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Ability to Predict Team Members' Behaviors in ICU Teams is Associated with Routine ABCDE implementation

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Abstract

Purpose: Poor coordination may impede delivery of the Awakening, Breathing Coordination, Delirium monitoring/management and Early exercise/mobility (ABCDE) bundle. Developing a shared mental model (SMM), where all team members are on the same page, may support coordination.

Materials and Methods: We administered a survey at the 2016 MHA Keystone Center ICU workshop. We measured different components of SMMs using five items from a validated survey, each on a 5-point Likert scale (strongly agree—strongly disagree). We measured self-reported routine ABCDE implementation using a single item 4-point Likert scale (ABCDE is routine—Made no steps to implement ABCDE). We examined the relationship between SMMs and routine ABCDE implementation using logistic regression, adjusting for confounders.

Results: Among the 206 (75%) responses, 157 (84%) reported using the ABCDE bundle and 80 (51% of 157) reported routine use. When clinicians agreed it was difficult to predict team members' behaviors, the odds of reporting routine ABCDE implementation significantly decreased [0.26 (0.10–0.66)]. Other SMM components related to knowing team members' skills, access to information, team adaptability, and team help behavior, were not significantly associated with the outcome.

Conclusion: Increasing awareness of team members' behaviors may be a mechanism to improve the implementation of complex care bundles like ABCDE.

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Keywords

Mechanical Ventilation; Shared Mental Model; Teamwork; Implementation Science

Introduction

Delivering the Awakening, Breathing Coordination, Delirium monitoring/management and Early exercise/mobility (ABCDE) care bundle to mechanically ventilated patients can reduce risk for iatrogenic harm [1–3]. Despite this knowledge, the ABCDE bundle remains difficult to implement in practice [4–6]. A systematic review on barriers to ABCDE bundle implementation identifies poor interprofessional coordination and teamwork as major contributing barriers to routine bundle delivery [7]. However, no interventions currently exist to facilitate coordination or to improve teamwork among clinicians who deliver the ABCDE bundle. To address this gap, it is necessary to first identify the specific mechanisms that may support coordination and teamwork in this complex care practice.

In the extant literature, developing a shared mental model (SMM) between team members is consistently identified as a mechanism that can facilitate coordination and improve overall team performance [8–14]. A SMM is a mutual knowledge structure shared by all team members concerning who is a part of the team, what their respective roles are, and how team members will work together to complete designated team tasks [15–20]. More simply, having a SMM is defined as team members “being on the same page” [21]. Team members demonstrate a SMM when they can explain the unique functions and responsibilities of their fellow team members and predict how each team member will behave in different team activities [8; 15]. By being able to predict each other’s behaviors, team members are better able to implicitly coordinate interdependent tasks which can improve overall team performance [9]. As such, many high-performing teams exhibit a SMM [8–14]. But the relationship between SMMs among ICU clinicians and complex care delivery has yet to be explored. Delivering complex interventions like the ABCDE bundle requires close coordination between multiple members of the ICU team and so it stands to reason that the presence, or absence, of a SMM may influence care delivery.

The purpose of the current study is to examine if perceptions of SMMs among ICU clinicians are associated with increased self-reported ABCDE bundle implementation—and if so, which components of the SMM are most useful in supporting routine implementation. Using items from a previously validated survey, we asked critical care clinicians to evaluate different components of their ICU team SMM including awareness of team members’ skills, ability to access information from team members, team adaptability, teammate willingness to provide help, and ability to predict other team members’ behaviors in patient care delivery [22]. We also asked how routinely their ICU team implements the ABCDE bundle. We hypothesized that reporting the presence of a SMM will be associated with greater odds of routine self-reported ABCDE bundle implementation.

Materials and Methods

Design

We administered a cross-sectional in-person electronic survey to critical care clinicians attending the annual Michigan Health and Hospital Association (MHA) Keystone Center ICU workshop in September 2016. The MHA Keystone Center operates a statewide ICU quality collaborative whose mission is to improve the delivery of ICU care in Michigan. Annual surveys have been administered at the workshop each year to examine ICU care practices since 2011 [5; 23–26]. Attendees include staff nurses, representatives from nursing leadership (managers, educators, and clinical nurse specialists), allied health professionals (respiratory therapists, physical, occupational, and speech therapists, clinical pharmacists), physicians, nurse practitioners/physician assistants, medical directors, and hospital administrators. All workshop attendees, excluding MHA Keystone staff, were eligible to participate in the survey.

The 2016 workshop survey included 21 items. We asked the respondents to report on demographic and organizational characteristics in their respective ICUs. In the remaining survey items, we asked about team composition in ABCDE delivery as well as perception of SMMs using items from the previously validated Team Survey [22–23]. The final survey was pilot tested with a small set of practicing ICU clinicians and researchers (1 nurse researcher, 5 ICU physician researchers) for flow and clarity as previously done [23]. The pilot testing process involved completing the survey, and reviewing all items for clarity, consistency and flow. Revisions were made to the non-SMM survey items based on the pilot testing feedback to enhance clarity and improve flow. We utilized the “skip-logic” function in the electronic survey; certain survey items were thus omitted for individual respondents based on how the respondent answered the previous question. For example, we asked all respondents, “Does your unit use the ABCDE bundle to guide care for ICU patients?” For those who answered “yes”, an additional survey item was presented, asking, “How well is ABCDE incorporated into your unit’s practice?” The survey item was omitted for respondents who answered “no” or “don’t know” for the previous question (see Supplemental Data File for a copy of the entire survey). The implication of the skip-logic use is that not all respondents were asked every question; questions-specific denominators are presented when relevant in the Results section.

The University of Michigan Internal Review Board reviewed the current study and determined it was exempt from formal IRB review (HUM00133136).

Measures

Primary Exposure Measure: Perception of Shared Mental Models (SMM). We measured perception of SMMs in the ICU team using six items from the previously validated Team Survey [22]. These six SMMs items were similarly deployed in another survey study aiming to examine the relationships between team building, SMMs, and team performance in information systems teams [19]. Though applied in a different industry, the investigators analyzed the convergent validity of these items and provide additional evidence supporting the identified six items as a valid approach to assess SMMs among team members. These six

SMM items were selected in our survey after theorizing these components of the SMM were most likely to be involved in ABCDE bundle delivery. Specific items from the Team survey that we used include: (1) “I am well aware of other team members’ skills and abilities.”, (2) “It is always obvious where team members should go for information when we need it.”, (3) “The ICU team adapts its behavior to meet the needs of different team members.”, (4) “Team members often contact me to offer help/advice just when I need it.”, (5) “I find it difficult to predict what other team members may do in a particular patient care situation.”, and (6) “If asked, I could explain all of the roles in the ICU team and how these roles overlap.” Each item was scored on a 5-point Likert scale ranging from “Strongly Agree” to “Strongly Disagree.” We removed the sixth SMM item from the final analysis due to a low-response rate on this item (<1%).

Primary Outcome Measures: Self-reported ABCDE Bundle Implementation. We measured ABCDE bundle implementation using a single item. We asked respondents, “How well is ABCDE incorporated into your unit’s practice?” Item responses were on a 4-point Likert scale ranging from: (1) “ABCDE is a routine part of every patient’s care”, (2) “We are working on ABCDE but have a few remaining challenges”, (3) “We have made some initial steps to implementing ABCDE.” to (4) “We are thinking about implementing ABCDE but have made no steps to do so.”

Confounders: To adjust for potential confounders that could influence the participants’ response on the outcome and primary exposure, we controlled for a respondent’s professional role, role as a direct patient care provider, and unit type in the model. We assessed professional role by asking the respondents (1) “What is your professional role?” with 12 response options (see survey for response options). We assessed a participant’s role in direct patient care by asking “Do you provide direct patient care (at least 50% of the time) in your role?” (Y/N/Don’t know). Lastly, we measured unit type by asking “What term best describes your primary unit?” with 7 options (medical/surgical/cardiac/neuro/trauma/mixed/other). In the final analysis, we condensed these responses to four categories: Medical, Surgical, Specialty, and Mixed.

Statistical Analysis

We used descriptive statistics and frequency tables to analyze our data. We performed a logistic regression with complete case analysis to examine the relationship between perceptions of a SMM and perceived ABCDE bundle implementation, unadjusted and adjusted (controlling for professional role, role as a direct patient care provider, and unit type). For the logistic regression analysis, we included all respondents who answered yes to the survey item, “Does your unit use the ABCDE bundle to guide care for ICU patients?” Among the 157 respondents who answered “yes” to the previous question, 4% (n=6) were missing values for the SMM items and were omitted from the final analysis. We clustered responses at the hospital level and used robust standard estimation. The calculated Cronbach’s alpha in our study sample is 0.75. STATA 15 was used for statistical analysis [27]. All tests were two-sided. A p-value less than 0.05 was considered statistically significant.

For the logistic regression, we dichotomized the response scales for the SMM items and the ABCDE bundle implementation item to achieve model convergence and due to a small sample size. This decision was made a priori based on previous analyses conducted using survey data from the Keystone Quality Collaborative [23]. We dichotomized our primary exposure, the 5-point Likert scale for the SMM items, into 2 categories: “Agree” (strongly agree and agree) and “Disagree” (neither, disagree and strongly disagree). For our primary outcome, ABCDE bundle implementation, we dichotomized the 4-point Likert scale into 2 categories: “Routine” (“ABCDE is a routine part of every patient’s care) and “Not routine” (“We are working on ABCDE but have a few remaining challenges”, “We have made some initial steps to implementing ABCDE.”, and “We are thinking about implementing ABCDE but have made no steps to do so”).

Results

The distribution of demographic and ICU organizational characteristics for the respondents is presented in Table 1. Nurses were most represented in the sample, with respondents being 29% staff nurses, 22% nurse managers, 6% nurse educators, and 7% clinical nurse specialists. Allied health professionals were also well represented; 7% were respiratory therapists and 4% were physical, occupational and speech therapists. Physicians represented 5% of the respondents with 3% identifying as medical directors. In addition, 16% of the respondents selected “other” as their professional role. Respondents for the 2016 survey did not specify their unique roles, however in previous and subsequent surveys administered at the MHA Keystone Conference, individuals who selected the “other” category indicated they are either professionals with dual roles (i.e. clinical nurse specialist and quality improvement coordinator) or professionals from nursing and/or hospital leadership whose respective titles are not provided in the prompt (i.e. nurse supervisor) [23]. About half (49%) of respondents reported they provide direct patient care at least 50% of the time. Medical (35%) and mixed ICUs (33%) were the most represented unit types in the sample, comprising more than 60% of the respondents’ primary units. The distribution of responses for the primary outcome, ABCDE bundle implementation, is also presented in Table 1. As exhibited in Table 1, 157 (84%) respondents reported using the ABCDE bundle to guide care. Of the 157 who reported use of the ABCDE bundle, over half (51%; n=80) reported ABCDE bundle implementation as routine; 49% (n=77) reported ABCDE bundle implementation as not routine.

The distribution of responses for the primary exposure variable of SMMs is presented in Table 2. The five SMM indicators are included in the table. The majority of respondents reported they agree (70–94%) that four out of five SMM items are present in their respective ICU team. A majority of respondents reported they disagree (n=144; 83%) with the last SMM item, perceived difficulty in predicting team behavior.

The results from the logistic regression suggest a positive relationship between perception of SMMs and odds of reporting routine ABCDE bundle implementation. As presented in Table 3, the odds of clinicians reporting ABCDE bundle as routine was 74% less (aOR 0.26 (0.10–0.66)) if they agreed (compared to disagreed) that they found it difficult to predict team members’ behavior. This was the only item that was significantly associated with self-

reported ABCDE implementation. The effects of the other SMM items on reporting routine ABCDE implementation were of a more modest absolute magnitude, with wider confidence intervals, and not statistically significant. [(1) awareness of team members' skills and abilities (adjusted odds ratio (aOR) 1.24 (95% confidence interval (0.24–6.42)), (2) ability to access information (aOR 1.63 (0.51–5.16)); (3) team adaptability (aOR 1.01 (0.43–2.37)); and (4) team aptitude toward providing help (aOR 1.04 (0.48–2.24)).]

Discussion

In our cross-sectional observational study, we found that a high percentage of critical care clinicians—over 70%—perceive their ICU teams demonstrate components of a SMM. Only one SMM component was associated with self-reported ABCDE implementation. That is, when respondents agreed it can be difficult to predict the behaviors of other members of the ICU team, the odds of reporting ABCDE delivery as routine was significantly less compared to those who disagreed with this statement.

Previous work suggests that SMMs are associated with improved team performance across multiple settings [8–14]. Having a SMM not only ensures team members are on the “same page” but it also enables team members to work effectively together through implicit coordination [28]. Specifically, implicit coordination is a team process characterized by members' abilities to predict the actions of other team members and adapt their behaviors accordingly in the absence of verbal communication [28–29]. Team members use implicit coordination to seamlessly complete interdependent tasks which can result in improved team performance [30]. In our survey we asked critical care clinicians to report on these two attributes of implicit coordination, but only ability to predict how team members behave in different patient care situations was associated with ICU team performance—operationalized as self-reported routine ABCDE delivery. A possible explanation for this finding may be that the mechanism by which SMMs achieve effective team performance varies based on context [31]. That is, certain components of the SMM may play a more critical role depending on the team task at hand.

Delivering the ABCDE bundle is challenging because there are many moving parts involved in this complex care practice. First, the ABCDE bundle is interprofessional and it can be difficult to coordinate tasks among different members of the ICU team [32]. Generally, the bedside nurse is responsible for delivering the spontaneous awakening trial as well as delirium monitoring and management. The bedside nurse also works collaboratively with other allied health professionals like physical therapy to deliver early mobility. Respiratory therapists, however, are more frequently described as being involved in the spontaneous breathing trial [23]. Second, the timely delivery of individual bundle components is often dependent on the successful implementation of other bundle components [33]. For example, delivering a spontaneous breathing trial after a patient passes his/her spontaneous awakening trial is considered more efficacious and recommended in standard practice [34]. Additionally, a study conducted by Miller and colleagues (2015) using prior Keystone ICU survey data found that reporting routine use of spontaneous awakening trials and delirium assessments was associated with an increased odds of reporting advanced early mobility compared to when respondents did not report routine use of awakening trials and delirium

assessments in their respective ICU units [5]. Understanding the bundle sequence, team members often need to predict how other clinicians will behave in different patient care situations to determine if and when it is appropriate to deliver their respective ABCDE bundle component. We can interpret the relationship between ability to predict team members' behaviors and self-reported ABCDE bundle implementation as further evidence supporting the role of perceived coordination in delivering this complex care practice.

The results of the current study, however, suggest that perception of SMMs in ICU teams does not fully explain the perceived variation in ABCDE bundle delivery. It is important to consider how other team and organizational factors impact this complex care practice. Team structure, for example, also influences team performance [35] and this appears to also be the case in ABCDE bundle delivery. Previous work shows that ICU team composition is associated with reported ABCDE bundle implementation. Specifically, reporting frequent involvement of the nurse and physician in the delivery of the spontaneous awakening trial was associated with an increased likelihood of reporting routine ABCDE bundle implementation [23]. Furthermore, in addition to team-related factors, other identified barriers to ABCDE bundle implementation include issues around perceived workload, patient safety, unclear protocol criteria, and staffing [7]. Based on this growing body of evidence, strategies to improve ABCDE bundle implementation will likely need to be multifaceted. Facilitating awareness of team members' behaviors may be one mechanism to improve coordination and support routine practice.

The methods presented in the current study are distinct from previous work evaluating the effects of SMMs and this may also explain why there is not a clear link between SMMs and self-reported ABCDE bundle implementation. Previous studies reporting a positive effect of SMMs on team performance have been largely conducted in simulation-based training scenarios such as simulated anesthesia induction and trauma resuscitation [11; 14; 36]. Completing a prescribed task with a purposefully assembled team in a contained environment is different from delivering a complex care bundle with an unbounded team in the clinical setting. Such variability may hinder our ability to study the theorized relationships between SMMs and team performance in clinical practice. In addition, there is no gold standard for measuring SMMs and a variety of measurement approaches are reported in the literature including paired comparison ratings, concept mapping, and observational rating tools [31; 37]. In our study, we examined perceptions of SMMs using items from a previously validated survey. The identified differences may explain why the results of the current study partially support previous literature, with only one SMM indicator—ability to predict team member behavior—having a significant effect on the primary outcome.

While being the first study to our knowledge to examine SMMs in critical care delivery, we acknowledge several limitations in the current study. The data was collected using a self-reported survey and may be prone to response bias. Causality cannot be determined given the cross-sectional observational study design. We had to eliminate one SMM item from our final analysis due to a low response rate. We were also unable to adjust for time spent on a given unit which may impact the development of a SMM within the teams. All attendees at the MHA Keystone ICU workshop were eligible to complete the survey and we included all

responses in the analysis for the current study. We recognize the professionals most likely to be involved in ABCDE bundle delivery include the bedside nurse, respiratory therapist, physician, and physical therapist. But due to the small sample size, we could not perform a sensitivity analysis to examine the relationship between perception of SMMs and report of routine ABCDE bundle delivery among specific professional roles. Including nursing leadership and medical directors when conducting survey research to assess implementation of evidence-based practice is consistent with other studies in the literature [38–41]. Attendees at the annual MHA Keystone Center ICU workshop represent a select group of critical care clinicians who are dedicated to improving the delivery of ICU care in Michigan. Their perceptions may not be generalizable to all critical care clinicians. Additionally, the majority of respondents were representatives from the nursing profession. Thus, the perceptions presented in the current study may not be fully representative of the diverse interprofessional team. Despite these limitations, the current study has important implications for developing practice interventions to improve the delivery of complex care bundles.

Conclusion

In conclusion, this cross-sectional observational study found that the ability to predict team members' behavior is one component of SMMs that is associated with odds of reporting routine ABCDE implementation. Previous work has shown SMMs can predict effective team performance, however the role of SMMs in complex care delivery was previously unexplored. Predicting team members' behaviors may promote coordination between members of the ICU team and enable timely delivery of the individual components of the ABCDE bundle. Increasing awareness of and familiarity with team members' behaviors may result in improved ABCDE implementation.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Demographic and organizational characteristics of respondents and ICUs (n=206 respondents within 56 unique hospitals)~

Respondent role	n=191
Staff nurse	56 (29%)
Nurse manager	42 (22%)
Nurse educator	11 (6%)
Clinical Nurse Specialist	14 (7%)
Respiratory therapist	12 (7%)
Clinical pharmacist	1 (0.5%)
Physical, Occupational & Speech Therapist	8 (4%)
Nurse practitioner/physician assistant	2 (1%)
Physician	4 (2%)
Medical director	5 (3%)
Hospital Administrator	5 (3%)
Other [^]	31 (16%)
Provide direct patient care at least 50% of time	93 (49%)
Does your unit use the ABCDE bundle to guide care for ICU patients?	N=186~
Yes	157 (84%)
No	18 (10%)
Don't Know	11 (6%)
ABCDE implementation~	n=157 ⁺
Routine part of every patient's care	80 (51%)
We are working on ABCDE but have a few remaining challenges	68 (43%)
Made initial steps to implement ABCDE	7 (5%)
Thinking about implementing ABCDE but have made no steps to do so	2 (1%)
ICU type	
Medical	66 (35%)
Surgical	25 (13%)
Specialty	37 (19%)
Mixed	62 (33%)

[^] Other included roles such as quality coordinator, nursing supervisor, performance improvement, etc.

~ Sample size differs slightly due missing (respondent role: n=15 missing; ABCDE implementation: n=20 missing; unit type n=16 missing)

⁺ Question was part of skip-logic/skip pattern

Table 2.

Frequency Distribution for Shared Mental Models Questions (n=174)

I am well aware of other team members' skills and abilities.	
Agree	163 (93.68%)
Disagree	11 (6.32 %)
It is always obvious where team members should go for information when we need it.	
Agree	132 (75.86%)
Disagree	42 (24.14 %)
The ICU team adapts its behavior to meet the needs of different team members.	
Agree	124 (71.26%)
Disagree	50 (28.74 %)
Team members often contact me to offer help/advice just when I need it.	
Agree	122 (70.11%)
Disagree	52 (29.89%)
I find it difficult to predict what other team members may do in a particular patient care situation.	
Agree	30 (17.24%)
Disagree	144 (82.76 %)

Table 3.

Odds Ratios Estimating the Effect of Shared Mental Models (SMM) on Routine ABCDE Implementation (n=151)

	Unadjusted OR (95% CI) ^a	Adjusted OR (95% CI) ^b
I find it difficult to predict what other team members may do in a particular patient care situation.	0.26 (0.11–0.66)	0.26 (0.10–0.66)
I am well aware of other team members' skills and abilities.	1.37 (0.23–8.03)	1.24 (0.24–6.42)
It is always obvious where team members should go for information when we need it.	1.62 (0.51–5.14)	1.63 (0.51–5.16)
The ICU team adapts its behavior to meet the needs of different team members.	1.05 (0.42–2.61)	1.01 (0.43–2.37)
Team members often contact me to offer help/advice just when I need it.	1.03 (0.53–2.00)	1.04 (0.48–2.24)

^aUnadjusted model estimating the effect of SSM components (reference disagree) on ABCDE implementation (reference not routine)

^bAdjusted model estimating the effect of SSM components (reference disagree) on ABCDE implementation (reference not routine) controlling for professional role, unit type, and direct patient care provider role (reference is providing care at least 50% of the time)