Assessing the Impact of Telemedicine on Nursing Care in Intensive Care Units

By Ruth Kleinpell, RN, PhD, APRN-BC, CCRN, Connie Barden, RN, MSN, CCRN-E, CCNS, Teresa Rincon, RN, BSN, CCRN-E, Mary McCarthy, RN, BSN, and Rebecca J. Zapatochny Rufo, RN, DNSc, CCRN

Background Information on the impact of tele–intensive care on nursing and priority areas of nursing care is limited.
Objectives To conduct a national benchmarking survey of nurses working in intensive care telemedicine facilities in the United States.
Methods In a 2-phased study, an online survey was used to assess nurses' perceptions of intensive care telemedicine, and a modified 2-round Delphi study was used to identify priority areas of nursing.
Results In phase 1, most of the 1213 respondents agreed to strongly agreed that using tele–intensive care enables them to accomplish tasks more quickly (63%), improves collaboration (65.9%), improves job performance (63.6%) and communication (60.4%), is useful in nursing assessments (60%), and improves care by providing more time for patient care (45.6%). Benefits of tele–intensive care included ability to detect trends in vital signs, detect unstable physiological status, provide medical management, and enhance patient safety. Barriers included technical problems (audio and video), interruptions in care, perceptions of telemedicine as an interference, and attitudes of staff. In phase 2, 60 nurses ranked 15 priority areas of care, including critical thinking skills, intensive care experience, skillful communication, mutual respect, and management of emergency patient care.
Conclusions The findings can be used to further inform the development of competencies for tele–intensive care nursing, match the tele–intensive care nursing practice guidelines of the American Association of Critical-Care Nurses, and highlight concepts related to the association's standards for establishing and sustaining healthy work environments. (*American Journal of Critical Care.* 2016;25:e14-e20)

Telemedicine in the intensive care unit (tele-ICU), or the use of telehealth techniques to provide care for acute and critically ill patients, has changed the way care is provided in ICU settings. Intensive care unit telemedicine has been defined as a technological innovation that uses audio, visual, or combined audiovisual communication to provide critical care from a remote location.[1] The use of ICU telemedicine enables clinicians to remotely monitor patients' vital signs, physiological status, and results of laboratory and diagnostic tests and to provide interventions as indicated by a patient's condition. Telemedicine also enables clinicians working in ICU settings to obtain consultation from expert practitioners at the remote monitoring site to promote best care for patients.[2-5]

The United States has approximately 45 tele-ICUs that reach more than 200 hospitals, with monitoring capability for more than 6000 beds (12% of ICU patients in the United States).[6] Although according to estimates, 800 to 1000 nurses currently practice in tele-ICUs and more than 16 000 bedside nurses interface with these units, information on the impact of tele-ICUs on nursing care is limited.

Tele-ICU Nursing

In 2010, the American Association of Critical-Care Nurses (AACN) convened a tele-ICU work group to address issues related to tele-ICU nursing practice. The *AACN Tele-ICU Nursing Practice Guidelines*[7] state that tele-ICU leaders and nurses must establish and sustain an environment that promotes effective communication, collaboration, and collegiality to ensure optimal quality outcomes; that tele-ICU nurses must demonstrate proficiency in specific knowledge, skills, and competencies to contribute maximally to patient outcomes and nursing practice; and that nurses must be actively engaged in measuring and analyzing

outcomes to ensure ongoing improvement in patient care and the contributions of tele-ICU nurses to care.

A consensus statement[8] on the research agenda in ICU telemedicine, developed by a working group of the Critical Care Societies Collaborative, which includes AACN, the American College of Chest Physicians, the American Thoracic Society, and the Society of Critical Care Medicine, identified the need for research on the impact of telemedicine. To date, little research has been conducted on this subject. The gap is especially notable for ICU nursing care. Without knowledge of the impact of ICU telemedicine on nursing care, advancement of tele-ICU nursing and the development of related nursing competencies will be limited.

> Information about the impact of telemedicine on nursing care is limited.

Specific Aims

The purpose of this study was to assess nurses' perceptions of the benefits of and barriers to implementing telemedicine. The specific study aims were to conduct a national benchmarking survey of nurses working in telemedicine facilities in the United States to identify barriers to and benefits of telemedicine with respect to nursing care, and to determine priority areas of care for nurses working in ICU telemedicine facilities. The results of the study form a foundation for developing competencies for tele-ICU nursing.

Methods

Eligible participants included nurses who were currently working in tele-ICU settings, including remote monitoring sites and units that interface with the sites. The study was conducted in 2 phases. In phase 1, nurses working in tele-ICUs and in ICUs that interface with tele-ICUs in the United States were surveyed on the nurses' perceptions of the benefits of and barriers to telemedicine and on the impact of tele-ICU on nursing care. A descriptive survey was

About the Authors
Ruth Kleinpell is director of the Center for Clinical Research, Rush University Medical Center, Chicago, Illinois, and a professor at Rush University College of Nursing, Chicago, Illinois. **Connie Barden** is currently the chief clinical officer of the American Association of Critical-Care Nurses, Aliso Viejo, California. During the study period, she was the clinical nurse specialist of the tele–intensive care unit at Baptist Health South Florida, Miami, Florida. **Teresa Rincon** is currently the operations director of the tele–intensive care unit, UMass Memorial Medical Center, Worcester, Massachusetts. During the study period she was director of nursing at Sutter Health, Sacramento, California. **Mary McCarthy** is director, Clinical Quality Value Analysis, Eastern Maine Healthcare Systems, Bangor, Maine. **Rebecca J. Zapatochny Rufo** is the, operations director of the tele–intensive care unit program at Resurrection Health Care, Chicago, Illinois.

Corresponding author: Ruth Kleinpell, RN, PhD, APRN-BC, CCRN, 600 S Paulina Ave, Ste 1080, Chicago, IL 60612 (e-mail: ruth_m_kleinpell@rush.edu).

used with an electronic survey tool (SurveyMonkey). The eICU Acceptance Survey[9] was adapted, with permission, to include questions on barriers to and benefits of the implementation of telemedicine on nursing care and on priority areas of care. The eICU Acceptance Survey was developed to assess nurses' acceptance of telemedicine technology in the ICU. The tool consists of 58 items divided into sections that include perceived usefulness, perceived ease of use, nurses' attitudes toward telemedicine, intention to use, and knowledge and awareness of telemedicine. Reliability and content validity were established in a study with 117 nurses to assess the acceptance of telemedicine technology.[9]

The reliability (coefficient α) was 0.88 and the corrected item-correlation ranged from 0.52 to 0.83, indicating that each item correlated well with other items. The coefficient α of each construct ranged from 0.91 (nurses' attitude toward eICU construct) to 0.96 (perceived usefulness construct). Collectively, the results provided psychometric evidence of reliability and validity.[9]

In order to conduct phase 1, a comprehensive database of nurses working in tele-ICUs and in ICU nursing units that interfaced with the tele-ICUs was developed. All tele-ICU sites in the United States were identified, and contact information was obtained. Sites were divided among the study coinvestigators, and directors of each tele-ICU program were sent an e-mail invitation to participate in the study. Surveys were sent to the operations directors of all 43 tele-ICU sites known to the investigators at the time. The directors were asked to distribute the surveys to their staff both in the tele-ICU and at the bedside. Three reminders were sent in the same manner before the closing date for return of the survey. The study was approved by the appropriate institutional review board as an expedited study because no personal identifiers were collected and participation was voluntary.

> A 2-round modified Delphi technique was used to rank priority areas of care identified by phase 1 participants.

For phase 2, a 2-round modified Delphi technique was used to rank priority areas of care identified by the participants of phase 1. The Delphi method is a systematic, interactive method in which a panel of experts answer questionnaires and provide ratings in 2 or more rounds.[10] The Delphi technique was designed to gather input from participants without requiring face-to-face contact. The process is often used to find consensus among groups. In the modified Delphi technique, mail or e-mail is used to gather information, provide feedback, and report conclusions.[11] The modified Delphi technique consists of a series of rounds to define the issue to solicit responses, compile responses, and prioritize responses. A total of 60 nurses from phase 1 who expressed interest in continued participation in the study completed phase 2. The modified Delphi study consisted of 2 rounds of electronic surveys: round 1 to identify the top 25 areas of priority care for nurses working in tele-ICU nursing and round 2 to take those identified areas and rank the top 15 areas of priority focus. Responses were compiled and prioritized on the basis of the participants' rankings.

Use of the Delphi technique protects the anonymity of participants while allowing researchers to examine consensus of broad analytical perspectives on a topic and enables sharing of information and reasoning among participants.[12] A challenge to Delphi surveys is encouraging participation in all rounds of the study. A $25 stipend in the form of an electronic gift card (AACN bookstore) was provided to those participants for phase 1 of the study; an additional $50 electronic gift card was provided to the participants from phase 1 who also participated in phase 2.

Results

A total of 1213 nurses responded to phase 1: nurses who worked in a tele-ICU (13.5%), bedside nurses who interfaced with the tele-ICU (76%), and nurses who worked in both capacities (10.5%). Number of years as a nurse ranged from less than 1 to 48 (mean, 16). A majority of the respondents (55.3%) had a baccalaureate degree in nursing, 27.0% had an associate degree, 8.5% had a master's degree, and 7.5% had a diploma. The number of years of critical care nursing ranged from less than 1 to 40 (mean, 12), and the number of years of tele-ICU nursing ranged from less than 1 to 20 (mean, 3). The demographic profile of the target group was reflective of the general population of nurses with respect to number of years as a nurse and number of years of critical care nursing. A higher percentage of the target group (55.3%) reported a baccalaureate degree in nursing; nationally, 37% of nurses report this degree preparation.[13]

Phase 1

Data from phase 1 were analyzed by using descriptive statistics. A majority of the respondents agreed to strongly agreed that tele-ICU systems offer nurses an opportunity to improve patient care (79.2%) and that tele-ICU is useful in their job (75.2%). Participants also agreed to strongly agreed that using the tele-ICU enables them to accomplish tasks more quickly (63%), improves collaboration (65.9%), improves job performance (63.6%), improves communication (60.4%), is useful in nursing assessments (60%), and improves

Table 1
Nursing perceptions of the use of tele–intensive care unit (ICU)[a]

Statement	Percentage of respondents				
	Strongly agree	Agree	Uncertain	Disagree	Strongly disagree
Using tele-ICU enables me to accomplish tasks more quickly	22.3	40.7	13.8	18.5	4.7
Using tele-ICU enables me to improve my job performance	22.0	41.6	15.5	16.8	4.0
Using tele-ICU in my job increases my productivity	20.4	48.0	15.8	20.5	5.0
Using tele-ICU makes it easier to do my job	22.5	41.4	14.1	17.9	4.1
I find tele-ICU useful in my job	29.1	46.1	9.7	11.2	3.9
I find tele-ICU is useful in nursing assessments (eg, laboratory results, trends in vital signs, problem lists, physician notes)	21.8	38.2	14.9	20.2	4.8
The use of tele-ICU improves patient care by giving the nurse more time with the patients	16.1	29.5	20.5	26.8	7.1
Tele-ICU systems offer nurses an opportunity to improve patient care	27.3	51.9	10.1	7.7	3.0
Tele-ICU can be a threat to patient privacy	6.8	21.3	13.1	44.0	14.8
Having a tele-ICU makes the nurse's job easier	17.7	38.5	19.5	19.1	5.2
Tele-ICU improves communication	15.5	44.9	18.6	17.0	4.0
Tele-ICU improves collaboration	19.9	46.0	17.4	13.0	3.8

[a] As reported by 1213 nurses in a national survey.

care by giving more time for patient care (45.6%). Only 28.1% of the participants agreed or strongly agreed that tele-ICU can be a threat to patients' privacy (Table 1).

As shown in Table 2, a number of benefits to using tele-ICU were cited, including ability to monitor trends in vital signs, detect unstable physiological status, provide medical management, enhance patient safety, detect arrhythmias, prevent self-extubation, and prevent falls. As shown in the Figure, barriers to using the tele-ICU included technical problems (audio and video), interruptions in care, perception that tele-ICU is an interference, and attitudes of staff.

Phase 2

In phase 2, a total of 60 respondents ranked priority areas of care (Table 3) identified in phase 1. Among the phase 2 participants, 93.3% were women; 68.3% had a baccalaureate degree in nursing, 15% had an associate degree, 10% had a master's degree, and 5% had a diploma in nursing.

Respondents were 22 to 66 (mean, 44.6) years old and had a mean of 9.5 (range, 2-40) years of nursing experience and a mean of 6 (range, 2-12) years working in their current setting. Respondents had a mean of 5 (range, 1.5-10) years of experience using tele-ICU and had worked a mean of 4 (range, 0-10) years as a tele-ICU nurse.

The responses from the modified Delphi rounds were compiled and rank ordered on the basis of respondents' ratings. The top 25 were rated in round 1 and the top 15 in round 2. Participants were asked to rank the top areas identified in phase 2 from most

Table 2
Benefits of using the tele–intensive care unit

Benefit	Percentage of respondents
Monitor trends in vital signs	15
Provide medical management	15
Enhance patient safety	14
Detect arrhythmias	13
Detect unstable physiological status	13
Prevent falls	9
Watch patient when nurse is out of the unit	9
Prevent self-extubations	7
Monitor infusions	5

important (1) to least important (15). After round 1, the following priority areas were not retained in the top 15 because of lower rankings: clinical knowledge of the tele-ICU system, comfortable with technology, interpretation of electrocardiograms, conduct clinical consultations, accurate documentation of tele-ICU care, use of the tele-ICU system to optimize medical management, current ICU bedside experience, and self-confidence. Table 4 gives the rank for each of the 15 most important areas of care for tele-ICU nursing.

According to the highest response rates, the most important abilities overall (n = 60) in tele-ICU nursing included critical thinking skills, being an expert clinician with ICU experience, and skillful
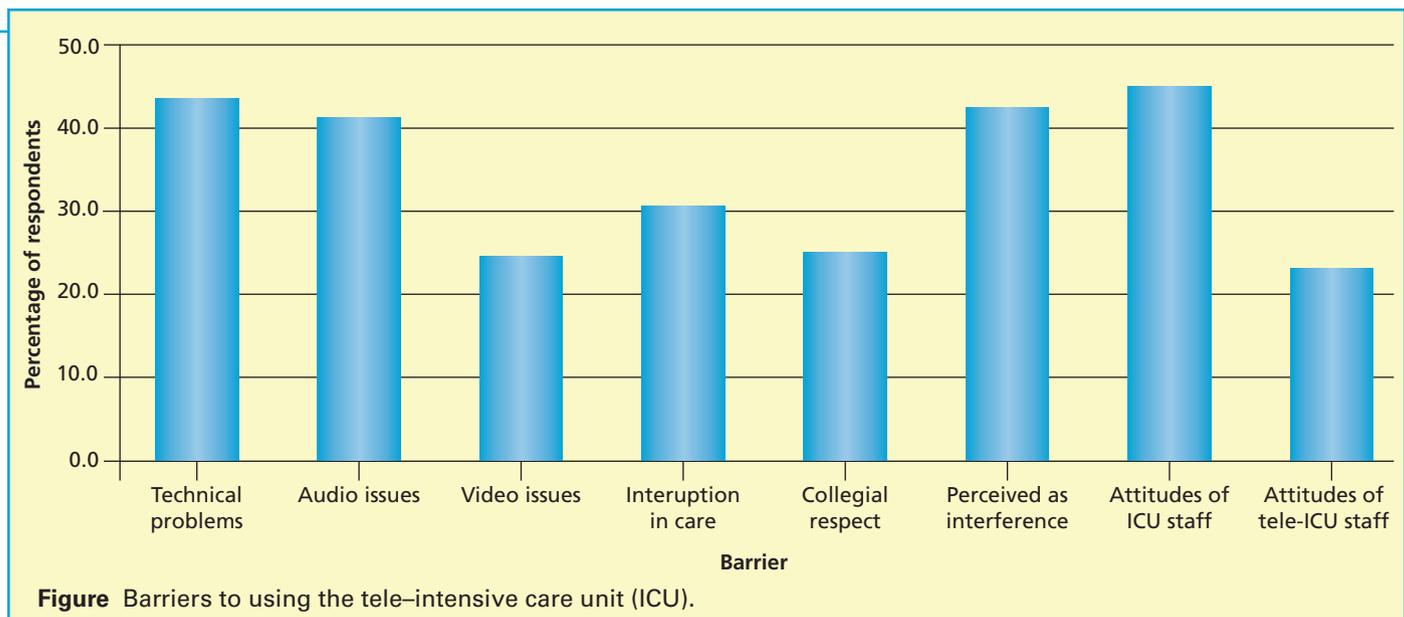
Figure Barriers to using the tele–intensive care unit (ICU).

Table 3
Top rated important abilities (competencies) needed for nurses working in the tele–intensive care unit (ICU)[a]

Competency	Percentage of respondents
Skillful communication	85.1
Mutual respect for tele-ICU and bedside staff	82.8
Clinical knowledge of the tele-ICU system	80.3
Knowledge of hemodynamic monitoring	76.5
Comfortable with technology	71.0
Ability to interact with multiple disciplines	70.2
Emergency patient care management	68.6
Understanding of laboratory values	68.5
Knowledge of medications	67.5
Knowledge of ventilator management	66.4
Interpretation of electrocardiograms	63.4

[a] As identified by 1213 nurses from phase 1 of the study.

communication. The least important ability was ability to mentor. Respondents who worked as both an ICU bedside nurse and a tele-ICU nurse (n = 5) included critical thinking skills, expert clinical ICU experience, and monitoring for unstable physiological status as the most important abilities for a tele-ICU nurse. Use of tele-ICU to enhance patient safety, ability to interact with multiple disciplines, and ability to mentor were rated of lesser importance than were other priority areas.

Tele-health ICU nurses were more likely to report that being an expert clinician with ICU nursing experience and being comfortable with technology were more important considerations, whereas bedside nurses were more likely to identify clinical knowledge of the tele-ICU system and knowledge of ventilator management as more important. Both groups identified skillful communication, critical thinking skills, interpretation of electrocardiograms, understanding laboratory values, and knowledge of emergency patient management as important competencies.

Several respondents provided additional comments on their experiences with using tele-ICU. One wrote, "Tele-ICU experience is one of the most unique fields that I have worked so far, and it has a vast potential in terms of reaching out and enhancing patient safety and care." Another related, "It requires tremendous interpersonal relationships, however, professionally and effective communication with a variety of disciplines." Another remarked, "Tele-ICU competency is a great need. The multiple skills required are a mix of common and unique skills."

Discussion

The target of 350 participants for phase 1 of this study was greatly exceeded, with 1213 participants. This level of participation indicates that many nurses have an interest in examining how tele-ICU is affecting nursing practice. The finding that 921 of the respondents (76%) in phase 1 worked solely in the ICU setting is an important consideration in interpreting our results. For example, although barriers related to perceptions of interference and to interruptions in care were identified, the majority of participants thought that tele-ICU enhanced patient care, improved productivity and collaboration, and made their job easier.

Respondents in phase 1 reported that communication (60.4%) and collaboration (65.9%) were improved with tele-ICU, and skilled communication and mutual respect ranked high in both phases of the

study (first and second in phase 1 and third and fourth in phase 2). Yet attitudes of ICU staff members were identified as a top barrier to using tele-ICU (45%), and attitudes of tele-ICU staff were also identified as a barrier (23.4%). This finding indicates a continued focus on understanding and implementing the principles of a healthy work environment at individual, institutional, and organizational levels. Further examination of the barriers identified in this study is needed to enhance knowledge related not only to tele-ICU nursing practice but also to general nursing attitudes and behaviors that may have adverse effects on the care of critically ill patients and the patients' families.

Other important areas of interest identified in this study are related to tele-ICU assistance with patient monitoring and safety and to critical thinking and advanced critical care nursing knowledge and experience. Knowledge translation, a process used to close the gap between creation of knowledge and use of that knowledge through synthesis, dissemination, and diffusion methods, has been advocated as a useful strategy for improving evidence-based practice in critical care.[14,15] A recently published multicenter study[2] indicated improved adherence to best-practice protocols and better mortality and length of stay in 56 ICUs in 15 states across the United States after implementation of tele-ICU services. Our results indicate that important priority areas for tele-ICU nursing practice involve both critical thinking and expertise and knowledge in critical care. Optimal leveraging of this experienced critical care workforce could be used to enhance implementation of best practices and optimization of outcomes of critically ill patients.

Our results add to the literature on tele-ICU nursing, which to date has included single-center observations and interviews of nurses who likened the nursing work to an air traffic control room[16] and an assessment of perceptions of tele-ICU among nurses in 3 ICUs in 2 settings that indicated general support of tele-ICU and concerns about privacy issues.[5]

Our results help address the lack of knowledge on the impact of tele-ICUs on ICU nursing care. Our identification of priority areas of tele-ICU nursing provides needed data for the development of competencies and optimization recommended in The *AACN Tele-ICU Nursing Practice Guidelines*.[7] In addition, the new knowledge can be used to identify areas for developing a research agenda for tele-ICU nursing care. Variations in the practice of ICU telemedicine are well known, including tele-ICU staffing patterns, qualifications of providers, ICU staffing models, leadership and governance, and adherence to best practices.[3] Additional research is needed to

Table 4
Most important priority areas of care for tele–intensive care unit (ICU) nursing[a]

1. Critical thinking skills
2. Expert clinician with ICU experience
3. Skillful communication
4. Mutual respect for bedside and tele-ICU colleagues
5. Emergency patient care management
6. Monitor for unstable physiological status
7. Knowledge of ventilator management
8. Correlation of arterial blood gases to mechanical ventilation
9. Knowledge of hemodynamic monitoring
10. Understanding laboratory values
11. Knowledge of medications
12. Monitor trends in vital signs
13. Use the tele-ICU system to enhance patient safety
14. Ability to interact with multiple disciplines
15. Ability to mentor

[a] As ranked by 60 tele-ICU nurses in a modified 2-round Delphi.

further delineate issues related to tele-ICU that specifically affect nursing practice.

A recent systematic review[17] indicated that the cost of tele-ICU implementation is substantial and that the impact of these programs on hospital costs or profits is unclear. No information on costs related to tele-ICU nursing care or on alternative nurse staffing models is currently available. This information would be beneficial to help maximize optimal nurse staffing, identify how best-practice care can be promoted with tele-ICU, and promote best patient care outcomes.

Limitations

Our study had several limitations, including the lack of information on a total sample size because no single source of identifying nurses working in tele-ICU is available. Although according to estimates, 800 to 1000 tele-ICU nurses were working at the time of the survey, estimates also suggest that potentially more than 16 000 nurses interface with the tele-ICU nurses. A study response rate could not be assessed because the true number of potential respondents was not known. A second limitation was the geographic representation available for the study; only those nurses working or interfacing with a tele-ICU were eligible to participate in the study.

> Most participants thought that tele-ICU enhanced patient care, improved productivity and collaboration, and made their jobs easier.

Conclusion

Tele-ICU nursing, as a growing subspecialty of critical care nursing, is part of a model of care that has the potential to affect patients, patients' families, and the entire health care team. This study was designed to elucidate the impact of the tele-ICU on nursing care and to identify priority areas of care for health care providers working in the remote facility. The results show promise in helping to further delineate competencies needed for optimal tele-ICU nursing practice and shape the research related to tele-ICU care.

eLetters
Now that you've read the article, create or contribute to an online discussion on this topic. Visit **www.ajcconline.org** and click "Submit a response" in either the full-text or PDF view of the article.

SEE ALSO
For more about nursing and telemedicine, visit the *Critical Care Nurse* Web site, **www.ccnnonline.org**, and read the article by Brindise et al "Development of a Tele-ICU Postorientation Support Program for Bedside Nurses" (August 2015).

REFERENCES
1. Groves RH Jr, Holcomb BW Jr, Smith ML. Intensive care telemedicine: evaluating a model for proactive remote monitoring and intervention in the critical care setting. *Stud Health Technol Inform.* 2008;131:131-146.
2. Lilly CM, McLaughlin JM, Zhao H, et al; UMass Memorial Critical Care Operations Group. A multicenter study of ICU telemedicine reengineering of adult critical care. *Chest.* 2014;145(3):500-507.
3. Lilly CM, Fisher KA, Ries M, et al. A national ICU telemedicine survey: validation and results. *Chest.* 2012;142(1):40-47.
4. Berenson RA, Grossman JM, November EA. Does tele-monitoring of patients—the eICU—improve intensive care? *Health Aff (Millwood).* 2009;28(5):w937-w947.
5. Mullen-Fortino M, DiMartino J, Entrikin L, Mulliner S, Hanson CW, Kahn JM. Bedside nurses' perceptions of intensive care unit telemedicine. *Am J Crit Care.* 2012;21(1):24-31.
6. Goran SF. Measuring tele-ICU impact: does it optimize quality outcomes for the critically ill patient? *J Nurs Manag.* 2012; 20(3):414-428.
7. American Association of Critical-Care Nurses. *The AACN Tele-ICU Nursing Practice Guidelines.* Aliso Viejo CA: American Association of Critical-Care Nurses; 2013.
8. Kahn JM, Hill NS, Lilly CM, et al. The research agenda in intensive care unit telemedicine: a consensus statement from the Critical Care Societies Collaborative. *Chest.* 2011;140(1):230-238.
9. Kowitlawakul Y. *Technology Acceptance Model: Predicting Nurses' Acceptance of Telemedicine Technology (eICU)* [dissertation]. Fairfax, VA: George Mason University; 2008.
10. Dillman DA. *Mail and Internet Surveys: The Tailored Design Method.* New York, NY: John Wiley & Sons Inc; 2000.
11. University of Illinois Extension. Modified Delphi Technique http://www.communitydevelopment.uiuc.edu/sp/Step6/Delphi%20Technique.pdf. Accessed October 2, 2015.
12. Hatcher T, Colton S. Using the internet to improve HRD research: the case of the web-based Delphi research technique to achieve content validity of an HRD-oriented measurement. *J Eur Ind Train.* 2007;31(7):570-587. doi:10.1108/03090590710820060.
13. American Association of Colleges of Nursing. Nursing fact sheet. http://www.aacn.nche.edu/media-relations/fact-sheets/nursing-fact-sheet. Last updated April 12, 2011. Accessed September 22, 2015.
14. Black MD, Schorr C, Levy MM. Knowledge translation and the multifaceted intervention in the intensive care unit. *Crit Care Med.* 2012;40:1324-1328.
15. Rincon TA. Integration of evidence-based knowledge management in microsystems: a tele-ICU experience. *Crit Care Nurs Q.* 2012;35:335-340.
16. Stafford TB, Myers MA, Young A, Foster JG, Huber JT. Working in an eICU unit: life in the box. *Crit Care Nurs Clin North Am.* 2008;20(4):441-445.
17. Kumar G, Falk DM, Bonello RS, Kahn JM, Perencevich E, Cram P. The costs of critical care telemedicine programs: a systematic review and analysis. *Chest.* 2013;143(1):19-29.