



FACTORS ASSOCIATED WITH NURSES' KNOWLEDGE OF AND PERCEIVED VALUE IN EVIDENCE-BASED PRACTICES

By Kristin Hittle Gigli, PhD, RN, CPNP-AC, CCRN, Billie S. Davis, PhD, Jennifer Ervin, PhD, and Jeremy M. Kahn, MD, MS

Background Little is known about how the education and specialty certification of intensive care unit nurses influence patients' outcomes.

Objective To examine the relationships between critical care nurses' education level and specialty certification, their individual psychosocial beliefs about their place on the intensive care unit team (in relation to 3 factors: professional identity, self-efficacy, and role clarity), and their perceptions of evidence-based practices used in the intensive care unit.

Methods A cross-sectional survey was emailed to nurses in 12 adult intensive care units within 6 hospitals in a single, integrated health care system.

Results Of 268 respondents, 180 (71%) had a bachelor of science degree or higher, and 71 (26%) had critical care certification. Compared with noncertified nurses, certified nurses reported greater knowledge of spontaneous breathing trials (4.6 vs 4.4 on a 5-point scale, $P = .03$) and lung-protective ventilation (4.2 vs 3.9, $P = .05$). Certified nurses reported significantly higher self-efficacy (4.5 vs 4.3 on a 5-point scale, $P = .001$) and role clarity (4.4 vs 4.2, $P = .05$) than noncertified nurses. Certification was also associated with greater perceived value in specific practices (daily interruption of sedation: adjusted odds ratio 2.5 [95% CI, 1.0-6.3], $P = .05$; lung-protective ventilation: adjusted odds ratio, 1.9 [95% CI, 1.1-3.3], $P = .03$). Education level was not associated with greater knowledge of or perceived value in evidence-based practices.

Conclusions Nursing specialty certification was associated with nurses' individual psychosocial beliefs and their perceptions of evidence-based practices in the intensive care unit, whereas education level was not. Supporting nurses in obtaining specialty certification could assist with the adoption of evidence-based practices as a means to improve quality of care in the intensive care unit. (*American Journal of Critical Care*. 2020;29:e1-e12)

More than 800 000 Americans require invasive mechanical ventilation in the intensive care unit (ICU) each year.¹ Many of these patients do not receive care via evidence-based practices that have been proven to save lives, such as daily spontaneous breathing trials to assess readiness to extubate, or lung-protective ventilation to prevent lung injury in patients with acute respiratory distress syndrome.²⁻⁵ Efforts are needed to speed the translation of evidence into practice and ensure that patients in the ICU receive the highest quality of care.

One strategy to promote evidence uptake is to leverage the role of ICU nurses. Indeed, robust data suggest that nurses' education level and attainment of specialty certification are associated with improved outcomes for patients.⁶⁻⁹ This evidence has led to calls to increase the percentages of nurses who have been prepared through baccalaureate programs (ie, a bachelor of science in nursing [BSN] degree) and who have received specialty certification (ie, CCRN certification, awarded by the American Association

Many patients who receive mechanical ventilation do not receive evidence-based care.

of Critical-Care Nurses Certification Corporation) as a means for improving the quality of care administered in the ICU.¹⁰⁻¹³ In response, the number of nurses with a BSN degree has

increased, and hospitals are actively working to increase the number of such nurses in their workforce.¹⁴ Hospitals are also providing incentives for nurses to attain certification and are participating in efforts to implement evidence-based practices in order to improve the care provided at their institutions.^{15,16}

Given the rising demand for critical care services and the limited supply of nurses, however, it may not be feasible for every ICU nurse to have a BSN degree, nor will it be possible for every nurse to attain specialty certification. Understanding the mechanism by which nurses' credentials are associated with the adoption of evidence-based practices is meaningful

About the Authors

Kristin Hittle Gigli is a postdoctoral fellow; **Billie S. Davis** is a senior analyst; and **Jeremy M. Kahn** is a professor of Critical Care, Medicine, and Health Policy, and the director of the Health Policy and Management Program, at the CRISMA Center, Department of Critical Care Medicine, University of Pittsburgh, Pittsburgh, Pennsylvania. **Jennifer Ervin** is a clinical lecturer in the Division of Pulmonary and Critical Care Medicine, Department of Internal Medicine, University of Michigan, Ann Arbor, Michigan.

Corresponding author: Jeremy M. Kahn, MD, MS, 3550 Terrace St, Room 602B, Pittsburgh, PA 15261 (email: jeremykahn@pitt.edu).

in ICUs where a large proportion of nurses do not have a BSN degree or CCRN certification. A better understanding of the influence of nurses with a BSN degree or CCRN certification on practice change may help speed the implementation of evidence-based practices such as lung-protective ventilation, daily interruption of sedation, and spontaneous breathing trials, which are known to improve outcomes for patients receiving mechanical ventilation but which many eligible critically ill patients do not receive.^{2,3,5}

Thus, we examined the relationship between nurses' level of education and certification status and (1) selected individual psychosocial beliefs about nurses' place in the ICU, including professional identity, self-efficacy, and role clarity, as well as the mediating effects of these beliefs on evidence-based practices, that may support a greater role for nurses in delivering evidence-based practices; (2) perceived knowledge of evidence-based practices; and (3) perceived value in specific evidence-based practices that aim to improve care for patients requiring mechanical ventilation in ICUs.

Methods

Study Design and Population

We developed a cross-sectional, electronic survey and administered it to intensive care nurses in 12 adult ICUs within 6 hospitals in a single, integrated health care system. This survey was associated with a larger study examining ICU team function and the delivery of evidence-based practices. All nurses employed in these ICUs were eligible to participate. We obtained a list of the names and email addresses for these individuals from the health care system's Office for Quality Improvement and Patient Safety.

Survey Development

We developed the survey instrument in the spring of 2017. Various theories guided us in this process: theories about the psychosocial underpinnings of organizational performance; the theory of planned behavior, which posits a central role for individual

attitudes, subjective norms, and perceived behavioral control in the intention to act; and the Consolidated Framework for Implementation Research, which posits that the characteristics of individual clinicians interact with local contexts to influence the implementation of best practices.¹⁷⁻¹⁹ In addition, we applied both existing knowledge of evidence-based practices that improve outcomes in patients receiving mechanical ventilation and data from prior studies of nurse characteristics that influence patient outcomes.^{3,20-22} We designed the survey to measure 4 domains: nurse demographics, perceived knowledge of evidence-based practices used in the ICU, perceptions about the value in evidence-based practices in the ICU, and individual psychosocial beliefs that are potentially associated with perceptions of evidence-based practices.²³⁻²⁶

Demographic questions evaluated education level (associate's, bachelor's, master's, or doctoral degree, dichotomized as BSN or higher vs not), specialty certification status (CCRN certification or not), age, and race. Questions pertaining to evidence-based practices encompassed perceived knowledge of and perceived value in 3 evidence-based practices used when caring for patients receiving mechanical ventilation: daily interruption of sedation, spontaneous breathing trials, and ventilation at a low tidal volume (a lung-protective ventilation strategy).^{3,5,21} Individual psychosocial beliefs included 3 composite measures: professional identity, defined as a feeling of self-worth derived from one's profession; self-efficacy, defined as the belief in one's ability to succeed in a task; and role clarity, defined as the notion that one knows what one needs to do and what is expected.^{3,5,20-26} Given that, on the basis of findings from prior studies, nurses who have strong professional identity and feel they have self-efficacy and role clarity may be more capable of providing evidence-based care, we hypothesized that these psychosocial beliefs would mediate the relations between nurse characteristics and perceived knowledge of and perceived value in evidence-based practices.^{26,27}

The survey contained 44 items, with a combination of items answered by using a 5-point Likert-type scale (ranging from 1 [strongly disagree] to 5 [strongly agree]) and demographic questions. It took approximately 10 minutes to complete. We pilot tested the survey in a single ICU to determine readability and content validity; we implemented changes on the basis of participant feedback. The final survey is available in Supplement 1; psychometric testing results are available in Supplement 2. We assessed composite item reliability using Pearson correlation for self-efficacy

(a 2-item construct) and the Cronbach α for professional identity and role clarity (constructs with more than 2 items); we found acceptable item reliability and within-item correlation.

Survey Administration

We administered the survey via Qualtrics, an online survey platform hosted by the University of Pittsburgh, from June through September 2017. All eligible participants received an email explaining the study goals and providing a link to the survey. We sent up to 4 email reminders to nonrespondents in order to increase participation. Each nurse could complete the survey only once. Participants who completed the survey received a \$5 gift card as an incentive. Institutional review board approval was obtained from the University of Pittsburgh Human Subjects Protection Office before we began collecting data.

Statistical Analysis

We analyzed nurses' demographic characteristics by using descriptive statistics. All other items were measured on a 5-point Likert-type scale. Data are reported as the mean (SD) and 95% confidence interval. We used the Student *t* test to examine the bivariate relationships between nurses' education level or certification status and the 3 individual psychosocial beliefs. We used sequential multiple regression to examine independent relationships among the independent variables

(nurses' education level or certification status) and the dependent variables (perceived knowledge of and perceived value in specific evidence-based practices). The unit of analysis was the individual nurse. We used

Huber-White confidence intervals to adjust the standard errors for clustering by ICU. We first fit separate models in which perceived knowledge of or perceived value in an evidence-based practice was the dependent variable, education level or certification was the primary independent variable, and age (a proxy for years of experience) was a covariate. Next, we fit the same models but added the 3 individual psychosocial beliefs as covariates. This approach allowed us to estimate the independent associations of nurse education or certification with our outcomes of interest while also testing whether these associations were mediated by individual

We hypothesized that nurses' professional identity, self-efficacy, and role clarity contribute to beliefs about evidence-based practices.

Table 1
Demographic characteristics of nurses working in adult intensive care units who responded to the survey (N=268)^a

Characteristic	No. (%) of respondents
Female sex	226 (84.3)
White race	257 (95.9)
Bachelor of science in nursing or higher ^b	180 (70.9)
Critical care nursing certification	71 (26.5)
Work in a teaching hospital	191 (71.3)

^aMean (SD) age was 33.1 (9.7) years.

^bOnly 254 nurses responded to this item.

psychosocial beliefs about nurses' place on the ICU team.

To enhance the interpretability of the models' results, we fit all models using logistic regression. Given the response distributions, we dichotomized the measures of nurses' perceived knowledge of or perceived value in specific evidence-based practices into "high level of knowledge" or "highly valued practice" (a score ≥ 4 on a 5-point scale) or "less high level of knowledge" or "less highly valued practice" (a score < 4 on a 5-point scale). Exponentiated coefficients in the models could then be interpreted as odds ratios for high perceived knowledge of and high perceived value in the practices. The threshold for statistical significance was set at $\alpha = 0.05$. We performed all statistical analyses in Stata software version 15.0 (StataCorp).

Results

Survey Respondents

A total of 268 nurses working in adult ICUs responded to the survey (Table 1). Respondents were primarily white and female, and most worked in a teaching hospital. Although the majority of the nurses had a BSN or higher degree, only about a quarter of respondents had CCRN specialty certification. Among nurses with a BSN or higher degree, 34.4% (n=62) also had specialty certification, whereas only 12.5% (n=9) of those without their BSN had CCRN certification ($P = .001$).

Perceived Knowledge of and Value in Evidence-Based Practices

Respondents reported a high level of perceived knowledge of the 3 evidence-based practices used in caring for patients receiving mechanical ventilation (Table 2). We found no significant differences in nurses' perceived knowledge of or perceived value in the 3 evidence-based practices related to nurses' education level. Nurses with specialty certification reported significantly more perceived knowledge of spontaneous breathing trials and lung-protective ventilation and reported greater perceived value in all 3 evidence-based practices than did nurses without CCRN certification.

Table 2
Nurses' report of perceived knowledge of and perceived value in specific evidence-based practices in adult intensive care units^a

Category	All nurses (N=268)	Nurses' education ^b			P	Professional certification			
		BSN or higher (n=180)	No BSN (n=74)	Mean difference (95% CI)		CCRN (n=71)	No CCRN (n=197)	Mean difference (95% CI)	P
Knowledge of									
Daily interruption of sedation	4.42 (0.61)	4.42 (0.60)	4.44 (0.65)	-0.02 (-0.16 to 0.18)	.89	4.49 (0.65)	4.40 (0.59)	0.09 (-0.27 to 0.08)	.29
Spontaneous breathing trials	4.47 (0.59)	4.50 (0.54)	4.43 (0.65)	0.07 (-0.22 to 0.09)	.38	4.61 (0.52)	4.42 (0.61)	0.19 (0.02-0.34)	.03
Lung-protective ventilation	4.00 (0.91)	4.01 (0.89)	4.00 (0.91)	0.01 (-0.25 to 0.24)	.95	4.18 (0.90)	3.94 (0.90)	0.24 (0.00-0.49)	.05
Value in									
Daily interruption of sedation	4.22 (0.81)	4.24 (0.82)	4.18 (0.81)	0.06 (-0.28 to 0.17)	.62	4.48 (0.63)	4.13 (0.85)	0.35 (0.13-0.57)	.002
Spontaneous breathing trials	4.31 (0.82)	4.30 (0.85)	4.31 (0.74)	-0.01 (-0.22 to 0.23)	.96	4.54 (0.63)	4.22 (0.86)	0.32 (0.09-0.53)	.006
Lung-protective ventilation	4.12 (0.81)	4.11 (0.86)	4.13 (0.67)	0.02 (-0.21 to 0.23)	.92	4.35 (0.66)	4.01 (0.84)	0.34 (0.10-0.53)	.004

Abbreviation: BSN, bachelor of science in nursing.

^aData are mean (SD) unless otherwise indicated.

^bOnly 254 nurses responded to the item regarding education.

Table 3

Nurses' report of individual psychosocial beliefs thought to mediate the relationship between nursing characteristics and perceptions about evidence-based practices in adult intensive care units^a

Individual psychosocial beliefs	All nurses (N = 268)	Nurses' education ^b				Professional certification			
		BSN or higher (n = 180)	No BSN (n = 74)	Mean difference (95% CI)	P	CCRN (n = 71)	No CCRN (n = 197)	Mean difference (95% CI)	P
Professional identity	4.14 (0.50)	4.16 (0.52)	4.10 (0.45)	0.06 (-0.19 to 0.08)	.40	4.13 (0.52)	4.15 (0.49)	-0.02 (-0.12 to 0.16)	.77
Self-efficacy	4.36 (0.53)	4.40 (0.52)	4.28 (0.57)	0.12 (-0.26 to 0.03)	.13	4.54 (0.52)	4.30 (0.52)	0.24 (0.09-0.38)	.001
Role clarity	4.23 (0.60)	4.25 (0.58)	4.19 (0.65)	0.06 (-0.21 to 0.11)	.54	4.35 (0.60)	4.19 (0.59)	0.16 (0.00-0.32)	.05

Abbreviation: BSN, bachelor of science in nursing.

^aData are mean (SD) unless otherwise indicated.

^bOnly 254 nurses responded to the item regarding education.

Individual Psychosocial Beliefs

Scores of the 3 individual psychosocial beliefs thought to be associated with the selected evidence-based practices are presented in Table 3. Overall, nurses reported strong professional identity, self-efficacy, and role clarity, all with mean scores greater than 4.0; for professional identity and self-efficacy, scores ranged from 2.5 to 5.0, and for role clarity, scores ranged from 1.7 to 5.0. We found no significant differences in reports of the individual psychosocial beliefs based on nurses' level of education. With regard to specialty certification, however, we did find significant differences, with higher levels of self-efficacy ($P = .001$) and role clarity ($P = .05$) among nurses who reported having specialty certification (Table 3).

Relations Between Nurse Characteristics and Perceptions About Evidence-Based Practices

Perceived Knowledge of Evidence-Based Practices.

Analysis of unadjusted effects indicated no significant associations between nurses' education level or certification status and perceived knowledge of evidence-based practices (Table 4). In our full model, we did not find significant associations between education level and perceived knowledge of the evidence-based practices or between certification status and perceived knowledge of the practices (Table 4). The 3 individual psychosocial beliefs were inconsistently associated with nurses' perceived knowledge of or perceived value in evidence-based practices. In the full model, among the 3 individual psychosocial beliefs, professional identity was most often associated with nurses' perceived knowledge of evidence-based practices (Table 4).

Perceived Value in Evidence-Based Practices.

Analysis of unadjusted effects indicated no significant associations between nurses' education level and perceived value in evidence-based practices. We did,

however, find that certification status was associated with the perceived value in 2 of the 3 evidence-based practices for patients receiving mechanical ventilation: daily interruption of sedation and lung-protective ventilation (Table 4). These associations persisted in the full model (Table 4). In addition, a nurses' professional identity was significantly associated with perceived value in spontaneous breathing trials among nurses with their CCRN, but overall, we found no significant differences in the perceived value in this practice between nurses with and nurses without CCRN certification (Table 4).

Discussion

In a cross-sectional study of ICU nurses, we examined the associations between nurses' education level and certification status, and their perceived knowledge of and perceived value in specific evidence-based practices used to care for patients receiving mechanical ventilation. We explored whether 3 individual psychosocial beliefs (professional identity, self-efficacy, and role clarity) were important mediators of the relationships between nurse education or certification and perceived knowledge of and value in evidence-based practices. We found that ICU nurses' specialty certification status was strongly associated with perceived knowledge of and perceived value in the use of these evidence-based practices, whereas nurses' educational level was not. The nurses' place on the ICU team, assessed via 3 psychosocial beliefs, had an inconsistent mediating effect on nurses' reported perceived knowledge of and perceived value in evidence-based practices.

These findings have important implications for nurses when delivering care in the ICU and adopting evidence-based practices in caring for patients receiving mechanical ventilation. Adoption of evidence-based practice is a strategy proven to improve outcomes.^{5,16,28} Many evidence-based practices remain

Table 4
Results of the multivariable regression analyses examining associations of education and certification with perceived knowledge of and perceived value in evidence-based practices

Category	Base model			Full model		
	Odds ratio	95% CI	P	Odds ratio	95% CI	P
Perceived knowledge of						
Daily interruption in sedation ^a						
BSN	1.56	0.46-5.32	.48	1.30	0.20-8.37	.78
Age	1.00	0.98-1.02	.99	0.99	0.97-1.00	.09
Professional identity				4.94	1.03-23.69	.05
Self-efficacy				3.01	0.85-10.71	.09
Role clarity				3.24	0.95-11.00	.06
Spontaneous breathing trials ^a						
BSN	3.08	0.71-13.35	.13	2.40	0.69-8.43	.17
Age	1.01	1.00-1.15	.04	1.05	0.97-1.14	.19
Professional identity				2.14	0.41-11.21	.37
Self-efficacy				2.56	0.39-16.76	.33
Role clarity				2.69	0.76-9.45	.12
Lung-protective ventilation ^a						
BSN	0.70	0.36-1.36	.30	0.61	0.35-1.07	.09
Age	1.03	0.98-1.08	.23	1.02	0.97-1.06	.53
Professional identity				1.55	0.99-2.43	.06
Self-efficacy				2.14	1.09-4.21	.03
Role clarity				1.49	0.86-2.58	.16
Daily interruption in sedation ^b						
CCRN	1.56	0.46-5.32	.48	0.63	0.20-2.35	.56
Age	1.00	0.98-1.02	.99	0.99	0.97-1.00	.09
Professional identity				4.68	1.03-21.27	.05
Self-efficacy				3.32	0.87-12.65	.08
Role clarity				3.34	0.94-11.84	.06
Spontaneous breathing trials ^b						
CCRN	2.48	0.23-26.45	.45	2.39	0.35-16.42	.38
Age	1.03	0.97-1.10	.35	1.00	0.95-1.06	.97
Professional identity				2.68	0.67-10.68	.16
Self-efficacy				3.65	0.65-20.43	.14
Role clarity				1.91	0.59-6.25	.28
Lung-protective ventilation ^b						
CCRN	1.68	0.91-3.10	.10	1.57	0.80-3.13	.19
Age	1.03	0.98-1.07	.25	1.01	0.97-1.06	.53
Professional identity				1.68	1.06-2.68	.03
Self-efficacy				1.95	0.86-4.43	.11
Role clarity				1.47	0.87-2.48	.15
Perceived value						
Daily interruption in sedation ^c						
BSN	1.12	0.33-3.79	.85	0.97	0.25-3.69	.96
Age	1.00	0.99-1.00	.81	1.00	0.99-1.00	.22
Professional identity				2.20	0.97-5.02	.06
Self-efficacy				3.31	1.18-9.26	.02
Role clarity				0.74	0.30-1.80	.51
Spontaneous breathing trials ^c						
BSN	1.02	0.30-3.47	.98	0.94	0.27-3.30	.92
Age	1.00	0.99-1.00	.52	1.00	0.99-1.00	.19
Professional identity				2.85	1.30-6.25	.009
Self-efficacy				1.92	0.66-5.62	.23
Role clarity				0.79	0.31-1.98	.61
Lung-protective ventilation ^c						
BSN	0.92	0.42-2.03	.84	0.84	0.35-2.03	.71
Age	1.00	0.99-1.00	.74	1.00	0.99-1.01	.65
Professional identity				1.51	0.83-2.76	.17
Self-efficacy				1.93	1.06-3.53	.03
Role clarity				1.17	0.52-2.65	.71

Continued

Table 4
Continued

Category	Base model			Full model		
	Odds ratio	95% CI	P	Odds ratio	95% CI	P
Daily interruption in sedation ^d						
CCRN	2.75	1.14-6.64	.03	2.50	1.00-6.30	.05
Age	1.00	0.99-1.00	.81	1.00	0.99-1.00	.30
Professional identity				2.42	0.97-6.07	.06
Self-efficacy				2.88	0.89-9.35	.08
Role clarity				0.74	0.29-1.95	.56
Spontaneous breathing trials ^d						
CCRN	2.44	0.85-7.00	.10	2.47	0.81-7.48	.11
Age	1.00	0.99-1.00	.55	1.00	0.99-1.00	.28
Professional identity				3.15	1.35-7.36	.008
Self-efficacy				1.64	0.45-6.04	.46
Role clarity				0.80	0.31-2.09	.65
Lung-protective ventilation ^d						
CCRN	2.06	1.14-3.72	.02	1.87	1.06-3.29	.03
Age	1.00	0.99-1.01	.72	1.00	0.99-1.01	.76
Professional identity				1.60	0.88-2.91	.12
Self-efficacy				1.68	0.93-3.04	.09
Role clarity				1.20	0.56-2.60	.64

Abbreviation: BSN, bachelor of science in nursing.

^aThese odds ratios can be interpreted as the odds of a respondent with a BSN or higher degree reporting a high level of knowledge of the evidence-based practice compared with a respondent without a BSN.

^bThese odds ratios can be interpreted as the odds of a respondent with specialty certification reporting a high level of knowledge of the evidence-based practice compared with a respondent without specialty certification.

^cThese odds ratios can be interpreted as the odds of a respondent with a BSN or higher degree reporting a high level of perceived value in the evidence-based practice compared with a respondent without a BSN.

^dThese odds ratios can be interpreted as the odds of a respondent with specialty certification reporting a high level of perceived value in the evidence-based practice compared with a respondent without specialty certification.

underused, partly because of gaps between providers' attitudes toward practices and the delivery of care at the bedside.² The strong association we found between specialty certification and nurses' perceived knowledge of and value in specific evidence-based practices is consistent with current knowledge regarding the value of specialty certification^{8,9,15} and supports the value of nurses with specialty certification, especially among institutions that aim to increase the adoption of evidence-based practices.

Contrary to our hypothesis, we did not find a significant relationship between nurses' education level and perceived knowledge of or perceived value in evidence-based practices. Nurses in this sample were highly educated, which could be a factor contributing to the null findings. In addition, characteristics of individual psychosocial beliefs, based on 3 measures, had only a small association with perceived knowledge of and perceived value in these practices. Prior studies have suggested that these factors are associated with improved outcomes for patients.^{6,20,22,29} However, given the limited associations with perceived knowledge of and perceived value in evidence-based care among ICU nurses found in this study, future studies are needed in order to elucidate better the clinical significance of these findings and to determine the mechanisms that result in improved outcomes for patients. Future studies of processes by

which to increase the value nurses give to evidence-based practices may speed the implementation of these practices by institutions.

As an important next step, researchers should examine how ICU nurses' knowledge of and value in evidence-based practices translate to the delivery of evidence-based care—not just their perceptions of those practices, as measured here. Prior studies demonstrate that knowledge and perceived value alone are not enough reason to adopt evidence-based practices, and thus future studies should evaluate similarities and differences among nurses' practices.^{2,16} Efforts to identify barriers to the use of evidence-based care in practice will allow for targeted interventions to address such barriers, to increase the adoption of condition-specific evidence-based practices such as those used with patients who require mechanical ventilation, and to improve the quality of care delivered in the ICU.

Limitations

This study has several limitations. First, it was conducted within a single health care system, and thus the results may not generalize to ICU nurses working at other institutions or in other regions of the country. Our measure of self-efficacy asked about a nurse's general ability to perform tasks and may not be sensitive enough to detect true relationships

between nurses' characteristics and their ability to implement specific evidence-based practices. These data are self-reported, and the respondents' perceived knowledge of and perceived value in evidence-based practices may not reflect the attitudes of all nurses working in ICUs, especially given the high number of nurses with a BSN degree in this sample. We did not gather information regarding nurses' years of experience or about certifications other than CCRN. These factors could be associated with nurses' individual psychosocial beliefs and could relate to their perceptions of evidence-based practices. In addition, because we administered this survey through the institution that employed the nurses, a risk of acquiescence existed; in an effort to reduce this effect, however, we administered the survey through a web-based platform, and responses were anonymous. Finally, the responses from nurses with different education levels and certification statuses showed minimal variation, which limits our ability to assess relationships among outcomes.

Conclusions

This study increases our knowledge of the role of education, certification, and professional identity among ICU nurses in their implementation of evidence-based practices for patients requiring mechanical ventilation. Specialty certification was associated with greater professional identity and higher perceptions of knowledge of and value in evidence-based practices used in the ICU, whereas education level was not. Supporting specialty certification among nurses is a plausible way to assist with the adoption of evidence-based practices as a means to improve ICU quality and should be evaluated further.

ACKNOWLEDGMENT

This work was performed at the University of Pittsburgh Medical Center and the University of Pittsburgh.

FINANCIAL DISCLOSURES

This work was funded by the US National Institutes of Health (grants K24HL133444 and T32HL007820) and the National Heart, Lung, and Blood Institute (grant K12HL138039).

REFERENCES

1. Stefan MS, Shieh MS, Pekow PS, et al. Epidemiology and outcomes of acute respiratory failure in the United States, 2001 to 2009: a national survey. *J Hosp Med.* 2013;8(2):76-82.
2. Cabana MD, Rand CS, Powe NR, et al. Why don't physicians follow clinical practice guidelines? *JAMA.* 1999;282(15):1458-1465.
3. Costa DK, White MR, Ginier E, et al. Identifying barriers to delivering the awakening and breathing coordination, delirium, and early exercise/mobility bundle to minimize adverse outcomes for mechanically ventilated patients: a systematic review. *Chest.* 2017;152(2):304-311.
4. Institute of Medicine. *Leadership Commitments to Improve Value in Health Care: Finding Common Ground—Workshop Summary.* Washington, DC: National Academies Press; 2009.
5. Lilly CM, Swami S, Liu X, Riker RR, Badawi O. Five-year trends of critical care practice and outcomes. *Chest.* 2017;141(4):723-735.

6. Aiken LH. Educational levels of hospital nurses and surgical patient mortality. *JAMA.* 2003;290(12):1617-1623.
7. Hickey PA, Gauvreau K, Porter C, Connor JA. The impact of critical care nursing certification on pediatric patient outcomes. *Pediatr Crit Care Med.* 2018;19(8):718-724.
8. Kendall-Gallagher D, Aiken LH, Sloane DM, Cimiotti JP. Nurse specialty certification, inpatient mortality, and failure to rescue. *J Nurs Scholarsh.* 2011;43(2):188-194.
9. Kitto S, Grant R, Chappell K, Lundmark V. The relationship between specialty certification of individual nurses and outcomes: developing a standardized taxonomy for research. *J Nurs Adm.* 2017;47(5):245-247.
10. Institute of Medicine. *The Future of Nursing: Leading change, Advancing Health.* Washington DC: National Academies Press; 2010.
11. Kleinpell RM. ICU workforce: revisiting nurse staffing. *Crit Care Med.* 2014;42(5):1291-1292.
12. Williams G, Schmollgruber S, Alberto L. Consensus forum: worldwide guidelines on the critical care nursing workforce and education standards. *Crit Care Clin.* 2006;22(3):393-406, vii.
13. An act to amend the education law, in relation to the educational preparation for practice of professional nursing; and the creation of a temporary nursing program evaluation commission. Assembly Bill A1842B, S 6768, Regular Sess. (NY 2017).
14. Spetz J. Projections of progress toward the 80% bachelor of science in nursing recommendation and strategies to accelerate change. *Nurs Outlook.* 2018;66(4):394-400.
15. Boyle DK, Gajewski BJ, Miller PA. A longitudinal analysis of nursing specialty certification by Magnet® status and patient unit type. *J Nurs Adm.* 2012;42(12):567-573.
16. Warren JI, McLaughlin M, Bardsley J, et al. The strengths and challenges of implementing EBP in healthcare systems. *Worldviews Evid Based Nurs.* 2016;13(1):15-24.
17. Griffin MA, Neal A, Parker SK. A new model of work role performance: positive behavior in uncertain and interdependent contexts. *Acad Manage J.* 2007;50(2):327-347.
18. LaMorte WW. The theory of planned behavior. 2019. <http://sphweb.bumc.bu.edu/otlt/MPH-Modules/SB/Behavioral-ChangeTheories/BehavioralChangeTheories3.html>. Accessed May 10, 2019.
19. CFIR Research Team-Center for Clinical Management Research. Consolidated framework for implementation research. <https://cfirguide.org>. Accessed May 10, 2019.
20. Fisher M. A comparison of professional value development among pre-licensure nursing students in associate degree, diploma, and bachelor of science in nursing programs. *Nurs Educ Perspect.* 2014;35(1):37-42.
21. Balas MC, Vasilevskis EE, Burke WJ, et al. Critical care nurses' role in implementing the "ABCDE bundle" into practice. *Crit Care Nurse.* 2012;32(2):35-38, 40-47; quiz 48.
22. Rose T, Nies MA, Reid J. The internalization of professional nursing values in baccalaureate nursing students. *J Prof Nurs.* 2018;34(1):25-30.
23. Rizzo JR, House RJ, Lirtzman SI. Role conflict and ambiguity in complex organizations. *Adm Sci Q.* 1970;15(2):150-163.
24. Randel AE, Jaussi KS. Functional background identity, diversity, and individual performance in cross-functional teams. *Acad Manage J.* 2003;46(6):763-744.
25. Spreitzer GM. Psychological empowerment in the workplace: dimensions, measurement, and validation. *Acad Manage J.* 1995;38(5):1442-1465.
26. Ervin JN, Kahn JM, Cohen TR, Weingart LR. Teamwork in the intensive care unit. *Am Psychol.* 2018;73(4):468-477.
27. Melnyk BM, Fineout-Overholt E, Feinstein NF, et al. Nurses' perceived knowledge, beliefs, skills and needs regarding evidence-based practice: implications for accelerating the paradigm shift. *Worldviews Evid Based Nurs.* 2004;1(3): 185-193.
28. Melnyk BM, Fineout-Overholt E, Gallagher-Ford L, Kaplan L. The state of evidence-based practice in US nurses: critical implications for nurse leaders and educators. *J Nurs Adm.* 2012;42(9):410-417.
29. McHugh MD, Kelly LA, Smith HL, Wu ES, Vanak JM, Aiken LH. Lower mortality in magnet hospitals. *Med Care.* 2013; 51(5):382-388.

To purchase electronic or print reprints, contact American Association of Critical-Care Nurses, 101 Columbia, Aliso Viejo, CA 92656. Phone, (800) 899-1712 or (949) 362-2050 (ext 532); fax, (949) 362-2049; email, reprints@aacn.org.

Survey Flow

Standard: Introduction (1 Question)

Standard: Identity, Efficacy (10 Questions)

Standard: Evidence-Based Practice (EBP) (10 Questions)

Standard: Rounding Team Composition and Attitudes (9 Questions)

Standard: Work Environment (6 Questions)

Standard: Demographics (7 Questions)

Standard: End Thanks (1 Question)

Page Break

Start of Block: **Introduction**

Q59 Welcome to our survey!

You've taken the first step by clicking on our survey link, so we want to start off and say thanks for that! We'll try to make sure that you don't regret it.

Just a reminder, this survey should take about 10 minutes. We appreciate you taking the time to complete the survey. You probably have a million other things you would rather be doing right now. Honestly, we get it. But there is much to learn about teamwork in the ICU, and we need your help!

We want to hear about your opinions and experiences; our ultimate goal is to understand how ICU teams function so that we can improve patient care in your hospital.

Please click on the icon below and to the right so we can get started!

End of Block: Introduction

Start of Block: **Identity, Efficacy**

Q78 For the following items, please think about whether the following are generally true for you (ie, on most days). Please answer as honestly as possible.

PROF_ID1 When others of the same professional background as me are recognized for their accomplishments, I feel like I have accomplished something too. By "professional background," we mean someone's status as a nurse, physician, respiratory therapist, care manager, etc.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

PROF_ID2 My professional background is an important reflection of who I am.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

PROF_ID3 The work I do is very important to me.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

PROF_ID4 My job activities are personally meaningful to me.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

SELF_EFFICACY1 I have the training necessary to carry out the everyday tasks in my job.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

SELF_EFFICACY2 I am confident about my ability to do my job.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

ROLE_CLARITY_GEN1 I know what my job responsibilities are.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

ROLE_CLARITY_GEN2 I know exactly what is expected of me in this ICU.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

ROLE_CLARITY_GEN3 I feel certain about how much decision-making authority I have on this job.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

End of Block: Identity, Efficacy

Start of Block: **Evidence-Based Practice (EBP)**

Q79 For the following items, please think about your personal experiences and opinion. Please answer as honestly as possible.

ATT_GEN_EBP1 Evidence-based practice improves the quality of patient care.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

Continued

ATT_GEN_EBP2 Research findings are useful in my day-to-day practice.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

ATT_GEN_EBP3 I am willing to invest the time necessary to incorporate new evidence into my practice.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

MV_EBP_KNOW_DIS I am confident in my understanding of interruptions in sedation for mechanically ventilated patients.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

MV_EBP_KNOW_SBT I am confident in my understanding of spontaneous breathing trials for mechanically ventilated patients.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

MV_EBP_KNOW_LPV I am confident in my understanding of lung-protective ventilation for mechanically ventilated patients.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

ATT_MV_EBT_DIS_NR There is little value in interrupting mechanically ventilated patients' sedation levels on a daily basis.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

ATT_MV_EBP_SBT_NR There is little value in performing daily spontaneous breathing trials for mechanically ventilated patients.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

ATT_MV_EBP_LPV_NR There is little value to performing lung-protective ventilation for mechanically ventilated patients.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

End of Block: EBP

Start of Block: **Rounding Team Composition and Attitudes**

Instructions 5

Guess what... You're already about 1/2 of the way through! Now, for this set of items we'd like you to select the answer that best reflects your attitudes about the ICU in which you work. If you work in multiple ICUs, please think only about **the one in which you work most frequently**.

We would like you to tell us about rounds in your ICU. By "rounds" we mean the time each day in which the members of the ICU systematically interact to review events of the previous day and make a plan for the current day.

ATT_ROUND51 Rounding is a constructive use of my time.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

ATT_ROUND52 Rounds allows detailed management/treatment plans to be established.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

ATTITUDE_RE_ATTEND1 The primary purpose of the ICU team is to assist the attending physician.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

ATTITUDE_RE_ATTEND2 The attending physician should always have the final word in decisions made by health care teams.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

FAM_1 Family members should be given the option to attend daily rounds.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

FAM_2 I am comfortable with the idea of family members participating in rounds.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

FAM_3 The patient's family members should be asked to leave when the ICU team is rounding.

- o Strongly Disagree (1)
- o Disagree (2)
- o Neither Agree nor Disagree (3)
- o Agree (4)
- o Strongly Agree (5)

Continued

FAM_4 Family member presence on daily rounds prevents the team from talking about important medical issues.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

End of Block: Rounding Team Composition and Attitudes

Start of Block: **Work Environment**

Instructions 5

Please keep going, you're almost done! There are just a few more things we'd like to know. For these next items we'd like you to think about the hospital in which you work, not just the ICU. If you work for multiple hospitals, please only think about the one in which you work most frequently.

WORK_ENVIRONMENT1 In this hospital, employees have the opportunity to participate in hospital policy decisions.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

WORK_ENVIRONMENT2 In this hospital, employee concerns are addressed.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

WORK_ENVIRONMENT3 It's clear that this hospital has high standards for patient care.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

WORK_ENVIRONMENT4 Hospital employees are regularly praised and recognized for a job well done.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

WORK_ENVIRONMENT5 The ICUs in this hospital are staffed with enough people to provide high quality patient care.

- Strongly Disagree (1)
- Disagree (2)
- Neither Agree nor Disagree (3)
- Agree (4)
- Strongly Agree (5)

End of Block: Work Environment

Start of Block: **Demographics**

Instructions 6

This is the last page! And yes, by last we mean this is the final set of information we need from you.

Please be as honest as possible when responding to these items.

AGE What is your age? _____

SEX What is your gender?

- Male (1)
- Female (2)
- Other (3)

ETHNICITY Please specify your ethnicity. Select all that apply.

- White (1)
- Hispanic or Latino (2)
- Black or African American (3)
- American Indian or Alaska Native (4)
- Asian (5)
- Native Hawaiian or Pacific Islander (6)
- Other (please specify) (7) _____

CURRENT_POSITION What is your current position in this ICU?

- Intensivist Physician (1)
- Attending Physician but not an Intensivist (2)
- Resident, Fellow, or other Physician-in-Training (3)
- Bedside Nurse (4)
- Respiratory Therapist (5)
- Clinical Pharmacist (6)
- Nutritionist (7)
- Social Worker (8)
- Physical Therapist (9)
- Physician Assistant (10)
- Nurse Practitioner (11)
- Other (please specify) (12) _____

Skip To: End of Block If CURRENT_POSITION != Bedside Nurse

BEDSIDE_NURSE_EDU What is your highest level of education in nursing?

- Associate's degree (1)
- Bachelor's degree (2)
- Master's degree (3)
- Doctorate (DNP or PhD) (4)

BEDSIDE_NURSE_CCRN Do you currently hold a CCRN certification from the American Association of Critical-Care Nurses?

- Yes (1)
- No (2)

End of Block: Demographics

Start of Block: **End thanks**

Q60 Thank you so much for participating in this study! We value your time (and of course your responses).

To receive compensation, please complete the WePay information if you have not already. You only need to complete this one time.

https://pitt.co1.qualtrics.com/jfe/form/SV_3sHSVkDyVI3EzCB

Should you have any questions, comments, or concerns, please feel free to contact us at UNITEDStudy@pitt.edu.

We hope you have a great rest of your day!

End of Block: End thanks

Supplement 2
Psychometric testing for composite items in the
UNITED study of teamwork in intensive care units

Construct	Definition	No. of items	Scale range ^a	Score, mean (SD)	Reliability
Professional identity	The clinician's professional self-concept based on attributes, beliefs, values, motives, and experience	4	1-5	4.14 (0.5)	$\alpha = 0.73$
Self-efficacy	The clinician's perceived ability to successfully perform their job	2	1-5	4.36 (0.5)	$r = 0.70$
Role clarity	Knowledge of one's own roles and responsibilities	3	1-5	4.23 (0.6)	$\alpha = 0.80$

^a All items were scaled so that higher scores indicate strong agreement.