Implementing the ABCDE Bundle, Critical-Care Pain Observation Tool, and Richmond Agitation-Sedation Scale to Reduce Ventilation Time

Jennifer Bardwell, DNP, FNP-C, AGACNP-BC
Sushama Brimmer, MD
Wesley Davis, DNP, ENP-C, FNP-C, AGACNP-BC, CEN

ABSTRACT

Prolonged mechanical ventilation of patients in intensive care units across the United States consumes billions of health care dollars every year. Using the awakening and breathing coordination, delirium monitoring/management, and early mobility (ABCDE) bundle along with the Critical-Care Pain Observation Tool and the Richmond Agitation-Sedation Scale combines the best available evidence to optimize outcomes for critically ill patients. This study is the first to examine the effects of implementing the ABCDE bundle, the Critical-Care Pain Observation Tool, and the Richmond Agitation-Sedation Scale together in a coordinated effort across multiple disciplines. The aim of using this combination of evidence-based tools is to reduce ventilation time by reducing oversedation, decreasing the incidence of delirium, and improving pain management.

Key words: artificial respiration, critical care, intensive care units, pain management, ventilator weaning

Mechanical ventilation (MV) for respiratory support remains a cornerstone of critical care medicine.[1,2] Prolonged MV is associated with complications including barotrauma, ventilator-associated pneumonia, sepsis, pulmonary embolism, and pulmonary edema.[3] Prolonged ventilation negatively affects quality of life,[4] prolongs hospital stays, and increases the economic burden.[5] Wunsch et al[6] reported that for patients receiving MV in intensive care units (ICUs), the mean (SD) individual medical cost was $34257 ($40559), accounting for approximately $27 billion in total health care costs each year in the United States. Recent clinical practice guidelines from

Jennifer Bardwell is Nurse Practitioner, CHRISTUS Good Shepherd Medical Center and Taylor Medical Center Urgent Care, Longview, Texas.

Sushama Brimmer is Chief Hospitalist and Medical Director, CHRISTUS Good Shepherd Medical Center, Longview, Texas.

Wesley Davis is Assistant Professor and Emergency Nurse Practitioner Specialty Coordinator, University of South Alabama College of Nursing, Mobile, Alabama, and Emergency Nurse Practitioner, Crook County Hospital; University of South Alabama College of Nursing, HAHN 4056, 5721 USA Drive North, Mobile, Alabama 36688-0002 (wesleydavis @southalabama.edu).

the American College of Chest Physicians and the American Thoracic Society recommend avoiding prolonged MV by using protocols to minimize sedation in patients receiving MV.[7]

Extant literature assesses different approaches to weaning patients from MV.[2,5,8] Current practice guidelines recommend using daily sedation vacations and spontaneous breathing trials, reducing the fraction of inspired oxygen before beginning breathing trials, and using the intermittent mandatory ventilation mode before attempting extubation to allow the patient to take breaths independent of the set ventilator rate.[9] Despite these guidelines and recommendations, the issue of prolonged ventilation time persists.

Because of the adverse clinical, health, and economic outcomes of prolonged MV, interventions should be used to promote the patient's well-being. The Neuman model allows the researcher to identify individual stressors that could negatively affect the patient and to create prevention strategies to decrease the impact on the patient's health.[10] This model also applies to patients in the ICU receiving MV. Some of the highest-ranked stressors in patients admitted to the ICU are fear of death, pain, needle sticks, confinement to bed by tubes or wires, and tube insertion into the mouth or nose.[11] Each of these primary stressors is related to interventions used in the ICU. According to the Neuman model, eliminating or decreasing the number of stressors in a timely fashion can promote a healing environment. Optimal sedation and analgesia can alleviate anxiety, panic, and discomfort associated with MV by reducing the duration of ventilation.[8] However, maintaining the appropriate balance of sedation and analgesia is challenging.[12]

Appropriate use and titration of sedation with the Critical-Care Pain Observation Tool (CPOT) (Table 1) and the Richmond Agitation-Sedation Scale (RASS) (Table 2) can prevent prolonged MV (Figure). The awakening and breathing coordination, delirium monitoring/management, and early mobility (ABCDE) bundle is a protocol that respiratory therapists and registered nurses can use to assess patients during sedation vacations and breathing trials for indications that extubation attempts have failed.[15] The CPOT and RASS are parts of the ABCDE bundle, which is recommended by the Agency

Table 1: Critical-Care Pain Observation Tool[a]

Indicator	Description	Score
Compliance with ventilator	Tolerating ventilator or movement	0
	Coughing but tolerating ventilator	+1
	Fighting ventilator	+2
Facial expression	Relaxed, neutral	0
	Tense	+1
	Grimacing	+2
Body movements	Not moving	0
	Protecting body	+1
	Restless	+2
Muscle tension	Relaxed	0
	Tense, rigid	+1
	Very tense or rigid	+2

[a] Data were derived from Gélinas et al.[13]

for Healthcare Research and Quality.[16] Published literature supports the reliability and validity of the CPOT.[17,18] The RASS is one of the most valid and reliable methods for measuring the quality and depth of sedation in adult patients receiving critical care.[19,20]

Using all available resources is mandatory to prevent oversedation, ensure successful extubation, and prevent reintubation or prolonged ventilation. However, previous studies have examined the effect of either the ABCDE bundle[21] or sedation[22] on ventilation time.

Our study objectives were to (1) determine if using the CPOT along with the RASS could reduce sedation time by treating pain instead of increasing the sedative dose and (2) use the ABCDE bundle to wean patients from ventilation. We used the rapid shallow breathing index (RSBI) and improved arterial blood gas values as indicators to wean patients from ventilation or determine the extubation time most likely to avoid reintubation.[23] The RSBI is calculated during a spontaneous breathing trial by dividing the respiratory rate (breaths per minute) by the mean tidal volume (milliliters). In patients who otherwise meet criteria for extubation, an RSBI of less than 105 breaths/min/L indicates that successful extubation is likely (97% sensitivity).[23] We used an RSBI of less than 105 breaths/min/L because this value was validated in the original study and in 2 subsequent validation studies.

Table 2: Richmond Agitation-Sedation Scale[a]

Score	Term	Description	
+4	Combative	Combative or violent, with immediate danger to self or staff	Proceed to CPOT Assessment
+3	Very agitated	Pulls or removes tube(s) or catheters; aggressive	
+2	Agitated	Has frequent nonpurposeful movements, fights ventilator	
+1	Restless	Anxious and apprehensive but not aggressive	
0	Alert and calm	Alert and calm	
−1	Drowsy	Awakens to voice stimulation, with eye opening/contact > 10 seconds	
−2	Lightly sedated	Briefly awakens to voice stimulation, with eye opening/contact <10 seconds	
−3	Moderately sedated	Has movement or eye opening to voice stimulation but no eye contact	
−4	Deeply sedated	No response to voice stimulation but has movement or eye opening to physical stimulation	Repeat RASS in 1 h
−5	Unarousable	No response to voice or physical stimulation	

Abbreviations: CPOT, Critical-Care Pain Observation Tool; RASS, Richmond Agitation-Sedation Scale.
[a] Data were derived from Sessler et al.[14]
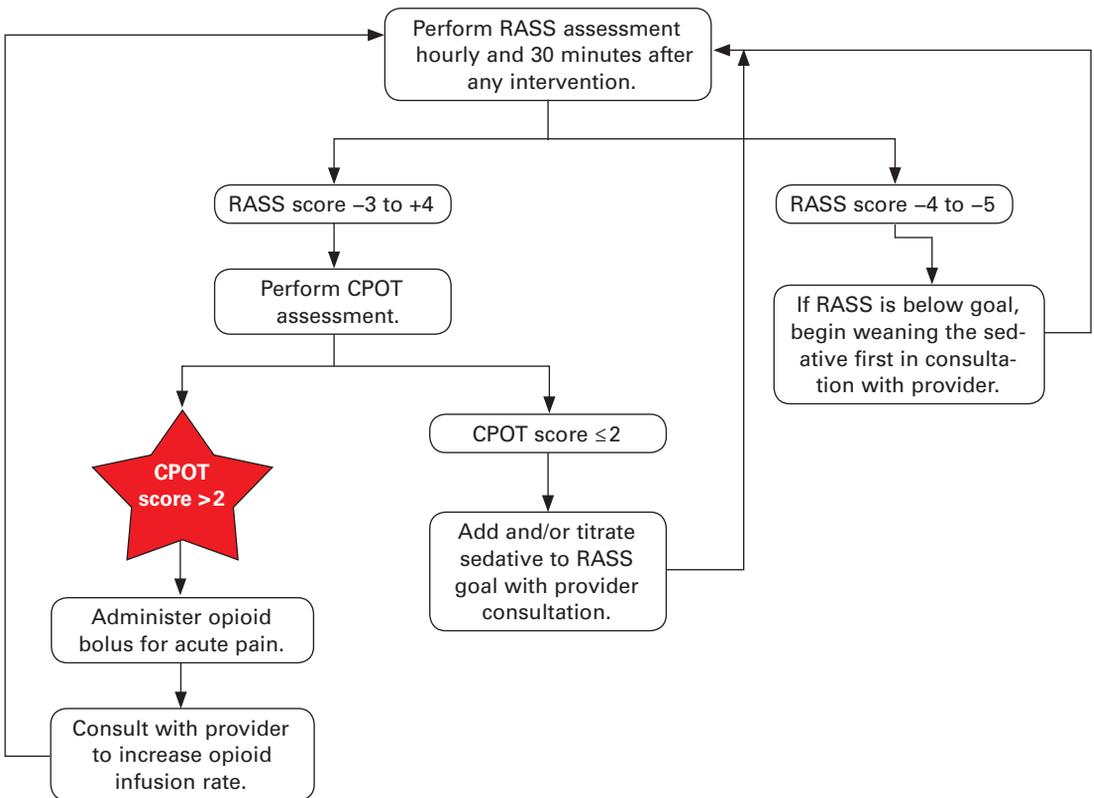
Figure: CPOT and RASS process map. CPOT indicates Critical-Care Pain Observation Tool; RASS, Richmond Agitation-Sedation Scale.

Methods

Data Collection

This study was conducted at a teaching hospital with a 34-bed ICU and included patients in neurosurgical, medical, and surgical (except cardiovascular surgery) ICUs. The ABCDE bundle was used to organize daily processes performed by the staff. The protocol provided structure and guidelines for sedation titration, sedation vacations, and daily procedures for weaning patients from ventilation. Per international guidelines,[9] non-benzodiazepine sedatives, such as propofol and dexmedetomidine, were used for sedation. Intravenous opioids, such as morphine and fentanyl, were used for analgesia. Intravenous acetaminophen or ketorolac was occasionally used to decrease the amount of opioids administered. The CPOT and RASS were used to provide appropriate treatment and prevent oversedation, differentiating between pain and agitation.

The ABCDE bundle was implemented on February 1, 2018, after the institutional review board granted approval for the study. Sedation level, pain scales, and vital signs were evaluated hourly. The ABCDE bundle was performed daily (usually during morning rounds). The staff recorded the following data from March to April 2018: intubation date and time, time sedation was initiated, RASS and CPOT scores for titrating sedation and pain medication, daily awakening trials, daily spontaneous breathing trials with the RSBI, time sedation was discontinued, and extubation time. We conducted a thorough chart review for each patient admitted to the medical ICU. The review included time each patient spent receiving MV, being intubated, and requiring sedation. After we obtained all information from the chart review, we compared chart data with the data collection sheets completed by ICU staff.

Study Participants

Participants eligible for the study required MV and were at least 18 years of age. Patients were intubated in the field by an emergency medical service, in the emergency department, or in the hospital during admission. We included only patients who were unable to self-report pain and had intact motor function. Patients dependent on home ventilators, those undergoing extubation because of a terminal condition,

Table 3: Patient Demographics		
Characteristic	**Before Intervention (n = 16)**	**After Intervention (n = 34)**
Sex		
Male	7	9
Female	9	25
Age, y		
20-39	3	8
40-59	6	9
60+	7	17
APACHE II score (on admission to ICU):		
0-10	0	6
11-20	6	14
21-30	8	10
31-40	1	3
41+	1	1

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; ICU, intensive care unit.

and those who required MV but were transferred to another facility (without the ability to continue to track data) were excluded. We excluded patients with brain injuries because the CPOT is not valid in these patients.

Study Variables

Duration of ventilation was calculated by intubation and extubation time. Duration of sedation, primarily propofol, was the time between initiation and discontinuation (usually during sedation vacation) before extubation. These variables were measured for each admitted patient before and after the intervention period.

Statistical Analysis

We performed retrospective analysis before bundle implementation for patients admitted to the ICU from February 1, 2017, to April 30, 2017, and after bundle implementation for those admitted from February 1, 2018, to April 30, 2018. We measured the rate of staff compliance with the ABCDE bundle, changes in number of ventilator days, and mean days of sedation before and after bundle implementation. All analyses were conducted with spreadsheet software (Microsoft Excel). P values less than .05 were considered statistically significant. A 2-tailed t test was used to analyze the data.

Table 4: Mean Ventilation and Sedation Times Before and After Bundle Implementation

	Before Intervention (n=16)	After Intervention (n=34)	Change	P value[a]
Mean (SD) ventilator days	3.92 (0.54-13.76)	1.94 (0.13-10.9)	−49.5%	.02
Mean (SD) sedation days	3.68 (0.43-13.73)	1.75 (0-6.01)	−47.6%	.12

[a]Two-tailed *t* test; significance was set at *P*=.05.

Results

Demographics of the patients included in the study are shown in Table 3. After implementation, our nursing staff bundle compliance rate was 76.5%. After ABCDE bundle implementation, mean ventilation time significantly decreased by nearly 50% (a difference of 1.98 days). The decrease in ventilation time was observed among all patients. Using the ABCDE bundle reduced sedation time by almost 50% (a difference of 1.93 days), although this finding was not significant (Table 4). Of the 34 patients included in the postintervention phase of the study, 1 required reintubation within 24 hours. None of the remaining 33 patients were readmitted within 30 days of hospital discharge or reintubated within 30 days of extubation.

Discussion

To our knowledge, this study is the first to examine the implementation of the ABCDE bundle together with the CPOT and RASS in the United States. Because conducting a randomized controlled trial was not feasible, we used a before-and-after study design to eliminate intervention bias between patients. Protocol-directed sedation and use of the CPOT and RASS reduced ventilation time, consistent with findings of previous studies[21,22] in which the use of an analgesia and sedation protocol was associated with reduced levels of sedation and shorter mean ventilation durations.

Implementation of the ABCDE bundle was intended to decrease patients' time receiving ventilation. The guideline was a reminder to implement daily sedation vacations and ventilator weaning, to provide a choice between analgesic or sedative medications, to be alert for delirium, and to promote early mobility. The components of the ABCDE bundle provided critical care providers with steps to discontinue sedation and MV for patients as early as possible.

The ICU staff members met all criteria except implementing early mobility while patients were receiving MV. Although all of the patients in this study received 30 to 45 minutes of physical therapy while receiving MV, ICU staff members voiced concern about the limited resources available to assist with early ambulation for these patients. These resources include ventilators designed for patient ambulation and mobility chairs. The ICU staff is working with physical therapists to provide additional ways (within existing financial constraints) to implement early mobility for patients receiving MV. Of the 34 patients enrolled in the study after bundle implementation, 3 were taken for ambulation for more than 10 steps and 12 were assisted to stand and transition into a bedside mobility chair. Preimplementation mobility data are not available because early ambulation was not a documentation requirement before this study was conducted.

The implementation of the CPOT and RASS together gave critical care nurses a guideline to use when patients exhibited pain or agitation while receiving ventilation. Using the 2 tools together allowed the staff to either treat pain or titrate sedation on the basis of each patient's physiologic signs. Nursing staff reported that at times the CPOT helped them identify physiologic signs indicating pain rather than agitation, which would have required up-titration of the sedative dose. Staff members were concerned about the lack of pain medication orders for some sedated patients. In these cases, staff members were directed to use their clinical judgment and treat according to each patient's symptoms and clinical condition.

Limitations

Most intubated patients stayed in the study once enrolled. However, our findings should be interpreted in light of limitations. The noncontrolled design of this study raises the possibility of confounding variables that may have influenced study outcomes. Because our study did not include patients with brain injuries, our findings may not be generalizable to neurological or trauma ICUs that care

for patients with these injuries. Furthermore, our study cannot be generalized to long-term ventilator care units. Terminally ill patients who were extubated were also excluded from the study. The purpose of this study was to implement an international guideline, so our findings should not be considered definitive until randomized controlled studies validate our results. Our study included only adults, and the results should not be extrapolated to children.

Conclusion

Implementation of an evidence-based protocol (the ABCDE bundle for ventilator weaning and the combination of the CPOT and RASS for sedation weaning) dramatically decreased the time patients underwent MV. Despite a nursing staff compliance rate of 76.5%, our data reveal that twice as many patients had a positive outcome after implementation. Continued staff education and permanent implementation of these protocols could continue to decrease ventilation and sedation times for patients in the ICU, resulting in substantial cost savings and successful patient outcomes.

REFERENCES

1. Marini JJ. Mechanical ventilation: past lessons and the near future. *Crit Care*. 2013;17(suppl 1):S1.
2. Weled BJ, Adzhigirey LA, Hodgman TM, et al; Task Force on Models for Critical Care. Critical care delivery: the importance of process of care and ICU structure to improved outcomes: an update from the American College of Critical Care Medicine Task Force on Models of Critical Care. *Crit Care Med*. 2015;43(7):1520-1525.
3. Klompas M. Complications of mechanical ventilation—the CDC's new surveillance paradigm. *N Engl J Med*. 2013;368(16):1472-1475.
4. Huttmann SE, Magnet FS, Karagiannidis C, Storre JH, Windisch W. Quality of life and life satisfaction are severely impaired in patients with long-term invasive ventilation following ICU treatment and unsuccessful weaning. *Ann Intensive Care*. 2018;8(1):38.
5. K Szilágyi A, Diószeghy C, Fritúz G, Gál J, Varga K. Shortening the length of stay and mechanical ventilation time by using positive suggestions via MP3 players for ventilated patients. *Interv Med Appl Sci*. 2014;6(1):3-15.
6. Wunsch H, Linde-Zwirble WT, Angus DC, Hartman ME, Milbrandt EB, Kahn JM. The epidemiology of mechanical ventilation use in the United States. *Crit Care Med*. 2010;38(10):1947-1953.
7. Ouellette DR, Patel S, Girard TD, et al. Liberation from mechanical ventilation in critically ill adults: an official American College of Chest Physicians/American Thoracic Society clinical practice guideline: inspiratory pressure augmentation during spontaneous breathing trials, protocols minimizing sedation, and noninvasive ventilation immediately after extubation. *Chest*. 2017; 151(1):166-180.
8. Devlin JW, Skrobik Y, Gelinas C, et al. Clinical practice guidelines for the prevention and management of pain, agitation/sedation, delirium, immobility, and sleep disruption in adult patients in the ICU. *Crit Care Med*. 2018; 46(9):e825-e873. doi:10.1097 /CCM.0000000000003299
9. Davidson AC, Banham S, Elliott M, et al; BTS Standards of Care Committee Member, British Thoracic Society/ Intensive Care Society Acute Hypercapnic Respiratory Failure Guideline Development Group, on behalf of the British Thoracic Society Standards of Care Committee. BTS/ICS guideline for the ventilatory management of acute hypercapnic respiratory failure in adults. *Thorax*. 2016;71(suppl 2):ii1-35.
10. Neuman BM, Fawcett J, eds. *The Neuman Systems Model*. 5th ed. Boston, MA: Pearson; 2011.
11. Kaur M, Patidar AB, Kaur J, Sharma SK. A comparative study of the patients' and staff nurses' perception of environmental stressors in ICU at a tertiary care hospital in Punjab, India. *Int J Nurs Educ*. 2013;5(2):114-117.
12. Wunsch H, Wagner J, Herlim M, Chong DH, Kramer AA, Halpern SD. ICU occupancy and mechanical ventilator use in the United States. *Crit Care Med*. 2013;41(12): 2712-2719.
13. Gélinas C, Fortier M, Viens C, Fillion L, Puntillo KA. Pain assessment and management in critically ill intubated patients: a retrospective study. *Am J Crit Care*. 2004;13(2):126-135.
14. Sessler CN, Grap MJ, Brophy GM. Multidisciplinary management of sedation and analgesia in critical care. *Semin Respir Crit Care Med*. 2001;22(2):211-226.
15. Balas MC, Burke WJ, Gannon D, et al. Implementing the awakening and breathing coordination, delirium monitoring/management, and early exercise/mobility bundle into everyday care: opportunities, challenges, and lessons learned for implementing the ICU Pain, Agitation, and Delirium Guidelines. *Crit Care Med*. 2013; 41(9)(suppl 1):S116-S127.
16. Implementing the ABCDE bundle at the bedside. Agency for Healthcare Research and Quality website. https:// innovations.ahrq.gov/qualitytools/implementing-abcde -bundle-bedside. Published May 2013. Updated July 3, 2013. Accessed October 19, 2018.
17. Keane KM. Validity and reliability of the critical care pain observation tool: a replication study. *Pain Manag Nurs*. 2013;14(4):e216-e225. doi:10.1016/j.pmn.2012.01.002
18. Buttes P, Keal G, Cronin SN, Stocks L, Stout C. Validation of the critical-care pain observation tool in adult critically ill patients. *Dimens Crit Care Nurs*. 2014;33(2):78-81.
19. Ely EW, Truman B, Shintani A, et al. Monitoring sedation status over time in ICU patients: reliability and validity of the Richmond Agitation-Sedation Scale (RASS). *JAMA*. 2003;289(22):2983-2991.
20. Arevalo JJ, Brinkkemper T, van der Heide A, et al; AMROSE Site Study Group. Palliative sedation: reliability and validity of sedation scales. *J Pain Symptom Manage*. 2012;44(5):704-714.
21. Kram SL, DiBartolo MC, Hinderer K, Jones RA. Implementation of the ABCDE bundle to improve patient outcomes in the intensive care unit in a rural community hospital. *Dimens Crit Care Nurs*. 2015;34(5):250-258.
22. Faust AC, Rajan P, Sheperd LA, Alvarez CA, McCorstin P, Doebele RL. Impact of an analgesia-based sedation protocol on mechanically ventilated patients in a medical intensive care unit. *Anesth Analg*. 2016;123(4):903-909.
23. Habacon GP, Tiglao E, DeGuia T, Del Poso W, Limpin ME. Rapid shallow breathing index rate as a predictor of weaning outcome during spontaneous breathing trial: a cohort study. *Chest*. 2016;150(4)(suppl):303A.