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Implementing the ABCDE Bundle into Everyday Care: Opportunities, Challenges and Lessons Learned for Implementing the ICU Pain, Agitation and Delirium (PAD) Guidelines

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Abstract

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Objective—The Awakening and Breathing Coordination, Delirium monitoring/management and Early exercise/mobility (ABCDE) bundle is an evidence-based, interprofessional, multicomponent strategy for minimizing sedative exposure, reducing duration of mechanical ventilation and managing intensive care unit (ICU) acquired delirium and weakness. The purpose of this study was to identify facilitators and barriers to ABCDE bundle adoption and to evaluate the extent to which bundle implementation was effective, sustainable, and conducive to dissemination.

Design—Prospective, before-after, mixed-methods study.

Setting—Five adult ICUs, 1 step-down unit, and a special care unit located in a 624 bed, academic medical center

Subjects—Interprofessional ICU team members at participating institution.

Interventions and Measurements—In collaboration with the participating institution, we developed, implemented, and refined an ABCDE bundle policy. Over the course of an 18 month period, all ICU team members were offered the opportunity to participate in numerous, multimodal educational efforts. Three focus group sessions, 3 online surveys, and 1 educational evaluation were administered in an attempt to identify facilitators and barriers to bundle adoption.

Main Results—Factors believed to facilitate bundle implementation included: 1) the performance of daily, interdisciplinary, rounds, 2) engagement of key implementation leaders, 3) sustained and diverse educational efforts, and 4) the bundle's quality and strength. Barriers identified included: 1) intervention related issues (e.g. timing of trials, fear of adverse events), 2) communication and care coordination challenges, 3) knowledge deficits, 4) workload concerns, and 5) documentation burden. Despite these challenges, participants believed implementation ultimately benefited patients, improved interdisciplinary communication, and empowered nurses and other ICU team members.

Conclusions—In this study of the implementation of the ABCDE bundle in a tertiary care setting, clear factors were identified that both advanced and impeded adoption of this complex intervention that requires interprofessional education, coordination, and cooperation. Focusing on these factors preemptively should enable a more effective and lasting implementation of the bundle and better care for critically ill patients. Lessons learned from this study will also help healthcare providers optimize implementation of the recent ICU Pain, Agitation and Delirium (PAD) Guidelines, which has many similarities but also some important differences as compared to the ABCDE bundle

Keywords

Delirium; immobility; intensive care unit; implementation research; ABCDE bundle; interprofessional

Introduction

Despite decades of research documenting the hazards of hospital-acquired delirium and weakness[1] these two conditions remain ubiquitous, frequently unrecognized, and under-appreciated in the intensive care unit (ICU).[2] As acknowledged in the new Society of Critical Care Medicine's *Pain, Agitation, and Delirium Guidelines*[3], both conditions

contribute to detrimental patient outcomes and are commonly precipitated and/or prevented by modifiable processes of care. These processes include sedative and opioid medication administration, mechanical ventilation, and immobility. Because a clinical team collectively manages these processes (e.g. nurses, physicians, pharmacists, and respiratory and physical therapists), any intervention aimed at reducing delirium and weakness would ideally be interprofessional.

The Awakening and Breathing Coordination, Delirium monitoring/management, and Early exercise/mobility (ABCDE) bundle[1,4-7] is an example of an interprofessional, evidence-based, multicomponent ICU management strategy aimed at reducing sedation exposure, duration of mechanical ventilation, and ICU-acquired delirium and weakness. The ABCDE bundle is comprised of a number of interventions shown to improve critically ill patients' outcomes in several well-designed clinical trials.[8-11]

The new Society of Critical Care Medicine's *Pain, Agitation, and Delirium (PAD) Guidelines*[3] guidelines published in 2013 have been incorporated into the ICU PAD Care Bundle, with corresponding metrics developed to facilitate implementation. The PAD bundle is more explicit than the ABCDE bundle (published in 2010) in its approach in prioritizing and having an integrated approach to assessing, treating and preventing significant pain, through use of validated monitoring instruments and the use of nonpharmacologic and pharmacologic (separate for non-neuropathic and neuropathic pain) therapies. With the availability of newer data, it is also broader in its definition of techniques to be employed to reduce sedative exposure; robust psychometric analyses have led to the recommendations of only two sedation scales—the RASS and the SASS for targeting sedation, and both the targeting of light levels of sedation and the daily interruption of sedation are recommended techniques to reduce sedative exposure. The PAD bundle also links PAD management strategies with breathing trials, early mobility protocols and environmental management strategies to preserve patients' sleep-wake cycles, in order to achieve synergistic improvements in ICU patient outcomes.

Despite the proven benefit behind the recommendations of both the ABCDE and the PAD bundle, evidence suggests many of the interventions are not routinely used in clinical care.[12] This discrepancy, between what is known and what is done, can be best described as a knowledge translation or implementation gap. The *Multi-society Task Force for Critical Care* Research recently acknowledged the need to advance critical care research paradigms and develop a better understanding of knowledge transfer and implementation in the ICU setting.[13] Achieving this goal requires increased attention to implementation research methods that promote understanding of adoption and dissemination of best practices.[14] This is particularly important considering the effort and expense required to perform well designed, prospective, randomized controlled trials (RCTs) in the ICU setting.

We recently completed an 18-month, interprofessional, implementation study that applied the ABCDE bundle into everyday care. This study provided a unique opportunity to understand the process of knowledge transfer related to sedation, delirium, weakness prevention, and interprofessional ICU management strategies. Using a structured implementation framework, we identified facilitators and barriers to ABCDE bundle

adoption and evaluated the extent to which bundle implementation was effective, sustainable, and conducive to dissemination. Lessons learned from this implementation study could provide valuable information to health care providers as they move forward with implementation of bundled care geared towards pain, agitation and delirium management.

Materials and Methods

Design and Setting

We performed a prospective, before-after, mixed-methods study involving interprofessional team members working in five adult ICUs, a medical/surgical step-down unit, and a hematology/oncology special care unit in a 624 bed, Midwestern, academic medical center. The study was conducted between November 1, 2010 and May 31, 2012. The institutional review board approved the study protocol and implied consent was obtained from team members who participated in focus groups and on-line surveys.

Multifaceted Intervention, Implementation, and Evaluation Process

The study was guided by the *Consolidated Framework for Implementation Research* (CFIR).[15] The CFIR is composed of five major domains (intervention characteristics, inner and outer setting, characteristics of the individuals involved, and the process of implementation) that are proposed to interact in rich and complex ways to influence implementation effectiveness.

Intervention characteristics—The ABCDE bundle is described in detail in several previous publications.[1,4-7] In brief, the bundle is comprised of five core components that include the performance of daily: 1) spontaneous awakening trials (SATs), 2) spontaneous breathing trials (SBTs), 3) coordination of components 1 and 2 (so that sedation is held before the breathing trial begins), 4) routine delirium and sedation/agitation screening and management, and 5) early progressive mobilization. Each component (except delirium monitoring/ management) is guided by predefined safety screen questions and success/ failure criteria derived from previous RCTs.[9,10] It is suggested that the bundle should be applied to every patient, daily, while they are in the ICU, unless a licensed provider writes an order advising against its use ("opt-out" method).[1] Certain elements of the bundle are "adaptable", meaning they can be modified to the setting without undermining the integrity of the intervention itself. For example, an ICU could decide to add additional safety screen questions or success/failure criteria to meet the needs of its particular patient population. On-line supplement 1 provides readers with the ABCDE policy used in the current study.

Inner and outer setting—At the beginning of the study, the medical center's critical care units were considered "semi-closed", meaning patients were required to have an intensivist consultation if their ICU length of stay exceeded 24 hours. On July 1, 2011 the critical care units transitioned to a "closed" model where all ICU patients were under the direct care of an intensivist with other physicians consulting as the patient's condition required. The intensivist could be from the "academic" or "private practice" service. The academic medical and surgical critical care services (CCS), which admitted the majority of ICU patients, generally consisted of one attending physician, a nurse practitioner or physician

assistant, residents, and on the medical team a critical care fellow. Attending physicians on the medical CCS rotated every 15 days and residents monthly. The surgical CCS had an in-house attending surgeon available 24 hours a day.

The nurse to patient ratio in the ICUs was generally 1:2 and in the step-down unit 1:4. Approximately 10% of the ICU nurses were Critical Care Registered Nurse certified. While the institution employed several critical care nurse educators, the participating units did not have specifically assigned clinical nurse specialists. Respiratory therapists were assigned to critical care units based on predicted workload and assigned therapy outside the ICU if the workload was lower than anticipated. Two full-time pharmacists and physical therapists were assigned to the critical care units.

Before the ABCDE bundle was adopted as standard of care, clinicians at the participating institution had some experience with SATs and SBTs. In addition, the institution did not have any delirium monitoring or management policies in place and only one ICU was in the beginning phase of an early mobility initiative.

Characteristics of individuals involved—All full and part-time registered nurses (RNs) (N=220), respiratory therapists (RTs) (N=70), pharmacists (N=5), physical therapists (PTs) (n=2), nurse practitioners (NPs) (N=4), physician's assistants (N=1), academic medical and/or surgical intensivists (N=17), and critical care fellows (N=9) who were 19 years of age or older and currently practicing in the aforementioned units were invited to participate in the research and implementation process. These interprofessional ICU team members were purposefully chosen because of their expertise and essential role in the ABCDE bundle.

Process of implementation

Planning and engaging phases—The institution's Chief Nursing Officer (CNO) was the first administrator that was contacted regarding the possibility of implementing the ABCDE bundle into everyday care, followed by the Critical Care Medical Director. Incorporating the Medical Directors' feedback, the research team developed the initial implementation plan. This interprofessional team met on numerous occasions to discuss: how key stakeholders may perceive the bundle, educational strategies (e.g. computer based, in person, etc.), marketing strategies (e.g. with graphics, pocket cards, etc.), evaluation strategies, methods of outcomes assessment, and communication strategies. The research team then collaborated with hospital administrators to identify and formally appoint interdisciplinary (i.e., nursing, PT, RT, pharmacy, and physicians trained in various specialties) ABCDE bundle implementation leaders. While numerous implementation leaders were identified, the most active members included the ICU nursing director, a lead RT, one medical and one surgical CCS physician, an ICU-based PT, 2 pharmacists, 2 assistant nurse managers, and a neurosurgeon with extensive ICU experience.

All implementation leaders received a file that described the bundle and supporting studies. We also provided the proposed delirium and sedation/agitation screening tools and resources. The implementation leaders were expected to become familiar with the ABCDE bundle prior to the initial group meeting. At this meeting, the research team and

implementation leaders discussed the ABCDE bundle and attempted to identify existing institutional policies related to sedation/analgesia, alcohol withdrawal, ventilator management, and mobility that would support or conflict with the ABCDE bundle. At subsequent meetings, the group discussed the bundles' evidence strength and quality, the relative advantages and disadvantages of change, perceived ABCDE bundle complexity/quality, and potential costs and barriers associated with bundle implementation.

Next we identified unit-level leaders. This group included ICU nurse managers, CCS NPs/PAs, nurse educators, the director of respiratory care, an additional ICU pharmacist, other CCS physicians, and members of the performance improvement team. Numerous meetings discussed the same topics as those held with the formal implementation leaders. Each of the unit-level leaders was then asked to identify staff that they thought may be willing to serve as ABCDE bundle champions. The research team then incorporated staff feedback and began the process of developing, obtaining, and distributing educational resources. These resources included a number of different informational posters/flyers, unit-level ABCDE bundle resource manuals, unit and specialty based in-services, and CAM-ICU and RASS pocket cards.

Executing phase—All members of the ICU team were offered the opportunity (via an email link) to complete a 30 minute computer-based ABCDE bundle training program. The training module focused on the problems of delirium and immobility in the ICU, the effects of sedation and ventilator management strategies on delirium and immobility, and valid techniques for assessing sedation and delirium. Participants were introduced to the individual components of the bundle, the safety screen and pass/fail criteria for SATs, SBTs, and early mobility components, and instructed on how to perform each step. Content for this activity came from multiple sources including material available at www.icudelirium.org. The program also contained two short videos that were developed specifically for the study. These videos, which included ICU professionals from the participating institution, demonstrated team members correctly administering the CAM-ICU and providing early mobilization to a mechanically ventilated patient. Learners completed the educational program at their own time and pace. Upon completion, all participants received continuing education credits (AMA PRA Category 1TM credit, ANCC nursing contact hours, and ACPE continuing education credit for pharmacists).

Two other ABCDE bundle related educational events also occurred before the bundle became standard of care. A leading ICU delirium expert and study consultant, presented at the institution's medical ground rounds. One of the institution's critical care nurse educators also received an educational grant to support the development and presentation of a nurse led 8-hour ABCDE bundle education day. The remaining educational efforts were purposively staggered over a nine month period. Our clinical research nurse, for example, provided numerous in-services to the participating units “lead” RNs on how to perform the CAM-ICU followed by direct observation until competence was achieved. An anesthesiologist team member provided ABCDE bundle education to physicians practicing in the ICUs.

Although not originally planned, several institutional team members independently provided additional ABCDE bundle education after it was adopted as standard of care. Pharmacists, for example, created, distributed, and analyzed a survey to assess ICU team member's knowledge and beliefs about sedative medications used in the ICU. Survey results were translated into tailored group and individual education. In another example, several ICU nurse educators and assistant nurse managers developed case studies and quizzes related to the ABCDE bundle. They also met with nurses to provide further education, answer questions, and receive feedback. They also developed and integrated ABCDE bundle training into the annual nursing education process.

Early in this stage, the research team also developed the institution's ABCDE bundle policy. Researchers consulted with both the medical and nursing ICU directors to determine what committee(s) the policy would have to be approved by before being considered standard of care as well as existing policies that would need to be reconciled. All ICU team members were provided, via e-mail, a copy of the draft policy and asked to provide their thoughts, concerns, and suggestions for improvement.

Three separate committees approved the final ABCDE bundle policy. With the assistance of two of the units' assistant nurse managers, a nurse educator, the medical director, and a lead RT we developed the ABCDE bundle documentation forms. For the first year of the study, RNs and PTs primarily used paper based charting, RTs documented primarily in the old EMR, and physicians used both forms of documentation. Mid-study the institution transitioned to an electronic medical record (EMR). This required the development and approval of multiple documentation forms and active collaboration with the EMR informatics specialist.

The ABCDE bundle became standard of care 11 months after study initiation. At this time, a study Co-PI regularly attend the ICU's performance improvement team (PIT) meetings, providing ABCDE bundle performance and outcome data and feedback at the meetings and upon request. The research team presented engaged PIT members to disseminate this data as widely as possible (e.g., to nurse managers so they could display in their units).

Reflecting and evaluating phase—We received feedback about the progress and quality of implementation throughout the study.

Focus group sessions: All ICU team members were invited via email to participate in three focus group sessions. They were assured that participation in these sessions was voluntary and that all of the information that was collected would be kept anonymous. The first two focus groups were conducted while the institution's ABCDE policy was being developed and the third was conducted six months after the policy became standard of care. All focus groups sessions were attended by a research team member with experience in qualitative research.

On-line ABCDE bundle knowledge and impediments surveys: The on-line surveys were administered at three different times. The first survey was conducted before the ABCDE bundle became standard of care. This 18-question survey was designed to not only assess

participants' perception of delirium but to explore their views on teamwork, collaboration, and resource availability in their ICUs (Table 1). Fifteen of the questions from this survey were derived from the “Safety Attitudes Questionnaire” developed by Sexton and colleagues.[16]

The second and third surveys were administered 4 and 9 months after the ABCDE bundle became standard of care. These 30-question surveys contained the same 18 questions administered in the initial survey and an additional 12 questions that focused specifically on participants understanding, perception, and confidence in their ability to implement the ABCDE bundle (Tables 1 and 2). Five questions were either multiple choice or open ended to allow participants to further explore these domains. The other twenty-five questions utilized a Likert scale with results ranging from disagree strongly, disagree somewhat, neutral, agree somewhat, and agree strongly.

Evaluation of computer-based, interprofessional, ABCDE bundle education: The online educational program included a comprehensive outcomes-based evaluation of its effectiveness that was based on Moore's model in the development and evaluation of educational activities.[17]

All online learners began the activity by completing a pre-test and immediately following completion of the activity were directed to a post-test and evaluation survey. The evaluation survey included questions on how well the content applied to the participants' clinical practice, if the activity influenced participants' capacity to execute the competencies learned, and participants' level of intention to change their clinical practice. They were also asked to provide specific examples of the practice changes that would occur as a result of the training.

Analysis

Focus group sessions were tape recorded, transcribed verbatim, and then analyzed line by line, labeling passages with theme labels, and comparing passages with similar themes.[18]

A tape recorder malfunction resulted in one session not being recorded; however detailed notes from the person leading the group leader were analyzed. Themes were also compared across groups for similarities and differences. All authors agreed on the final thematic labels. Descriptive statistics were used to analyze results of the online surveys and educational evaluation. Narrative comments provided by participants were analyzed in a manner similar to the focus group sessions.

Results

Thirty-six participants attended the three focus group sessions, 99 completed the *Knowledge and Impediments* surveys, and 328 completed the on-line education and evaluation. Participants' profession and whether the information was obtained before or after the ABCDE bundle was adopted as standard of care can be found in Table 3. Because strikingly consistent themes emerged across data collection methodologies, the results are presented collectively.

Intervention Characteristics

Evidence strength and quality—Participants in the online educational evaluation believed the ABCDE bundle (intervention) was clinically relevant, beneficial, and of high quality. Participants felt the ABCDE bundle positively influenced their patients' outcomes (77%), was applicable to their current practice (68%), and was evidence-based (67%). Stakeholders' perception of the value of the ABCDE bundle changed substantially post-implementation. The percentage of respondents that agreed or strongly agreed with the statement that they "believed the ABCDE bundle improves patient outcomes" was only 29% at four months and 50% at eight months after adoption (Table 1).

Adaptability—A consistent theme among RNs was that of perceived harm. One nurse felt it was "unethical not to sedate ICU patients" while another stated "one person told me I can't give narcotics before a trial, we should never do this". Others expressed the belief that the bundle may contribute to fatigue, emotional liability, physiologic instability, and psychological distress. For example, one survey participant wrote that there is "a detrimental emotional effect of turning off sedation while intubated and restrained and then resuming at half-rate. For patients who are on the ventilator longer term, this seems to be very disturbing for them". A RT expressed concern regarding performing SBTs at night because "patients need rest". The fear of "treatment related adverse events" was also cited by 29% of participants in the educational evaluation.

A consistent belief expressed was that the ABCDE bundle should not be applied to all types of patients (e.g. burn, neurosurgical) and that these populations should either be excluded from the policy or added to the safety screens. As one survey participant noted "there are some additional reasons why it would not be appropriate to get a patient out of bed that are not listed on the options for protocol. Example; pt is a quadriplegic/no muscle tone to safely sit in a chair without sliding right out… Often times in these cases I end up just choosing a choice that really isn't the correct choice for lack of choices."

Another perceived intervention related impediment involved the "timing" of the SATs and SBTs, which participants believed contributed to unnecessary delays in extubations. One survey participant expressed the opinion that the SATs and SBTs should be moved to day shift so that "the doctors could be there to make the decision to extubate while the patient was still on a SBT". Another participant noted that performing "SBTs immediately before rounds would be easier to facilitate follow-through" i.e. extubation. Another RT reported "we are doing this at 3 or 4 am in the morning to these poor patients who should be sleeping at this hour not awakening. Then we do the SBTs and if the pass they are put on CPAP 5/5. We call the residents and they say put them back on their regular settings and we'll evaluate them at rounds. Why don't we just extubate them then? So silly. Why do we have to wait?" While, some RNs felt that moving SATs and SBTs to day shift would not be such a good idea because of "how busy that shift already was" and the fact that "this is when we are supposed to be walking our patients", there appeared to be clear consensus that both SATs and SBTs should be completed on day, rather than night shift.

Relative Advantages—Certain stakeholders perceived ABCDE bundle adoption as clearly beneficial and advantageous in terms of improving patient care. They reported feeling the use of continuously infused sedatives had dramatically decreased since implementation and that they were now “more autonomous and empowered” in terms of how to sedate their patients. They also believed that patients were more frequently mobilized and that in the end this “will be a tremendous benefit for their patients”. Several participants in the post-implementation focus group session felt that delirium screening was relatively “simple and straightforward” and that the CAM-ICU was “helpful, particularly for newer nurses”.

Others reported finding value in using a protocol that was “new” and “based on strong evidence”. For example, focus group participants stated that before the bundle was implemented into everyday care some of the ventilator practices were “from the 70s and 80s “, that there was no consistent mode of mechanical ventilation weaning (e.g. “all the doctors are different”), and that “you never are quite sure what the plan for the day is for the patient because the plan changes when every new person (MD) comes”. This was supported by observations from the Critical Care Medical Director who noted that prior to ABCDE implementation that SBTs frequently occurred while patients remained on continuously infused sedative drips, patients who apparently passed a SBT were often returned to their previous ventilator settings without documented reasons, and patients were generally kept heavily sedated.

Complexity: A lack of understanding of the ABCDE bundle and knowledge deficits related to delirium, sedation, and immobility were problems reported post-implementation. For example, participants reported being “unclear about the protocol” and feeling that “the whole process is very confusing and does not make sense especially with the limited education we received”. Despite numerous narrative comments regarding perceived bundle complexity and knowledge deficits, 83% of survey respondents reported understanding the individual components ABCDE bundle.

Inner and Outer Setting

Needs and resources—Focus group participants pre-implementation were particularly concerned about how the ABCDE bundle would affect their workload. For example, one RT noted that in general patients are placed on SBTs only “for 2-4 minutes” before the therapist decides if they will “fly”. They noted that this occurred because RTs normally have “10 patients with 7-8 vents and it's just way too much” because they often “float between floors and the ICU”. One RT noted it felt like he was in a “sailboat without wind”. Explaining that there is often “no one to help” and “while we are supposed to be dedicated to a unit, that often doesn't work and we get pulled for transport, which bumps everything”. A RN also expressed concern about how the bundle would affect workload noting that nurses often had “two patients needing trials and that it is very difficult to coordinate them”. This was consistent with the educational evaluation findings where, over 75% of the participants reported “lack of time” as a possible barrier to making a change in their practice.

Several high-level administers supported bundle implementation. Early in the implementation phase, the CNO expressed strong support for the initiative stating that she would agree to “help out in anyway necessary” because “nursing was deeply committed to adopting evidence-based practices and doing the right thing for patients and their families”. In addition to recommending several key implementation leaders she also agreed to cover some of the costs for the nursing hours needed to provide ABCDE bundle education. Similar support was garnered from the Critical Care Medical Director who was formally responsible for the decision to adopt the ABCDE bundle as standard of care for all participating units.

Despite the support of leadership, bedside providers often did not perceive the same level of support. A number of participants reporting that the biggest challenge to ABCDE implementation was that “the appropriate staff was not available the help them implement it.” One survey participant stated, “There is simply not enough staff (respiratory, physical therapy, care techs, RNs) to do the labor intensive mobility work with ventilated patients”. One-half of the respondents reported believing they had the support that they needed from other personnel to implement the ABCDE bundle.

Culture—When speaking about perceived challenges prior to actual implementation, inconsistency in practice among intensivists, surgeons, specialists, and private physicians was noted. There was also a perceived reluctance to follow both new and existing protocols. Certain medical specialties were deemed particularly challenging because they “are not open to recommendations”, “think they know everything”, “believe that protocols are for everyone but their patients” or because “we are often afraid of them”. One participant noted that “doctors were a major road block to treating pain” noting that “you often have to go around them to get what you want”. There was an overall consensus that all of the professions would be reluctant to follow a new policy since there were already “so many that it's tough to remember them all” and that they already “had a 12 inch thick policy book”.

The perception was supported by participant feedback regarding the role of ABCDEs in clinical care. For example, one survey participant reported, “I don't need a protocol to tell me if my patient is delirious, nor do I need one to ambulate my patent, or to extubate my patient. If other staff feel this is helpful I believe they should use it, it is extra unnecessary work for the staff that understands patient care”. Years of ICU practice seemed to be an important factor in the attitude toward practice adoption, with one participant stating, “I simply don't need it because I already know what I am doing. But it may be good for novices though”. Similar thinking was expressed by another participant who noted that “it could be good for an inexperienced nurse, therapist or MD, however, it is pretty much a waste of my time. I am able to make the distinction between delirious and awake and alert”.

A lack of acceptance of the bundle, particularly among MDs, remained a consistent theme post-implementation with participants reporting that the “physicians don't use it”, “MDs still always ordering weaning parameters”, and another stating that the “physicians are not on the same page” as other team members.

Networks and communication—Numerous interprofessional communication and care coordination barriers were identified. For example, participants noted that because the different specialties all rounded at different times "it makes it very difficult for interdisciplinary rounds to occur." Communicating at night was particularly challenging, with participants stating that you simply "don't call the private practice doctors at night". While others offered that at night "you call the resident or whoever is standing around and all they say is I have to talk to my supervisor who is a fellow".

The biggest care coordination problem seemed to be related to a lack of consistent interdisciplinary rounds. Also, when rounding did occur, ABCDE bundle related interventions and outcomes were felt to be rarely, if ever, discussed. While the groups were unhappy with the frequency in which rounds occurred, they appeared committed to the process itself noting that they would "love" for them to occur.

Characteristics of Individuals

Self-efficacy—Confidence in the ability to use the CAM-ICU to screen from delirium dropped 4 months post bundle adoption (64% pre 46% post), but then rose again slightly 8 months after implementation (55%) (Table 1). Between the second and third surveys, the percentage of respondents who agreed or strongly agreed they were confident in their ability to use the bundle increased from 47 to 75%. The number of participants who agreed or strongly agreed that disagreements in their unit were resolved appropriately increased to 79% 8 months after adoption compared to 54% in the pre-implementation period. Perception regarding the frequency, value, and ability to provide input during interdisciplinary rounds also increased steadily between the 4 and 8 month post implementation period.

Process of Implementation

Participants reported that they learned most about the ABCDE bundle by completing the online educational program (38%). Just over 92% of respondents reported that they would make a change in their clinical practice after viewing the online ABCDE bundle education. Physicians, pharmacists, and nurses were most likely to indicate their intention to change their clinical practice (100%, 100% and 95% respectively), while physical and respiratory therapists were less likely (73% and 87% respectively). Of those indicating they would make a change of practice, approximately 70% responded that they were very committed. When asked to compare adequacy of knowledge about the ABCDE bundle prior to completing the online activity, only 32% indicated it was adequate compared to 90% afterwards.

Other educational experiences that were found to be beneficial included attending unit based in-service's (17%), the availability of pocket cards (15%), and unit poster displays (10%). Participants consistently reported, however, that they needed more education regarding "the CAM-ICU and the whole bundle in general". For example, one RN stated, "now we are doing the CAM-ICU for all of our patients, but there is no change in what we do with the patient. No one knows what to do with delirium".

A number of documentation concerns were revealed. In general there was agreement that any ABCDE bundle documentation form would need to be short, available electronically, and visible to all disciplines involved in the patient's care. One participant noted that effort would be better placed at teaching “the nurses what they need to do and know instead of filling out another unnecessary piece of paperwork”. Concern was expressed that documentation of the ABCDE bundle would be treated like the institutions' daily goals sheets, which one participant noted were “pointless” because the “nurses did them initially, but no one looked at them, no one cared, so we don't do them anymore.” While another suggested “not creating another checklist because we would use 2 weeks and then abandon, like the daily goal sheets”.

Participants shared a number of suggestions on ways to improve ABCDE bundle implementation. These suggestions included providing continuing educational efforts, simplifying the process (i.e. making the policy shorter and easier to read, merging documentation into existing EMR assessments), adding to daily rounding sheet, creating early mobilization teams, and creating a “unit champion” award. One participant commented “you should review with everyone every 6-12 months because of staff turnover”. Talking about the policy “consistently” was also deemed important, with one participant suggesting that the “intensivist should make sure it is always talked about on daily rounds”.

Discussion

There is an unmet need to understand how to translate evidence-based knowledge into practice in the ICU setting; a complex, inter-professional environment that cares for the sickest of medical and surgical patients. Employing the CFIR framework, we rigorously evaluated the implementation process of the ABCDE ICU delirium and weakness prevention bundle. Data regarding perceived facilitators and barriers to ABCDE bundle implementation were extremely consistent between the focus groups and the on-line surveys. Participants identified the performance of daily interdisciplinary rounds, the use of standardized delirium and sedation screening tools, and intense and sustained education as factors that they believed helped facilitate ABCDE bundle adoption.

Participants felt ABCDE bundle implementation had resulted in significant practice changes that would ultimately benefit their patients. These perceived practice changes included more frequent interdisciplinary rounds, a decrease in the use of continuously infused sedatives, better care coordination, and more frequent and earlier mobilization. After implementation, participants reported that they believed disagreements were resolved more appropriately, that they valued and provided regular input during interdisciplinary rounds, and that they felt feeling more autonomous and empowered.

Numerous barriers to successful adoption of the ABCDE bundle were also identified. Interestingly many of the barriers identified by participants prior to bundle adoption remained after it became standard of care. These barriers included inconsistent medical practice, reluctance to follow both new and existing protocols, numerous care coordination and communication barriers, workload and documentation related concerns, and a number of protocol related concerns (e.g. fear of treatment related adverse events, timing of SATs and

SBTs). Despite intense and multimodal education, knowledge deficits related to delirium, sedation, and immobility persisted as a prevalent theme throughout the study period. Many of these barriers (time constraints, knowledge, attitudes, engagement difficulties) and facilitators (education, quality of evidence) are consistent with prior studies exploring barriers and facilitators to behavior change in the ICU.[19,20,21]

Upon analyzing our results with the CFIR framework[15], we found that characteristics of the intervention (ABCDE bundle) both helped and hindered the implementation process. While the vast majority of stakeholders perceived the ABCDE bundle to be evidence-based, influential to patient outcomes, and of high quality, concern was expressed that it was not yet adequately adapted to meet the needs of patients and providers at their particular institution (e.g. timing of SATs and SBTs). The relative advantage of adopting the bundle compared to standard practice was also questioned. For example, many participants expressed concerns related to the safety of the bundle. Nurses in particular worried that SATs would cause their patients to have increased pain, agitation, and physiologic instability; while some physicians seemed to question the safety of not performing weaning parameters prior to extubation. These findings are consistent with prior SAT and SBT studies.[22-24] Table 4 provides a summary of the intervention related concerns and potential methods of addressing them.

An additional feature of the intervention is that it requires clear, consistent, and timely communication across providers. The process of patient awakening is intended to be followed by spontaneous breathing trial, and extubation if the patient passes. This requires coordinated care and timing among the various professionals as well as effective communication. In many circumstances this would be best achieved via a process of multi-disciplinary rounds. Without this formal structure in place, achieving coordination of the ABCDE bundle proved challenging. Formalizing the process of interdisciplinary rounds proved to be a key element to both improving inter-professional communication as well as improving ABCDE compliance. The benefit of interdisciplinary rounds are well documented in the literature,[25,26] and we would strongly advocate for their incorporation for ICUs seeking to implement the ABCDE bundle.

The research team viewed leadership engagement and institutional support as crucial components to the many implementation “successes” that were achieved. The medical and nursing directors, for example, were extremely involved in all phases of the implementation process. They were helpful in identifying other key implementation leaders, explaining the cultural and historical factors that may influence change (e.g. relatively recent merger of private and academic hospitals), and helped clarify the complex “web of social networks”[15]. The financial commitment the CNO provided for the nursing hours needed to develop and attend educational events was both symbolic and substantive in the success of implementation. Institutional funds also supported the visiting scholar who was perceived to be a strong motivational and positive change force. Elements of the organizational culture, such as this leadership support, are believed to influence adherence to guideline recommendations.[27]

One of the “key” lessons learned was how important it is to assess an institution's “absorptive capacity for change”.[15]During the implementation process, the institution was undergoing major organizational and practice changes (going to a closed model of ICU delivery, implementing a new EMR, performing annual staff evaluations), with variable institutional priority. For example, because the ICU PIT was in the process of implementing a number of other initiatives they did not become actively engaged with ABCDE bundle implementation until late in the process. The number of performance improvement initiatives also made finding ABCDE bundle champions difficult since because many of them potential champions were committed to other projects, a factor that may have adversely affected the adoption speed of this project.

Despite being offered numerous, multifaceted, and multimodal educational initiatives many of the ICU providers reported a lack of understanding of the ABCDE bundle and continued knowledge deficits related to the management of delirium, sedation, and immobility. Participants also reported particularly low levels of confidence in their ability to use the CAM-ICU to screen for delirium. While nearly all of the RNs, RTs, PTs, and pharmacists that practiced in the ICUs completed the on-line ABCDE bundle education, 41% of the MDs did so. While we intentionally tried to make this educational session relatively brief, it is possible that it was simply not enough information to improve understanding of the many complex components of the ABCDE bundle. One study, for example, that explored the implementation of sedation, pain and delirium tools found that extended repetitive training led to higher implementation rates than one time training alone.[28]Another possible explanation was that the research team did almost all of the education and monitoring of outcomes. If these changes were initiated and implemented purely by the clinical staff, buy-in may have improved due to an increased sense of ownership.

In terms of the process of implementation, one of the major decisions we question was whether it was appropriate to try and implement all of the individual ABCDE bundle components at once. We made this decision because our baseline perception was that the institution had prior experience with SATs and SBTs and believed little emphasis would be needed on the actual “ABC” components. We determined that this was not the case midway through the study on analysis of our quantitative patient data. This illustrates the importance of regularly, frequently, and objectively measuring performance to achieve a more accurate picture of the status-quo current state in order to measure the degree of success at each stage and actively inform and adaptions to the implementation of the intervention.

The lessons learned from the implementation of the ABCDE bundle provide a wealth of information for the implementation of other bundled elements of care and in particular to the new 2013 Pain, Agitation and Delirium Bundle, given that there are significant similarities in the two. The ABCDE bundle was developed as a “sticky message” in 2010, based on best available literature, to help healthcare providers with an easy to use framework for best sedation and delirium practices. The 2013 PAD guidelines differs from the ABCDE bundle in terms of the methods used, their content and scope. All statements and recommendations were developed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) method (www.gradeworkinggroup.org), which allowed for guideline recommendations to be based upon not only the strength of the evidence, but the risks and

benefits of each intervention as well. Emphasis was paid on the psychometric analysis of available pain, agitation/sedation scales and delirium monitoring instruments, to recommend best tools. Management of pain was a priority, thereby reducing the probability of pain related agitation being treated by oversedation, and focus was on light sedation (whether via targeted lighter levels of sedation or daily interruption of sedation). Thus some elements of implementing the PAD bundle may actually be easier given the very specific recommendations with regards to pain management and monitoring instruments. Additionally, the more liberal approach to reducing sedative exposure (light sedation vs. sedation interruption), without the explicit need to coordinate awakening and breathing trials, would perhaps be easier to implement in environments where daily interruption of sedation was perceived harmful and the coordination with daily breathing trials, resource intensive.

There are several limitations to our ABCDE bundle implementation study. While a number of individual ICUs participated in the research, the study was conducted at a single, academic medical center. This not only limits generalizability, but may also be a factor in why some challenges were so hard to overcome. For example, one multicenter implementation study of an evidence-based SBT protocol found that many of the participating institutions reported that local implementation barriers were more easily overcome when reference was made to the multicenter partnership.[24] These authors suggest that voluntary peer networks create a mutual opportunity and accountability for implementing best practices. Another study limitation was relatively low participation in the focus group sessions and online surveys. It is possible that participation was motivated by strong beliefs either “for” or “against” bundle implementation. It is also likely, however, that this low participation was more reflective of the institutions inexperience with ICU clinical studies.

Conclusion

In this implementation study, we found a number of factors facilitated and/or impeded effective ABCDE bundle adoption. Future implementation efforts would benefit from prospectively addressing characteristics of the intervention, the inner and outer setting, individuals involved, and the process of implementation. This will require intense and sustained interprofessional education, coordination, and cooperation.

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Table 1
Knowledge and impediments survey-Likert scale questions and results

	Time 1 %	Time 2 %	Time 3 %
I believe delirium is a problem frequently experienced by patients in my unit	85.7	62.1	77.3
I believe delirium negatively effects patient outcomes in my unit	92.8	86.1	81.8
I am confident in my ability to use the CAM-ICU to screen for delirium	64.3	45.7	55.0
I understand the individual components of the ABCDE bundle		73.7	82.8
I believe the ABCDE bundle improves patient outcomes		29.0	50.0
I am confident in my ability to use the ABCDE bundle		47.2	75.0
I believe the ABCDE bundle is being used in my unit		59.5	56.8
I believe the documentation involved in the ABCDE bundle is too time consuming		35.3	27.9
I have the support I need from other personnel to implement the ABCDE bundle		50.0	53.4
Management supports my daily efforts in implementing the ABCDE bundle		57.1	63.6
In my unit, it is difficult to speak up if I perceive a problem with patient care*	78.6	77.7	76.2
Disagreements in my unit are resolved appropriately	54.2	63.9	79.0
It is easy for personnel in my unit to ask questions when there is something that they do not understand	100.0	86.1	80.9
The physicians and nurses in my unit work together as a well-coordinated team	100.0	58.8	78.6
The levels of staffing in my unit are sufficient to handle the number of patients	64.3	50.0	63.1
I experience good collaboration with nurses in my unit	100.0	82.8	95.3
I experience good collaboration with staff physicians in my unit	84.6	63.6	72.1
I experience good collaboration with pharmacists mu unit	85.7	91.7	90.0
I experience good collaboration with respiratory therapists in my unit	92.9	83.3	89.8
I experience good collaboration with physical therapists in my unit	85.7	82.6	82.8
Communication breakdowns that lead to delays in delivery of care are common in my unit*	42.9	54.8	51.2
Interdisciplinary rounds are regularly performed in my nit	78.6	59.3	82.1
I value interdisciplinary rounds in my unit	0.0	78.5	92.3
I regularly provide input during interdisciplinary rounds in my unit	64.2	62.0	84.8
My input is well received during interdisciplinary rounds in my unit	100.0	66.7	84.4

*Table 1 summarizes percentage of individuals who either agreed or strongly agreed with questions. Items marked with an * indicate the percentage of individuals who strongly disagree/disagree with statement.

Table 2

Knowledge and impediments survey-Multiple choice/open ended questions

- The part of the ABCDE bundle that is most beneficial to patients is: 1) awakening trials 2) breathing trials 3) care coordination 4) delirium monitoring and management 5) early mobility 6) other please specify _____
- The part of the ABCDE protocol that is least beneficial is: 1) awakening trials 2) breathing trials 3) care coordination 4) delirium monitoring and management 5) early mobility 6) other please specify _____
- My biggest challenge in implementing the ABCDE protocol is _____
- The best way to improve the ABCDE protocol at our institution would be _____
- I learned the most about the ABCDE protocol by: 1) completing the on-line educational program 2) attending unit based in-services 3) participating in the focus groups 4) the posters displayed in my clinical area 5) pocket cards 6) other please describe_____

Table 3

Breakdown of study participants by time period*

Profession	Focus Group		Knowledge & Impediment Survey			On-line Education & Evaluation
	Pre	Post	Pre	Post (1)	Post (2)	Pre
Registered Nurse	16	8	9	26	23	203
Nurse Practitioner/ Physician's Assistant			1	0	2	
Respiratory Therapist	8	2	0	5	0	63
Pharmacist	1	1	1	4	4	26
Physician	0	0	0	1	7	7
Physical Therapist	0	0	0	1	0	15
Other	0	0	4	1	10	14
Total	**25**	**11**	**15**	**38**	**46**	**328**

Thirty-six participants attended the three focus group sessions, 99 completed the Knowledge and Impediments surveys, and 328 completed the on-line education and evaluation.

Table 4
Points to consider when implementing the ABCDE Bundle

Spontaneous Awakening Trial (SAT) and Spontaneous Breathing Trial (SBT) Coordination

- **Timing of trials-**The optimal timing of trials (night or day shift) is yet to be determined. Performing trials on the night shift may be practical because of workload related issues (e.g. less "off unit" time, distractions, and tasks) or if the institution has experience and success performing them at this time. It is possible that performing trials at this time may interfere with sleep patterns. Performing trials on day shift may be more practical because physicians are present and maybe more willing to make the decision to extubate at the time of SBT pass. There are also more people present during the day which may be beneficial in terms of having assistance if needed (e.g. patient does not tolerate trial). Staffing challenges and the need to perform numerous other tasks (e.g., early mobilization), however, may make performing trials during the day difficult. It is unclear whether performing multiple trials in one day is beneficial or detrimental to patient outcomes.
- **Knowledge deficits-** Anticipate the need to address several key points including: weaning parameters no longer being necessary, risks of over sedation, fear of increase in adverse events (e.g., self-extubation, falls, hemodynamic instability), misperceptions regarding protocol (e.g., not being able to provide opioids for pain, futility of restarting infusions at ½ of previous rate, that is better to use continuously infused sedatives vs. only when necessary), role sedatives play in sleep patterns, etc.
- **Safety screen questions and pass/fail criteria-** Carefully review existing studies and discuss applicability to certain populations (e.g., neurosurgical, patients with open abdomens, etc.). Clearly delineate the steps and criteria involved in the process. Encourage discussion and come to agreement on the benefits and risks of adding more exclusion criteria.
- **Documentation-** Before creating an ABCDE bundle policy, carefully review any and all existing policies and procedures for duplication, redundancy, or contraindications. All ABCDE bundle related documentation forms should be able to be viewed by other disciplines. Consider adding an open ended answer to safety screen and pass/fail criteria so that clinicians can document reasons procedures were not performed that fell outside normal criteria. Anticipate reluctance to use any new form of documentation.
- **Communication-** Encourage RNs and RTs to collaboratively determine optimal timing of trials. Discuss results of trials daily on interdisciplinary rounds. Determine who will follow outcomes and adherence to trials. Discuss who will hold clinicians accountable for performing procedures on a daily basis.
- **Will an "opt-out" method be adopted-** The decision should be made early on whether RNs and RTs will be empowered to implement protocols known to benefit patients rather than waiting for a physician to order trials on a daily basis.

Delirium monitoring/management

- **Assessment-** The frequency of delirium and sedation/agitation assessment and which screening instrument will be used will need to be determined.
- **Education-** The method (e.g. use of case studies, train the trainer), frequency, and modality (e.g. in-person, online) of delirium education will need to be decided. Delirium prevention and treatment strategies (both pharmacologic and non-pharmacologic) will need to be developed and "rolled" out to all members of the interprofessional team. Long standing myths regarding delirium will need to be identified and addressed (e.g. normal for older adults to become confused, delirium has no long-term consequence). Do NOT underestimate the amount of education that will be needed to address this part of the bundle.

Early Mobility

- **Safety screen questions and pass/fail criteria-** Carefully review existing mobility studies and discuss applicability to certain populations (e.g., neurosurgical, patients with open abdomens, etc.). Clearly delineate the steps and criteria involved in the process. Encourage discussion and come to agreement on the benefits and risks of adding more exclusion criteria.