Implementation of a Multidisciplinary Ventilator-Weaning and Sedation Protocol in a Community Intensive Care Unit

Amanda L. Rumpke, RN, MSN, ACNP, CCRN; Beth A. Zimmerman, RN, BSN

Prolongation of mechanical ventilation poses serious personal and financial threats to healthcare consumers. To that end, many healthcare-related groups have established mechanisms for rapid weaning and subsequent extubation of mechanically ventilated patients. Our objectives were to create and implement an evidenced-based, multidisciplinary care-driven ventilator-weaning protocol as well as revise existing ventilator sedation protocols to decrease length of stay in addition to time spent on the ventilator. Our findings are presented in this article.

Keywords: Mechanical ventilator, Sedation, Weaning

BACKGROUND

Unfortunately, mechanical ventilation is frequently necessary for those who have a critical illness. Meade and colleagues\(^1\) state that nearly 90% of all critically ill patients require endotracheal intubation with subsequent ventilatory support. A vast amount of evidence substantiates the conclusion that prolongation of mechanical ventilation yields sequelae, which negatively impacts patients. To further compound the issue, the requisite need for sedation coupled with its unreliable effects on a metabolically unstable patient may potentiate complications.\(^2\) Other negative obstacles, including nosocomial pneumonias, can stem directly from some form of mechanical ventilation.\(^3\) Regrettably, these harmful repercussions not only impact health, but also serve to potentially devastate healthcare consumers financially.\(^6\) Given the United States’ current financial woes and ever-changing Medicare payment standards, any mechanism capable of reducing cost while improving patient care deserves further scrutiny. To that end, healthcare-related groups, including researchers, nurse educators, managers, and advanced practice nurses, have long sought to identify ways to recover costs while sustaining excellent care principles.

In 1996, Ely and colleagues\(^9\) sought to reduce healthcare expenditures and improve patient outcomes by developing a standardized care method for the weaning of ventilated patients. His group found that the use of a daily screening assessment process not only decreased time
spent on the ventilator, but also diminished the need for invasive procedures such as tracheostomy placement.

Since that time, other well-documented studies have shown that weaning protocols managed by groups other than physicians, including nurses and respiratory therapists (RTs), have been both effective and safe.\textsuperscript{10,11}

**OBJECTIVE**

As a result of this compelling evidence, the leadership team of our 18-bed mixed medical, surgical, community intensive care unit (ICU) felt an obligation to establish and subsequently implement a ventilator-weaning protocol consistent with prevailing national trends. Our aims were to improve patient outcomes by decreasing (1) ICU length of stay, (2) days of mechanical ventilation, and (3) healthcare-associated costs with a standardized approach to weaning directed by nurses and RTs within our intensivist-directed, open-admission ICU.

The weaning task force sought to develop a protocol that allowed for weaning based on clinician autonomy, as well as empowered judgment and decision making skills on the part of those directly caring for patients. The task force aimed to provide immediate bedside caregivers with evidenced-based tools that would enhance their ability to establish weaning readiness, as well as provide a mechanism for actual weaning and non–physician-directed extubation.

**METHODS**

Over a 6-month period, a multidisciplinary task force was created, consisting of an intensivist, clinical pharmacist, ICU educator, manager, clinical coordinators, staff registered nurses (RNs), RTs, and our quality director. During this time frame, we began to better understand how our current standard of care influenced patient’s outcomes. By using measurable indicators

| TABLE 1 | Length of Stay of ICU Patients Compared With Ventilated Patients Before and After Intervention |

| LOS ICU Patients Compared With Ventilated Patients |

| ICU OVERALL ALOS | 3.5 | 3.4 | 3.6 | 3.3 | 3.1 | 3.0 | 2.9 | 3.0 | 2.9 | 3.0 | 2.9 | 3.0 | 2.9 | 3.0 | 2.9 | 3.0 | 2.9 | 3.0 | 2.9 | 3.0 | 2.9 | 3.0 | 2.9 | 3.0 |
| ICU ALOS VENTED PTS | 8.7 | 7.5 | 7.3 | 6.4 | 6.1 | 6.0 | 5.9 | 6.1 | 6.0 | 5.9 | 6.1 | 6.0 | 5.9 | 6.1 | 6.0 | 5.9 | 6.1 | 6.0 | 5.9 | 6.1 | 6.0 | 5.9 | 6.1 | 6.0 |

Abbreviations: ALOS, average length of stay; ICU, intensive care unit; LOS, length of stay. Arrow indicates protocol initiation. Arrow indicates protocol initiation.
such as average ventilator days and ICU length-of-stay patterns, we were able to glean an enormous amount of information about our typical patient population. Month-to-month variations in ICU length of stay are not uncommon. Upon historical information analysis, we found that patients who required mechanical ventilation had ICU stays that nearly doubled the stay necessary for those patients who remained free of the ventilator (Tables 1 and 2).

Establishing a formal set of assessment criteria for our diverse patient population was a daunting challenge. Consequently, allowing for ready identification of patients suitable for discontinuation from mechanical ventilation was of great concern. Through the review of various research databases such as MEDLINE and CINAHL, the task force was able to determine evidenced-based measures that indicate probable weaning success. Initially the group chose to focus on physiological measures such as respiratory rate, heart rate, temperature, and oxygen saturation for the preliminary weaning assessment, which was titled “general readiness to wean.”

Some groups warn, that while utilization of physiological parameters alone as predictors for successful weaning may be useful, overall patient outcomes, with regard to re-intubation, remain largely inconsistent.\(^{12}\) As a result, we chose to add other assessment criteria in addition to the previously mentioned physiological measurements. Pressure support, current settings of fraction of inspired oxygen, levels of positive end-expiratory pressure, and overall patient sedation were added to the initial screen. As a whole, this approach was deemed the most straightforward as well as the most widely used method for weaning,\(^{9-12}\) although it should be noted that there is little agreement on the most suitable set of conditions.\(^{12,13}\)

While the group felt that the previously mentioned assessment criteria were evidenced based, we found it appropriate to provide for some subjective capabilities within the grossly objective assessment. As a result, the protocol itself (Figure 1) was designed to enable and empower both RN and RT staff to readily identify patients who are able to wean and ultimately extubate them using an assessment algorithm based on both physiological values as well as personal observations, which would be a part of the patient’s medical record. As a result, if the bedside clinicians felt that the patient’s subjective

### TABLE 2

**Average Duration of Mechanical Ventilation Preintervention**

<table>
<thead>
<tr>
<th>VENT DAYS</th>
<th>ICU</th>
<th>FAIRFIELD</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAN 2007</td>
<td>160.0</td>
<td></td>
</tr>
<tr>
<td>FEB 2007</td>
<td>140.0</td>
<td></td>
</tr>
<tr>
<td>MAR 2007</td>
<td>120.0</td>
<td></td>
</tr>
<tr>
<td>APR 2007</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>MAY 2007</td>
<td>80.0</td>
<td></td>
</tr>
<tr>
<td>JUN 2007</td>
<td>60.0</td>
<td></td>
</tr>
<tr>
<td>JUL 2007</td>
<td>40.0</td>
<td></td>
</tr>
<tr>
<td>AUG 2007</td>
<td>20.0</td>
<td></td>
</tr>
<tr>
<td>SEP 2007</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>OCT 2007</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>NOV 2007</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>DEC 2007</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>JAN 2008</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>FEB 2008</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>MAR 2008</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>APR 2008</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>MAY 2008</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>JUN 2008</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: ICU, intensive care unit; VENT, ventilator.
RN/RT Driven Ventilator Weaning Assessment and Protocol

Assess General Readiness to Wean Daily at 0500
***document to be kept on RT chart next to patient

Current Vent Settings: ________________________  Vent Day #: __________

General Readiness to Wean Assessment: Patient exhibits stable presenting disease and... (Mark all that apply; to be completed by night-shift RN and RT)

***Note: Rotofrane therapy excludes patient from RN/RT driven ventilator weaning assessment

**All of those marked in bold/left-hand column must be met in order to proceed

☐ Respiratory Rate < 30
☐ Heart Rate > 50 or < 120
☐ Blood Pressure >90
☐ SpO2 >90
☐ FiO2 ≤ 0.50
☐ Peep ≤5
☐ Richmond Agitation-Sedation Scale (RASS) > -1
☐ Positive Cough & Gag Reflex

☐ Pressure support volume (PSV) ≤ 10
☐ If on Vasopressors - stable vital signs
☐ No use of Accessory Muscle
☐ Minimal Secretions
☐ Temperature >97 or <100.4

Total Score = ___/13  If bold items met and score ≥ 10 proceed to Sedation Assessment.

Sedation Assessment (completed q 1 hour in Horizon E Documentation (HED) under pain notes; night-shift RN to document prior to sedation wean)

Current Medications(s) being utilized for sedation
☐ Precedex  Dose: ______
☐ Propofol  Dose: ______

Time of Last Analgesic (if not on Fentanyl drip): ______

Current RASS Score: ______

☐ See Ventilator Sedation Protocol for sedation weaning directives

After Sedation Goal met proceed to Respiratory Assessment

RN to contact RT Time: ______

Respiratory Assessment (completed by day-shift RN and RT)

If above criteria met:
Start spontaneous breathing trial:

- Settings: CPAP 0 – 5, same FiO2 PSV 10
- Time Changed: ______

RN Notified of Vent Setting change by:
Respiratory Therapist: ________________
Time: ______

Respiratory Therapist to obtain Rapid Shallow Breathing Index (RSBI) after 20min on CPAP (TVl in Liters, Ex: RR = 16 on TV of .4, 16/.4=40)
Time: ______  Score: ______

Figure 1. Registered nurse/respiratory therapist-driven ventilator-weaning protocol.

Assessment did not correlate with their objective findings, they were able to discuss the matter with the intensivist prior to extubating the patient.

Ventilator Weaning

According to the protocol, patients would be assessed daily at 5 AM by both the RT and RN at the patient’s bedside. If at that time the patient was deemed suitable for a spontaneous breathing trial (SBT), sedation quantities were decreased, and the patient is placed on continuous positive airway pressure. If the patient remained stable after a 20-minute continuous positive airway pressure/STB trial, a rapid shallow breathing index, a measure chosen for its effectiveness, utility, and potential for cost savings,⁹,¹⁴,¹⁶ is obtained to determine if, in fact, the patient meets the criteria and could be extubated per protocol.

Overall, the task force felt that this team approach would not only foster healthy work environments between both departments involved, but also permit for enhanced patient safety as the patient would be observed by multiple staff members, instead of solely by the bedside nurse.
Sedation

While determining the sequence of events that would be involved in this protocol, the task force acknowledged several issues that could potentially thwart the process. Sedation was of primary concern. As described by Kress and colleagues, daily interruption of continuous sedation infusions is linked to enhanced patient outcomes, which include decreased length and total number of ventilator days. Secondary to this and similar evidence, the group felt that it would be appropriate to do a daily “wakeup,” an intervention already in place, which would coincide with the 5 AM assessment of the patient by the RN and RT. This would allow a more accurate evaluation of the patient’s ability to maintain adequate tidal volumes and effective oxygenation.
Despite this, several other approaches exist regarding maintenance of appropriate patient sedation and comfort. Other evidence suggests that a more appropriate sedative selection along with more objective sedation algorithms has been shown to reduce the duration of mechanical ventilation while maintaining patient comfort. Daily interruption of continuous sedation infusions is linked to enhanced patient outcomes.
As a result, we sought to integrate previously share that inappropriate Assessment to Extubation Times (N = 27) Dimensions of Critical Care Nursing Vol. 29 / No. 1 6 22.20 7 25.90 60.6 y
Thus, congruence was created between Age and Diagnosis (Ventilated Patients: 2002 practice guidelines. accordance with the Society of Critical Care Medicine’s continuing to promote appropriate levels of sedation in reflect new weaning protocol (Figure 2) directives while ventilator sedation protocol should be redrafted to within our ICU. We felt that the earlier version of our approach would suit the typical patient population of our medical-surgical ICU while integrating rapid weaning techniques with novel approaches to sedation.

We had previously initiated several interventions, such as utilization of a standardized sedation assessment scale, as well as routine sedation interruption in conjunction with other ventilator bundle recommendations set forth by the Institute for Healthcare Improvement within our ICU. We felt that the earlier version of our ventilator sedation protocol should be redrafted to reflect new weaning protocol (Figure 2) directives while continuing to promote appropriate levels of sedation in accordance with the Society of Critical Care Medicine’s 2002 practice guidelines.

The group also felt that utilization of our current sedation scoring method limited our capacity to compare the sedation scores of our patients with those presented in the healthcare literature. As a result, the more reliable and objective Richmond Agitation-Sedation Scale was chosen. Thus, congruence was created between our assessment and those of other groups observed in the literature and also allowed for better assessment of related agitation, a common complication of sedation and critical illness.

### TABLE 3
Assessment to Extubation Times (N = 27)

<table>
<thead>
<tr>
<th>Time from assessment to extubation</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1 h</td>
<td>2</td>
<td>7.40</td>
</tr>
<tr>
<td>1.1-2 h</td>
<td>6</td>
<td>22.20</td>
</tr>
<tr>
<td>2.1-3 h</td>
<td>3</td>
<td>11.10</td>
</tr>
<tr>
<td>3.1-4 h</td>
<td>2</td>
<td>7.40</td>
</tr>
<tr>
<td>&gt;4 h</td>
<td>2</td>
<td>7.40</td>
</tr>
<tr>
<td>Extubation failures</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>Not extubated/expired/chronically ventilated</td>
<td>12</td>
<td>44.40</td>
</tr>
</tbody>
</table>

Pain

Other comfort measures, including pain control, were a task force priority. Sessler et al share that inappropriate pain therapies and assessment can cause physiological harm to those who are critically ill. As a result of the work of Sessler and colleagues, our process was modified to include continuous, short-acting fentanyl infusions. This effectively replaced an antiquated system of periodic morphine injections, which upon further scrutiny appeared to frequently, albeit anecdotalty, delay extubation secondary to the reduced metabolism of a patient population known to have impaired renal function. Medications such as dexmedetomidine (Precedex), an α2-agonist with sedative and analgesic properties, were also added to enhance pain control as well as expedite the weaning process.

While keeping patients calm during and after extubation was certainly a priority for the group, extubation ultimately superseded. Because dexmedetomidine has no adverse affects on one’s capability for gas exchange, its addition, with a Food and Drug Administration-approved maximum dose of 1 μg/kg per minute, allowed for patient comfort during weaning, thus effectively meeting 2 goals with 1 intervention.

Despite the evidence that supports utilization of dexmedetomidine, the group collectively agreed that propofol (Diprivan) should remain a sedative option given the potential severity of illness observed. As has been recom-

### TABLE 4
Age and Diagnosis (Ventilated Patients: December 2008) (N = 27)

<table>
<thead>
<tr>
<th>Sex</th>
<th>n</th>
<th>%</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>14</td>
<td>51.85</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>13</td>
<td>48.14</td>
<td></td>
</tr>
<tr>
<td>Average age</td>
<td></td>
<td>60.6 y</td>
<td></td>
</tr>
<tr>
<td>Admission diagnosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arrest</td>
<td>2</td>
<td>7.40</td>
<td></td>
</tr>
<tr>
<td>AMI</td>
<td>2</td>
<td>7.40</td>
<td></td>
</tr>
<tr>
<td>GI bleed</td>
<td>1</td>
<td>3.70</td>
<td></td>
</tr>
<tr>
<td>Mental status change</td>
<td>1</td>
<td>3.70</td>
<td></td>
</tr>
<tr>
<td>Pneumonia</td>
<td>6</td>
<td>22.20</td>
<td></td>
</tr>
<tr>
<td>Pneumothorax</td>
<td>1</td>
<td>3.70</td>
<td></td>
</tr>
<tr>
<td>Postoperative care</td>
<td>3</td>
<td>11.10</td>
<td></td>
</tr>
<tr>
<td>Respiratory failure</td>
<td>7</td>
<td>25.90</td>
<td></td>
</tr>
<tr>
<td>Sepsis</td>
<td>3</td>
<td>11.10</td>
<td></td>
</tr>
<tr>
<td>Seizure</td>
<td>1</td>
<td>3.70</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: AMI, acute myocardial infarction; GI, gastrointestinal. Bold items represent majority values.
mended in the literature\textsuperscript{25,26} and because of the continued potential for complications such as propofol infusion syndrome, a maximum dose of 80 \( \mu \)g/kg per minute was carried over through protocol revision.

**Education and Staff Acceptance**

Secondary to the nature of this particular protocol, the task force believed that obtaining and maintaining staff buy-in were crucial to achieve project success. Because managing a massive process change can be overwhelming for even the most seasoned professional, the group eventually opted for a course of intensive, mandatory education for all ICU nursing and respiratory therapy staff. This 2-week educational blitz, encompassing nearly 70 employees and 2 departments, involved several small 1-hour classes that ended with roundtable discussion.

The content of the courses focused on protocol directives and case scenarios surrounding the assessment as well as weaning and consequent extubation of ventilated patients. Nearly all of the staff feedback was positive, allowing us to proceed with protocol implementation with a sense of confidence.

**RESULTS**

Those patient receiving mechanical ventilation during December 2008 underwent chart audit to determine appropriate use of both weaning and sedation protocols. Several trends were observed nearly 5 weeks after commencement of the newly instituted ventilator-weaning protocol. During that time, 27 patients were supported with mechanical ventilation. Of those 27 patients, 5 ventilated

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**TABLE 5**

<table>
<thead>
<tr>
<th>Month and Date</th>
<th>VENTILATOR USAGE &gt; 96 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sep 2008</td>
<td>78</td>
</tr>
<tr>
<td>Oct 2008</td>
<td>8</td>
</tr>
<tr>
<td>Nov 2008</td>
<td>8</td>
</tr>
<tr>
<td>Dec 2008</td>
<td>4</td>
</tr>
</tbody>
</table>

Arrow indicates protocol initiation.
patients succumbed to their critical illness. Another 8 patients were either extubated and placed in palliative care or were transferred to other facilities while receiving ventilatory support. Of the 15 remaining patients, all were extubated using the weaning protocol with no extubation failures (reintubations). Tables 1 and 3 depict postintervention quality indicators such as average ICU length of stay as well as weaning-to-extubation times. Characteristics, such as age, sex, and admission diagnosis of patients who underwent mechanical ventilation during this 5-week time frame, are displayed in Table 4 (majority values appear in bold).

Extubation failure was defined as patient reintubation 24 hours or less after successful SBT and extubation. Although no extubation failures were observed, it should be noted that 1 patient who was extubated using the protocol was reintubated greater than 24 hours after weaning and later transferred to hospice. This patient was accounted for within the palliative care group.

**Extubation failure was defined as patient reintubation 24 hours or less after successful SBT and extubation.**

### DISCUSSION

Despite obvious limitations such as small sample size, lack of random assignment, and employment of a short time frame for fact collection, utilization of historical controls yields results that show a positive impact on overall patient outcomes. As is noted by the data displayed in Table 5, the duration of mechanical ventilation greater than 96 hours was decreased after protocol directives were implemented, a result similar to those of several other well-documented studies.6,11,27

However, because more than 1 intervention was instituted during the time frame in question, the circumstances surrounding the diminished number of ventilator days are uncertain. More comprehensive data analysis is needed to determine the role of both sedation and clinician-based weaning assessment with regard to outcomes of mechanical ventilation.

Other concerns surrounding process issues were observed on chart audit. Despite apparent adherence to protocol directives, documentation, using the developed assessment form, was not always completed appropriately. In fact, nearly 6% of extubated patients had documentation deficiencies during chart review. While much of this discrepancy can be attributed to current documentation standards within the facility, further education for staff on the appropriate application of assessment documentation standards appears necessary.

### CONCLUSION

This article describes our multidisciplinary and multifactorial approach to quality improvement regarding ventilator weaning and sedation. As a whole, we feel that our project has successfully met several of the intervention objectives specified prior to protocol development and initiation. As a result we feel this protocol could be safely applied to other patients exhibiting similar characteristics. Although this data does not reflect a decreased length of stay as a result of our process changes, we believe that further data collection will effectively reduce the duration of ICU stays. To that end, the task force will continue to review findings related to patient outcomes and cost-effectiveness of this multidisciplinary weaning assessment and modified sedation model.

### References


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Amanda L. Rumpke, RN, MSN, ACNP, CCRN, currently serves as a pulmonary and critical care nurse practitioner at Mercy Hospital in Fairfield, Ohio. She has recently completed the Adult Acute Care Nurse Practitioner program through the University of Cincinnati. During the design and implementation of this project, Ms Rumpke served as the Intensive Care educator, and has spearheaded several quality improvement projects. She plans to continue this and other projects as an advanced practice nurse.

Beth A. Zimmerman, RN, BSN, currently serves as Mercy Hospital Fairfield’s quality director. Ms Zimmerman has significant critical care experience and continues to evaluate and implement process improvement projects hospital-wide.

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