Perceptions of Workload Burden and Adherence to ABCDE Bundle Among Intensive Care Providers

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Background Use of the interprofessional Awakening and Breathing Coordination, Delirium Monitoring and Management, and Early Mobility (ABCDE) bundle is recommended practice in intensive care, but its adoption remains limited.

Objective To examine the relationship between intensive care unit provider attitudes regarding the ABCDE bundle and ABCDE bundle adherence.

Methods A 1-time survey of 268 care providers in 10 intensive care units across the country who had worked at least 4 shifts per month to examine their attitudes toward workload burden, difficulty carrying out the bundle, perceived safety, confidence, and perceived strength of evidence. Logistic regression models were used to examine the relationship of unit-level provider attitudes with ABCDE bundle adherence in 101 patients, adjusted for patients' age, severity of illness, and comorbidity.

Results For every unit increase in workload burden, adherence to the ABCDE bundle decreased 53% (odds ratio [OR], 0.47; 95% CI, 0.28-0.79; $P = .004$). Bundle difficulty (OR, 0.29; 95% CI, 0.08-1.07), perceived safety (OR, 0.51; 95% CI, 0.10-2.65), confidence (OR, 0.37, 95% CI, 0.10-1.35), and perceived strength of evidence (OR, 0.69; 95% CI, 0.14-3.35) were not associated with ABCDE bundle adherence. For every unit increase in perceived difficulty carrying out the bundle, adherence with early mobility was reduced 59% (OR, 0.41; 95% CI, 0.19-0.90; $P = .03$). In addition, ABCDE bundle adherence (ie, ventilator bundle) was less than DE bundle adherence (ie, ventilator-free bundle) (97% vs 72%, $z = 5.47$; $P < .001$).

Conclusions Focusing interventions on workload burden and factors influencing bundle difficulty may facilitate ABCDE bundle adherence. (*American Journal of Critical Care.* 2017;26:e38-e47)

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Intensive care unit (ICU) delirium and ICU-acquired weakness are common and serious public health problems. Duration of ICU delirium has been associated with reduced probability of survival after hospital discharge and long-term cognitive impairment.[1-3] Likewise, ICU-acquired weakness is independently associated with postdischarge mortality and reduced physical functioning up to 5 years following critical illness.[4,5] Attention is now turning to the long-term outcomes of ICU survivors and the role of critical care therapies on daily life. Interprofessional approaches are a solution for taking the complexity of critical care therapies and bundling them into organized, practical, and traceable procedures.[6]

Implementation of the interprofessional, evidence-based ABCDE bundle (Awakening and Breathing Coordination, Delirium assessment/management, and Early mobility) has resulted in reduced ventilator, delirium, and hospital days; increased ICU mobilization; and marked financial benefits.[7-9] Implementation of the ABCDE bundle is not only endorsed by critical care societies (eg, Society of Critical Care Medicine, American Association of Critical-Care Nurses), but also by national quality improvement agencies (eg, Institute for Healthcare Improvement, Agency for Healthcare Research and Quality, and the Centers for Disease Control and Prevention) as a means to enhance the quality and safety of critical care. Despite endorsements and evidence for effectiveness of the ABCDE bundle, its uptake is limited.[10-17] In a recent survey, 212 interprofessional Michigan ICU health care professionals reported that only 12% of them have implemented the ABCDE bundle despite a statewide quality improvement initiative.[18]

Factors affecting interprofessional ICU protocol implementation and adherence are poorly understood. Review of the literature suggests that provider attitudes (ie, prevailing tendencies and way of thinking) influence protocol implementation and adherence.[19-21] For example, a study[22] to evaluate factors influencing nurses administration of sedatives in patients receiving mechanical ventilation showed that nurses' attitudes toward the efficacy of sedation were associated with reports of sedative administration. Nurses' attitudes toward the mechanical ventilation experience were positively correlated with sedation practices ($r_s = 0.28$; $P < .01$) and the intention to administer sedatives to all patients receiving mechanical ventilation ($r_s = 0.58$; $P < .01$).[22]

The conceptual framework for interprofessional bundle implementation (Figure 1) illustrates earlier studies' findings that organizational domains (such as policy and protocol factors [ie, accessibility, clarity, complexity], unit milieu [ie, coordination among disciplines], tasks [ie, autonomy and time demands], physical environment [ie, unit layout and access to supplies]) can have a direct influence on provider attitudes. However, the association of ICU provider attitudes with adherence to the ABCDE bundle is unknown. Therefore, the objective of this study was to examine the associations of ICU provider attitudes with ABCDE bundle adherence. Specific provider attitudes include (1) workload burden, (2) bundle difficulty, (3) perceived safety, (4) confidence in carrying out the bundle, and (5) perceived strength of evidence of the ABCDE bundle. We hypothesized that provider attitudes are associated with execution of the ABCDE bundle.[20,23]

Methods

This multicenter, prospective, cohort study was funded by an American Association of Critical-Care Nurses–Sigma Theta Tau International critical care grant. Approval was obtained from the institutional review board at each of the participating centers.

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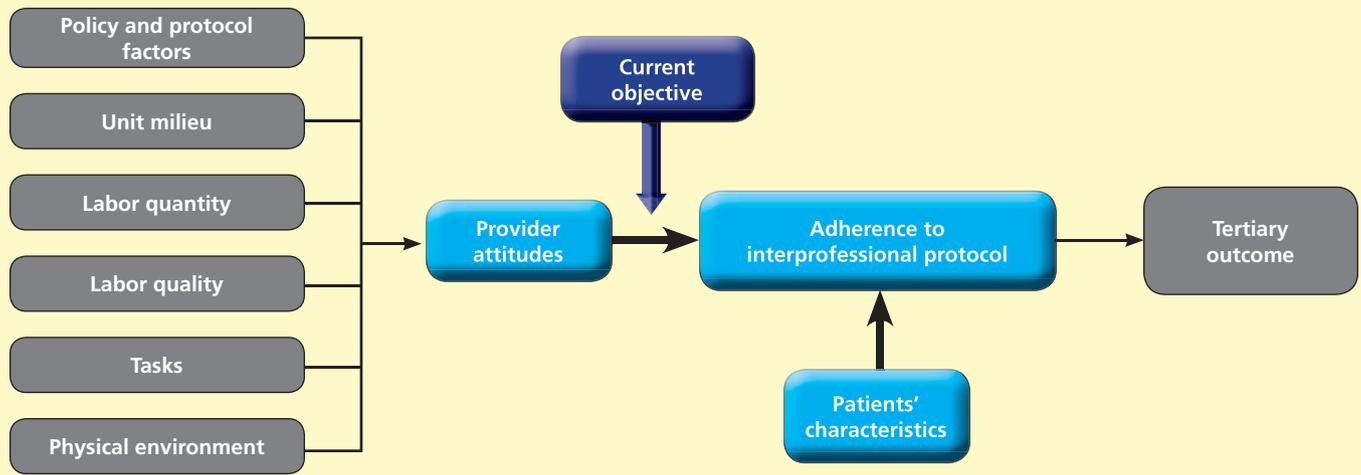
Figure 1 Conceptual framework for interprofessional bundle implementation. Organizational domains such as policy and protocol factors, unit milieu, labor quantity, labor quality, tasks, and physical environment are proposed to influence provider attitudes and, thus, adherence to the Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility (ABCDE) bundle. Associations between provider attitudes and ABCDE bundle adherence in particular were sought in this study. Provider attitudes include workload burden, bundle difficulty, perceived safety of ABCDE bundle implementation, confidence in performing the ABCDE bundle, and perceived strength of evidence for the ABCDE bundle.

Vanderbilt University was the coordinating center for the study. Recruitment was conducted within the medical and surgical ICUs in 6 participating centers: Baystate Medical Center (Springfield, Massachusetts), Vanderbilt University Hospital (Nashville, Tennessee), University Hospital San Antonio (San Antonio, Texas), University of Maryland Medical Center (Baltimore, Maryland), University of Michigan Health System (Ann Arbor, Michigan), and Harborview Medical Center (Seattle, Washington).

The ABCDE bundle definitions used in this investigation were defined at the start of this study in 2014 and have subsequently been modified as part of the ICU Liberation Initiative to include the current ABCDEF bundle (www.icudelirium.org and www.iculiberation.org).

Sample

A total sample of 268 ICU health care professionals included registered nurses, advanced practice nurses, physical therapists, occupational therapists, respiratory therapists, pharmacists, and physicians providing care to patients (≥4 shifts/month) nested in eligible medical and surgical ICUs practicing the ABCDE bundle in participating hospitals. A waiver of documentation of informed consent was obtained for administration of the anonymous survey to ICU health care professionals. Patients included those with qualifying organ failure (ie, noninvasive ventilation, treatment for shock)

> ABCDE bundle adherence was computed for the entire period of ventilator ICU days.

enrolled in an ongoing clinical trial with daily tracking of ABCDE bundle adherence.

Procedures

A 71-item, content-validated electronic ABCDE provider survey was used to collect data on the provider attitudes (content validity index, 0.96; $P = .05$, $\alpha = 0.95$).[23] The investigator conducted in-person meetings with the leaders of each unit and department at participating hospitals to describe survey distribution requirements. An electronic survey link was forwarded to the targeted ICU health care professionals by unit and departmental leaders. Survey participation was facilitated through the use of unit signage and recruitment postcards. Site-specific methods were employed to reach the target sample while, at the same time, reducing sampling error. Reminders were sent to ICU health care professionals at 4 and 8 weeks to maximize survey response rates.

Daily conduct of the ABCDE bundle was at the discretion of the ICU team and guided by a standardized protocol (Figure 2). The investigators had no role in performing ABCDE bundle components. Adherence was tracked via the ABCDE adherence checklist (Figure 3). The checklist was placed at the patient's bedside and completed daily (ie, 24-hour calendar day) by the nurses and other health care professionals involved in completing ABCDE bundle components. ABCDE bundle adherence checklists were distributed, collected, and recorded daily by trained study staff. All study data were managed using Research Electronic Data Capture (REDCap) tools hosted at Vanderbilt University by either the

study's principal investigator (L.M.B.) or trained personnel.[24]

Variables and Measures

Provider attitudes are defined as the internal disposition of health care professionals to adhere to the ABCDE bundle. Provider attitudes were calculated from 10-point visual analog scale responses. Higher scores represented more positive views for all but workload burden and bundle difficulty attitudes. Five analyses of 2 individual items and 3 subscales of provider attitudes were run. The 3 provider attitude subscales, perceived safety of ABCDE bundle implementation ($\alpha = 0.73$), confidence in performing the ABCDE bundle ($\alpha = 0.69$), and perceived strength of evidence for the ABCDE bundle ($\alpha = 0.86$), were used for ease of analysis. Workload burden and bundle difficulty were each analyzed as individual items because of the poor subscale reliability ($\alpha = 0.16$). Averages for each of the provider attitude subscales (Table 1) and individual items were subsequently calculated and aggregated by unit.

ABCDE bundle adherence was defined as all 5 components (ABCDE bundle) requiring completion during ventilator ICU days and the delirium assessment/management and early mobility components (DE bundle) requiring completion during ventilator-free ICU days, as awakening and breathing trial coordination are not relevant for patients who are not undergoing mechanical ventilation. ABCDE bundle adherence was computed for the entire period of ventilator ICU days as [(days of ABCDE bundle adherence)/(total ventilator ICU days)]. DE bundle adherence was computed for the entire period of ventilator-free ICU days as [(days of DE adherence)/(total ventilator-free ICU days)]. Adherence to individual components on ventilator days (ABCDE bundle) and ventilator-free days (DE bundle) was computed separately using the same equation.

Statistical Analysis

Statistical analyses were conducted using IBM SPSS version 23 (IBM Corp) and STATA, version 14 (StataCorp LLC). Graphical and descriptive statistical methods were used to summarize and evaluate data distributions. Frequency distributions were used to summarize nominal data. Continuous variable distributions for provider attitudes and adherence data were skewed; therefore, median and interquartile ranges were used to summarize those data. Provider attitude data were first aggregated at the unit level. Subsequently, those unit-level provider attitude scores were linked with the patient adherence records in the respective units. Logistic

ABC

Awakening and Breathing Coordination
Eligibility for ABC = On the ventilator

SAT Safety Screen: No active seizures, no active alcohol withdrawal, no active agitation, no active paralytics, no active myocardial ischemia, no evidence of ↑ intracranial pressure

If passed the safety screen, perform SAT
(stop all sedatives/analgesics used for sedation)
   If fail → restart sedatives if necessary at ½ dose and titrate as needed
   If pass → perform SBT safety screen

SBT Safety Screen: No active agitation, oxygen saturation ≥ 88%, F_{IO_2} ≤ 50%, PEEP ≤ 7.5 cm H_2O, no active myocardial ischemia, no significant vasopressor use, displays any inspiratory efforts

If passed the safety screen, perform SBT
SBT is discontinuation of active ventilator support through a T-tube or ventilator with a rate set as 0, CPAP/PEEP ≤ 5 cm H_2O, and pressure support of ≤ 5 cm H_2O.
   If fail → return to ventilator support at previous settings
   If pass → team should consider extubation

D

Delirium Nonpharmacologic Interventions
Eligibility for D = RASS score ≥ -3 (any movement or eye opening to voice)

Pain: Monitor and/or manage pain using an objective scale
Orientation: Talk about day, date, place; discuss current events; update white boards with caregiver names; use clock and calendar in room
Sensory: Determine need for hearing aids and/or eyeglasses
Sleep: Provide and encourage sleep-preservation techniques such as noise reduction, day-night variation, "time-out" to minimize interruptions of sleep, promoting comfort and relaxation

E

Early Mobility
Eligibility for E = All study patients

Exercise Safety Screen: RASS score > -3, F_{IO_2} < 0.6, PEEP < 10 cm H_2O, no increase in vasopressor dose (2 hours), no active myocardial ischemia (24 hours), no arrhythmia requiring the administration of a new antiarrhythmic agent (24 hours)

Levels of Therapy (if passes safety screen):
   1. Active range-of-motion exercises in bed and sitting position in bed
   2. Dangling
   3. Transfer to chair (active), includes standing without marching in place
   4. Ambulation (marching in place, walking in room/hall)

Figure 2 ABCDE protocol.

Abbreviations: ABCDE, Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility; CPAP, continuous positive airway pressure; F_{IO_2}, fraction of inspired oxygen; PEEP, positive end-expiratory pressure; RASS, Richmond Agitation-Sedation Scale; SAT, spontaneous awakening trial; SBT, spontaneous breathing trial.

regression models were used to test the effects of unit level provider attitude values on ABCDE bundle adherence and select individual bundle components (ie, coordination and early mobility) while controlling for relevant patient characteristics (ie, age, Charlson Comorbidity Index, Acute Physiology and Chronic

DATE: _____/____/_____

Figure 3 ABCDE checklist.

Abbreviations: ABCDE, Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility; ROM, range of motion; SAT, spontaneous awakening trial; SBT, spontaneous breathing trial.

2-13). Patients were mostly white (88%) and male (58%), with a mean age of 54.6 years (Table 2). Patients were admitted to the ICUs for several different medical and surgical reasons, with the highest percentage admitted for management of sepsis and/or septic shock (38%). APACHE II scores for the sample population (mean, 27.7; SD, 9.3) indicated a high severity of illness, yet comorbidity was minimal per the Charlson Comorbidity Index (median, 1.5; IQR, 0-2.3).[26,27]

Provider Characteristics and Attitudes

The survey response rate was 25%. Surveys were excluded for the following reasons: wrong unit (n=9) and lack of provider attitude data for analysis (n=106). A total of 268 surveys were included in the analysis. The majority of participants were nurses (49%, n=131) and physicians (24%, n=64). The remainder of the sample included nurse practitioners (n=6), occupational therapists (n=7), pharmacists (n=10), physical therapists (n=20), and respiratory therapists (n=30).

Participants reported a high perceived strength of evidence (median, 9.4; IQR, 8.3-9.9) for the ABCDE bundle. Most participants reported feeling confident (median, 8.6; IQR, 7.0-9.5) with ABCDE bundle implementation with a moderate perceived level of safety (median, 8.75; IQR, 7.7-9.6). Workload burden associated with the bundle was neutral (median, 5.2; IQR, 2.8-7.0), and participants tended to disagree with having difficulty carrying out the bundle (median, 4.0; IQR, 2.0-5.9).

ABCDE (Ventilator Days) and DE (Ventilator-Free Days) Bundle Adherence

Adherence was measured for 101 patients on a total of 752 ICU days (Figure 4). Variation in ABCDE bundle adherence (on ventilator days) was noted across units (range, 38%-85%). DE bundle adherence (on ventilator-free days) was less variable among units (range, 86%-100%). Overall bundle adherence was greater on ventilator-free (DE bundle) days than on ventilator (ABCDE bundle) days across all units (97% vs 72%, $z=5.47$; $P<.001$). Overall ABCDE bundle adherence was lower in surgical units than in medical units, but that difference was not statistically significant (63% vs 75%, $z=1.89$; $P=.06$). When bundle components were evaluated individually (Table 3), coordination (ie, breathing trial preceded by awakening trial, 89%) and early mobility (86%) had the lowest levels of adherence for patients receiving mechanical ventilation. Reasons for ABCDE bundle components not being completed are recorded in Table 4. The most common reason

Health Evaluation [APACHE] II score, ventilator status). There were not enough cases of nonadherence to evaluate logistic regression in the remaining individual bundle components. To maintain the statistical power and variability in ABCDE adherence among assessments for the same patient, the standard errors in each model were adjusted for clustering of patients' data.[25] Statistical significance was determined as a P value less than .05.

Results

Patient Characteristics

A total of 101 patients were enrolled in the study: 70 enrolled in medical units (median, 11; range, 3-22) and 31 enrolled in surgical units (median, 10; range,

for awakening trials not being completed was respiratory instability (33.3%). The most common reason for breathing trials not being completed was positive end-expiratory pressure greater than 7.5 cm H_2O (36.9%). The most common reason for early mobility not being completed was a score of -4 or -5 on the Richmond Agitation-Sedation Scale (23.8%). Reasons for not completing coordination and delirium assessment/management were not tracked.

Associations of Provider Attitudes and ABCDE Bundle Adherence

Results of the logistic regression analyses are presented in Table 5. After patients' characteristics (ie, age, Charlson comorbidity index, APACHE II score, ventilator status) were controlled for, the likelihood of adherence to the ABCDE bundle decreased 53% for every unit increase in the response to workload burden (OR, 0.47; 95% CI, 0.28-0.79; $P = .004$). Provider attitudes of bundle difficulty, perceived safety, confidence, and perceived strength of evidence were not significantly associated with ABCDE bundle adherence.

Upon evaluation of individual bundle components, for every unit increase in the response to bundle difficulty, the likelihood of early mobility adherence decreased 59% (OR, 0.41; 95% CI, 0.19-0.90; $P = .03$). Provider attitudes of bundle difficulty, perceived safety, confidence, and perceived strength of evidence were not significantly associated with coordination adherence. Variation in awakening trial, breathing trial, and delirium assessment/management adherence was minimal; thus, odds ratios could not be calculated for these components.

Discussion

Although previous investigations associated nurses' attitudes with sedation practices, no one has linked interprofessional provider attitudes with ABCDE bundle adherence.[22] A multisite, multidisciplinary study of ICU health care professionals was conducted to investigate whether provider attitudes are associated with ABCDE bundle adherence. We demonstrated statistically significant relationships between provider attitudes and ABCDE bundle adherence (Table 5). After select patient characteristics were adjusted for, the odds of ABCDE bundle adherence were 53% less with perceptions of high workload burden than with low workload burden. Additionally, adherence to early mobility was 59% less likely when reported difficulty with carrying out the bundle was high. Therefore, focusing interventions on reducing workload burden and

Table 1
Provider attitude subscales and individual items

Question

Perceived EASE of Completion of the ABCDE bundle (analyzed as individual items)
  The bundle greatly increases my **WORKLOAD** *(0-10 strongly [dis]agree)*
  The team has **DIFFICULTY** carrying out the bundle *(0-10 strongly [dis]agree)*

Perceived SAFETY of the ABCDE bundle *($\alpha = 0.73$)*
  Spontaneous awakening trial *(hazardous 0, safe 10)*
  Spontaneous breathing trial *(hazardous 0, safe 10)*
  Delirium assessment/management *(hazardous 0, safe 10)*
  Early mobility *(hazardous 0, safe 10)*

CONFIDENCE in performing the ABCDE bundle *($\alpha = 0.69$)*
  Spontaneous awakening trial *(uncertain 0, confident 10)*
  Spontaneous breathing trial *(uncertain 0, confident 10)*
  Delirium assessment/management *(uncertain 0, confident 10)*
  Early mobility *(uncertain 0, confident 10)*

Perceived STRENGTH OF EVIDENCE of the ABCDE bundle *($\alpha = 0.86$)*
  Importance of completing the ABCDE bundle *(not important 0, important 10)*
  The literature strongly supports SATs *(0-10 strongly [dis]agree)*
  The literature strongly supports SBTs *(0-10 strongly [dis]agree)*
  The literature strongly supports delirium assessment/management *(0-10 strongly [dis]agree)*
  The literature strongly supports early mobility *(0-10 strongly [dis]agree)*

Abbreviations: ABCDE, Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility; SAT, spontaneous awakening trial; SBT, spontaneous breathing trial.

Table 2
Characteristics of patients monitored for ABCDE bundle adherence[a]

Characteristic	Value (N = 101)
Age, mean (SD)	54.6 (13.6)
Sex, No. (%)	
Female	42 (41.6)
Male	59 (58.4)
White race, No. (%)	89 (88.1)
APACHE II score, mean (SD)	27.7 (9.3)
Charlson Comorbidity Index, median (IQR)	1.5 (0-2.3)
Admitting diagnosis, No. (%)	
Sepsis/septic shock	38 (37.6)
Airway protection, other pulmonary	26 (25.7)
Chronic obstructive pulmonary disease/asthma	15 (14.8)
Acute lung injury	10 (9.9)
Transplants	4 (4.0)
Metabolic imbalance or cirrhosis	3 (3.0)
Cardiomyopathy or arrhythmia	2 (2.0)
Other reason	3 (3.0)

Abbreviations: ABCDE, Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility; APACHE II, Acute Physiology and Chronic Health Evaluation II; IQR, interquartile range.
[a] Patient inclusion criteria include age ≥18 years, in one of the study intensive care units (ICU) with qualifying organ failure (ie, mechanical ventilation, noninvasive ventilation, treatment for shock). This sample represents a population highly susceptible to the development of delirium and ICU-acquired weakness and require the full ABCDE bundle. Patient exclusion criteria included severe dementia, neurologic injuries, pregnancy, moribund, active seizures, and prisoners.
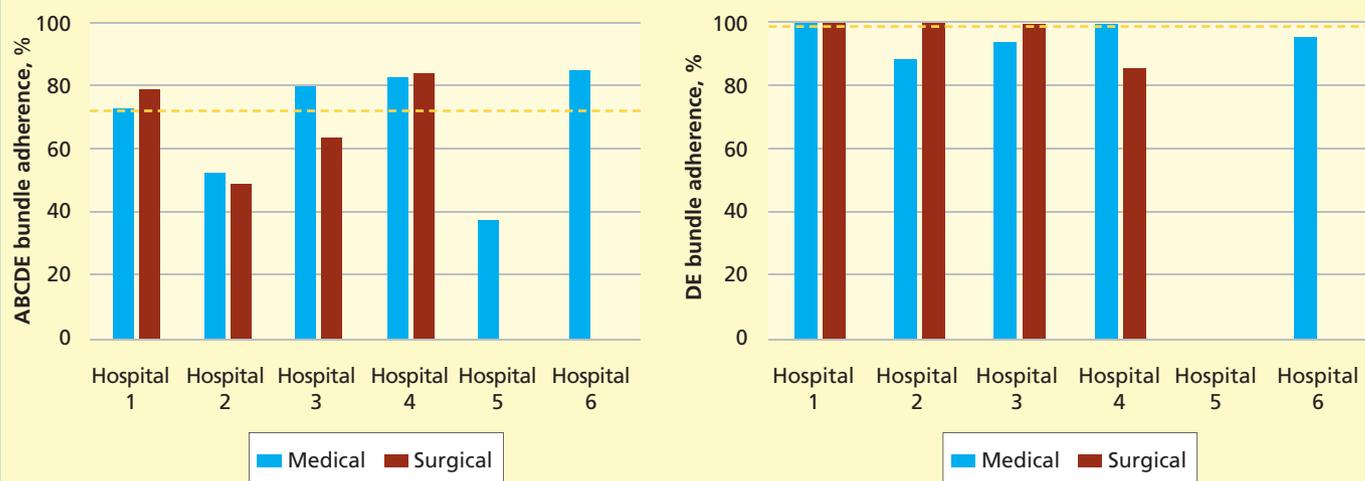
Figure 4 Unit adherence to ABCDE (while receiving mechanical ventilation) and DE (while not receiving mechanical ventilation) bundle. A total of 101 patients were observed for adherence on 561 ventilator days and 191 ventilator-free days across 10 intensive care units (6 medical units, 4 surgical units). Overall ABCDE bundle adherence (72% represented by dashed line) was less than DE bundle adherence (97% represented by dashed line) in all units (*P*<.001) as well as when compared by medical (*P*<.001) and surgical units (*P*<.001). Overall ABCDE bundle adherence was not significantly greater in medical units than in surgical units (*P*=.06). Surgical units in hospitals 5 and 6 did not participate in the study. Hospital 5 did not have DE bundle data; all measured bundle days were ventilator days.

Abbreviations: ABCDE, Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility; DE, Delirium assessment/management and Early mobility.

Table 3
Adherence rates for individual bundle components[a]

| | Adherence to bundle component, % (No.) of days | | | | | | |
| | Mechanical ventilation (n=561) | | | | | No mechanical ventilation (n=191) | |
Unit	A	B	C	D	E	D	E
All units	97 (544)	96 (539)	89 (500)	100 (561)	86 (480)	99 (189)	98 (187)
Medical intensive care units	97 (399)	96 (394)	90 (368)	100 (410)	88 (362)	100 (117)	97 (113)
Surgical intensive care units	96 (145)	96 (145)	87 (132)	100 (151)	78 (118)	97 (72)	100 (74)

Abbreviations: A, awakening trial; B, breathing trial; C, coordination (breathing trial preceded by awakening trial); D, delirium assessment/management; E, early mobility.
[a] A total of 101 patients in 10 intensive care units (6 medical and 4 surgical) were observed for 561 days of mechanical ventilation and 191 days without mechanical ventilation.

simplifying task implementation may facilitate ABCDE bundle adherence.

Overall, adherence to the ABCDE bundle was 72% on ventilator days, when all bundle components are required, and 97% on ventilator-free days, when only delirium assessment/management and early mobility components are required (*P*<.001). Upon evaluation of previous work, we were unable to find reports of full ABCDE bundle adherence on ventilator days or DE bundle adherence on ventilator-free days for comparison. Various studies report adherence to individual ABCDE bundle components as follows: 71% to 100% for awakening trials,[8,19,28,29] 67% to 100% for breathing trials,[19,28,29] 87% for coordination,[29] 46% to 92% for delirium

assessment/management,[8,19,21,28] and 82% for early mobility.[21,28] Differing definitions of adherence across studies make comparisons difficult. For example, Balas et al[19] reported breathing trial adherence as patients receiving a breathing trial at least once during the ICU stay while Klompas et al[29] reported breathing trial adherence as the percentage of days with a breathing trial done when indicated. In spite of that, our individual component adherence results are consistent with the previous reports of ABCDE bundle implementation.

The adherence results found in this investigation support previous findings suggesting that bundle complexity influences adherence.[19,20] Those components of the ABCDE bundle that require the

most coordination across disciplines (ie, coordination of awakening and breathing trials and early mobility) have the lowest levels of adherence on ventilator days: 89% for coordination of awakening and breathing trials and 86% for early mobility. Awakening trial (97%), breathing trial (96%), and delirium (100%) bundle components, which are essentially single-discipline activities, had higher rates of adherence on ventilator days. This finding is further evidenced by increased adherence to early mobility (98%) on ventilator-free days when mobilization may not necessitate the presence of a respiratory, physical, or occupational therapist for execution.

Understanding the particular provider attitudes associated with ABCDE bundle adherence provides a basis for devising interventions to improve implementation. Guided by the conceptual framework, we suggest intervening in those organizational domains that influence perceived ease of completion (ie, workload burden and difficulty carrying out the bundle), which in turn may lead to improved adherence to the overall ABCDE bundle and those bundle components that require the most coordination across disciplines (ie, awakening and breathing trial coordination and early mobility). We had found that policy and protocol factors, unit milieu, and access to supplies and equipment are organizational domains most closely associated with difficulty carrying out the bundle.[23] Thus, for example, access to supplies and equipment can be improved by keeping necessary ABCDE bundle supplies (eg, ambulatory bag, ventilator extension tubing, gait belt) and equipment (eg, walker, high-back chair, oxygen tank, lift) in the patient's room and/or geographically convenient supply rooms so as to maximize nurses' efficiency of movement. Specific strategies that target both policy and protocol factors as well as unit milieu include the development of standardized protocols (eg, checklists, daily goal sheets), structured rounding processes (eg, interprofessional rounds), and interprofessional training (eg, simulation training, core competencies).[30]

We hypothesized that provider attitudes regarding perceived safety, confidence, and perceived strength of evidence would be associated with ABCDE bundle adherence, but the findings were not statistically significant. The internal consistency of both our perceived safety ($\alpha = 0.73$) and confidence ($\alpha = 0.69$) subscales may not have been reliable enough to make associations and most likely require further refinement before future attempts to evaluate relationships. Further investigation of perceived safety and confidence with refined subscales is necessary to

Table 4
Documented reasons for ABCDE bundle components not being completed

Bundle component	Reason not completed	No. (%) of patients
Awakening trial	Adherent, failed screening	
	Respiratory instability	65 (33.3)
	Agitation	51 (26.2)
	Myocardial ischemia	34 (17.4)
	Paralytic infusion or neurologic instability	26 (13.3)
	Nonadherent	
	Patient off unit	10 (5.1)
	Other, SAT was indicated	9 (4.6)
Breathing trial	Adherent, failed screening	
	PEEP >7.5 cm H_2O	168 (36.9)
	$F_{IO_2} > 0.50$	87 (19.7)
	Failed SAT, no SBT	61 (13.4)
	Significant vasopressor infusion	53 (11.6)
	Agitation	28 (6.2)
	Respiratory or myocardial instability	21 (4.6)
	Nonadherent	
	Patient off unit/other	12 (3.1)
	Other, SBT was indicated	17 (3.7)
Coordination	Not recorded	
Delirium assessment/ management	Not recorded	
Early mobility	Adherent, failed screening	
	RASS score -4 or -5	113 (23.8)
	PEEP > 10 cm H_2O	84 (17.7)
	$F_{IO_2} > 0.60$	56 (11.8)
	Increased vasopressors in past 2 hours	47 (9.9)
	Respiratory or myocardial instability	16 (3.4)
	Adherent, other reason	
	Recent effect of sedative medications	40 (8.4)
	Clinical team refused	23 (4.9)
	Other, mobility not indicated	8 (1.7)
	Nonadherent	
	Unknown, mobility was indicated	79 (16.7)
	No staff or staff unavailable	6 (1.3)
	Patient off unit	2 (<1)

Abbreviations: ABCDE, Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility; F_{IO_2}, fraction of inspired oxygen; PEEP, positive end-expiratory pressure; RASS, Richmond Agitation-Sedation Scale; SAT, spontaneous awakening trial, SBT, spontaneous breathing trial.

elucidate whether a relationship with ABCDE adherence is present. Further refinement of the perceived strength of evidence subscale items may also be required to ensure that the appropriate constructs are being captured. A second potential explanation for the null findings is the study's small sample size. Researchers in studies with larger sample sizes may be more able to identify relationships between provider attitudes and ABCDE bundle adherence.

Strengths of the current study include interprofessional input for provider attitudes regarding the ABCDE bundle and a statistical analysis that allowed us to control for covariates. Still, some limitations must be addressed. First, we applied the ABCDE

Table 5

Relationship between provider attitudes and ABCDE bundle adherence: adjusted odds ratios[a,b]

Provider attitudes	ABCDE bundle	A[d]	B[d]	C	D[d]	E
	Results, odds ratio (95% CI)[c]					
Perceived ease of completion						
Workload burden	**0.47 (0.28-0.79)**	—	—	0.69 (0.35-1.36)	—	0.65 (0.37-1.14)
Bundle difficulty	0.29 (0.08-1.07)	—	—	0.39 (0.15-1.02)	—	**0.41 (0.19-0.90)**
Perceived safety of ABCDE bundle implementation	0.51 (0.10-2.65)	—	—	0.84 (0.13-5.58)	—	2.63 (0.75-9.23)
Confidence performing ABCDE bundle	0.37 (0.10-1.35)	—	—	0.31 (0.08-1.18)	—	1.25 (0.41-3.81)
Perceived strength of evidence for ABCDE bundle	0.69 (0.14-3.35)	—	—	1.08 (0.23-5.10)	—	3.46 (0.81-14.87)

Abbreviations: A, awakening trial; ABCDE, Awakening and Breathing Coordination, Delirium monitoring and management, Early mobility; B, breathing trial; C, coordination (breathing trial preceded by awakening trial); D, delirium assessment/management; E, early mobility.

[a] Select patient covariates included in all regression analyses included age, Acute Physiology and Chronic Health Evaluation (APACHE) II score, and Charlson Comorbidity Index. Ventilator status was also included as a covariate in the logistic regression for ABCDE bundle and early mobility adherence.
[b] This table reflects the attitudes of 268 unique providers who cared for 101 patient clusters with 727 total opportunities for ABCDE bundle and individual component adherence at the unit level.
[c] Bolded results are statistically significant ($P<.05$).
[d] Variation (ie, nonadherence) was not enough in awakening trial, breathing trial, and delirium assessment/management adherence; therefore, odds ratios could not be calculated.

bundle framework as originally described by Vasilevskis et al.[31] At this time, the bundle was described as an evolving framework open to new strategies being included. Since its original publication, the bundle has now developed into the ABCDEF bundle to include family engagement and recommendations from recent guidelines.[6,32] Next, ABCDE adherence data were not collected on every patient in the ICU. Bedside providers were encouraged to perform ABCDE bundle components daily; thus, adherence data for this study most likely result in an overestimate of the actual unit adherence. Finally, nonresponse bias may be a concern because of the low survey response rate. The assistance of ICU leaders was solicited for guidance on the best methods to achieve survey response goals, but it is possible that only ICU health care providers with strong opinions for or against the ABCDE bundle participated in the survey.

> Focusing interventions on reducing workload burden and simplifying task implementation may facilitate ABCDE bundle adherence.

Conclusions

The ABCDE bundle is recommended practice in critical care, but evidence suggests that utilization is low and implementation varies. In this study, adherence to the ABCDE bundle was influenced by workload burden of the bundle. Secondary analysis demonstrated adherence to early mobility was influenced by perceived difficulty with carrying out the bundle. Focusing on interventions to address workload burden and difficulty with carrying out

the bundle may optimize implementation. Consider use of checklists, daily goal sheets, and interprofessional training in addition to evaluating geographic convenience of ABCDE bundle supplies and equipment as interventions to optimize implementation. Future research requires refinement of provider attitude subscales, which will allow us to further investigate relationships with ABCDE bundle adherence using larger sample sizes for ICU providers, patients, and units. A prospective study is indicated to determine if interventions to influence provider attitudes regarding workload and simplicity of task implementation result in improved ABCDE bundle adherence.

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Evidence-Based Review and Discussion Points

By Ronald L. Hickman, RN, PhD, ACNP-BC

Evidence-Based Review (EBR) is the journal club feature in the *American Journal of Critical Care*. In a journal club, attendees review and critique published research articles: an important first step toward integrating evidence-based practice into patient care. General and specific questions such as those outlined in the "Discussion Points" box aid journal club participants in probing the quality of the research study, the appropriateness of the study design and methods, the validity of the conclusions, and the implications of the article for clinical practice. When critically appraising this issue's EBR article, found on pp e38-e47 (available online at www.ajcconline.org, see abstract on p 270), consider the questions and discussion points outlined in the "Discussion Points" box.

Delirium and generalized muscle weakness are commonly occurring consequences among patients receiving mechanical ventilation in the intensive care unit (ICU). When implemented, the ABCDE bundle (Awakening and Breathing, Coordination, Delirium assessment and management, and Early mobility) has yielded significant reductions in the occurrence of delirium, the duration of mechanical ventilation, and the length of hospital stay, as well as increases in early mobilization of critically ill patients. Despite compelling evidence of the effectiveness of the ABCDE bundle, the adoption and use of this evidence-based strategy have been limited, and too little is known about the factors that affect the implementation of and adherence to the ABCDE bundle.

The authors of this study conducted a multicenter, prospective cohort study of critical care providers to describe associations among provider attitudes and adherence to the ABCDE bundle. Participants were critical care providers (ie, registered nurses, advanced practice nurses, physical therapists, respiratory therapists, occupational therapists, pharmacists, and physicians) who had worked at least 4 shifts per month in one of the 10 participating medical or surgical ICUs. To assess provider attitudes, participants were administered a 71-item electronic ABCDE provider survey. To assess adherence, an ABCDE adherence checklist was completed daily by a registered nurse and all other critical care providers involved in the patient's care. A total of 268 critical care providers completed the ABCDE provider survey, and adherence data were captured for 101 critically ill patients.

The authors report that workload burden significantly affected adherence to the ABCDE bundle. Specifically, the authors note that for every unit increase in workload burden, there was a 53% decrease in the adherence to the ABCDE bundle. In addition to the workload burden, the perceived difficulty of carrying

Investigator Spotlight

This feature briefly describes the personal journey and background story of the EBR article's investigators, discussing the circumstances that led them to undertake the line of inquiry represented in the research article featured in this issue.

Leanne Boehm, RN, PhD, ACNS-BC, is currently a Veterans Affairs Quality Scholar at Tennessee Valley Healthcare System and a postdoctoral fellow at Vanderbilt University School of Nursing, Nashville, Tennessee. For more than a decade, Dr Boehm has provided care to critically ill patients and their families as a registered nurse, a research nurse, and a board-certified clinical nurse specialist. While in the role of a research nurse, she realized that becoming a nurse scientist would allow her to contribute to affecting the lives of patients and families beyond her ICU.

Leanne M. Boehm

When reflecting on her experience conducting the study, Dr Boehm comments, "I greatly enjoyed my work on this project." "I was well-received in almost all circumstances and grateful for the providers' optimism toward the research, and [for their] helping me achieve my aims," she adds. While collecting data for this project, Dr Boehm remarks that she received a lot of questions and comments from providers, which led to them sharing additional information about the challenges of their work.

Dr Boehm recalls that while conducting this study she talked with several staff members during her visits to different institutions. "Several asked about my work and why I was doing it. I'd like to think I at least inspired them to become involved in quality improvement efforts at the unit level," she says.

out the ABCDE bundle was negatively associated with adherence to the early mobility component of the ABCDE bundle. The results of this study highlight the influence of perceptions of workload burden and difficulty of carrying out the bundle: perceived greater workload or greater difficulty in completing the bundle significantly reduces critical care providers' adherence to the ABCDE bundle.

Information From the Authors

Leanne Boehm, RN, PhD, ACNS-BC, lead author on this EBR article, provides additional information about the study. She comments that the study was designed to provide insights on factors (ie, workload burden and bundle difficulty) that influence whether a critical care provider or team of interprofessional providers would implement and adhere to the ABCDE bundle.

According to Dr Boehm, the study was meant to shed light on modifiable factors, such as provider attitudes, that may be responsive to interventions to facilitate implementation of and adherence to the ABCDE bundle. Reflecting on the next steps in developing the evidence regarding adherence to the ABCDE bundle, she would use established theories of behavior change and would capture data to describe the cost-effectiveness of adherence to the ABCDE bundle.

Implications for Practice

The study findings establish that critical care providers' perceptions of the workload burden and difficulty influence adherence to the ABCDE bundle. Dr Boehm encourages readers of the *American Journal of Critical Care* to implement the ABCDE bundle into care of critically ill patients undergoing mechanical ventilation.

"I would recommend training and utilizing available ancillary personnel and family members

to assist with conducting ABCDE bundle activities if indicated," she comments. Additionally, Dr Boehm and her colleagues also remark that prospective clinical trials are needed to evaluate the effectiveness of strategies to influence critical care providers' attitudes regarding workload and to identify approaches to facilitate adherence to the ABCDE bundle tasks.

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Discussion Points

A. Description of the Study
❏ What is the significance of the problem posed by the authors?
❏ What is the purpose of the study?

B. Literature Evaluation
❏ What are the known barriers to adherence to the ABCDE bundle?
❏ How do the authors justify the need to conduct the study?

C. Sample
❏ Who was eligible to participate in this study?
❏ How were participants recruited to participate in this study?

D. Methods and Design
❏ Did the authors have a reliable measure of the provider attitudes regarding the ABCDE bundle? What is the supporting evidence for your response?
❏ Describe how data were collected for this study.

E. Results
❏ What were the major findings of this project?
❏ How can you use these findings to improve the quality of nursing care at your hospital?

About the Author
Ronald L. Hickman is an associate professor, Case Western Reserve University, and an acute care nurse practitioner at University Hospitals Case Medical Center, Cleveland, Ohio.

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