiratory effort, including tachycardia, tachypnea, accessory muscle use, restlessness, nasal flaring, grunting at end-expiration, and a fearful facial expression. Some would argue that routine premedication with opioids and sedatives will prevent distress during ventilator withdrawal, however, many clinicians fear hastening patient death and are reluctant to medicate without clear evidence of patient distress.

**Recommendation**

More studies are needed to identify reliable behaviors that signify respiratory distress when the patient is unable to generate a self-report. Brain-dead patients by definition will not show distress, cough, gag, or breath during or following ventilator withdrawal, and sedation or analgesia is not indicated. Comatose patients are unlikely to demonstrate distress except for, perhaps, tachypnea and tachycardia. Initiation and escalation of sedatives and opioids should be guided by patient behaviors.

**Premedication**

Four investigators reported about premedication. Campbell et al recommended premedication with morphine and/or a benzodiazepine if the patient showed signs of distress before withdrawal or if the conscious patient desired medication. Because subjects in the sample were comatose, only 13% of patients were premedicated; an average Glasgow Coma Scale (GCS) score of 7 was reported for those premedicated and 4 for those with no premedication. Investigators at the University of Washington reported progressive escalation of infusions of opioids or benzodiazepines in the 8 hours preceding a planned ventilator withdrawal. The justification for dose escalation was not reported from this retrospective review. Ankrom et al reported that “small” doses of morphine and a benzodiazepine were given before ventilator withdrawal, but doses and indications were not reported. O’Mahoney reported premedication if the patient was alert or had a history of recent agitation before the withdrawal.

**Medication During or After Withdrawal**

Variance in reporting characterized the descriptions of medications used during ventilator withdrawal. All investigators used an opioid, usually morphine, and some used a benzodiazepine occasionally or always. Table 2 is a summary of the morphine characteristics reported across investigations. As seen, doses ranged from very small to very large. As discussed, most studies did not report how distress was measured or how dose escalation was determined.

**Recommendation**

As is the standard with pain management, opioids should be initiated to signs of distress and the advice to “start low and titrate slowly” is sage. Anticipatory premedication is a sound practice if distress is already evident and if distress can be anticipated. There is no justification for medicating a brain-dead patient, and one could argue that the patient in coma with only minimal brainstem function is also unlikely to experience distress. Doses that correspond to customary dosing for the treatment of dyspnea should guide dosing during ventilator withdrawal. Documentation of the signs of distress and rationale for dose escalation is important to ensure continuity across professional caregivers and to prevent overmedication and the appearance of hastening death.

**Weaning Method**

Terminal extubation is characterized by ceasing ventilatory support and removing the endotracheal tube in one step. Extubation was the only method used in 2 studies. Terminal weaning is a process of step-wise, gradual reductions in oxygen and ventilation, terminating with placement on a t-piece or with extubation. Rapid terminal weaning was the only method used in one study with an average weaning interval of 15 minutes. In 2 studies, investigators reported various methods used with no rationale provided for choice of method.

In a survey of physician practices related to ventilator withdrawal, investigators found that surgeons and anesthesiologists preferred terminal weaning compared with internists and pediatricians who preferred extubation. It is interesting to note that physician rather than patient characteristics contributed to
choice of method. There are no known investigations that compare these methods.

**Recommendation**

With no comparative evidence to support one method over another, it is difficult to make a recommendation. Rapid terminal weaning may afford the clinician with the most control because it allows for careful, sequential adjustments to the ventilator with precise titration of medications to ensure patient comfort. Continuous patient monitoring with readily accessible opioids and sedatives will afford the patient and family comfort regardless of method employed.

**Extubation Considerations**

Campbell et al were the only investigators who recommended extubation as a separate decision based on the patient’s airway integrity, volume of pulmonary secretions, and ability to experience distress. Of comatose patients, 35% were extubated after rapid terminal weaning. Of note, survival was longer for those who were extubated (85.3 ± 35 hours) compared with the patients who remained intubated (12.95 ± 4.96 hours; \( P < .01 \)).

Rocker reported no significant difference in duration of survival when the patients who were extubated (median 1.1 hours) were compared with those who had either a tracheostomy or endotracheal tube maintained (median 1.2 hours).

**Recommendation**

Removal of the endotracheal tube should be performed whenever possible because of patient comfort and the aesthetic appearance of the patient. However, in some cases, airway compromise can be anticipated, such as when the patient has a swollen, protuberant tongue, or has no gag or cough reflexes. In cases of airway compromise, the disconcerting noises may be more distressing to the attendant family than the presence of the tube. Aerosolized racemic epinephrine is a useful intervention to reduce stridor after extubation. Family counseling about usual noises that can be expected and cause no distress should be done prior to extubation.

**Duration of Survival**

All the investigators reported about duration of survival. In 4 studies, patients who died following ventilator withdrawal comprised the sample; thus 100% of patients died. All the patients who were withdrawn died in 2 studies and 2 brain-dead patients were included in the sample from Daly et al. Campbell et al reported that of 31 comatose patients, 35% were extubated after rapid terminal weaning. Of note, survival was longer for those who were extubated (85.3 ± 35 hours) compared with the patients who remained intubated (12.95 ± 4.96 hours; \( P < .01 \)).

### Table 2: Summary of Reports of Morphine Administered During Ventilator Withdrawal

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Total morphine (duration)</th>
<th>Average hourly dose</th>
<th>Range of dosing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faber-Langendoen and Bartels</td>
<td>NR</td>
<td>NR</td>
<td>0–80 mg/h</td>
</tr>
<tr>
<td>Daly et al</td>
<td>NR</td>
<td>NR</td>
<td>1–59 mg/h</td>
</tr>
<tr>
<td>Campbell et al</td>
<td>36 ± 10 mg (24 h from beginning of withdrawal)</td>
<td>5.5 mg/h</td>
<td>NR</td>
</tr>
<tr>
<td>Mayer and Kossoff</td>
<td>6–456 mg (30 h from beginning of withdrawal)</td>
<td>6.3 mg/h</td>
<td>2.5–20 mg/h</td>
</tr>
<tr>
<td>Ankrum et al</td>
<td>206 ± 265 mg (patient survived &lt;30 min) 78 ± 14 mg (patient survived longer than 30 min)</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>O’Mahoney et al</td>
<td>12 mg (extubation until death)</td>
<td>6 mg/h</td>
<td>1–50 mg/h</td>
</tr>
<tr>
<td>Rocker et al</td>
<td>24 mg (4 h before death)</td>
<td>24 mg/h median</td>
<td>2–340 mg/h</td>
</tr>
<tr>
<td>Chan et al</td>
<td>81 mg (24 h before death)</td>
<td>Increased from 4 mg/h to 16.2 mg/h during interval before withdrawal</td>
<td>NR</td>
</tr>
</tbody>
</table>

**Abbreviation:** NR, not reported.
patients, 2 patients (6%) survived to hospital discharge, and O’Mahoney et al discharged 3 of 21 (14%) patients after ventilator withdrawal.1,11

Across studies the duration of survival ranged from 2 minutes to 9 days after ventilator withdrawal. Median survival across studies ranged from 35 minutes13 to 7.5 hours.9 Campbell et al reported no relationship between duration of survival and use of sedation/analgesia, GCS score, or PaO2/FiO2 but there was a significant inverse correlation with illness severity measured with APACHE II14 (r = −0.42, P < .05).4 Mayer et al also found no relationship between duration of survival and GCS score.8 Ankrom et al reported no correlation between analgesia use and duration of survival; however, patients who died in less than 30 minutes received an average total morphine dose of 206 ± 265 mg morphine, and those who died more than 30 minutes after withdrawal received an average of 78 ± 111 mg morphine.10 This suggests a clinical significance, although the analysis with a small sample and a large standard deviation may not have yielded a statistical significance.

Of note, both Campbell et al and Chan et al reported no significant relationship between analgesia/sedation and duration of survival.13,14 However, with similar average reported GCS scores (5.3 vs 4), Campbell reported an average total morphine dose of 36 mg for the 24-hour period after withdrawal and an average survival of 24.2 hours (median 2.3 hours). This contrasts sharply with the average total morphine dose of 81 mg for the 24-hour period before death and the median survival after ventilator withdrawal of 35 minutes (range, 1 minute to 14.8 hours).

Summary
Small samples and largely retrospective chart reviews characterize the body of evidence about processes for ventilator withdrawal. Thus, it seems fair to say that the evidence is largely lacking to predict the best method that ensures patient comfort without hastening death. Palliation versus hastening death may be difficult to distinguish in this context because the patients are often near death before the ventilator is withdrawn. The cited research is not conclusive to make recommendations in all cases of ventilator withdrawal. Therefore, a number of suggested processes may be useful in this clinical context as well as with a team approach to the procedure and patient care.

First, a common measure of dyspnea or respiratory distress should be identified and used across clinicians to guide the initiation and escalation of opioids or sedatives, such as noting the presence of behaviors specific to respiratory distress. Additionally, monitoring the patient for signs of affective distress, such as fear, is essential. Brain-dead patients do not experience or display signs of distress.

Premedication or medication during and following withdrawal of mechanical ventilation with opioids and benzodiazepines is useful if the patient is experiencing distress before withdrawal or likely to experience distress during or after. Brain-dead patients do not require medication because there is no distress. Comatose patients may require little or no analgesia or sedation unless objective signs of respiratory distress are apparent. Doses should be initiated according to the patient’s tolerance and escalated only to signs or reports of distress.

Every attempt should be made to extubate patients after ceasing mechanical ventilation because the endotracheal tube is a source of iatrogenic discomfort. However, in some cases, particularly when the patient is unresponsive, it may be best to keep the endotracheal tube, such as when the tongue is swollen, when gag and cough reflexes are absent, or when there is a large volume of pulmonary secretions. Studies are needed to identify best methods.

References


