Implementation Strategies Used to Facilitate ABCDEF Bundle Adoption:

A Scoping Review

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Author Note

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Abstract

Problem: Administration of the ABCDEF bundle (A - Assess, prevent, and manage pain; B - Both spontaneous awakening trials and spontaneous breathing trials; C - Choice of analgesia and sedation; D - Delirium: assess, prevent, and manage; E - Early mobility/exercise; F - Family engagement/empowerment) is associated with improvements in a number of important patient-centered outcomes. Despite its demonstrated safety and effectiveness, overall adoption of the ABCDEF bundle and its individual components into everyday clinical practice remains low.

Purpose: The purpose of the scoping review is to identify strategies used by prior studies and quality improvement (QI) efforts to facilitate ABCDEF bundle implementation and critically evaluate the implementation strategies that were used to facilitate adoption of this evidence-based, interprofessional intervention.

Methods: A scoping review of electronic databases (CINAHL, PubMed, Web of Science, Scopus, PsychInfo, Medline) was completed. Research studies, QI projects, systematic reviews, or metanalyses published from 2009-2020, in English, and available as full-text articles which described implementation of either the ABCDE bundle or ABCDEF bundle in the intensive care unit were eligible for inclusion. Studies that did not explicitly mention the ABCDE or ABCDEF bundle, were conducted solely with the pediatric population, or focused only on one element of the bundle (e.g., early mobility) were excluded. The Expert Recommendations for Implementing Change (ERIC) compilation provided 73 implementation strategies used to guide data extraction. Content analysis was performed and summary statistics were reported.

Results: Ten studies were eligible after screening 368 titles and abstracts and reviewing 23 full-text studies. Across studies, an average of 35 different strategies were used, with studies integrating a range of 8-54 strategies per study. The most frequently used implementation

strategies included an implementation glossary, educational materials, bundle facilitation, providing clinical supervision, and recruiting/training for leadership. Seventeen ERIC strategies were not used and, importantly, no studies reported testing the effectiveness of any of the implementation strategies efforts that were used to increase bundle adoption.

Implications for practice: Future evaluation of implementation strategies used in ABCDEF bundle implementation is essential to effectively allocate efforts and resources. Future research should focus on t identifying, testing, and reporting the specific methods and resources needed for effective and sustained ABCDEF bundle implementation. Until effective implementation is understood, the excessively high morbidity, mortality, and cost associated with standard critical care delivery will continue and the public health benefit of the ABCDEF bundle will not be fully realized.

Keywords: ABCDEF bundle, implementation, barriers, facilitators, intensive care unit, ICU

Introduction

The current mortality and healthcare resource utilization related to the ongoing COVID-19 global pandemic highlight the importance of evidence-based and effective delivery of critical care services. While peak death toll and health system resource estimates differ widely, a sudden, unprecedented, and ongoing need for mechanical ventilation and intensive care unit (ICU) services is highly anticipated (Ferguson, et al., 2020). To achieve maximal societal benefit in this time of great need and uncertainty, it is imperative we identify and test pragmatic ways of successfully integrating evidence-based ICU interventions into everyday practice.

A robust and growing body of research demonstrates clinical outcomes improve when integrated, interprofessional approaches to mechanical ventilation (MV) liberation, symptom management, and immobility are applied early during critical illness. One such innovation is the ABCDEF bundle. The ABCDEF bundle (A - Assess, prevent, and manage pain; B - Both spontaneous awakening trials and spontaneous breathing trials; C - Choice of analgesia and sedation; D - Delirium: assess, prevent, and manage; E - Early mobility/exercise; F - Family engagement/empowerment) is a group of evidence-based interventions carried out by the multidisciplinary team that was created in response to the often harmful iatrogenic effects of critical illness and critical care practices (Ely, 2017). When applied in practice, ABCDEF bundle performance is associated with meaningful improvements in hospital survival, mechanical ventilation duration, coma and delirium rates, restraint-free care, ICU readmissions, and post-ICU discharge disposition (Pun et al., 2019). These outcomes not only impact the patient's quality of life, but also have the potential for significant cost-savings for hospital systems (Kram, 2017). Even if not implemented in its entirety, a higher percentage of bundle implementation correlates to better patient outcomes (Barnes-Daly, Phillips, & Ely, 2017). Unfortunately, studies

continue to demonstrate ABCDEF bundle adoption remains dismally low, with one international survey indicating only 57% of ICUs have implemented the bundle with differing rates of compliance (Morandi et al., 2017), indicating that clinicians continue to struggle with multiple barriers to bundle delivery (Costa et al., 2017).

Recent research has focused on identifying barriers and facilitators to effective ABCDE and ABCDEF bundle implementation, an important contribution to our understanding of how to translate evidence into practice. Barriers to bundle implementation include unclear protocol or lack of knowledge as well as patient, clinician, protocol, and ICU setting- related factors (Costa et al., 2017). A consistently established barrier to successful bundle implementation is its complex nature and need to interdisciplinary team coordination (Costa et al., 2017). However, because a dose-responsive relationship exists; even partial implementation of the bundle significantly improves patient outcomes (Pun et al, 2019). Providers can be encouraged, then, that even imperfect implementation of the bundle has significant impact on patient outcomes. A few key facilitators to bundle implementation include tailoring already developed protocols to specific unit needs, easy access to bundle-related supplies and equipment, and more ancillary staff (Balas et al., In press). Implementation efforts, then, must involve a dual effort to capitalize on these facilitators and overcome the barriers to ABCDEF bundle use.

Information about barriers and facilitators suggest the process of implementing complex interventions requires careful planning, resources, and evidence-based guidance (Balas, 2013). There remains, however, a gap in understanding how to most effectively implement the ABCDEF bundle into the critical care setting. Implementation science is the study of methods to enhance adoption, uptake, and integration of evidence-based practice, interventions, and policies into the health care setting (Powell et al., 2015). Implementation strategies are those methods

used to accomplish the integration of clinical innovations. The Expert Recommendations for Implementing Change (ERIC) compilation offers conceptual clarity to the field of implementation research by offering terms and definitions for implementation strategies (Powell et al., 2015). Developed by implementation experts, a total of 73 discrete implementation strategies and corresponding definitions are offered in the ERIC compilation. Implementation experts have divided these strategies into thematic concept categories and ranked individual strategies by importance and feasibility (Waltz et al., 2015).

While there is a growing body of literature identifying the barriers and facilitators to ABCDEF bundle implementation, there remains a lack of evidence-based guidance on specific implementation strategies used to address barriers and leverage facilitators when implementing the bundle. Thus, this scoping review seeks to determine which ERIC implementation strategies have been used in past ABCDEF bundle implementation efforts and to examine if certain implementation strategies are more effective than others in increasing ABCDEF bundle implementation.

Methods

The reporting of this scoping review adheres to the Preferred Reporting Items for Systematic reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) checklist (Tricco et al., 2018). A scoping review was deemed appropriate for the topic of interest due to the emerging nature of the research. To contrast scoping reviews and systematic reviews, the former aims to identify gaps in the research and identify and present the existing range of research to guide practice and future research efforts; the latter actively synthesizes existing evidence to generate recommendations (Peters et. al., 2015). The purpose of this research inquiry is to identify strategies used by prior studies and quality improvement (QI) efforts to facilitate

ABCDEF bundle implementation and critically evaluate the implementation strategies to highlight areas for future research. As such, a scoping review was conducted.

Conceptual Model

The Consolidated Framework for Implementation Research (CFIR) was used to guide this scoping review. CFIR is a conceptual framework which can be used to identify factors which could affect the implementation and effectiveness of an intervention, specifically assessing factors from a multilevel perspective. The CFIR is used to categorize factors affecting implementation into five major domains: intervention characteristics, outer setting, inner setting, characteristics of the individuals involved, and the process of implementation (Damschroder et al., 2009).

Eligibility criteria

Research studies, QI projects, systematic reviews, or metanalyses published in English and available as full-text articles which described an implementation strategy of either the ABCDE bundle or ABCDEF bundle implementation in the intensive care unit were eligible for inclusion. Studies that did not explicitly mention the ABCDE or ABCDEF bundle, were conducted with only the pediatric population, or focused only on one element of the bundle (e.g., early mobility) were excluded.

Information sources

Electronic databases CINAHL, PubMed, Web of Science, Scopus, and Embase were searched for studies published from 2009-2020. The search terms used were “ABCDEF bundle” OR “ABCDE bundle.” Data in this review come from a search completed on January 21st, 2020.

Search

The full electronic search was completed using the terms "ABCDEF bundle" OR "ABCDE bundle" and using date constraints from January 2009- January 2020. The final search was completed in January 2020, so this month was included in the last ten years inclusion criteria due to several potentially relevant articles being published during this month.

Selection of sources of evidence

After removing duplicates, the initial search resulted in 368 unique articles (see Figure 1). Titles and abstracts were then reviewed for eligibility by two reviewers and 345 studies were excluded. Twenty-three full text-articles were reviewed by the same two reviewers and 10 were selected for ultimate inclusion. Disagreements on inclusion were resolved through discussion between the two reviewers (PD, MB) until a consensus was met.

Data charting process

We used the 73 implementation strategies developed by the ERIC project to guide data extraction (see Table 1). Eligible studies were vetted for identification of specific implementation strategies using both the name and definition of the strategy as defined by the ERIC project. When appropriate, supplemental materials provided by studies were consulted. Discrepancies were discussed by two reviewers until consensus was met.

Two reviewers (MB and PD) independently reviewed all titles and abstracts of studies using the eligibility criteria. Any discrepancies in selection were discussed until a consensus was reached. After excluding ineligible sources, MD and PD completed data extraction of eligible sources and entered results into an electronic spreadsheet. Extracted data included: 1) authors, 2) title, 3) years which study was conducted, 4) study design, 5) ABCDE or ABCDEF bundle, 6) number of participants, 7) type of ICU, 8) guiding theory, 9) safety screen success or failure

criteria, 10) definition of bundle compliance, 11) actual bundle compliance, 12) provider outcomes, 13) patient and clinical outcomes, 12) cost outcomes, 13) implementation strategies, 14) barriers, 15) facilitators, 16) perceived benefits, 17) definition of each component, 18) how each bundle component is measured.

Results

The initial search yielded 454 results (see Figure 1). After removing duplicates, the search resulted in 368 unique articles. Titles and abstracts were then reviewed for eligibility and 345 studies were excluded. Twenty-three full text-articles were reviewed and 10 were selected for inclusion. After excluding studies which did not specifically address the strategies used to implement the bundle, the review included 10 unique research articles (see Table 2). Of these 10, 4 manuscripts reported the implementation methods used in to discrete collaborative initiatives: Balas 2013 & Balas 2014 came from a Robert Wood Johnson Foundation Interdisciplinary Nursing Quality Research Initiative: Barnes-Daly 2018 & Pun 2019 came from the ICU Liberation ABCDEF collaborative. Thus, in total, eight discrete implementation efforts were analyzed. The earliest study was published in 2013 and the most recent was 2019. The sample size of the studies ranged from 30 patients to over 17,000 patients. Six out of eight implementation efforts utilized the ABCDE bundle and the remaining two implemented the ABCDEF bundle (Table 2).

Across studies, an average of 35 different strategies were used, with studies integrating a range of 8-54 strategies per study (Table 3). Five implementation strategies were used by all eight implementation efforts. These strategies included develop an implementation glossary, educational materials, bundle facilitation, providing clinical supervision, and recruiting/training for leadership. These strategies fell into the three concept categories of develop stakeholder

interrelationships (n=2), provide interactive assistance (n=2), and train and educate stakeholders (n=1).

Seventeen ERIC strategies were not utilized by the studies (see Table 4). These strategies fell into the concept categories of utilize financial strategies (n=8), change infrastructure (n=4), engage consumers (n=2), adapt and tailor to the context (n=1), provide interactive assistance (n=1), and train and educate stakeholders (n=1). Also, of note, only one collaborative reported using patient and family driven strategies, such as prepare patients/consumers to be active participants, obtain and use patients/consumers and family feedback, and involve patients/consumers and family members.

Importantly, when screened for the evaluation of implementation strategies, no studies reported evaluating the effectiveness of any individual implementation strategies. Likewise, none purposefully compared the use of certain implementation strategies versus others, so it is not possible to understand which strategies were significantly effective or ineffective. Studies did consistently evaluate overall bundle adherence, but because individual strategies were not assessed, it is not possible to understand if certain strategies promote bundle adherence more than others. Additionally, few studies reported long-term follow up on bundle adherence, so a gap in understanding of how to implement the bundle in a sustainable way remains.

Discussion

As the demand for mechanical ventilation and critical care services grows, there is an urgent need to ensure safe and effective evidence-based interventions are delivered in a timely, systematic, and reliable way in everyday ICU practice. Unfortunately, translational delays continue as evidenced by the relatively low global ABCDEF bundle performance rates (Morandi et al., 2017). The purpose of this scoping review was to determine which ERIC implementation

strategies have been used in past ABCDEF bundle implementation efforts and to examine if certain implementation strategies are more effective than others in increasing ABCDEF bundle implementation. We found many evidence-based implementation strategies suggested in the ERIC project were used to foster ABCDEF bundle implementation. Unfortunately, no studies to date have evaluated which of these strategies are most effective. Implementation outcomes, such as bundle adherence and compliance, were reported by some studies, but these outcomes cannot be attributed to particular implementation strategies as studies did not evaluate strategies individually. This is important considering the time, cost, and human resources needed to deliver the implementation strategies.

The high average number of implementation strategies used per project (35.6) indicates researchers understand the complexity associated with implementing the ABCDEF bundle. The five implementation strategies used by all eight efforts, develop an implementation glossary, develop educational materials, facilitation, provide clinical supervision, and recruit, designate, and train for leadership, demonstrate a diverse approach to implementing the bundle. These strategies fell into the three concept categories of develop stakeholder interrelationships (n=2), provide interactive assistance (n=2), and train and educate stakeholders (n=1), all categories which focus on preparing team members. This finding reveals a general acceptance that working with individuals must be a key component in the implementation of a new intervention. In initial implementation, the equipping of individuals may be a key strategy, but we would hypothesize that to support sustained implementation, there should be more emphasis on creating an infrastructure which will support the bundle. There is a definite need to integrate a comprehensive, systematic approach to implementation to ensure not only initial adoption and adherence, but to ensure sustainability and hardwiring of the intervention over time.

Only one implementation effort described using patient and family-driven strategies. It is important to note, though, that only two implementation efforts utilized the most recent edition of the bundle (ABCDEF), which includes family engagement and empowerment as a key component. Because family engagement and empowerment were not a priority in the original bundle, the minimal use of this group of strategies is an expected finding.

When considering the 17 ERIC strategies not utilized by any efforts (see Table 3), it is noteworthy that eight of these unused strategies were financially oriented. As a growing body of research (Kram, 2017) demonstrates the cost-saving effect of ABCDEF bundle implementation, hospital systems or insurance entities may benefit from financially penalizing units which do not utilize this bundle on appropriate patients. This may increase the urgency of bundle implementation, promoting better patient outcomes and quicker translation of evidence into practice. Such strategies have been used successfully in the critical care setting before. One quality improvement project used provider education, audit and feedback, and unit-based provider financial incentives to improve resource utilization in the ICU; these strategies resulted in significant cost savings and repeated in a subsequent year (Murphy et al., 2016). Noting the contention that surrounds financial incentives in clinical practice, the authors offer necessary components to using financial incentives ethically: the incentive should be evidence-based, an amount which catches unit attention but is not excessive, and unit-level incentives versus individually-based incentives should be used because they encourage providers to asses overall practice, not make decisions on a individual patient level. The concern is fair, too, of how sustainable it is for units to utilize financial incentives or disincentives. But, a key benefit of unit-based incentives, as stated above, is change to provider practice totally, not on a patient-to-

patient level. As such, the duration of the incentives may only need to be as long as it takes to alter practice norms until the use of the ABCDEF bundle becomes as widespread as is necessary.

Importantly, no studies evaluated the effectiveness of individual implementation strategies. Ultimately, this poses a major risk for hospital systems in the potential wasting manpower and resources to employ potentially ineffective implementation strategies.

As there remains a gap in the literature for research trial that identify, test, and report the methods and resources needed for efficient and sustained ABCDEF bundle implementation, there is little evidence-based guidance on how to most effectively implement the interventions. Hospital systems are left to anecdotal evidence to guide their efforts and, in such, lack accuracy and efficiency in their efforts. Being that a common barrier to bundle implementation is perceived increased workload, understanding which implementation strategies are or are not effective could decrease staff burden. At its current state, the school of thought in implementing the ABCDEF bundle is to try a wide variety of strategies and to hope that the combination will produce some effects that stick. One might envision a dart board at which a player throws a handful of many darts, all at the same time, with the hopes that a few of the darts hit the target. This, however, is an inaccurate technique and not a sustainable use of resources. A more innovative method would be to use fewer darts, individually thrown, using greater precision to hit the target. If implementation strategies were evaluated individually, we could transition to an era of refined ABCDEF bundle implementation which was more precise, more effective, and less cumbersome. Closer evaluation of future bundle implementation efforts will benefit hospital systems and help drive ABCDEF bundle implementation into an efficient, sustainable matter.

Several qualities strengthened this scoping review. First, using broad search terms allowed the authors to review every potential article including ABCDE and ABCDEF bundle,

leaving little room for missing information. Another key strength was the double screening done independently by both authors, which occurred at every major step of the review and ensured accuracy in the data reported. Several limitations are clear in this scoping review, too. First, because no studies evaluated the effectiveness of individual implementation efforts, this review is unable to comment on which implementation strategies are the most effective in aiding bundle implementation. Additionally, there was not uniform language used by studies in describing their implementation efforts. Therefore, it is possible that the reviewers misinterpreted the methodology of an implementation effort, resulting in either misattribution of a strategy which was not used or failure to recognize a strategy which was utilized. In future articles describing implementation efforts, the use of uniform language to describe implementation strategies, such as those offered by the ERIC project, would minimize this potential for error.

Conclusion

A variety of implementation strategies have been used in attempts to integrate the ABCDEF bundle into routine critical care. This scoping review presents a summary of common strategies and highlights the need for additional research to systematically evaluate the effectiveness of strategies on implementation and patient outcomes. Future research using an implementation science approach to critically evaluate effectiveness of strategies would provide valuable information to clinicians on optimal methods for bundle adoption, adherence, and sustained integration over time.

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Tables

Table 1. Definitions of ERIC strategies.

ERIC Strategy	Definition
Access new funding	Access new or existing money to facilitate the implementation
Alter incentive/allowance structures	Work to incentivize the adoption and implementation of the clinical innovation
Alter patient/consumer fees	Create fee structures where patients/consumers pay less for preferred treatments (the clinical innovation) and more for less-preferred treatments
Assess for readiness and identify barriers and facilitators	Assess various aspects of an organization to determine its degree of readiness to implement, barriers that may impede implementation, and strengths that can be used in the implementation effort
Audit and provide feedback	Collect and summarize clinical performance data over a specified time period and give it to clinicians and administrators to monitor, evaluate, and modify provider behavior
Build a coalition	Recruit and cultivate relationships with partners in the implementation effort
Capture and share local knowledge	Capture local knowledge from implementation sites on how implementers and clinicians made something work in their setting and then share it with other sites
Centralize technical assistance	Develop and use a centralized system to deliver technical assistance focused on implementation issues
Change accreditation or membership requirements	Strive to alter accreditation standards so that they require or encourage use of the clinical innovation. Work to alter membership organization requirements so that those who want to affiliate with the organization are encouraged or required to use the clinical innovation
Change liability laws	Participate in liability reform efforts that make clinicians more willing to deliver the clinical innovation
Change physical structure and equipment	Evaluate current configurations and adapt, as needed, the physical structure and/or equipment (e.g., changing the layout of a room, adding equipment) to best accommodate the targeted innovation
Change record systems	Change records systems to allow better assessment of implementation or clinical outcomes
Change service sites	Change the location of clinical service sites to increase access
Conduct cyclical small tests of change	Implement changes in a cyclical fashion using small tests of change before taking changes system-wide. Tests of change benefit from systematic measurement, and results of the tests of change are studied for insights on how to do better. This process continues serially over time, and refinement is added with each cycle

Conduct educational meetings	Hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, and community, patient/consumer, and family stakeholders) to teach them about the clinical innovation
Conduct educational outreach visits	Have a trained person meet with providers in their practice settings to educate providers about the clinical innovation with the intent of changing the provider's practice
Conduct local consensus discussions	Include local providers and other stakeholders in discussions that address whether the chosen problem is important and whether the clinical innovation to address it is appropriate
Conduct local needs assessment	Collect and analyze data related to the need for the innovation
Conduct ongoing training	Plan for and conduct training in the clinical innovation in an ongoing way
Create a learning collaborative	Facilitate the formation of groups of providers or provider organizations and foster a collaborative learning environment to improve implementation of the clinical innovation
Create new clinical teams	Change who serves on the clinical team, adding different disciplines and different skills to make it more likely that the clinical innovation is delivered (or is more successfully delivered)
Create or change credentialing and/or licensure standards	Create an organization that certifies clinicians in the innovation or encourage an existing organization to do so. Change governmental professional certification or licensure requirements to include delivering the innovation. Work to alter continuing education requirements to shape professional practice toward the innovation
Develop a formal implementation blueprint	Develop a formal implementation blueprint that includes all goals and strategies. The blueprint should include the following: 1) aim/purpose of the implementation; 2) scope of the change (e.g., what organizational units are affected); 3) timeframe and milestones; and 4) appropriate performance/progress measures. Use and update this plan to guide the implementation effort over time
Develop academic partnerships	Partner with a university or academic unit for the purposes of shared training and bringing research skills to an implementation project
Develop an implementation glossary	Develop and distribute a list of terms describing the innovation, implementation, and stakeholders in the organizational change
Develop and implement tools for quality monitoring	Develop, test, and introduce into quality-monitoring systems the right input—the appropriate language, protocols, algorithms, standards, and measures (of processes, patient/consumer outcomes, and implementation outcomes) that are often specific to the innovation being implemented
Develop and organize quality monitoring systems	Develop and organize systems and procedures that monitor clinical processes and/or outcomes for the purpose of quality assurance and improvement
Develop disincentives	Provide financial disincentives for failure to implement or use the clinical innovations

Develop educational materials	Develop and format manuals, toolkits, and other supporting materials in ways that make it easier for stakeholders to learn about the innovation and for clinicians to learn how to deliver the clinical innovation
Develop resource sharing agreements	Develop partnerships with organizations that have resources needed to implement the innovation
Distribute educational materials	Distribute educational materials (including guidelines, manuals, and toolkits) in person, by mail, and/or electronically
Facilitate relay of clinical data to providers	Provide as close to real-time data as possible about key measures of process/outcomes using integrated modes/channels of communication in a way that promotes use of the targeted innovation
Facilitation	A process of interactive problem solving and support that occurs in a context of a recognized need for improvement and a supportive interpersonal relationship
Fund and contract for the clinical innovation	Governments and other payers of services issue requests for proposals to deliver the innovation, use contracting processes to motivate providers to deliver the clinical innovation, and develop new funding formulas that make it more likely that providers will deliver the innovation
Identify and prepare champions	Identify and prepare individuals who dedicate themselves to supporting, marketing, and driving through an implementation, overcoming indifference or resistance that the intervention may provoke in an organization
Identify early adopters	Identify early adopters at the local site to learn from their experiences with the practice innovation
Increase demand	Attempt to influence the market for the clinical innovation to increase competition intensity and to increase the maturity of the market for the clinical innovation
Inform local opinion leaders	Inform providers identified by colleagues as opinion leaders or "educationally influential" about the clinical innovation in the hopes that they will influence colleagues to adopt it
Intervene with patients/consumers to enhance uptake and adherence	Develop strategies with patients to encourage and problem solve around adherence
Involve executive boards	Involve existing governing structures (e.g., boards of directors, medical staff boards of governance) in the implementation effort, including the review of data on implementation processes
Involve patients/consumers and family members	Engage or include patients/consumers and families in the implementation effort
Make billing easier	Make it easier to bill for the clinical innovation
Make training dynamic	Vary the information delivery methods to cater to different learning styles and work contexts, and shape the training in the innovation to be interactive
Mandate change	Have leadership declare the priority of the innovation and their determination to have it implemented

Model and simulate change	Model or simulate the change that will be implemented prior to implementation
Obtain and use patients/consumers and family feedback	Develop strategies to increase patient/consumer and family feedback on the implementation effort
Obtain formal commitments	Obtain written commitments from key partners that state what they will do to implement the innovation
Organize clinician implementation team meetings	Develop and support teams of clinicians who are implementing the innovation and give them protected time to reflect on the implementation effort, share lessons learned, and support one another's learning
Place innovation on fee for service lists/formularies	Work to place the clinical innovation on lists of actions for which providers can be reimbursed (e.g., a drug is placed on a formulary, a procedure is now reimbursable)
Prepare patients/consumers to be active participants	Prepare patients/consumers to be active in their care, to ask questions, and specifically to inquire about care guidelines, the evidence behind clinical decisions, or about available evidence-supported treatments
Promote adaptability	Identify the ways a clinical innovation can be tailored to meet local needs and clarify which elements of the innovation must be maintained to preserve fidelity
Promote network weaving	Identify and build on existing high-quality working relationships and networks within and outside the organization, organizational units, teams, etc. to promote information sharing, collaborative problem-solving, and a shared vision/goal related to implementing the innovation
Provide clinical supervision	Provide clinicians with ongoing supervision focusing on the innovation. Provide training for clinical supervisors who will supervise clinicians who provide the innovation
Provide local technical assistance	Develop and use a system to deliver technical assistance focused on implementation issues using local personnel
Provide ongoing consultation	Provide ongoing consultation with one or more experts in the strategies used to support implementing the innovation
Purposely reexamine the implementation	Monitor progress and adjust clinical practices and implementation strategies to continuously improve the quality of care
Recruit, designate, and train for leadership	Recruit, designate, and train leaders for the change effort
Remind clinicians	Develop reminder systems designed to help clinicians to recall information and/or prompt them to use the clinical innovation
Revise professional roles	Shift and revise roles among professionals who provide care, and redesign job characteristics
Shadow other experts	Provide ways for key individuals to directly observe experienced people engage with or use the targeted practice change/innovation
Stage implementation scale up	Phase implementation efforts by starting with small pilots or demonstration projects and gradually move to a system wide rollout

Start dissemination organization	Identify or start a separate organization that is responsible for disseminating the clinical innovation. It could be a for-profit or non-profit organization
Tailor strategies	Tailor the implementation strategies to address barriers and leverage facilitators that were identified through earlier data collection
Use advisory boards and workgroups	Create and engage a formal group of multiple kinds of stakeholders to provide input and advice on implementation efforts and to elicit recommendations for improvements
Use an implementation advisor	Seek guidance from experts in implementation
Use capitated payments	Pay providers or care systems a set amount per patient/consumer for delivering clinical care
Use data experts	Involve, hire, and/or consult experts to inform management on the use of data generated by implementation efforts
Use data warehousing techniques	Integrate clinical records across facilities and organizations to facilitate implementation across systems
Use mass media	Use media to reach large numbers of people to spread the word about the clinical innovation
Use other payment schemes	Introduce payment approaches (in a catch-all category)
Use train-the-trainer strategies	Train designated clinicians or organizations to train others in the clinical innovation
Visit other sites	Visit sites where a similar implementation effort has been considered successful
Work with educational institutions	Encourage educational institutions to train clinicians in the innovation

Table 2. Characteristics of included studies.

Author, Year	Setting/sample size	Design	Guiding Theory/Framework	ABCDE or ABCDEF Bundle
Balas, 2013	463 adults in a 624-bed academic medical center	Prospective, before-after, mixed-methods study	CFIR	ABCDE
Balas, 2014	296 adults in a 624-bed academic medical center	Prospective, cohort, before-after	CFIR	ABCDE
Barnes-Daly, 2016	6064 MICU/SICU patients from 7 community hospitals	Prospective cohort quality improvement initiative	____	ABCDEF
Barnes-Daly, 2018	Over 17,000 from 75 ICUs	QI project	CFIR, Plan-Do-Study-Act	ABCDEF
Carrothers, 2013	81 ICU providers from open/mixed MICU, SICU	QI project	_____	ABCDE
Hsieh, 2015	1855 MV adults in 2 ICUs	Prospective cohort study	_____	ABCDE
Kram, 2015	83 adults in one ICU	QI pre/post implementation	John Hopkins Nursing Evidence-Based Practice Model	ABCDE
Pun, 2019	15,226 adults (MV or no MV) from 68 ICUs	Prospective, multicenter, cohort study from a national QI collaborative	_____	ABCDEF
Ren, 2017	143 adults on MV in one ICU	Cross-sectional overall, before-after controlled study	_____	ABCDE
Sosnowski, 2018	30 MV adults from one ICU	Prospective, single center, randomized controlled feasibility study	United Kingdom Medical Research Council's framework	ABCDE

Note: ABCDE: A - Awakening and B - breathing C - coordination, D - delirium monitoring/management, and E - early exercise/mobility. ABCDEF: A - Assess, prevent, and manage pain; B - Both spontaneous awakening trials and spontaneous breathing trials; C - Choice of analgesia and sedation; D - Delirium: assess, prevent, and manage; E - Early mobility/exercise; F - Family engagement/empowerment.

Table 3. Summary of Implementation Strategies Reported Across Studies

	Balas (2013) Balas (2014)	Barnes-Daley (2016)	Barnes-Daley (2018) Pun (2019)	Carrothers (2013)	Hsieh (2017)	Kram (2015)	Ren (2017)	Sosnowski (2018)
Access new funding	X	X	X	X	X	X	--	X
Assess for readiness and identify barriers and facilitators	X	--	X	X	X	X	--	X
Audit and provide feedback	X	X	X	X	X	X	--	--
Build a coalition	X	X	X	X	--	--	--	--
Capture and share local knowledge	X	X	X	X	X	--	--	X
Centralize technical assistance	X	--	X	--	--	--	--	X
Change physical structure and equipment	--	--	--	X	X	X	--	--
Change record systems	X	X	X	X	X	X	--	X
Conduct cyclical small tests of change	--	--	X	--	X	--	--	--
Conduct educational meetings	X	X	X	X	X	X	--	X
Conduct educational outreach visits	X	X	X	X	--	--	--	--
Conduct local consensus discussions	X	--	X	X	--	--	--	X
Conduct local needs assessment	X	X	X	X	X	X	--	X
Conduct ongoing training	X	X	X	X	X	X	--	X

Create a learning collaborative	--	--	X	X	--	--	--	--
Create new clinical teams	--	X	X	--	X	X	--	X
Develop a formal implementation blueprint	X	X	X	--	X	X	--	X
Develop academic partnerships	X	--	X	--	--	X	--	--
Develop an implementation glossary	X	X	X	X	X	X	X	X
Develop and implement tools for quality monitoring	X	--	X	--	X	X	--	X
Develop and organize quality monitoring systems	X	--	X	--	X	X	--	X
Develop educational materials	X	X	X	X	X	X	X	X
Develop resource sharing agreements	X	X	X	--	--	--	--	--
Distribute educational materials	X	X	X	--	X	X	X	X
Facilitate relay of clinical data to providers	X	X	X	X	X	X	--	--
Facilitation	X	X	X	X	X	X	X	X
Identify and prepare champions	X	X	X	X	X	X	--	X
Identify early adopters	X	X	X	X	X	X	--	X
Inform local opinion leaders	X	X	X	--	--	X	--	X
Intervene with patients/consumers to	--	--	X	--	--	--	--	--

enhance uptake and adherence								
Involve executive boards	X	X	X	X	X	X	--	--
Involve patients/consumers and family members	--	--	X	--	--	--	--	--
Make training dynamic	X	X	X	X	X	X	--	X
Mandate change	X	X	--	X	X	X	X	X
Model and simulate change	X	X	X	X	X	--	--	X
Obtain and use patients/consumers and family feedback	--	--	X	--	--	--	--	--
Obtain formal commitments	X	--	X	X	X	X	--	--
Organize clinician implementation team meetings	X	X	X	X	X	X	--	X
Prepare patients/consumers to be active participants	--	--	X	--	--	--	--	--
Promote adaptability	X	X	X	X	X	X	X	--
Promote network weaving	X	X	X	X	--	--	--	--
Provide clinical supervision	X	X	X	X	X	X	X	X
Provide ongoing consultation	X	X	X	X	X	X	--	X
Purposely reexamine the implementation	X	X	X	X	X	X	--	X

Recruit, designate, and train for leadership	X	X	X	X	X	X	X	X
Remind clinicians	X	X	X	X	X	X	--	X
Revise professional roles	--	X	X	--	--	X	--	X
Stage implementation scale up	X	--	X	X	X	X	--	--
Start dissemination organization	--	--	X	--	--	--	--	--
Tailor strategies	X	X	X	X	X	X	--	X
Use advisory boards and workgroups	X	X	X	X	X	X	--	X
Use an implementation advisor	--	--	X	X	--	--	--	--
Use data warehousing techniques	--	--	X	X	--	--	--	--
Use train-the-trainer strategies	X	X	X	X	--	--	--	--
Visit other sites	--	--	X	--	--	--	--	--
Work with educational institutions	X	X	X	X	--	--	--	--

Table 4. Unutilized implementation strategies.

ERIC Strategy	Description
Utilize financial strategies (n=8)	
Alter incentive/allowance structures	Work to incentivize the adoption and implementation of the clinical innovation
Alter patient/consumer fees	Create fee structures where patients/consumers pay less for preferred treatments (the clinical innovation) and more for less-preferred treatments
Develop disincentives	Provide financial disincentives for failure to implement or use the clinical innovations
Fund and contract for the clinical innovation	Governments and other payers of services issue requests for proposals to deliver the innovation, use contracting processes to motivate providers to deliver the clinical innovation, and develop new funding formulas that make it more likely that providers will deliver the innovation
Make billing easier	Make it easier to bill for the clinical innovation
Place innovation on fee for service lists/formularies	Work to place the clinical innovation on lists of actions for which providers can be reimbursed (e.g., a drug is placed on a formulary, a procedure is now reimbursable)
Use capitated payments	Pay providers or care systems a set amount per patient/consumer for delivering clinical care
Use other payment schemes	Introduce payment approaches (in a catch-all category)
Change infrastructure (n=4)	
Change accreditation or membership requirements	Strive to alter accreditation standards so that they require or encourage use of the clinical innovation. Work to alter membership organization requirements so that those who want to affiliate with the organization are encouraged or required to use the clinical innovation
Change liability laws	Participate in liability reform efforts that make clinicians more willing to deliver the clinical innovation
Change service sites	Change the location of clinical service sites to increase access
Create or change credentialing and/or licensure standards	Create an organization that certifies clinicians in the innovation or encourage an existing organization to do so. Change governmental professional certification or licensure requirements to include delivering the innovation. Work to alter continuing education requirements to shape professional practice toward the innovation
Engage customers (n=2)	

Increase demand	Attempt to influence the market for the clinical innovation to increase competition intensity and to increase the maturity of the market for the clinical innovation
Use mass media	Use media to reach large numbers of people to spread the word about the clinical innovation
Adapt & tailor to context (n=1)	
Use data experts	Involve, hire, and/or consult experts to inform management on the use of data generated by implementation efforts
Provide interactive assistance (n=1)	
Provide local technical assistance	Develop and use a system to deliver technical assistance focused on implementation issues using local personnel
Train & educate stakeholders (n=1)	
Shadow other experts	Provide ways for key individuals to directly observe experienced people engage with or use the targeted practice change/innovation

Figures

Figure 1. PRISMA diagram of eligible studies