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Jacqueline Roliardi
36” x 36”
Mixed media

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The American Journal of Critical Care (AJCC), with its first bimonthly publication in July of 1992, is now publishing its 25th volume. Founding AJCC was based on AACN’s need for an association-owned, high-quality, scholarly, peer-reviewed journal that would document the significant research and clinical findings of all health care practitioners interested in the ideals of critical care, particularly the tradition of interdisciplinary teams caring for critically ill patients and their families with well-honed expertise and great mutual respect. The new journal also reflected the previously untested ability of AACN to create in-house production systems for a scientific journal in which we all could take pride.

History of the Journal

In 1990, the AACN Board of Directors was concerned that the publication of the scientific journal AACN owned at that time, Heart & Lung (published for AACN by C.V. Mosby), was no longer a viable option for the association, so they decided to start a new journal titled the American Journal of Critical Care. The decision was a bold one, giving the coeditors only 6 months to find enough original high-quality papers to fill a first issue. Although it seemed like a Herculean task, both editors (C.B.B. and K.D.) unhesitatingly agreed it could be done, and—with a fearful lack of overt trepidation—agreed to do it.

The process of launching a new scientific journal entailed several challenges. Application for listing in Index Medicus (now MEDLINE) was done as expeditiously as possible, but the process usually takes 3 years and there were no guarantees. Reviewers from Heart & Lung were invited to continue reviewing for AJCC, and members of the editorial board also were invited to continue their services. AACN recruited an in-house editorial staff, a mechanism for soliciting advertisements was initiated, and we were off!

The results of this activity were remarkable and reflected the good will and talent of the critical care community. Manuscripts were submitted, reviewed, and accepted at the same rate they had been previously; most of the reviewers agreed to review for the fledgling publication; and a new editorial board was formed. The coeditors had many moments of anxiety, but by the end of the first year of the new journal it was clear we were on a successful path and that AACN’s scientific journal was well established.

AJCC was listed in Index Medicus in less than 2 years. Much credit for that achievement should be given to AACN staff member Ramon Lavandero, who was quite persistent in his efforts with the relevant authorities, showing them that the new journal had the same editors, similar scientific content, and an editorial board as expert as the older indexed journal Heart & Lung. The circulation was just under 80,000 and the journal continued to be a membership benefit of AACN. The faith early authors and AACN Board members had in AJCC turned out to be justified.

Increasing Readership

The founding coeditors were keen to increase readership and relevance, particularly for clinicians and researchers, so various strategies were implemented to incorporate the suggestions of readers and authors using carefully collected survey data. Members provided important suggestions for increasing...
the clinical relevance of the journal that led to new regular features (eg, Clinical Pearls, ECG case studies, continuing education credits for designated articles) and a change in the format of articles. Authors were generally less helpful in suggesting potential changes: those whose manuscripts were accepted liked AJCC and the review process they experienced; those whose manuscripts were rejected did not. (No surprise there!) The coeditors recognized that most contributors were first-time authors and spent a great deal of time and effort trying to help restore the egos of those rejected so they would continue with their scientific endeavors. The coeditors also took part in a session on publishing at the annual AACN National Teaching Institute & Critical Care Exposition to encourage new authors and recruit new reviewers.

There were trends in research that the coeditors came to dread. For instance, the descriptive study by Nancy Molter on the needs of families with a critically ill relative, published in 1979, showed the high priority families ascribed to information about the patient’s condition and prognosis. This single published paper rendered the subject axiomatic. Although many authors subsequently submitted manuscripts on the needs assessment of family members in different critical care subspecialties, often with detailed statistical analysis, the conclusion that information helps the families of critically ill patients remained the same. Keeping family members in different critical care subspecialties, the coeditors agreed, was an unanswerable question. The coeditors recognized that most manuscripts were rejected, some whose manuscripts were accepted just short of outrage occasionally was. For AJCC, the AJCC surely would not have succeeded. Good reviewers are part of any journal’s prized assets—in fact, they are the real heroes of scientific journal production. In the case of AJCC, it must be a labor of love, as the only recompense for reviewers was (and remains) annual recognition in its pages; hours of effort are not compensated monetarily. The founding coeditors were pleased to see so many reviewers continue their service to the journal after we retired.

It is equally heartening to see the journal in such good hands today. The founding coeditors feel pride in what we started and wonder what will challenge the current coeditors as we enter the digital age of paperless publication. We wish them good luck!

The statements and opinions contained in this editorial are solely those of the coeditors in chief.

FINANCIAL DISCLOSURES
None reported.

REFERENCE

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Letters

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Pressure Ulcers Caused by Masks During Noninvasive Ventilation

We read with interest the paper in the July issue by Schallom et al1 about pressure ulcers induced by nasal-oral and full-face masks during noninvasive ventilation (NIV).

The study is attractive and almost reassuring because it shows that full-face masks are more comfortable and resulted in less pressure ulcers than nasal-oral masks. However, we detect some elements about the internal and external validity of this research that need to be further considered.

First, the staff members involved in the pressure ulcer assessment had 100% agreement, but the authors didn’t report any statistical test performed.

Second, we are concerned about the timing of skin assessment: once in the morning and once in the evening. However, we don’t know the real number of hours that passed between the evaluations. According to preclinical and clinical studies, pressure ulcers can develop in 4 to 6 hours under a sustained load and, even if the threshold pressure of 32 mm Hg to close the capillary flow is still in question, a recent literature review reveals that tissue-interface pressures of 30 to 37 mm Hg together with shear forces seem to be sufficient to provide tissue impairment and pressure ulcers.2

For these reasons we think that skin assessment should be done at least every 2 to 4 hours, differently from the low level evidence based recommendation of “at least twice daily assessment” stated by the recent pressure ulcer prevention and treatment guidelines.3 Nevertheless a large number of different kind of nasal-oral mask is available. So, the results reported by Schallom et al1 cannot be exported in a broader context, because they referred to a “unique technology.” In their article, the authors refer to a generic “comfort level” that should be put in relation to reproducible and documented parameters or evaluation criteria such as amount of gas flow, pain, difficulty in sedation, claustrophobia.

Moreover, there was a lack of data collection about patients’ risk factors for pressure ulcer development as body mass index, diabetes, inotrope/vasoactive agents infusion, edema, vascular disease, nutritional status, chronic skin condition, history of previous pressure damage, steroid therapy treatment, and cytotoxic drugs.4 We don’t know if these important variables were comparable in the 2 studied groups.

Furthermore, no data were collected about the setting of NIV modes, inspiratory pressure, positive-end expiratory pressure, gas flows, and the types of ventilators employed. In fact, Dellweg et al5 showed that inspiratory and expiratory pressure levels affect skin pressure contact, and increasing inspiratory pressure determines higher air leaks. Consequently, there is, often, the need to tighten further the mask harness in order to limit these leaks.

Finally, no data about humidification were provided. Unfortunately, the automated setting of some kind of heated humidifiers can bring to an excess of gas humidification inside the interfaces, lowering the patients’ comfort and tolerance level to the masks.

Even if we believe that full-face masks can really represent a valid alternative to nasal-oral masks for the prevention of pressure ulcers, in view of the constraints and aspects described above, we think that further studies with more methodological strength are needed to provide evidence about this issue.

Stefano Bambi, RN, MSN
Florence, Italy
Adriano Peris, MD
Florence, Italy
Antonio M. Esquinas, MD, PhD
Murcia, Spain

FINANCIAL DISCLOSURES
None reported.

REFERENCES

doi: http://dx.doi.org/10.4037/ajcc2016906

Response:
We would like to thank Bambi and colleagues for their interest in our work. They asked many important questions, which we will address.

Regarding the first comment on lack of statistical tests performed on agreement, no analysis was conducted as there was no disagreement among the
assessments during the validation period. All of the nurses on the team were either certified wound nurses or nurses with multiple years of experience on our pressure ulcer team conducting weekly or monthly skin audits. Therefore, we had a high level of expertise on skin assessment and pressure ulcer staging before project initiation. The 2 respiratory therapists involved in data collection were educated throughout the research development phase that occurred over 6 months as we were exploring the problem and planning interventions.

We agree that pressure ulcer development is multifactorial and that pressure ulcers can occur within several hours. We noted that a limitation to the study was a nonrandomized design with the potential for differences in participants’ characteristics between the 2 groups and therefore also risk factors. Unlike traditional pressure ulcers over pressure areas, device related pressure ulcers from noninvasive ventilation (NIV) masks present the problem of inability to relieve the pressure or shear forces due to the ongoing need for NIV assistance. Thus risk factors may have a smaller impact on pressure ulcer development and performing skin assessments is more challenging.

Before placing any patient on a NIV mask, the bedside nurse and therapist assessed and recorded the skin integrity of each patient. Skin assessments were conducted at time of enrollment and then at least every 12 hours at 8 AM and 8 PM. In addition, skin assessments were performed with any repositioning, removal or reapplication of the mask when a trial without the mask was attempted. The additional assessments were variable for time interval for each patient. As discussed in the results, time to ulcer development was found as early as 1.25 hours of mask wear. In the implications for practice, we recommended frequent assessment of the skin at each opportunity of mask removal and at least every 12 hours. With this frequency of assessments, we were able to prevent the higher levels of pressure ulcers we had seen prior to this study.

Bambi and colleagues make an excellent observation regarding humidification and pressure settings on the NIV and their potential impact on pressure ulcer development. Patients were initially started with a nonhumidified delivery of oxygen with both masks. Patients were transitioned to humidity only after 12 hours of continuous wear. The mean hours worn was 3 hours longer with the full-face mask; however wear time was not significantly different between groups. Therefore, humidity most likely did not have an influence on the higher rate of development with the nasal-oral mask.

We reviewed acceptable leak parameters with nurses and respiratory care practitioners. Before the study, we often found that masks were tightened on the face to allow no or very minimal air leakage. Therefore, prior to implementing the study, education and competency for all respiratory therapists and critical care nurses on proper application of both types of masks with allowable leak was completed. Ventilators used to apply noninvasive ventilation during the study during both time periods were Respironic Vision or Respironic V-60 (Phillips). All ventilators were placed in spontaneous/timed mode. The maximum allowable pressure is 20 cm H2O for the Vision and 30 cm H2O for the V-60. All patients had inspiratory and expiratory pressures monitored during therapy, but the information was not included in the study.

Lastly, we agree that comfort with the mask is multifactorial. We chose to use a 5-point scale for mask comfort, which would include factors you described, such as claustrophobia, pressure from mask, moisture, or pain, to help the participants differentiate pain at other sites and to obtain an overall discomfort rating from the mask itself. A 5-point Likert scale to measure discomfort associated with NIV masks has been used by other researchers. Gregoretti et al and Lemyze et al associated a lower number with higher discomfort. We chose to stay consistent with our pain scale, which used a higher number to represent greater discomfort and used different descriptors. We asked the participants to rate comfort specific to the mask and specifically asked about eye comfort with the mask.

As the first prospective study to examine pressure ulcers as the primary outcome associated with noninvasive ventilation with masks readily available to clinicians, we agree that further research is needed. Future studies can include exploration of traditional risk factors as well as risks associated with various inspiratory and expiratory pressures with NIV as proposed by Bambi and colleagues.

Marilyn Schallom, RN, PhD, CCNS, CCRN
St Louis, Missouri
Lisa Cracchiolo, BA, RRT, AE-C,
St Louis, Missouri

FINANCIAL DISCLOSURES
None reported.

REFERENCES


doi: http://dx.doi.org/10.4037/ajcc2016948
Nurses’ Roles as Intermediaries

Structured family meetings with an interdisciplinary team are an important part of family centered care. However, barriers to successful nurse involvement have hindered effective nurse participation and contribution. Ahluwalia and colleagues conducted focus groups with 30 intensive care unit (ICU) nurses to explore their experiences and perceptions related to nursing roles and challenges regarding family meetings. They identified the following 3 major themes:

1) Multiple roles: nurses act as coordinator, advocate, and translator during and after family meetings.
2) Barriers: Lack of resources to attend meetings, no invitation to attend, and feeling unable to speak up to contradict a physician.
3) Lack of power: Conflict between understanding family preferences and inability to communicate any discrepancies to physicians.

The authors recommend multidisciplinary skills training and relationship building, premeeting huddles to align communication, and creation of a designated time and space for nurse contributions during family meetings.

See Article, pp 33-38

Norepinephrine Dosing in Obese Patients With Septic Shock

The Surviving Sepsis Campaign International Guidelines recommend norepinephrine (NE) as the first choice vasopressor in patients with fluid refractory shock. However, differing drug information sources and research studies comparing dosing type have lead to provider and institution inconsistency. In addition, patient weights can frequently change during an ICU stay; thus applying weight-based dosing can lead to possible inaccuracies and errors. To understand the effect of weight-based versus non-weight-based NE dosing on maintaining a mean arterial pressure (MAP) of > 65 mm Hg, Radosevich and colleagues retrospectively compared 100 obese patients with 100 nonobese patients with septic shock. They found the following:

• Obese patients required a lower weight-based (µg/kg/min) infusion rate than nonobese patients.
• Non–weight-based doses (µg/min) were similar between groups.
• Total intravenous fluid amounts were similar between groups.
• Results suggest weight-based dosing strategies may not be necessary even in patients with weight extremes.

See Article, pp 27-32

Telemedicine and ICU Nursing Care

Telemedicine uses audio, visual or combined audiovisual communication to provide critical care from a remote location. Intensive care unit-telemedicine (tele-ICU) also enables consultation with experts to provide best practice for patients. Kleinpell and colleagues first surveyed 1213 nurses who worked in a tele-ICU or an ICU that interfaced with the tele-unit to identify perceived benefits and barriers to telemedicine. Most nurses noted that using tele-ICU did the following:

• Enhanced patient care
• Improved productivity and collaboration
• Made their jobs easier.

Next, the researchers used a modified Delphi technique with 60 nurses to rank priority areas of care and found the following:

• The top rated competencies needed for nurses were skillful communication and mutual respect for tele-ICU and bedside staff.
• The most important abilities were critical thinking skills and expert clinical ICU experience. The authors recommend using this data for development of tele-ICU nursing competencies to match the AACN Tele-ICU Nursing Practice Guidelines (http://www.aacn.org/wd/practice/docs/tele-icu-guidelines.pdf).

See Article, pp e14-e20

Nurses Enhancing Family Resilience

Intensive care unit (ICU) admission can cause psychological stress for patients and families. Family resilience is the ability of families to rebound from challenging events. In order to understand nurse perceptions on fostering family resilience, Ellis and colleagues conducted interviews and focus groups with SICU nurses caring for a long stay patient (minimum 7 days). Their findings show the following:

• Improved presurgery education of patients and families may decrease unrealistic outcome expectations for families and clinicians.
• Helping families find a balance between supporting the patient and meeting their own needs can strengthen the family unit.
• Effective and routine communication between the provider team and family can reduce discrepancies and enhance families’ sense of control and comfort.

Integrating a formal assessment to identify and support key family resilience factors can help families cope with the stress of a long-term ICU hospitalization.

See Article, pp 39-45
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Background  Mechanical ventilation is associated with atrophy and weakness of the diaphragm. Ultrasound is an easy noninvasive way to track changes in thickness of the diaphragm.

Objective  To validate ultrasound as a means of tracking thickness of the diaphragm in patients undergoing mechanical ventilation by evaluating interobserver and interoperator reliability and to collect initial data on the relationship of mode of ventilation to changes in the diaphragm.

Methods  Daily ultrasound images of the quadriceps and the right side of the diaphragm were acquired in 8 critically ill patients receiving various modes of mechanical ventilation. Thickness of the diaphragm and the quadriceps was measured, and changes with time were noted. Interoperator and interobserver reliability were measured.

Results  Intraclass correlation coefficients between operators and between observers for thickness of the diaphragm and quadriceps were greater than 0.95, indicating excellent interoperator and interobserver reliability. Patients receiving assist-control ventilation (n = 4) showed a mean decline in diaphragm thickness of 4.7% per day. Patients receiving pressure support ventilation (n = 8) showed a mean increase in diaphragm thickness of 1.5% per day. Quadriceps thickness declined in all participants (n = 8) at a mean rate of 2.0% per day.

Conclusions  Use of ultrasound to measure thickness of the diaphragm in 8 intensive care patients undergoing various modes of mechanical ventilation was feasible and yielded reproducible results. Ultrasound tracking of changes in thickness of the diaphragm in this small sample indicated that the thickness decreased during assist-control mode and increased during pressure support mode. (American Journal of Critical Care. 2016;25:e1-e8)

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doi: http://dx.doi.org/10.4037/ajcc2016563

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Rapid Response Team Calls and Unplanned Transfers to the Pediatric Intensive Care Unit in a Pediatric Hospital

By Stacey Humphreys, MD, and Balagangadhar R. Totapally, MD

Background  Variability in disposition of children according to the time of rapid response calls is unknown.

Objective  To evaluate times and disposition of rapid response alerts and outcomes for children transferred from acute care to intensive care.

Methods  Deidentified data on demographics, time and disposition of the child after activation of a rapid response, time of transfer to intensive care, and patient outcomes were reviewed retrospectively. Data for rapid-response patients on time of activation of the response and unplanned transfers to the intensive care unit were compared with data on other patients admitted to the unit.

Results  Of 542 rapid responses activated, 321 (59.2%) were called during the daytime. Out of all rapid response activations, 323 children (59.6%) were transferred to intensive care, 164 (30.3%) remained on the general unit, and 19 (3.5%) required resuscitation. More children were transferred to intensive care after rapid response alerts (P = .048) during the daytime (66%) than at night (59%). During the same period, 1313 patients were transferred to intensive care from acute care units. Age, sex, risk of mortality, length of stay, and mortality rate did not differ according to the time of transfer. Mortality among unplanned transfers (3.8%) was significantly higher (P < .001) than among other intensive care patients (1.4%).

Conclusion  Only 25% of transfers from acute care units to the intensive care unit occurred after activation of a rapid response team. Most rapid responses were called during daytime hours. Mortality was significantly higher among unplanned transfers from acute care than among other intensive care admissions. (American Journal of Critical Care. 2016;25:e9-e13)

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doi: http://dx.doi.org/10.4037/ajcc2016329

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ASSESSING THE IMPACT OF TELEMEDICINE ON NURSING CARE IN INTENSIVE CARE UNITS

By Ruth Kleinpell, RN, PhD, 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)

©2016 American Association of Critical-Care Nurses
doi: http://dx.doi.org/10.4037/ajcc2016808

HARRIS-BENEDICT EQUATION AND RESTING ENERGY EXPENDITURE ESTIMATES IN CRITICALLY ILL VENTILATOR PATIENTS

By Michele Ferreira Picolo, RD, MS, Alessandra Fabiane Lago, MS, Mayra Gonçalves Menegueti, RN, MS, Edson Antonio Nicolini, MD, Anibal Basile-Filho, MD, PhD, Altacílio Aparecido Nunes, MD, PhD, Olindo Assis Martins-Filho, PhD, and Maria Auxiliadora-Martins, MD, PhD

Background In routine practice, assessment of the nutritional status of critically ill patients still relies on traditional methods such as anthropometric measurements, biochemical markers, and predictive equations.

Objective To compare resting energy expenditure measured by indirect calorimetry (REEIC) with REE calculated by using the Harris-Benedict equation with 3 different sources of body weight (from bed scale, REEHB1; ideal body weight, REEHB2; and predicted body weight, REEHB3).

Methods This study included 205 critically ill patients (115 men, 90 women) evaluated within the first 48 hours of admission and undergoing mechanical ventilation. REE was measured by indirect calorimetry for 30 minutes and calculated by using the Harris-Benedict equation with the 3 sources of body weight. Data were compared by the Bland-Altman method.

Results The values based on ideal and predicted body weight (REEHB2 and REEHB3) did not agree with REEIC. Bland-Altman analysis showed that the limits of agreement varied from +796.1 kcal/d to -559.6 kcal/d for REEHB2 and from +809.2 kcal/d to -564.7 kcal/d for REEHB3. REEIC and REEHB1 (body weight determined by bed scale) agreed the best; the bias was -18.8 kcal/d. However, REEHB still overestimated REEIC by +555.3 kcal/d and underestimated it by -593.0 kcal/d.

Conclusion For measuring REE in critically ill patients undergoing mechanical ventilation, calculation via the Harris-Benedict equation, regardless of the source of body weight, cannot be substituted for indirect calorimetry. (American Journal of Critical Care. 2016;25:e21-e29)

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doi: http://dx.doi.org/10.4037/ajcc2016758

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PubMed/MEDLINE (1966–November 2014) was searched to identify relevant published studies on the overall frequency, types, and examples of medication errors during medical emergencies involving cardiopulmonary resuscitation and related situations, and the breakdown by type of error. The overall frequency of medication errors during medical emergencies, specifically situations related to resuscitation, is highly variable. Medication errors during such emergencies, particularly cardiopulmonary resuscitation and surrounding events, are not well characterized in the literature but may be more frequent than previously thought. Depending on whether research methods included database mining, simulation, or prospective observation of clinical practice, reported occurrence of medication errors during cardiopulmonary resuscitation and surrounding events has ranged from less than 1% to 50%. Because of the chaos of the resuscitation environment, errors in prescribing, dosing, preparing, labeling, and administering drugs are prone to occur. System-based strategies, such as infusion pump policies and code cart management, as well as personal strategies exist to minimize medication errors during emergency situations. (American Journal of Critical Care. 2016;25:12-20)
Human errors, as noted by the Institute of Medicine publication *To Err Is Human,* are common in critical care, particularly medication-related errors. A recent review indicated that medication errors in the intensive care unit (ICU) range from 8.1 to 234 per 1000 patient-days. Medication errors during emergent situations such as cardiopulmonary resuscitation, however, are less well known. Because patients in cardiac arrest may be in their most vulnerable state, medication errors in these situations have enormous potential to produce a detrimental outcome. The stress of the situation, commotion, use of high-risk medications, and fast-paced environment of resuscitation present a perfect situation for medication errors to occur as described in the Swiss cheese model. Because the prognosis of a patient in cardiac arrest is poor, harm due to a medication error may go undetected and simply be attributed to the emergency situation.

In this review, we describe medication errors in emergency situations, including overall frequency and type, and provide specific examples reported in the literature. We also review system-based strategies for avoiding these errors and offer personal approaches for health care professionals who respond to cardiac arrests and the associated situations. For the purpose of this review, a code-related situation refers to active cardiopulmonary resuscitation or other critical state of the patient in which cardiac arrest is imminent if interventions are not undertaken, such as rapid-sequence intubation.

**Methods**

In order to identify studies in which the frequency and types of medication errors during emergency situations were evaluated, a literature review was conducted. An English-language search was conducted by using PubMed/MEDLINE (1966–November 2014) and Boolean logic with the search term *medication error* and any of the following terms: *emergency, cardiac arrest,* and *resuscitation.* Titles and abstracts were reviewed initially to determine relevance. References of selected articles were examined to identify additional relevant literature.

Original research articles were included in the review if the incidence or frequency of medication errors was reported as a study objective and the study included true in-hospital medical emergencies. Studies involving errors that occurred before admission to a hospital were excluded. Studies on specific interventions during resuscitation were not included in the primary literature review but may be mentioned where applicable throughout the discussion in this article. Of 895 articles screened, 6 met the criteria for inclusion. Other articles were excluded for the following reasons: 852 were not deemed code related as defined for this review, 4 were review articles, 10 were editorials or letters to the editor, 11 were intervention studies, 9 involved the prehospital setting, 2 were evaluations of errors other than medication errors, and 1 did not quantify the medication errors mentioned. The included studies are summarized in Table 1.

Both authors (A.H.F. and S.E.P.) participated in a quality assessment of the identified studies. Because of the heterogeneity in design of the studies, no single quality assessment score was applicable to all 6 of the studies. At a minimum, each author independently evaluated the study in terms of the following considerations: sample size (number of code-related events analyzed or number of centers included), method of identifying errors during the event (reporting vs observation), potential limitations of extracting from the specific registry or adverse-event database, scope of observation for potential errors (observation of error alone vs quantification of syringe contents), and overall generalizability of the studies, including whether limited to certain types of hospitals (academic vs community) or specific areas of the hospital (emergency department vs ICU). Discussions were held to compare key strengths and weaknesses.
identified in the various study designs. Any strength or weakness in study design identified by both authors independently was automatically included in Table 1. Any strength or weakness in design not originally identified by both authors independently was discussed, and if consensus was reached, was included with the other assessments.

**Frequency of Medication Errors During Emergent Code Situations**

The reported frequency of medication errors during code situations is widely variable, with estimates from less than 1% to 50%, largely depending on the study design and the method used to detect medication errors. Various approaches have been used to study these errors, including database mining, simulations, and observational studies.

**Database Mining**

The first study in which investigators used database mining to quantify and analyze medication errors during code situations was a review of code-related medication errors reported to MEDMARX, a national, voluntary, anonymous medication-error reporting system currently maintained by the United States Pharmacopeia. Among 1,043,939 errors in the database from 834 health care facilities, a code situation was identified as a contributing factor in 0.22% (2,288) of events. Surprisingly, the majority of errors identified (74%) involved patients other than the patient being resuscitated, a phenomenon Lipshutz et al termed “collateral damage.” The most common type of error reported in the patient not having a code-related situation was error of omission, most likely due to alterations in workload and...
insufficient staffing for a given situation. Although errors affecting the patient actually having a code-related event were not as common, they were more severe. Compared with non–code-related in-hospital errors, code-related errors were 39 times more likely to result in patient harm and 51.5 times more likely to result in patient death. Autonomic medications and sedative hypnotics accounted for almost 40% of errors that occurred during the resuscitation attempt that affected the patient being resuscitated.4 One proposal made by the investigators4 to reduce medication errors in code situations included reducing the number of code situations, certain something that rapid response teams have done in recent years.10

In a second study on resuscitation system errors and survival, Ornato et al5 analyzed the American Heart Association Get With the Guidelines National Registry of Cardiopulmonary Resuscitation, a database created in 2000 to collect data and create guidelines for inpatient cardiopulmonary resuscitation for hospitals throughout the United States. Medication errors constituted 42.6% of reported resuscitation system errors, more than any other category, including defibrillation and airway management. The majority of the reported medication errors involved a delay greater than 5 minutes in administration of a vasopressor, and almost 2000 other errors involved selection of the wrong medication, wrong route of administration, and wrong dosage.11

The limitations of using registry data to fully analyze medication errors during emergencies is highlighted by a third study6 in which researchers investigated critical incidents related to cardiac

<table>
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<tr>
<th>Notable findings</th>
<th>Strengths</th>
<th>Limitations</th>
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<tbody>
<tr>
<td>Compared with non–code-related errors, code-related errors were 39 times more likely to result in patient harm and 51.5 times more likely to result in patient death</td>
<td>One of the largest medication error reporting systems in the United States</td>
<td>Limited to community hospitals; may not reflect influence of trainees on medication errors</td>
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<td>Medication errors during resuscitation were associated with an increased hazard ratio for death before hospital discharge, regardless of initial rhythm</td>
<td>Integrity and standardization of the data by trained NRCPR abstractors from each participating center</td>
<td>Registry hospitals represent only 10% of US hospitals</td>
</tr>
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<td>Medication errors represented the fewest errors of all subgroups of errors reported; they were exceeded by errors related to alerting the resuscitation team, human performance, malfunction and availability of technical equipment, physical environment, and insufficient monitoring</td>
<td>Sole included study conducted outside of the United States</td>
<td>Much smaller sample size than the previous database studies because only Denmark included</td>
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<tr>
<td>Almost 10% of doses ordered were never given</td>
<td>May provide closer estimate of frequency of errors because of prospective observation</td>
<td>Possible underrecognition of medication error during a code as well as underreporting</td>
</tr>
<tr>
<td>Presence of a pharmacist for only approximately 50% of simulations but was the only significant predictor in a multiple logistic regression analysis, showing a protective effect and an odds ratio of 0.09 for making a medication error</td>
<td>May provide closer estimate of frequency of errors because of prospective observation</td>
<td>Hawthorne effect in simulation studies</td>
</tr>
<tr>
<td>The potential for harm existed in 14% of the recorded errors</td>
<td>Prospective study with observation of real events offers best opportunity to observe errors as they happen in practice</td>
<td>Simulation studies cannot replicate the emotions and fatigue of a real event</td>
</tr>
<tr>
<td>Of nonaseptic technique errors identified, 8% were caught by the pharmacist observer before drug reached the patient</td>
<td>Observer was not present on nights or weekends; these times may have had drastically increased error rates</td>
<td>Relatively small sample size</td>
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arrests reported to the Danish Patient Safety Database. In contrast to the number of errors identified by using the American Heart Association registry, the frequency of medication errors observed in this study (7%) constituted a small number of safety events related to cardiac arrests reported to the Danish database.

Simulation
Kozer et al\(^7\) conducted a prospective, observational study of physicians and nurses taking part in simulated resuscitation events in a university-affiliated pediatric emergency department. Syringes containing medications prepared by participating nurses or physicians were analyzed for content and concentration. Among 125 orders for medications, four 10-fold errors were identified. A striking observation was that almost 10% of medications ordered were never given during the scenario. Of the 58 syringes analyzed by the laboratory, 16% had a deviation greater than 20% from the expected dose, and 7% deviated from the expected dose by 50% or more.\(^7\)

A similar study by Porter et al\(^8\) involving simulated resuscitation of a child by medical residents was published in 2014. Before intervention by other healthcare professionals, the potential error rate was 40.8%. The final error rate (those errors not corrected before reaching the patient) was 26.5%. Unlike the situation in the simulation study by Kozer et al,\(^7\) in the study by Porter et al, a pharmacist was present for 46.9% of the simulations. Multiple logistic regression analysis indicated that the presence of a pharmacist was the only variable that retained significance, indicating a protective effect of pharmacists with an odds ratio of 0.09 (95% CI, 0.01-0.64) for making a medication error.

Although a logical assumption is that dosing and preparation of medications for children in code-related situations may be more prone to errors because of the weight-based and smaller dosing having to be done in a chaotic environment, similar errors have occurred in simulations with adults. In a simulation study\(^11\) of a patient with septic shock and unstable hemodynamic status, measured contents of prepared catecholamine infusions were compared with the amount ordered. Approximately 70% of the norepinephrine infusions and 50% of the epinephrine infusions did not meet the standards of the United States Pharmacopeia (ie, the concentration was <90% or >110% of that expected), including an infusion that contained no active drug at all. Adapa et al\(^13\) reported that preparing infusions at the bedside in this emergent simulation resulted in an odds ratio of 17.0 (95% CI, 5.2-55) for making a medication error compared with preparing the infusions in a calmer environment or having the infusions prepared in the pharmacy. Other evidence\(^12,13\) has highlighted the error-prone nature of preparing critical infusions at the bedside, including vasopressors and opioids. Task analysis\(^16\) has identified a total of 41 potential steps in the process of preparing a drug infusion, providing 41 opportunities for error during the fast-paced environment of medical emergencies.

Prospective Observation
The first and only prospective observational study\(^9\) on medication errors in emergent situations was published in 2012. A pharmacist observer at a large, tertiary care, academic medical center observed the medical emergency team respond to 50 patients via a modified-direct observation method. The observer could intervene if in the observer’s professional opinion the medication error would cause marked patient harm; otherwise the pharmacist was present as a nonparticipating member of the medical emergency team. When errors of aseptic technique were excluded, the rate of medication errors was 0.5 per dose administered. The majority of these errors involved prescribing and administering medications. Of the nonaseptic technique errors identified, 14% were judged to be potential causes of adverse drug events because of the potential for harm that existed.

Breakdown of Errors by Type and Recommendations for Avoidance

Reported examples from the literature corresponding to each step of the medication process that follows are described in Table 2.

Prescribing
Errors in prescribing account for 10.7% to 46% of code-related medication errors.\(^5,19\) Although verbal orders in general are discouraged by multiple organizations, including the Joint Commission and the Institute for Safe Medication Practices (ISMP), such orders are often a necessity during code situations.\(^19,20\)

Prescribing errors during code-related situations most likely are due to a combination of stress errors, knowledge-deficit errors, incomplete orders, and inaccurate interpretation of verbal orders. During emergencies, practitioners are encouraged to read back verbal medication orders and to clarify incomplete orders.\(^19\) As a double-check process, stating the dose and medication either before administering a medication or when handing the medication to another code team member for administration should be encouraged to ensure that the entire
during resuscitation. Addressing potential sources dose, and route, has been proposed to reduce ordering medications, including the drug name, and route for any medication intended to be delivered depending on the break in process. Dosing errors are similar to prescribing errors, but differ slightly depending on whether interventions or the other convention may not be fully aware of or the other convention may not be fully aware of.

Dosing

Dosing errors during code-related situations are similar to prescribing errors, but differ slightly depending on the break in process. Dosing errors have ranged from 2% to 65% of the total code-related medication errors, although errors involving dosing may have been classified in other categories, such as prescribing. The ISMP provides recommendations on accessibility of drug information during resuscitation events. In addition to ensuring that reference cards with typical doses and titration guidance are available, other system factors deserve attention. For example, medications commonly used during and after resuscitation efforts should be included in the libraries of all “smart-pump” intravenous infusion devices (devices with built-in computers containing electronic libraries of information on selected drugs and fluids, including predetermined volumes and concentrations with corresponding administration rate limits) regardless of the location in the hospital and should be set to default starting doses, simply requiring entering of the patient’s weight to begin. Errors with catecholamine dosing in micrograms per kilogram per minute vs micrograms per minute may be more likely to occur in institutions that allow both dosing conventions to be used. In addition to possibly making dosing errors, resuscitation leaders unfamiliar with one or the other convention may not be fully aware of where the patient is on the spectrum of vasopressor dosing. For children, using a standardized dosing system based on weight, such as the Broselow tape, during simulations has been associated with significant reductions in deviations from recommended doses. Use of these standardized dosing systems

<table>
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<tr>
<th>Type of error</th>
<th>Description</th>
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<tr>
<td>Prescribing</td>
<td>A dose of “0.3 of epi” was ordered during an anaphylaxis resuscitation. A registered nurse prepared and administered 0.3 mg of epinephrine via the intravenous route rather than the intramuscular route as intended. After intubation, a patient in septic shock was started on norepinephrine and vasopressin 0.4 units/min, as opposed to the intended 0.04 units/min. This 10-fold overdose that continued infusing in the patient was attributed as a likely cause of the patient subsequently having a myocardial infarction. A physician prescribed dextrose 50% for a neonate rather than the correct 10% dextrose product.</td>
</tr>
<tr>
<td>Dosing</td>
<td>For hypotension during a code, a weight-based dopamine infusion was started in micrograms per kilogram per minute, although the patient’s weight in pounds was used to calculate the dose. A physician on an emergency response team ordered “narcan: the normal dose” for a patient who was slow to arouse after opioid treatment. A pharmacist observer intercepted the error before a 10-fold overdose was given.</td>
</tr>
<tr>
<td>Drug preparation</td>
<td>An epinephrine infusion prepared by a nurse during a simulation of a rapidly decompensating patient with sepsis had no epinephrine in the infusion container on laboratory investigation. A nurse’s medication was prepared by using glass ampoules without using a filter needle, thus increasing the risk of glass emboli.</td>
</tr>
<tr>
<td>Mislabling</td>
<td>Succinylcholine 100 mg was ordered for rapid-sequence intubation. The entire contents of 1 vial (200 mg) were drawn into a syringe, and the entire syringe contents administered to the patient, resulting in a 2-fold overdose.</td>
</tr>
<tr>
<td>Administration techniques</td>
<td>A patient in status epilepticus was ordered a loading dose of phenytoin. The correct amount was drawn up in a syringe and given as an intravenous “push,” resulting in the patient becoming hypotensive. Cases in which intravenous medications were not flushed through the intravenous access after administration have been observed and documented.</td>
</tr>
<tr>
<td>Technical aspects</td>
<td>A registered nurse looking for a vial of midazolam on the code cart removed a vial of furosemide. The product vial and orange caps were similar for the 2 medications. An empty box of epinephrine syringes was found in the code cart, resulting in a delay before the patient received epinephrine. After opening the locked drug drawer during a code, nursing staff found that the drug tray had not been refilled or exchanged since the last code, resulting in a delay of first-line drugs being initiated during the code.</td>
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Drug shortages introduce additional opportunities for error into the code situation.
based on weight is recommended, particularly in the pediatric emergency department, where few data may be available when a patient arrives requiring resuscitation.

Drug Preparation

Previous studies\(^7\,9\,11\) have indicated that drug preparation errors may account for 10% to 26% of all code-related medication errors. These percentages may be underestimations, because only a few studies have included tests for the actual content of medication prepared. The results in studies\(^7\,11\) that included such tests were striking, as described previously.

Reference cards used for determining dosing infusions should also contain easy-to-follow instructions on admixtures.\(^18\) A specific amount of medication in a specific amount of diluent should be listed to result in the standardized institutional concentration. Simply listing the concentration of the infusion introduces the possibility of mathematical error when infusions are prepared during a resuscitation event. One recommendation is that a designated person or persons be responsible for preparing medications during resuscitation.\(^9\)

Another complicating factor is that medications with different labeling systems, such as dilution ratio or percentage, rather than mass concentration (milligram or microgram per milliliter), fill the code cart. These medications include epinephrine (1:1000 and 1:10000), lidocaine (2%), and magnesium (50%), among others. Because the labeling of these medications dates back many decades, the labeling does not have to adhere to the stringent regulatory standards of today. Thus, confusion about these notations and potential for error remain high.\(^22\,23\)

Mislabeling

In the only evaluation\(^9\) of labeling during code situations, mislabeling accounted for 14% of the code-related medication errors detected. Because of time constraints and limited personnel, at times medications are not labeled at all during use. Two circumstances must simultaneously be present for no labeling to be acceptable practice: First, time absolutely does not allow for labeling, and second, the preparer of the medication either administers the medication personally or hands the medication directly (one at a time) to the person administering the drugs. All other times, properly labeling prepared medications is strongly encouraged. The mislabeling of sedative and paralytic medications for rapid-sequence intubation remains one of the most high-risk scenarios for the occurrence of mislabeling. For those instances in which the critical nature of the situation does not allow labeling, some practitioners have devised personal systems to avoid confusion. For example, using 2 different sized syringes (eg, a 5-mL syringe for sedatives and 10-mL syringe for paralytics) to draw up doses of the sedative and paralytic may help differentiate the contents of the unlabeled syringes.

No standardized guidelines exist for labeling medications prepared during resuscitation situations. Some practitioners may choose to document the dose only, whereas others may choose to document concentration only, as well as drug name on the syringe. Anesthesiologists routinely work out of modified code carts in the operating room, and substantial research has been done on medication errors in this setting.\(^24\) In the most recent Statement on the Labeling of Pharmaceuticals from the American Society of Anesthesiologists,\(^25\) concentration, rather than dose, is recommended. Consider the situation in which a partial amount of the syringe contents is given to a patient. If the label on the syringe gives dose, rather than concentration, for someone other than the preparer to determine how much medication is left in the syringe for immediate use will be increasingly difficult, if not impossible. To facilitate the labeling process for infusions, the ISMP recommends that preprinted, ready-to-use labels be included in the code cart for infusions commonly prepared during codes.\(^19\) This process could be adopted for syringes prepared from the code cart or rapid-sequence intubation supply kit.

Administration Techniques

The final step of the medication process is not exempt from error during the chaos of an emergency. Errors in administration account for 28% to 57.6% of all reported errors related to code situations.\(^4\,9\) The severity of these errors varies, as indicated in Table 2. Recently, the concept of “dead space” during infusions has emerged.\(^26\) Central catheters may contain up to 0.5 mL of dead space, which may be problematic for medications with low-volume infusion rates.\(^28\) This issue may apply to medications given via non–free-flowing or longer catheters. In addition to fully priming infusion catheters before administration of the infusion is started, common infusions given during codes should be given into free-flowing catheters or directly into the most proximal port to allow for quick delivery. If this practice is not followed, depending on the concentration, the drug may not reach the patient’s systemic
circulation for several minutes. Some researchers\textsuperscript{26} have even suggested giving a bolus dose with the same concentration as the infusion as a way to prime the catheter during emergent situations.

**Technical Aspects**

Like many other incidents in medicine, technical errors occur in code-related emergencies. These errors may cause serious delays in administration of medication, which is associated with an increased risk of in-hospital mortality after in-hospital cardiac arrest.\textsuperscript{5} Use of usability testing and human factors engineering principles to optimize the design of code carts can result in faster completion of task activities while reducing wasteful actions.\textsuperscript{27} The ISMP provides a number of recommendations on medication stocking of the code cart that may help reduce technical errors.\textsuperscript{18} Some of the recommendations are given in Table 3.

**Other Challenges**

Drug shortages may affect medications involved in code situations. For example, recent shortages of dextrose 50%, prefilled syringes of epinephrine, etomidate, and sodium bicarbonate presented challenges during resuscitation efforts. Communication from the pharmacy department to nursing and medical staff is essential to ensure that alternative agents and instructions are understood when drug shortages arise in order to recognize and prevent potential medication errors.

Although uncommon, addition of new medications in the cardiopulmonary resuscitation algorithm occurs occasionally. For example, because of the favorable results of a recent study,\textsuperscript{28} some providers may ask for methylprednisolone during resuscitation efforts. New medications bring additional challenges to reducing medication errors; not only must new medications be added to code carts throughout the entire institution but also all personnel must become familiar with the dosing and delivery systems of the new medications, which with methylprednisolone may include the Act-O-Vial system.\textsuperscript{29}

Finally, as previously mentioned, the impact of medication errors as collateral damage from code-related events may be larger than anticipated.\textsuperscript{4} Policies and procedures that allow for some degree of cross coverage, including review of the medication administration record while the patient’s primary nurse is involved with a code, are encouraged.

Suggested system changes to reduce medication errors during codes bring to light the potential role of the pharmacist. In a recent survey,\textsuperscript{30} only 8\% of bedside nurses thought they had sufficient knowledge of resuscitation medications. Dissemination of drug knowledge and oversight of medication administration by a pharmacist, as well as a designated person responsible for drug preparation, are system changes that may have an effect on medication errors during code situations.\textsuperscript{7} The presence of a pharmacist during in-hospital cardiopulmonary arrests is associated with a nearly 2-fold increase in compliance to guideline recommendations and has the potential to reduce the errors of omission noted in previous studies\textsuperscript{4,7,31} of code-related errors. The involvement of a pharmacist in management of patients who have been resuscitated can also be beneficial. A pharmacist can facilitate the preparation and administration of analgesics and sedatives, help titrate vasopressors, assess compatibility of newly added medications, initiate rapid administration of appropriate antibiotics in patients with sepsis, and take part in other activities.\textsuperscript{32-34} For these reasons, inclusion of pharmacists with training in Advanced Cardiac Life Support on code response teams is recommended by the ISMP.\textsuperscript{18}

In conclusion, medication errors during medical emergencies, particularly cardiopulmonary resuscitation and surrounding events, are not well characterized but may be more frequent than previously thought. Because of the chaos of the resuscitation environment, errors may occur in prescribing, dosing, preparing, labeling, and administering drugs and in other aspects of care.

**FINANCIAL DISCLOSURES**

None reported.

**Table 3**

<table>
<thead>
<tr>
<th>Selected recommendations to optimize technical aspects of code cart management\textsuperscript{a}</th>
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<tr>
<td>Use separate adult and pediatric code carts depending on the area of the hospital. If universal code carts are unavoidable, the carts should have separately labeled drawers for adult and pediatric medications.</td>
</tr>
<tr>
<td>Require the pharmacy and therapeutics committee or resuscitation committee to approve all drug references as well as stocked medications on the code cart, including concentrations, container sizes, and quantities, to standardize code carts across the institution.</td>
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<tr>
<td>The pharmacy department should have full responsibility for restocking the code cart, with defined policies for identifying expiration dates of stocked medications and restocking of the code cart.</td>
</tr>
<tr>
<td>Ready-to-use syringes and premixed infusions should be used as much as possible. The availability of multiple-dose vials should be limited.</td>
</tr>
<tr>
<td>An illustration or photograph of the code cart contents and layout should be available on the code cart to familiarize staff with contents and serve as a reference during the code.</td>
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\textsuperscript{a} Based on information from the Institute for Safe Medication Practices.\textsuperscript{18}

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REFERENCES


NURSES’ ATTITUDES, CLINICAL EXPERIENCE, AND PRACTICE ISSUES WITH USE OF PHYSICAL RERAINTS IN CRITICAL CARE UNITS

By Kristi J. Stinson, RN, PhD, APN-BC

Background Physical restraints are more likely to be used in critical care units than in other hospital units because use of invasive procedures and mechanical ventilation is more common in critical care units. Initiation and maintenance of physical restraint devices is largely a nursing responsibility. Previous clinical experience is a variable often suggested to be related to intensive care nurses’ use of physical restraints.

Objective To examine the relationships between registered nurses’ clinical experience, their practice issues (nurses’ actions while caring for patients who are physically restrained), and their attitudes toward the use of physical restraints (feelings about use of restraints and about caring for patients who are restrained) in critical care units.

Methods In a descriptive correlational study, data were collected online via the Physical Restraint Questionnaire. Participants’ (n=413) clinical experience was classified by using Patricia Benner’s novice to expert framework.

Results No strong correlation was found to explain any variance between attitudes toward use of physical restraints in critical care and clinical experience in nursing in general, clinical experience in critical care, and nursing practice issues with use of physical restraints. However, nurses with more clinical experience were more likely to have learned about use of physical restraints in their basic nursing curriculum.

Conclusions The reported lack of content addressing use of physical restraints in today’s nursing curriculum is a concern, as physical restraints are commonly used in critical care units. (American Journal of Critical Care. 2016;25:21-26)
Use of physical restraints on hospitalized patients has been a common and controversial practice for many years. Physical restraints are more likely to be used in critical care units than in other hospital units because of the greater frequency of invasive procedures and the use of mechanical ventilation in critical care units. The critical care environment itself can cause agitation and added stress by the presence of mechanical ventilation, multiple invasive procedures, fear, pain, anxiety, sensory overload, and disruption of sleep cycles, thus increasing the likelihood of use of physical restraints.

About the Author
Kristi J. Stinson is an assistant professor in the College of Nursing at Seton Hall University, South Orange, New Jersey.

Corresponding author: Kristi J. Stinson, RN, PhD, APN-BC, Seton Hall University College of Nursing, 400 South Orange Ave, South Orange, NJ 07079 (e-mail: Kristi.stinson@shu.edu).

Physical restraint use in acute care settings has been associated with a variety of injuries. These injuries include pressure ulcers and nosocomial infections as well as bruising, lacerations, nerve injury, and strangulation. Bladder and bowel incontinence, decreased cognitive ability and awareness, mobility problems, and increased disorientation have also been associated with physical restraint use, as have feelings of demoralization, isolation, and loss of freedom. Yet, despite these known potential complications, physical restraint use in critical care environments continues both internationally and in the United States.

Published reports show that it is the nurses who decide whether or not to restrain a patient with a physician’s verbal order often obtained after physical restraints have been applied, if at all. In looking at various factors that can influence this decision, no consensus is apparent in the research findings to support a relationship between staffing, experience level, education level, nurses’ attitudes toward use of physical restraints, and practice issues related to use of physical restraints (ie, nurses’ actions while caring for patients who are restrained).

Methods and Instrumentation
A descriptive, correlational study, done as part of a larger doctoral study, was conducted by using 2 instruments for data collection: a demographic scale created by the researcher and the Physical Restraint Questionnaire. Permission to use the Physical Restraint Questionnaire was obtained from the author of the instrument. It was originally developed to examine knowledge of nursing personnel in nursing homes in the United States about physical restraint. It has subsequently been administered to nurses working in other health care settings where physical restraints are used, including critical care units.

Although the entire instrument contains 4 subscales, 2 subscales of the Physical Restraint Questionnaire were used in the current study: Subscale 3, Nursing Practice Issues and Subscale 4, Attitudes Toward Physical Restraint Use. The Nursing Practice Issues subscale has 17 items, each with 3 answer choices—all, sometimes, and never. Thirteen items are rated as positive and have frequency anchors of always (3) to never (1), and 4 items are rated as negative and have frequency anchors of always (1) to never (3). The Attitudes Toward Use of Physical Restraints subscale has 12 items. Each item has 3 answer choices—agree (2), disagree (0), and undecided (1). Both subscales could be completed in a total of 10 minutes. The data from Subscale 1 was garnered by using this researcher’s own demographic sheet. Subscale 2 (Assessment of Knowledge about Physical Restraint Use) was not used because knowledge about physical restraints was not a study variable for this research.

Content validity was established for this instrument in several ways. Items for the questionnaire were generated from a careful review of the literature. It was then reviewed and examined by 5 nurse experts in the care and management of patients regarding the use of restraints. The questionnaire had an original content validity index score of 86%. Although this instrument has not been widely used, it is the only instrument written in English currently available to assess attitudes and nursing practice issues related to physical restraint use. Suen et al used the Physical Restraint Questionnaire in their study examining the knowledge, attitudes, and practices of staff in rehabilitation settings in Hong Kong. Test-retest reliability was established by using the intraclass correlation coefficient. The intraclass correlation coefficients of 3 of the subsections were as follows: Knowledge of Physical Restraint Use, 0.85;
Attitudes Toward Physical Restraint Use, 0.84; and Nursing Practice Issues with Physical Restraint Use, 0.99. This result was seen as reliable.\textsuperscript{17} Yeh et al\textsuperscript{15} used this instrument in their study examining nurses’ practices related to use of physical restraints in Taiwanese intensive care units. Two subsections were used in that study: Attitude Toward Restraint Use (Cronbach $\alpha = 0.70$) and Nursing Practice Issues with Restraint Use (Cronbach $\alpha = 0.73$).

Although few reports of its use have been published, this instrument is reliable.\textsuperscript{15,17,18} In this study, the reliability for the Nursing Practice Issues with Physical Restraint Use subscale was modest (Cronbach $\alpha = 0.56$). The reliability for the Attitudes Toward Physical Restraint Use subscale was higher (Cronbach $\alpha = 0.78$).

**Data Collection Procedures and Sampling**

All data collection was conducted electronically by using SurveyMonkey. An online solicitation form was sent to all members of the American Association of Critical-Care Nurses (AACN) within the body of the weekly AACN e-newsletter. A link to the research surveys was embedded within the e-newsletter for 4 consecutive weeks. Online data collection helps to minimize any potential risks and allows greater maintenance of confidentiality.\textsuperscript{19} Only the researcher was able to obtain the completed questionnaire through a private passcode.

Confidentiality and anonymity of participants were maintained throughout the entire data collection process. There is a function of the SurveyMonkey online format that is designed to allow data collection to be anonymous to the researcher. This function was used. All collected data were recorded anonymously. The coding system used did not have any identifying information such as names, addresses, or social security numbers. Informed consent was implied by the voluntary completion of the research instruments by all participants. To ensure further confidentiality of all responses, submitted data were stored only on a memory key and kept in a locked, secure place accessed only by the researcher.

**Description of the Sample**

The participants were 413 primarily white (91\%) critical care nurses ranging in age from 19 to 68 (mean, 45.6) years from across the United States; the largest number of those (47.5\%) had a bachelor of science degree in nursing. Participants were classified as experts on the basis of Benner’s\textsuperscript{20} classifications, in both experience in nursing in general (88\%) and in critical care (82\%) in particular. The demographic characteristics of this sample were similar to those listed by AACN.\textsuperscript{21}

**Data Analysis**

Tables 1 to 4 show the survey results by mean score, standard deviation, actual range of scores, potential ranges of scores, and a coefficient (reliability

---

**Table 1**

<table>
<thead>
<tr>
<th>The Physical Restraint Questionnaire: survey results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Content</strong></td>
</tr>
<tr>
<td>-------------</td>
</tr>
<tr>
<td>Nursing practice issues</td>
</tr>
<tr>
<td>Attitudes toward use of physical restraints</td>
</tr>
</tbody>
</table>

**Table 2**

<table>
<thead>
<tr>
<th>Means, standard deviations, and bivariate correlations for main study variables using Pearson and Spearman $\rho$ coefficients\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>---------------</td>
</tr>
<tr>
<td>Attitudes toward use of physical restraints</td>
</tr>
<tr>
<td>1: Clinical experience, nursing in general</td>
</tr>
<tr>
<td>2: Clinical experience, critical care</td>
</tr>
<tr>
<td>3: Nursing practice issues</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Bold indicates $P < .05$. Dash indicates not applicable.

**Table 3**

<table>
<thead>
<tr>
<th>Summary of stepwise multiple regression\textsuperscript{a}</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Step</strong></td>
</tr>
<tr>
<td>---------</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

\textsuperscript{a} No other exploratory variables were entered into the regression equation.

\textsuperscript{b} $F$ change was significant ($P = .001$).

\textsuperscript{c} $F$ change was significant ($P = .005$).

**Table 4**

<table>
<thead>
<tr>
<th>One-way analyses of variance for various predictor variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
</tr>
<tr>
<td>--------------</td>
</tr>
<tr>
<td>Total time working in nursing in general</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total</td>
</tr>
<tr>
<td>Total time working in nursing in general + nursing practice issues with use of physical restraints</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

\textsuperscript{a} $P < .001$.

\textsuperscript{b} $P < .001$. 

---

www.ajcconline.org
From novice through expert, there were no significant differences in nurses’ attitudes toward use of physical restraints.

Results

The results of this stepwise multiple regression indicated that the total time spent in nursing accounted for 2.6% of the variance in nurses’ attitudes toward physical restraint use in critical care \( R^2 = 0.026, F_{1,411} = 10.76, P = .001 \). Total time in nursing in general and nursing practice issues together accounted for 4.3% of the variance in nurses’ attitudes toward use of physical restraints in critical care \( R^2 = 0.043, F_{2,410} = 9.19, P < .001 \). Total time in critical care and clinical decision making did not account for any variation in attitudes toward use of physical restraints in critical care that was not already explained. This small explained variance indicates that, overall, this is a weakly correlated model. However, statistical significance was found, which allows some generalization of the results to the overall population.

In addition to the analysis of the main study variables, bivariate correlation analysis was conducted with the demographic information provided by the study participants. The variable used for Benner stage in nursing (novice through expert) was a categorical variable. In order to be used for multiple regression and correlation, categorical variables must be coded. For this study, the categorical variable of the Benner stage was coded as novice (1), advanced beginner (2), competent (3), proficient (4), and expert (5).

A statistically significant moderate correlation was found between time working in nursing (Spearman \( \rho = 0.374 \)) as well as time working in critical care (Spearman \( \rho = 0.356 \)) and the likelihood of content about use of physical restraints being taught in basic nursing education (Spearman \( \rho \) range, 0.310-0.396). This finding means that the more time the participant spent working in nursing and working in critical care, the more likely that participant had been taught content about use of physical restraints in his or her basic nursing education. Novice nurses were less likely than expert nurses to have been taught such content.

Discussion

The results indicate that no strong correlation was found to explain the variance between the dependent criterion variable (attitudes toward use of physical restraints in critical care) and the independent predictor variables (clinical experience in nursing in general, clinical experience in critical care, and nursing practice issues with use of physical restraints) in the model. No differences were found in any of the Benner stages of clinical experience. Nurses at all of Benner’s levels from novice through expert had no significant differences in their attitudes toward use of physical restraints.

When the ancillary demographic data provided by the participants was examined, it was found that overall clinical experience in nursing and clinical experience in critical care had statistically significant correlations with the likelihood of content about use of physical restraints being taught during the nurse’s basic nursing education. The range of the correlations was from 0.310 to 0.396. This result means that, in this sample, those nurses who had worked longer and had more clinical experience in nursing were more likely to have been taught content about physical restraints during their basic nursing education. Novice nurses were less likely than expert nurses to have been taught any content about use of physical restraints in their basic nursing education. Use of physical restraints is still common, particularly in the critical care environment, and novice nurses may be working there; thus, education about use of physical restraints strongly needs to continue to be included in nursing curricula.

Although the correlations found between the major study variables were small to moderate, they have clinical significance to nursing practice. Existing publications indicate that no consensus
has been reached on practice issues and attitudes regarding use of physical restraints in critical care.2,7,11-15 The findings of this study show that continued research in this area is needed to explore possible relationships.

One strength noted with this study is the work done in regard to practice issues and attitudes regarding use of physical restraints in the critical care environment. Use of physical restraints is clinically, socially, and ethically relevant to nursing practice. This study’s results, although small, can be used to guide decisions and directions of future quality initiatives related to use of physical restraints in critical care environments in the United States.

Another strength of this study was the large national sample that was obtained. The sample came from the AACN, whose membership has characteristics similar to those of the Health Resources and Services Administration’s national sample of 2008.22 Based on the number of main study variables (5), a power analysis at a 0.80 power level with an alpha level of .05 determined that a sample of 91 would be adequate for correlational analyses. This study had a sample of 413. Participants were from all regions of the United States, thus giving the findings some generalizability to a larger population.

Another strength of this study was the use of online data collection. Online data collection allowed participants to answer the questionnaire electronically at their convenience and in the location of their choosing. Advantages of using an online format when conducting research include higher response rates, reduced cost of data collection, lack of geographical boundaries, and fewer respondent errors and item omissions.23

Limitations

A single professional organization was used to elicit a convenience sample for this study. This sampling technique unknowingly solicited a high number of nurses with advanced clinical experiences. When using Benner’s work for categorizing the participants on the basis of their experience levels, a higher level of experts (n = 88%) was yielded in a specialty area that created a homogeneous sample. This homogeneity most likely skewed the results and influenced the overall outcomes. For future studies, this limitation will be considered and a different sampling process may be used.

Another contributing factor to the reduced strength of the correlations may have been the small sizes of Benner’s20 subgroups: for nursing in general: novice (n = 2), advanced beginner (n = 9), competent (n = 32), and proficient (n = 22); for nursing in critical care: novice (n = 9), advanced beginner (n = 13), competent (n = 47) and proficient (n = 30). These small sizes may have resulted in an inadequate power to detect a greater strength in the correlations.

Conclusions

In summary, the findings of this study will add to the small existing body of research conducted to compare registered nurses’ clinical experience, clinical decision making processes, practice issues with physical restraint use, and attitudes toward use of physical restraints in the critical care environment. The results of this study, although small, can be used to guide decisions and directions of future initiatives on use of physical restraints in critical care environments.

FINANCIAL DISCLOSURES

None reported.

References


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Background
Whether or not norepinephrine infusions for support of hemodynamic status in patients with septic shock should be weight based is unknown. This situation is particularly pertinent in patients who are extremely overweight or obese.

Objective
To compare dosing requirements and effect of norepinephrine on blood pressure in obese and non-obese patients with septic shock.

Methods
In a retrospective cohort study, data on adult patients with septic shock who received norepinephrine infusion for support of hemodynamic status in a tertiary care, academic medical center were analyzed. Patients were categorized as obese (body mass index ≥ 30) or nonobese (body mass index < 30). The primary outcome was dosing requirements of norepinephrine at 60 minutes after the start of the infusion. The secondary outcome was the log-transformed ratio of mean arterial pressure to norepinephrine.

Results
The final cohort consisted of 100 obese and 100 nonobese patients. Mean norepinephrine infusion rate at 60 minutes was 0.09 (SD, 0.08) µg/kg per minute in the obese group and 0.13 (SD, 0.14) µg/kg per minute in the nonobese group (P = .006). The non-weight-based dose at 60 minutes was 9 µg/min in obese patients and 8 µg/min in nonobese patients (P = .72). The log transformed mean arterial pressure to norepinephrine ratio at 60 minutes was 2.5 (SD, 0.9) in obese patients and 2.5 (SD, 0.8) in nonobese patients (P = .54).

Conclusions
The Surviving Sepsis Campaign international guidelines for the management of severe sepsis and septic shock recommend norepinephrine as the first-choice vasopressor for patients with fluid-refractory shock. The recommended target for vasopressor therapy is a mean arterial blood pressure (MAP) greater than 65 mm Hg. In clinical trials, both weight-based and non-weight-based dosing of norepinephrine have been used to achieve this target. Similarly, drug information sources provide both weight-based and non-weight-based dosing recommendations. The difference in recommendations between sources often leads to inconsistency in dosing between providers and institutions.

Use of weight-based dosing is based on the assumption that a linear relationship exists between a patient’s weight and his or her total norepinephrine requirement. However, pharmacokinetic and pharmacodynamic studies of norepinephrine in patients with septic shock have shown great interpatient variability, low correlation between dose and plasma concentration, and low correlation between plasma concentration and clinical response. In addition, weight is often estimated in critical care, and the estimate may not be accurate. During hospitalization, documentation of a patient’s weight may be changed to correct an erroneous estimate made at admission or to account for real changes due to fluid accumulation. Changes in the weight used for weight-based dosing of norepinephrine in these circumstances could lead to arbitrary changes in the total amount of drug delivered to patients that are unrelated to hemodynamic requirements. Thus, the need for weight-based dosing of norepinephrine in these patients is unclear, and such dosing may be a source of medication errors due to logistical reasons. Use of weight-based dosing is particularly a concern for patients who are obese.

Current guidelines do not provide any recommendations on weight-based or non-weight-based dosing of norepinephrine. For logistical reasons, a non-weight-based dosing strategy with titration to response may be preferred. However, the need for weight-based dosing is unclear. The objective of this study was to compare dosing requirements for norepinephrine in obese and nonobese patients with septic shock. We hypothesized that total dosing requirements and effect on MAP would be similar between the 2 groups, suggesting that a non-weight-based dosing strategy is appropriate.

Materials and Methods

Study Population

This retrospective cohort study was an analysis of data on patients admitted to the medical and surgical-trauma intensive care units (ICUs) at the University of Arizona Medical Center, Tucson, Arizona, a tertiary care, academic medical center. The study was approved by the hospital site review authority and the university’s institutional review board. Adult ICU patients with septic shock who received norepinephrine as the sole vasopressor for unstable hemodynamic status for at least 1 hour and were admitted during the period July 2009 through June 2012 were included in the study. The medical center has no standard protocol for norepinephrine dosing. Patients were excluded if they received another vasopressor within 1 hour of the start of the norepinephrine infusion. The purpose of this exclusion was to minimize any possible effect of other vasopressors on norepinephrine requirements. Also, patients were excluded if they were less than 18 years old or if the primary treatment team was not the medical or surgical ICU team.

Definitions

Patients were categorized as obese or nonobese on the basis of their body mass index (BMI), calculated as weight in kilograms divided by height in meters squared. Patients with a BMI of 30 or higher were considered obese; those with a BMI less than 30 were categorized as nonobese. Septic shock was defined as unstable hemodynamic status despite fluid administration and proven or suspected infection in conjunction with at least 2 of the following criteria for systemic inflammatory response: heart rate greater than 90/min, body temperature less than 36°C (96.8°F) or greater than 38°C (104°F), or a white blood cell count less than 4000/µL or

About the Authors

John J. Radosevich is a clinical pharmacist, critical care, Pharmacy Department, St Joseph’s Hospital and Medical Center, Phoenix, Arizona. Asad E. Patanwala is an associate professor and Brian L. Erstad is a professor and department head, Pharmacy Practice and Science, College of Pharmacy, University of Arizona, Tucson, Arizona.

Corresponding author: Asad E. Patanwala, PharmD, 1295 N Martin Ave, PO Box 210202, Tucson, AZ 85721 (e-mail: patanwala@pharmacy.arizona.edu).
greater than 12,000/µL, or the presence of more than 10% bands. Unstable hemodynamic status was defined as systolic blood pressure less than 90 mm Hg or MAP less than 65 mm Hg. These definitions are consistent with published definitions and definitions used in previous studies on the effects of body mass on hemodynamic response to vasopressor therapy.4-10 In order to determine the effect of weight on MAP and norepinephrine dosing requirements, the 2 measurements were combined and log-transformed into a single variable: the log MAP:NE ratio. This combined variable was used in a previous study11 because MAP and norepinephrine dosing are interrelated. This measure is meaningful because the adequacy of norepinephrine dosing is a function of MAP and the ratio reflects the combined effect of both the vasopressor and blood pressure.

Data Collection

The pharmacy computer system was used to identify patients who received norepinephrine during the study period. Consecutive patients were evaluated for inclusion. Because nonobese patients were expected to outnumber obese patients, a blocking scheme was used to obtain an equal number of patients in the obese and nonobese groups during similar periods. The purpose of this step was to minimize bias and to ensure that obese and nonobese patients would be included from similar periods. Potential patients were selected in chronological order in blocks of 10. The procedure was to enroll 5 patients in each group for a block of 10 total patients. For example, if 5 eligible nonobese patients were included before 5 obese patients, then nonobese patients were skipped until 5 obese patients were identified and included. Once the block of 10 was completed, the process was continued until 100 patients were included in each group.

The patients’ medical records were accessed, and the following data were collected for each patient: age, sex, height, weight, BMI, primary service, corticosteroid use, and source of infection. Nurses used electronic bed scales to obtain patients’ weight. Laboratory data collected included serum levels of creatinine and cortisol, pH, hematocrit, and white blood cell count. MAP values were obtained via arterial catheter measurements. Fluids administered in the 6 hours before and the 6 hours after the start of the norepinephrine infusion were noted. Fluid replacement was not standardized at the medical center during the study period. Severity of illness was measured by calculating the Sequential Organ Failure Assessment score, and comorbid conditions were assessed by using the Charlson Comorbidity Index. All laboratory data and Sequential Organ Failure Assessment scores were obtained at the time the norepinephrine infusion was started, which was also the time of admission for most patients.

End Points

The primary outcome measure was the norepinephrine infusion rate 60 minutes after the start of administration of the drug for treatment of septic shock, when titrated to a goal MAP of 65 mm Hg or greater. This goal MAP is part of the institutional protocol. The secondary outcome measure was a comparison of the log MAP:NE ratio at 60 minutes after the start of the infusion. These outcome measures are consistent with those of previous studies11,12 on the effect of vasopressors on MAP.

Statistical Analysis

Baseline, demographic, and outcome variables of obese and nonobese patients were compared. Categorical variables were compared by using the Fisher exact test. Continuous variables were analyzed by using the Mann-Whitney test. A nonparametric test was used because the variables did not meet the assumption of normality. The norepinephrine infusion rates and log MAP:NE ratios were compared between groups by using an unpaired t test. A linear regression analysis was performed to determine the effect of weight on log MAP:NE ratios at 60 minutes, after adjustments for baseline MAP.

Data were reported as percentages, medians and interquartile ranges (IQRs), or means and standard deviations, as appropriate. A power analysis was conducted by using the norepinephrine infusion rates from a previous investigation.13 For an infusion rate of 0.1 µg/kg per minute, an SD of 0.07, an effect size of 0.03 µg/kg per minute, power of 80%, and \( \alpha = .05 \), the estimated sample size was 87 patients in each group. This number was increased to 100 patients in each group to increase power. A 2-sided \( \alpha = .05 \) was used for all analyses. All analyses were performed by using Stata 13 software (StataCorp LP).

Results

Study Cohort

During the 3-year period studied, 1340 patients received norepinephrine. Of these, 482 were not evaluated because of the blocking scheme for case selection. Of the remaining cases, 658 patients were excluded because they received norepinephrine for an indication other than septic shock or they received norepinephrine under the care of a service.
other than the medical or surgical ICU team. Thus, a total of 200 patients were included in the final study cohort (100 obese and 100 nonobese).

Overall, the median age was 61 years (IQR, 53-72), and 54% were men. The majority of patients were white (62%) or Hispanic (28%). Most patients were under the care of the medical ICU (90%). Also, a large proportion of patients (61%) were receiving mechanical ventilation at the time infusion of norepinephrine began. The median Sequential Organ Failure Assessment score was 8 (IQR, 6-10), and the median Charlson Comorbidity Index was 2 (IQR, 1-4). The most common presumed infection was pneumonia (56%). Demographic comparisons between obese and nonobese patients are reported in Table 1. Clinical characteristics are reported in Table 2. No significant baseline differences were detected between the groups. The only exception was that patients in the nonobese group were slightly older ($P < .001$), with a median age of 65 years (IQR, 56-77 years), than were patients in the obese group, whose median age was 58 years (IQR, 50-66 years).

### Norepinephrine Dosing and MAP

Mean MAP at baseline was 54 (SD, 8) mm Hg in the obese group and 56 (SD, 8) mm Hg in the nonobese group ($P = .11$). At 60 minutes after infusion of norepinephrine began, mean MAP increased to 73 (SD, 11) mm Hg in the obese group and 74 (SD, 14) mm Hg in the nonobese group ($P = .48$). The initial rate of infusion was 0.07 (SD, 0.21) µg/kg per minute in the obese group and 0.08 (SD, 0.06) µg/kg per minute in the nonobese group ($P = .76$). At 60 minutes, the infusion rate was 0.09 (SD, 0.08) µg/kg per minute in the obese group and 0.13 (SD, 0.14) µg/kg per minute in the nonobese group ($P = .006$). The equivalent non-weight-based dose ([ie, micrograms per kilogram per minute] x weight) at 60 minutes was 9 µg/min in the obese group and 8 µg/min in the nonobese group ($P = .72$). At 60 minutes, the percentage of patients with MAP 65 mm Hg or greater was 81 in the obese group and 72 in the nonobese group ($P < .001$), with a line difference detected between the groups.

### Fluids and Medications

Obese patients received 2513 (IQR, 1315-3967) mL of intravenous fluids, and nonobese patients received 2975 (IQR, 2013-4380) mL. These values are equivalent to a weight-based volume of 22 (IQR, 13-38) mL/kg in the obese group and 46 (IQR, 33-66) mL/kg in the nonobese group. Fluid use within 6 hours before infusion of norepinephrine began was

---

**Table 1**

Baseline demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obese</th>
<th>Nonobese</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (IQR), y</td>
<td>58 (50-66)</td>
<td>65 (56-77)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Weight, median (IQR), kg</td>
<td>101 (89-119)</td>
<td>66 (59-7)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Body mass index, median (IQR)</td>
<td>36 (32-42)</td>
<td>24 (21-26)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Male sex</td>
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<td>58</td>
<td>.26</td>
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<tr>
<td>Ethnicity</td>
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<td>.70</td>
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<tr>
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<tr>
<td>Hispanic</td>
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<tr>
<td>Type of intensive care unit</td>
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<tr>
<td>Medical</td>
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<td>91</td>
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<tr>
<td>Surgical</td>
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<td>9</td>
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<tr>
<td>Mechanical ventilation</td>
<td>68</td>
<td>54</td>
<td>.06</td>
</tr>
</tbody>
</table>

*Abbreviation: IQR, interquartile range.

* Values in second and third column are percentage of patients unless otherwise indicated in first column.

**Table 2**

Clinical characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obese</th>
<th>Nonobese</th>
<th>$P$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum level of creatinine, mg/dL</td>
<td>1.8 (1.0-3.5)</td>
<td>1.5 (0.9-3.1)</td>
<td>.15</td>
</tr>
<tr>
<td>Cortisol, µg/dL</td>
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<td>14.7 (11.4-24.2)</td>
<td>.78</td>
</tr>
<tr>
<td>pH</td>
<td>7.33 (7.25-7.40)</td>
<td>7.35 (7.27-7.42)</td>
<td>.18</td>
</tr>
<tr>
<td>Hematocrit, %</td>
<td>38.5 (27.4-35.9)</td>
<td>31.6 (28.2-37.3)</td>
<td>.23</td>
</tr>
<tr>
<td>White blood cell count, per µL</td>
<td>15.3 (9.4-20.4)</td>
<td>15.4 (9.1-24.4)</td>
<td>.43</td>
</tr>
<tr>
<td>SOFA score</td>
<td>8.0 (6.0-10.0)</td>
<td>8.0 (6.0-10.5)</td>
<td>.57</td>
</tr>
<tr>
<td>Charlson Comorbidity Index</td>
<td>2 (1-4)</td>
<td>2 (1-4)</td>
<td>.99</td>
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<tr>
<td>Source of infection, % of patients</td>
<td>54</td>
<td>57</td>
<td>.88</td>
</tr>
<tr>
<td>Pulmonary</td>
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<tr>
<td>Joint</td>
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<td></td>
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*Abbreviations: SOFA, Sequential Organ Failure Assessment.

* Values in second and third column are median (interquartile range) unless otherwise indicated in first column.
Obese patients with septic shock required a lower weight-based norepinephrine infusion rate than did nonobese patients.

Discussion

The key finding in this study was that obese patients with septic shock required a lower weight-based norepinephrine infusion rate than did nonobese patients. As a result, the non–weight-based doses were similar between groups. Our results suggest that a weight-based dosing strategy may not be necessary and that a non–weight-based dosing strategy can be used even in patients who are obese.

Potential disadvantages are associated with weight-based regimens in critically ill patients. For instance, weight-based dosing can increase the complexity of care and may lead to medication errors. 

This situation is particularly true during nonautomated programming of infusion pumps, which requires an additional step of weight entry and a need for calculation. For instance, if the weight value used in the pump is erroneously changed, then the same infusion rate would result in a different total norepinephrine dose being delivered to the patient. In the ICU, patients experience frequent and often dramatic weight fluctuations, sometimes within a single day. These fluctuations can affect the weight clinicians should program into pumps for weight-based infusions. 

With weights changing so frequently, applying weight-based dosing in the ICU, where a change in staff often occurs every 12 hours, may lead to potential medications errors or adverse events. Even with accurate pump programming, a patient’s weight commonly must be estimated, and the estimate is often inaccurate. Because of the aforementioned concerns, use of non-weight-based dosing for norepinephrine infusions would help simplify dosing regimens and most likely would improve patient safety.

Recent studies have indicated that the outcomes (i.e., hospital mortality) and characteristics (i.e., type of underlying infection) of critically ill obese patients differ from those of nonobese patients. These differences may be due to underlying pathophysiological mechanisms or differential use of therapies or suboptimal drug dosing. Optimizing drug dosing is particularly difficult because little is known of the effect of obesity on pharmacokinetics and pharmacodynamics for most drugs. Package inserts for many medications have weight-based dosing recommendations, but because many clinical trials do not include a large number of obese patients, appropriate dosing in obese patients is often unknown. This lack of information is the case for most of the commonly used vasoactive medications in the ICU, including norepinephrine. Although norepinephrine is titrated to effect, our study provides evidence that weight-based dosing may not be necessary.

An interesting finding in our study was that obese and nonobese patients received similar amounts of fluids. Thus, the weight-adjusted fluid volume was greater in the nonobese patients. This difference may be attributed to the lack of a linear relationship between circulating blood volume and weight. Compared with lean body mass, adipose tissue is relatively poorly perfused. Thus, weight-adjusted volume decreases as BMI increases, a finding that may help explain the differences in fluid requirements between our 2 groups. Alternatively, obese patients might have received less fluid than needed and thus could have required more norepinephrine. However, we did not show a higher norepinephrine use in the obese group, suggesting that the patients most likely did receive adequate fluid replacement.

In a study of patients with septic shock or trauma who required a catecholamine infusion, norepinephrine was initiated and titrated in increments of 0.1 µg/kg per minute. Plasma levels of norepinephrine were measured several times after the infusion. The results indicated that body weight did not influence pharmacokinetic parameters such as clearance or volume of distribution. If dosing should be based on body weight for norepinephrine, then the following must be true. First, the relationship between dose administered and pharmacokinetic parameters, including concentration of norepinephrine, must be significant. However, we found no correlation between dose and concentration in this study. Second, the relationship between circulating concentrations of norepinephrine and resulting
effects on MAP must be significant. However, great interpatient variability and unpredictability exist between concentration and MAP.13

Our study has limitations related to the study design. Because it was a retrospective cohort study, we were dependent on accurate documentation in the medical record. The groups were well matched with respect to all demographics, with the exception of age. However, this small difference in age is not considered clinically meaningful. Also, the majority of patients included in the study were admitted to the medical ICU; thus, our results may not be generalizable to patients in surgical or cardiovascular ICUs. Our outcome measures were determined at 60 minutes after the start of the norepinephrine infusion, similar to the methods used in previous studies. Thus, our results should be extrapolated with caution beyond this time frame. Overall, less fluid was administered to the obese group than to the nonobese group. This discrepancy may have confounded norepinephrine requirements. If the obese patients received less fluid, then they would be expected to require more norepinephrine, suggesting that the current infusion rate in that cohort is inflated. However, the total norepinephrine dose was similar in the 2 groups. This finding strengthens our rationale for using a non–weight-based approach, because even though obese patients may have received smaller amounts of fluids than nonobese patients did, the obese group did not require a higher dose of norepinephrine, as would be the case if weight-based dosing were used.

Compared with nonobese patients, obese patients have lower weight-based norepinephrine dosing requirements for septic shock. This difference translates to similar total norepinephrine dosing requirements to achieve MAP goals. Consequently, a non–weight-based dosing strategy with titration to effect may be appropriate in obese patients with septic shock. Because of the ease of use and logistical advantages, non–weight-based dosing is appealing for critically ill patients. Future prospective studies are needed to compare weight-based vs non–weight-based dosing strategies for norepinephrine.

ACKNOWLEDGMENTS
This study was conducted at the University of Arizona Medical Center, Tucson, Arizona.

FINANCIAL DISCLOSURES
None reported.

REFERENCES

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; e-mail, reprints@aacn.org.
Background

Nurses’ involvement in family meetings in the intensive care unit is central to supporting consistent communication and shared understanding within the care team and with patients and patients’ family members. Evidence suggests the existence of major barriers to the effective participation and contribution of nurses during family meetings.

Objectives

To characterize the nature and extent of nurses’ involvement in family meetings in the intensive care unit, including identifying barriers to nurses’ participation and opportunities for involvement.

Methods

Meetings with focus groups of nurses at a Veterans Affairs medical intensive care unit were recorded, transcribed, and qualitatively analyzed by using the constant comparative method.

Results

Thirty critical care nurses participated in 6 focus groups. Three major themes describing nurses’ involvement in family meetings were identified: nurses can play multiple roles in supporting conduct in family meetings, nurses face critical barriers to fully realizing these roles, and nurses end up as intermediaries in family meetings. Subthemes pertained to being well positioned to act as the patient’s advocate, yet feeling undervalued and underempowered to contribute important information in family meetings, often resulting in mixed messages about care preferences, prognosis, or goals of care that nurses did not feel able to address during the meeting.

Conclusion

Nurses are positioned to play essential roles in family meetings, but their full involvement remains unrealized. Communication training and greater attention to nurses’ empowerment and to facilitating the nurse-physician relationship in the context of family meetings most likely would increase appropriate involvement of nurses in the meetings. (American Journal of Critical Care. 2016;25:33-38)
Structured family meetings in the intensive care unit (ICU), whereby members of the providing care team meet with the patient and/or the patient’s family to discuss the patient’s condition, prognosis, treatment preferences, and options, are an important aspect of patient-centered care. Evidence suggests that ICU family meetings decrease family stress, increase care consistent with expressed wishes, and lead to higher ratings of the quality of dying in the ICU. Several critical care professional societies support routine structured family meetings in the ICU.

Guidelines emphasize that family meetings should be interdisciplinary, including at least an ICU physician and an ICU nurse in addition to the patient and/or the patient’s family, to ensure that multiple perspectives contribute to shared understanding and consistent communication within the care team. Patients and families report that interdisciplinary communication and collaboration are key aspects of good end-of-life care.

Evidence suggests there are barriers to successful involvement of nurses in family meetings. Despite recommendations for interdisciplinary ICU family meetings, evidence of poor communication and collaboration between nurses and physicians in the ICU suggests the existence of major barriers to successful involvement of nurses in family meetings. In a study of nurses in 4 adult ICUs, nurses identified the need for better communication among physicians, family members, and nursing staff, highlighting concerns about physicians not listening to nurses’ input on patient care. In another study, Thomas et al found that compared with ICU physicians, ICU nurses were less likely to rate collaboration and communication with physicians as “high,” that more input into decision making was needed, that nurses’ input was not well received, and that nurse-physician disagreements were not adequately resolved. Such issues within the ICU care team most likely spill over into family meetings, further hindering consistency in communication and patient-centered decision making.

To better understand the nature and extent of nurses’ involvement specifically in ICU family meetings and to identify opportunities for improvement, we elicited ICU nurses’ perceptions of the nurses’ roles in family meetings and the nurses’ perspectives on barriers and facilitators to participation in these meetings.

**Methods**

**Setting**

This qualitative, cross-sectional study of ICU nurses’ experiences and perceptions of ICU family meetings was conducted in the 26-bed general ICU at the Portland Veterans Affairs Medical Center, Portland, Oregon. The study was approved by the institutional review board of the Greater Los Angeles Veterans Affairs Medical Center.

**Participants and Data Source**

A multipronged approach was used to recruit a convenience sample of ICU nurses for 6 focus groups offered at various day and evening times during a 1-week period. First, information sheets describing the nature and purpose of the study were distributed via e-mail 1 month and again 1 week before the scheduled focus groups. Interested nurses could respond to the e-mail by selecting a focus group to attend. The information sheets were also posted with sign-up sheets in break and conference rooms in the ICU. In addition, immediately before each scheduled focus group, 2 study investigators walked through the ICU reminding nurses of the focus group and inviting the nurses to join if interested. All participants provided verbal consent to participate at the start of the focus group.

**About the Authors**

Sangeeta C. Ahluwalia is a policy researcher, RAND Corporation, Santa Monica, California, and an adjunct assistant professor, Fielding School of Public Health, University of California Los Angeles. Hannah Schreibels-Baum is a health science specialist, Veterans Affairs Greater Los Angeles Healthcare System, Los Angeles, California. Thomas J. Prendergast is a clinical professor of medicine, Oregon Health Sciences University, and section chief, Pulmonary and Critical Care Medicine, Portland Veterans Affairs Medical Center, Portland Oregon. Lynn F. Reinke is an investigator, Veterans Affairs Puget Sound Healthcare System, and a clinical associate professor, University of Washington School of Nursing, Seattle, Washington. Karl A. Lorenz is a core investigator and staff clinician, Veterans Affairs Greater Los Angeles Healthcare System, and an associate professor of medicine, School of Medicine, University of California Los Angeles.

Corresponding author: Sangeeta C. Ahluwalia, RAND Corporation, 1776 Main St, Santa Monica, CA 90401 (e-mail: sahluwal@rand.org).
Nurses could play multiple, critical roles before, during, and after family meetings.

Data Collection and Analyses
On the basis of existing literature and a consensus-focused discussion, 3 members of the research team (S.C.A., T.J.P., and K.A.L.) developed an initial draft of a semistructured, open-ended focus group guide to facilitate an exploration of nurses’ roles in and perspectives of participation in ICU family meetings. Questions in the guide were refined on the basis of input provided by 2 experts with extensive research and clinical experience in conducting family meetings. Questions covered how family meetings were scheduled and conducted; how nurses participated in the preparation, conduct, and follow-up of family meetings; what the nurses would like to change about the roles they described; and what challenges the nurses faced in participating in family meetings. The lead investigator (S.C.A.) facilitated all focus groups, and a second investigator (H.S.B.) took detailed field notes during each focus group meeting. All focus groups were recorded and lasted 40 to 60 minutes. Because of a risk of identifiability, demographic information was not collected from the participants.

Recordings of focus groups were professionally transcribed verbatim. With the focus group guide as the framework, an initial codebook was developed. Two investigators (S.C.A. and H.S.B.) first independently read and coded a single focus group transcript and then met to refine the codebook to reflect any new codes. A similar process was used for 2 additional focus group transcripts; after that no new codes emerged and a final codebook was agreed on. The investigators then used this final codebook to independently code all 6 transcripts and had regular meetings to discuss new codes or any coding conflicts. Coding discrepancies were resolved through discussion and consensus. After all transcripts were coded, codes were compared within and across transcripts to develop larger categories, and identified relationships between these categories were used to develop a set of themes that integrated the data. All qualitative analyses were conducted by using ATLAS.ti, version 6.0.15, software (Scientific Software Development GmbH).

Results
A total of 30 ICU nurses participated in the 6 focus groups. Three major themes and several subthemes pertaining to nurses’ experiences, roles, and challenges associated with ICU family meetings were identified (see Table).

Theme 1: Nurses Can Play Multiple Roles in Supporting Family Meetings
Nurses described being in a position to play multiple, critical roles before, during, and after family meetings, including coordinator, advocate, and translator. This playing of multiple roles occurred mainly because the nurses viewed themselves as the single member of the clinical team who was consistently present with the patient and the patient’s family, as well as routinely in contact with other members of the health care team and services. For example, in discussing her role as coordinator, a nurse said, “Nursing is really the hub of coordinating everything, just because we have contact with all the different services, so usually [we] are the coordinator for the meeting.”

Another nurse described how the amount of time nurses spent with patients and patients’ families by the bedside allowed the nurses to serve as advocates during the family meeting by contributing relevant information shared only with the nurses: “I think that’s the role because you’ve had a chance to have a relationship with that family member that the physician just doesn’t have. They just don’t spend that amount of time with them to be able to establish that.”

<table>
<thead>
<tr>
<th>Primary theme</th>
<th>Subthemes</th>
<th>Content of discussion</th>
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<tbody>
<tr>
<td>Nurses play multiple roles in family meetings</td>
<td>Nurse as coordinator</td>
<td>Expectations about scheduling and organizing</td>
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<td>Nurse as advocate</td>
<td>Bedside role of nurses</td>
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<td>Nurse as translator</td>
<td>Relationship of trust between nurse and patient/family</td>
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<td>Barriers to realizing nursing roles in family meetings</td>
<td>Systems barriers</td>
<td>Lack of resources and support</td>
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<td>Undervalued</td>
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<td>Expectations of nurses’ roles</td>
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<td>Nurse as intermediary</td>
<td>Mixed messages</td>
<td>Poor communication between patient/family and physician</td>
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<td>Poor communication between and among clinicians</td>
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Nurses also described how the relationship they developed with patients and patients’ families over time positioned the nurses well to translate and reinforce information given to the patients or family members by physicians: “A lot of times people come in and say stuff and then [the family] looks at us for the interpretation of what they’re saying. Because they know us and we speak the language that they’ve gotten used to hearing.”

Theme 2: Nurses Face Barriers to Fully Realizing Their Roles in Family Meetings

Despite the multiple roles that nurses identified related to supporting family meetings, many nurses also described various barriers to fully realizing these roles. They described logistical barriers, such as a lack of resources, to setting up the meeting: “We’re short a person who would be making all those arrangements, would be making [the meeting happen]. . . . and it’s not the nurses doing it because they don’t have the time.”

Nurses also described feeling undervalued and underempowered to effectively contribute during the family meeting. Nurses who described feeling undervalued highlighted situations in which their input was not actively solicited by the physician: “During the meeting, I am taking notes. Sometimes the doctors will be like, ‘What do nurses think?’ but routinely I think the doctors just talk to the family.” Although nurses sometimes could not attend the meeting because of their duties of patient care, in some instances, nurses reported not being invited by the ICU physician to attend the meeting at all. Nurses described feeling underempowered to speak up in a family meeting when their contribution might contradict what a physician was communicating to the family: “If the doctor was painting a really rosy picture that we’re going to do this and we’re going to do that and I know this is just a terrible situation, I wouldn’t feel that I was allowed to say, you know, this poor man is dying.”

Sometimes nurses who felt underempowered in family meetings held expectations about the role of a nurse that limited the nurses’ ability to fully participate in the meeting. For example, they thought that topics such as prognosis or palliative care were not within their responsibilities or area of expertise to broach with patients, even if the nurses knew the information needed to be communicated: “It’s not appropriate for us to be telling them this stuff. Sometimes the doctors put it on the nurses, and it’s like, whoa, whoa, whoa, this is your job. I may know it, but it’s not my place to tell them. And that’s something that needs to be addressed by the physician. And a lot of times it is not. Everything is left unsaid.”

Theme 3: Nurse as Intermediary—Holding Information But Lacking Power

Nurses often felt “caught in the middle,” or the “middleman” as a result of being a consistent presence among the patients, patients’ family members, and the care team but simultaneously limited in the capacity to fully participate in family meetings. This scenario most often played out when a nurse held relevant information about care preferences communicated by a patient or the patient’s family before the meeting that was not similarly communicated during the meeting: “There’s some patients who tell us they don’t want to continue to do these kind of treatments. . . . And then when they come to meetings, they say things are going great, thank you for all of your treatment. We get stuck with hearing all the complaining, but none of the communication of this is what we really want. So some of the frustrations that we tend to voice are the ones that are in the middle.”

Another nurse described the dilemma posed by hearing mixed messages about prognosis conveyed by physicians during scheduled weekly family meetings: “And sometimes doctors will tell them one thing and then the next week it seems like they tell them another thing. And then the next week they give them false hope on another thing. And we’re sitting there scratching our heads and pulling out our hair going, oh God, what do we do now?”

For the subthemes of feeling undervalued or underempowered in the family meeting, nurses typically described not being able to address such discrepancies in communication during the family meeting. Mixed messages from physicians often resulted in a conflict over goals of care that was a particular concern to nurses: “In certain cases there is a huge disconnect in goals of care . . . amongst the teams a lot of times. Different doctors have different opinions. So, there can be a disconnect between what they say to the family. Then the goals of care will change and it seems like we backpedal sometimes.”

Discussion

Nurses have an important role to play in ICU family meetings, by sharing information about the patient’s condition, advocating for the patient’s wishes, and helping patients and patients’ families understand the care plan.13 Interdisciplinary ICU family meetings are strongly recommended to address the concerns of patients and patients’ families and clarify goals of care.1 Our findings suggest that despite being in a position to play multiple,
important roles pertaining to family meetings, optimal involvement of nurses in these meetings is limited by several factors. Our findings reflect and are similar to larger challenges ICU nurses face in their daily practice and communication with patients, patients’ families, and physicians.20 Recent efforts to improve nurses’ participation in family meetings have focused on end-of-life care, training in communication skills, and education21-23; however, greater attention to empowering nurses within the interprofessional team and to strengthening the nurse-physician relationship may be needed to engender sustainable improvements in the way family meetings are conducted.

A more proactive approach to involving nurses in family meetings may be necessary to facilitate nurses’ participation and maximize the potential for family meetings to increase the quality of ICU care. Like nurses in other studies,17,18 the participants in our study thought that physicians did not actively solicit nurses’ input during family meetings. In addition, nurses reported that they often heard conflicting messages on care preferences or prognosis during the family meeting but did not call out these discrepancies during the meeting. These findings highlight a major gap in the conduct of family meetings, whose purpose is to facilitate consistent messaging and align understanding between participants about the patient’s condition, prognosis, and goals of care.19,24 Creating a designated time and space during ICU family meetings for nurses to contribute relevant information, address any unspoken wishes the patient may have expressed separately, and highlight potentially conflicting information communicated between participants may increase nurses’ involvement. The designated time might be during the meeting or immediately before the meeting (eg, the premeeting huddle) when the nurse and physician share information, develop a plan for the meeting, and align communication.1,25

Nurses’ expectations of their role in family meetings may pose an important constraint to the nurses’ full involvement in these meetings. The nurses in our study reported a belief that it was not within their role to broach topics such as prognosis or palliative care during family meetings, even when the nurses knew such information needed to be communicated. Clear and consistent communication about prognosis and other difficult topics during the family meeting is central to ensuring that patients receive timely and appropriate preference-concordant care throughout the course of care and particularly at the end of life. Although our findings suggest that nurses view these topics as outside of their role and scope of practice, other investigators26,27 suggest that nurses prefer greater involvement in communication related to advance care planning. Moreover, physicians generally think that nurses are competent to communicate with patients and families about prognosis, goals, and end-of-life treatment preferences.24 Helping nurses reset their expectations about their roles in family meetings may help increase effective involvement of nurses in the meetings.

Greater empowerment most likely is a necessary and critical component of any effort to increase nurses’ involvement in ICU family meetings.24 Nurses reported feeling underempowered to speak up during family meetings, particularly when their input contradicted information a physician was conveying. Nurses also said that they often did not address mixed messages about prognosis or conflicts about goals of care during family meetings. Nurses have previously reported moral distress in situations in which they perceived that inappropriate care was delivered as a result of the mismatch between prognosis and care29 and in situations in which they did not agree with decisions made by physicians.20,30 Often this moral distress is associated with nurses’ inability to take corrective actions because of systems-level constraints or the perceived inability to influence end-of-life decision making.30,31 Attention to empowering nurses in the ICU to become active participants in the family meeting within the context of the interprofessional team may decrease unspoken and unaddressed conflicts and consequently decrease moral distress and burnout of nurses. Furthermore, such empowerment may lead to greater shared responsibility by ICU physicians and nurses, a change that may be an appropriate goal in the context of the interdisciplinary family meeting.

Because our study was done at single center, the generalizability of our findings is limited. Because our recruitment strategy was designed to maximize participation across day shift and night shift nurses, we have some selection bias in our study sample. However, we think that the information collected across shifts provides a deeper understanding of nurses’ perceptions of their participation in family meetings. Finally, observing nurses’ participation during family meetings was beyond the scope of this study; these data most likely would further support our nurse-reported findings about nurses’ involvement in ICU family meetings.

Nurses are uniquely positioned to play essential roles related to ICU family meetings, yet nurses’ full and effective participation remains unrealized. In
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Ahluwalia was supported by a career development award from the National Palliative Care Research Center. The preparation of this article was supported in part by the Implementation Research Institute, George Warren Brown School of Social Work, Washington University, St Louis, Missouri, through the National Institute of Mental Health (R25 MH080916-01A2) and the Department of Veterans Affairs, Health Services Research and Development Service, Quality Enhancement Research Initiative.

ACKNOWLEDGMENTS
This research was performed at the Portland and West Los Angeles Veterans Affairs medical centers.

FINANCIAL DISCLOSURES

Dr Ahluwalia was supported by a career development award from the National Palliative Care Research Center. The preparation of this article was supported in part by the Implementation Research Institute, George Warren Brown School of Social Work, Washington University, St Louis, Missouri, through the National Institute of Mental Health (R25 MH080916-01A2) and the Department of Veterans Affairs, Health Services Research and Development Service, Quality Enhancement Research Initiative.

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Empowering the "Cheerers": Role of Surgical Intensive Care Unit Nurses in Enhancing Family Resilience

By Lauren Ellis, MA, PhD, Jessica Gergen, MSPH, Leah Wohlgemuth, MSPH, Marie T. Nolan, RN, PhD, MPH, and Rebecca Aslakson, MD, PhD

Background  Supporting family resilience, the ability of families to rebound from stressful events, is a goal of family nursing. Critical care nurses act as liaisons between patients’ families and other clinicians and thus are uniquely situated to promote family resilience.

Objective  To explore how nurses perceive the experiences of long-stay surgical intensive care unit patients and their families in order to gain insights on how nurses could cultivate family resilience.

Methods  A qualitative study including semistructured interviews (n = 13) and 4 focus groups (n = 17) with nurses in 3 surgical intensive care units in a large teaching hospital.

Results  Three themes were identified: expectations, support, and communication. Nurses noted that clinicians’ and families’ unrealistic expectations regarding the patient’s recovery can foster false hope. Nurses recognized families as “cheerers” who provide support by being involved in patient care and observed how extensive family involvement can be beneficial to patients but overwhelming for families. Nurses noted that communication among providers, families, and patients is the cornerstone of creating meaningful relationships. Nurses stated that with many teams involved, discrepancies in information can occur and often confuse and disturb patients’ families. Thus, nurses identified ways to enhance family resilience through routine and consistent communication.

Conclusions  Nurses note unique stresses faced by families of patients in surgical intensive care units. Using the family resilience model, nurses can identify and enhance key family resilience factors. (American Journal of Critical Care. 2016;25:39-45)
Admission to the intensive care unit (ICU) stresses both patients and their families, with negative physical and psychological effects for patients occurring both in the ICU\textsuperscript{1-4} and in the months to years following discharge.\textsuperscript{5-11} Family members of ICU patients have high levels of depression, anxiety, posttraumatic stress disorder, and caregiver burden.\textsuperscript{12-15} Of note, the administrative structure and culture of the surgical ICU (SICU) may contribute further unique stresses for patients and their families, as SICUs frequently involve multiple care teams and providers, and much of surgical culture is centered around what Cassell and colleagues\textsuperscript{16} refer to as a rescue culture, that is, a surgical culture focused on saving the patient at all costs.

When a family encounters a difficult situation, such as a family member’s admission to the SICU, the entire family system is often altered.\textsuperscript{17} Yet, certain attributes of the family unit can strengthen the family’s response to crisis and help them to cope.\textsuperscript{18} Family resilience refers to the ability of family members to rebound from challenging events.\textsuperscript{18,19} In a conceptual review on family resilience, Black and Lobo\textsuperscript{18} identified 10 prominent protective and recovery factors of resilient families: positive outlook, spirituality, family member accord, flexibility, family communication, financial management, family time, shared recreation, routines and rituals, and support network.

Promoting family resilience has been identified as a goal of family nursing.\textsuperscript{20} As providers who frequently interact with patients and their families, ICU nurses have a profound influence on the experience of families\textsuperscript{21} and are in a unique position to assess and support families in crisis. In the literature, critical care nurses have been described as power brokers and translators who help make connections and facilitate information sharing between physicians, patients, and patients’ families.\textsuperscript{22}

Building on the literature and the role of critical care nurses as a major resource for families, in this qualitative study, we explored how SICU nurses perceived the experiences of long-stay SICU patients and their families in order to provide insights on how SICU nurses may better cultivate family resilience. Families of long-stay patients were chosen because these families may more easily become exhausted after several days of seeking to provide what Plakas and colleagues\textsuperscript{23} refer to as vigilant attendance.

Methods

The objective of this qualitative study was to elucidate nurses’ perceptions of the experience of long-stay SICU patients and their families, and the role of the nurse in caring for them, by using a grounded theory approach. This study was conducted as part of a larger research project to explore experiences of SICU patients, their families, and their providers related to palliative care.

The study was conducted between January 2012 and April 2013 at the Johns Hopkins Hospital with nurses recruited from 1 of 3 SICUs: a 15-bed cardiac SICU that admits patients following cardiac surgery; a 14-bed SICU and intermediate care unit that predominantly admits patients after trauma, transplant, and vascular surgeries; and an 18-bed general SICU that predominantly admits patients after thoracic, general abdominal, plastic, gynecologic, and ear/nose/throat surgeries. Each SICU operates under a semiopen administration plan; patients are admitted by the primary surgeon with his or her corresponding house-staff team, but with a required ICU team consultation.

This study involved interviews with nurses of long-stay patients in the SICU because of their unique perspective on how families of long-stay patients respond to this stressful event. Nurses were eligible for the study if they were providing care for a patient who had been in the SICU for at least 7 days. The long-stay patient’s nurse on the day of enrollment was approached for potential interview. If the nurse declined, the previous night nurse or

Certain attributes of the family unit can strengthen a family’s ability to cope with crisis.
Nurses recognized that extensive family involvement could be both beneficial and detrimental.

Results

Nurses' efforts to promote and maintain the resilience of families were apparent in the following 3 major themes that emerged in the data: expectations, support, and communication (Tables 1-3).

Expectations

A common theme concerned the expectations of surgeons and families regarding the patient's recovery (Table 1). Nurses described an expectation among surgeons that their surgical interventions would fix their patients and that patients would recover. Nurses viewed this as a consequence of surgeons' desire to avoid failure. In focus groups, nurses described surgeons as optimistic, even when patients have significant morbidity and potential mortality. They understood that maintaining a positive outlook was important but believed the surgeons' overly optimistic outlook created discrepancies in information shared with families, which often fostered false hope and created a barrier to discussions about end-of-life care. Nurses noted that patients and families enter the SICU with their own expectations that are often unrealistic. Nurses recognized the difficulty that patients' families and surgeons have accepting the possibility of poor outcomes but suggested that improved presurgery education of families and patients may better align expectations with reality.

Support

Another factor in family resilience that nurses noted was family support to the patient enacted through their involvement in the direct care of the patient and monitoring of the patient’s condition (Table 2). Nurses described various ways in which families were supportive: being with the patient, being present during rounds, providing emotional support, and carrying out small tasks in patient care. Nurses enjoyed working with supportive families, and some tried to engage families in patient care. Many nurses shared stories about the support that family members provide to a sick patient and described them as motivators because they often help patients reach daily goals such as “sitting up” or “getting mobile.” However, nurses recognized that extensive family involvement had both beneficial and detrimental

a charge nurse who was familiar with the patient’s care was approached for potential interview. Interviews were conducted at a time and location convenient for the nurse. Nurses who agreed to interview but did not respond after 3 attempts or who could not schedule an interview within 4 weeks were dropped from the study.

A total of 13 semistructured interviews with SICU nurses were completed in 2 iterations from January 2012 to April 2013. Interviews began with broad questions about the experience of patients in the SICU and their families, including the hopes, goals, fears, and challenges for the patient. The nurses were invited to elaborate when they described the stress of the patient-family experience, the strengths of the families, and the nurse’s role in supporting them. The interview also explored nurses’ general perceptions of the SICU experience, including what constitutes a good or bad SICU stay.

After preliminary analysis of 6 interviews, questions were added to the interview guide to explore emerging themes for the next iteration of interviews. Participants were recruited and interviewed until theoretical saturation was reached. The mean duration of the interview was 44 minutes; the shortest was 11 minutes and the longest was 66 minutes.

To triangulate interview data and assess group norms, 4 focus groups with SICU day shift and night shift nurses were convened in the spring of 2012. All SICU nurses were eligible for participation in focus groups, which were advertised by e-mail and by flyers posted in each unit. A total of 17 nurses participated, ranging from 3 to 5 participants per group, and each took place within one of the SICUs. The mean duration of the focus groups was 49 minutes; the shortest was 31 minutes and the longest was 71 minutes.

Each interview and focus group was digitally recorded and transcribed. Following the constructivist grounded theory approach of Charmaz,24 we collected and analyzed data in an iterative fashion in which topics were first identified through open coding during preliminary analysis of early interviews and then explored in remaining interviews. Focused codes generated from open coding were organized into a scheme and applied to 3 transcripts by members of the study team (L.E., J.G., and L.W.), who then met to compare double-coded transcripts, resolve discrepancies, and finalize the coding scheme. The final coding scheme was applied to all transcripts, with the coders meeting regularly to review the analysis. In keeping with the constructivist grounded theory method, analytic memos were constructed to conceptualize themes.

Written informed consent was obtained before each interview or focus group. This study was reviewed and approved by the institutional review board at Johns Hopkins Hospital.

Results

Nurses’ efforts to promote and maintain the resilience of families were apparent in the following 3 major themes that emerged in the data: expectations, support, and communication (Tables 1-3).

Expectations

A common theme concerned the expectations of surgeons and families regarding the patient’s recovery (Table 1). Nurses described an expectation among surgeons that their surgical interventions would fix their patients and that patients would recover. Nurses viewed this as a consequence of surgeons’ desire to avoid failure. In focus groups, nurses described surgeons as optimistic, even when patients have significant morbidity and potential mortality. They understood that maintaining a positive outlook was important but believed the surgeons’ overly optimistic outlook created discrepancies in information shared with families, which often fostered false hope and created a barrier to discussions about end-of-life care. Nurses noted that patients and families enter the SICU with their own expectations that are often unrealistic. Nurses recognized the difficulty that patients’ families and surgeons have accepting the possibility of poor outcomes but suggested that improved presurgery education of families and patients may better align expectations with reality.

Support

Another factor in family resilience that nurses noted was family support to the patient enacted through their involvement in the direct care of the patient and monitoring of the patient’s condition (Table 2). Nurses described various ways in which families were supportive: being with the patient, being present during rounds, providing emotional support, and carrying out small tasks in patient care. Nurses enjoyed working with supportive families, and some tried to engage families in patient care. Many nurses shared stories about the support that family members provide to a sick patient and described them as motivators because they often help patients reach daily goals such as “sitting up” or “getting mobile.” However, nurses recognized that extensive family involvement had both beneficial and detrimental
Communication was the most prominent and influential enhancer or detractor of family resilience.

### Table 1
**Illustrative quotations concerning the domain of “Expectations”**

<table>
<thead>
<tr>
<th>Quotation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>The department of surgery in general has this expectation... [that] we're going to fix [the patients] or they're going to get better after their surgery. I feel like we don't really have enough discussions about the possibility of dying, especially when patients have been in the [intensive care unit] for a long time, when they're kind of headed down that path. A [lot] of the physicians will still paint a rosy picture for the families instead of asking the patient, “What do you really want? Would you rather die? Would you rather let us talk about making you more comfortable?” – Focus group participant</td>
<td></td>
</tr>
<tr>
<td>[Families] feel like the patient is sick, they're going to get a transplant, they're going to get back to their baseline and feel better, but it's hard to ever prepare anybody for this course. Obviously, you go into it thinking you’re going to come out of it fine, but that's not always the case, unfortunately. – Interview participant</td>
<td></td>
</tr>
</tbody>
</table>

### Table 2
**Illustrative quotations concerning the domain of “Support”**

<table>
<thead>
<tr>
<th>Quotation</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>We call it “the cheerers.” Sometimes when we walk the patient on the hallway, we tell them, “Look at the cheerers.” Here is the wife, the daughter, whatever. And it helps... Sometimes we even ask the family members to push the chair for us when we’re holding the patient, walking the hallway, and they like to do it. They feel like they have some kind of participation. – Interview participant</td>
<td></td>
</tr>
<tr>
<td>I think family plays a strong role in the process. They’re making the decisions for a lot of our patients because our patients aren’t able to speak for themselves, so they play a very strong role in that case. They’re huge support systems. – Focus group participant</td>
<td></td>
</tr>
<tr>
<td>They just wanted to talk to him, so that’s why they stayed but I knew... the daughter had mentioned that she had to leave at... ideally she was going to leave around 2 or 2:30 because to get her daughter to the gymnastics practice... but she said, “If that doesn’t happen, then that’s okay.” – Interview participant</td>
<td></td>
</tr>
</tbody>
</table>

**Communication**

Communication is another factor in family resilience (Table 3). Nurses primarily referred to family communication with them and other providers in the SICU, noting that this was the cornerstone of creating a meaningful patient-provider relationship and improving patient and family experiences. The theme of communication contains 3 subcategories: routine communication, discrepancies in communication, and family communication.

**Routine Communication with Providers.** Nurses repeatedly mentioned the importance of the unit’s routine communication infrastructure among providers, including rounds, logs, and shift-change reports. Each of these provided opportunities for the nurse to have the most recent information on the patient’s status and to convey the patient’s and family’s needs and factors associated with resilience to other providers. Nurses considered themselves as the provider with the most knowledge of how the family was responding to having a family member in the SICU and recognized the importance of all team members having this information when interacting with the family.

**Discrepancies.** Nurses noted that even when providers communicate with one another, there is not always agreement regarding patient care, and disagreements can cause undue stress and confusion for patients’ families. Such discrepancies occur not only between providers, but also between patients’ families and providers. One common discrepancy is when one team of providers or specialists fails to communicate with others, and patient care is consequently compromised by delays, misinformation, or other disagreements regarding a care plan. In addition, when the prognosis of a patient worsens, nurses discussed having trouble expressing their thoughts about appropriate care for the patient. Given such a large team caring for sick patients, nurses viewed these discrepancies as inevitable and recurring, although undeniably problematic and stressful for nurses, patients, and patients’ families.

**Family Communication.** The majority of nurses described their interactions with patients and patients’ families as positive and recognized that an
important aspect of their role includes interacting with and caring for families by getting to know the families, building rapport, and respecting or advocating for families’ wishes. Nurses perceived answering families’ questions as a valuable service that put families at ease: “being right there, the patients can ask you a question, or the family; you want to answer them and not put them off and defer them to somebody else.” Nurses felt that patients’ families ask questions because of their lack of medical knowledge and that providing answers eases their uncertainty. Yet, sometimes nurses saw a family’s repeated questions about the same issue as an indication of anxiety or difficulty accepting the patient’s status. This perception was especially apparent when nurses fielded “a question that there just is no answer to” such as whether cancer will return.

Discussion

Nurses in this study had a great deal to say about the value of patients’ family members, whom they called “the cheerers” for the often uplifting support they provided to seriously ill patients. Findings revealed SICU nurses less as power brokers as described by Cassell22 and more as family enablers; SICU nurses can promote some of the key family resilience factors by assessing and strengthening the family unit throughout the patient’s SICU stay. Nurses particularly focused on family support for the patient and family communication. These findings are consistent with key attributes identified in the family resilience model, which emphasizes that each family has innate strengths and areas for further growth.18

A positive yet realistic outlook is crucial for cultivating family resilience; nurses’ recognition of the importance of having such an outlook stemmed from their concern about family stress brought on by unrealistic expectations. In fact, nurses acknowledged how false hope can undermine family resilience. This finding is consistent with a report by Smith et al23 that false hope creates more anxiety for terminally ill patients than being told a realistic, albeit potentially devastating, prognosis. Recognizing the importance of managing expectations, nurses can help patients’ families cope with uncertainty and stress regarding the patient’s prognosis by promoting a positive yet realistic outlook. Nurses can reinforce a positive outlook by setting daily goals while reiterating an honest assessment of the patient’s status. Even when unexpected complications occur, nurses can help patients’ families have flexible expectations, enabling families to rebound.

A support system is also known to enhance family resilience.18 Nurses discussed the family’s role in being a support system that aids the patient in the SICU and individual family members. Some nurses helped families balance meeting the needs of the patient with meeting needs of other family members. Nurses found that involving the family in

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Table 3
Illustrative quotations for the domain of “Communication”

<table>
<thead>
<tr>
<th>Routine communication</th>
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<tbody>
<tr>
<td>Whatever team is your patient, they’ll go around from room to room and they go over from start to finish of where the patient started, and where they are right now. And then, basically go through what the goals are, what needs to be done today, what the expectations are, and sometimes we even have evening rounds. –Interview participant</td>
</tr>
<tr>
<td>(They) come on rounds throughout the night to check on the patient or to check on you, and say, asking us as nurses, “Do you have any concerns? Is there anything that you think we should look into?” Not all the doctors do that, and I think that makes a difference. –Focus group participant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discrepancies</th>
</tr>
</thead>
<tbody>
<tr>
<td>It can be very challenging because usually when the doctors walk out of the room . . . [as the nurse] I feel like I’m the one in the room and [the family is] like “What’s going on? You guys have been telling me one thing, and they come in and tell me another thing.” –Interview participant</td>
</tr>
<tr>
<td>I just think it is really important that the family doesn’t see that we are not on the same page if it is something that we can just quickly talk about and figure out what the case is. Because I feel like it is really difficult for the families when they are getting different information . . . it’s really confusing to them. –Interview participant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Family communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>I feel like the fact that I built that rapport with them and was able to answer their questions a little more in depth, and not have them have to go home and look it up on WebMD or figure it out for themselves, not just for the patient, but it appears to make the family’s experience a little bit better because people feel more secure and safer with their loved ones in our care because I know what I am talking about, and I know what my resources are, and I know how to answer their questions in an attentive manner. –Focus group participant</td>
</tr>
<tr>
<td>Just making sure they had all their questions answered, and I encouraged them to have a piece of paper and write down questions for the different teams. I would say, “Oh, that’s actually a really good question for the surgical team. They will be by to do afternoon rounds soon.” So, she would write it down, and so that helped her kind of organize her concerns and things and just kind of guiding her to do that. –Interview participant</td>
</tr>
</tbody>
</table>
small tasks for the patient or allowing family members to voice their opinion regarding the patient’s care empowers the family and promotes autonomy. This finding is further supported by clinical practice guidelines recommending that families be encouraged to provide as much patient care as they are comfortable doing. Nurses enjoyed working with supportive families because it gave them a sense that the patient was cared for and that the family members supported one another through the adversity of a SICU stay. Nurses perceived themselves as helping families to be supportive by cultivating a relationship with them. Doing so gives nurses a distinctive opportunity to recognize when families need help and encouragement in order to provide support to the patient.

Communication was the most prominent and influential enhancer or detractor of family resilience in this study. Routine communication between the provider team and the patient’s family enhances the family’s sense of control and comfort. Nurses reported that supportive families often tried to be present during routine communication. These findings are consistent with other research that shows patients and their families want timely, clear, and compassionate communication from clinicians, even when the news is bad or difficult to hear.

Per our study, contradictory information given to families by providers significantly increased the family’s feeling of uncertainty about the patient’s prognosis and plan of care and fomented family feelings of distrust in the care and care team. Nurses often serve as the point of contact for family members’ questions about the patient and as a source of information. Nurses must be able to not only discuss this information with families, but also be consulted by other providers to ensure that information discrepancies and disagreements are resolved before those providers speak with families. The need for better communication between interdisciplinary teams and families of patients who are critically ill or at the end of life is emphasized in the National Institutes of Health (NIH) State of the Science Report on palliative and end-of-life care. It is a natural fit for nurses to act as the translators who facilitate information sharing between providers, patients, and patients’ families.

In brief, effective communication between the nurse and the patient’s family is critical to building family resilience.

Overall, this study revealed that nurses can identify and foster key family resilience factors to help patients’ families cope with the stress of long-term ICU stays. Given this finding, future interventions should focus on encouraging behaviors that enhance family resilience and limiting behaviors that undermine it.

Limitations of This Study

This research had several limitations. First, the views of the nurses who agreed to participate in this study may differ from the views of nurses who refused to participate, which may have introduced information bias. Second, this study focused intentionally on nurses’ perceptions and thus findings cannot be triangulated with patients’ or family members’ perceptions. Third, although interviews were conducted in a private space, most were conducted where the nurses worked, which could have influenced what nurses shared because of concern that a nurse manager or other team members may overhear them. Last, because this study included only 1 hospital, the findings may not be transferable to SICUs at other hospitals.

Implications and Conclusions

Consistent with practice guidelines recommending that ICU staff receive training in assessing family members’ stress levels, the results of this study suggest that SICU nurses could integrate a formal assessment of family resilience into the admission process. This assessment could focus on the family resilience factors of support and communication, and it could include the illness of the patient in the ICU, the needs of family members at home, and the social environment in which the family functions. Families could be invited to routinely rate the quality and consistency of communication with providers, and this rating could be incorporated into interdisciplinary patient rounds and the plan of care. This assessment could enable the SICU team to more effectively target family interventions to support family factors that enhance resilience.

More research is needed to explore how nurses may promote other attributes of resilient families that were not explored in this study, such as spirituality. Future research should focus on creating interventions that target the family as a unit, which requires methods that would involve the entire family. Such research could involve surveying multiple family members or it could involve family as a unit focus groups such as those performed by Eggenberger and Nelms. Family resilience is a dynamic concept, so longitudinal research may provide insight into how resilience may change over time in families of patients who remain in the ICU for long stays.

ACKNOWLEDGMENTS

The authors thank the Johns Hopkins Hospital, the institution at which this work was performed, and the nurses who agreed to participate in the study.

FINANCIAL DISCLOSURES

R. Aslakson was supported through grants from the Foundation for Anesthesia Education and Research and the Johns Hopkins School of Medicine.
REFERENCES


SATISFACTION WITH ELIMINATION OF ALL VISITATION RESTRICTIONS IN A MIXED-PROFILE INTENSIVE CARE UNIT

By Diane K. Chapman, DNP, APRN, CCRN, FNP-C, Dave S. Collingridge, PhD, Lorie A. Mitchell, RN, MSN, Elizabeth S. Wright, RN, MSN, Ramona O. Hopkins, PhD, Jorie M. Butler, PhD, and Samuel M. Brown, MD, MS

Background
Open and patient-tailored guidelines have been recommended as the preferred visitation model in critical care settings; however, many critical care units continue to restrict visitation.

Objectives
To determine whether a transition from minimally restrictive to unrestricted visitation hours improves satisfaction of patients’ family members and whether such a transition affects nurses’ satisfaction and nurses’ perceptions of satisfaction among patients’ families.

Methods
Using a prospective, observational design in a 24-bed intensive care unit in a tertiary care hospital, validated instruments were used to survey family members visiting patients and all nurses working in the unit before and after a change in the visitation policy. Visitation hour guidelines were changed from closed during nursing hand-off report (3 hours daily) to open at all times, depending on patients’ preference and clinical status.

Results
One hundred three family members (50 before and 53 after the change in visitation guidelines) and 128 nurses (61 before and 67 after the policy change) were surveyed. Unrestricted visitation hours significantly improved family members’ satisfaction with the convenience of visitation hours and waiting room ambiance, and nurses’ perceptions of families’ satisfaction also improved.

Conclusions
Elimination of even minimal restrictions on visitation hours improved family satisfaction and improved nurses’ perceptions of family satisfaction with the visitation policy. Nurses’ satisfaction did not change. These findings support open and patient-centered visitation guidelines in critical care settings. (American Journal of Critical Care. 2016;25:46-50)
Visitation restrictions for critically ill hospitalized patients commonly specify who can visit patients (eg, immediate family only) and when visits can occur (eg, at scheduled intervals).1-3 Such restrictions can be stressful to patients with support persons outside of the traditional immediate family.3 In April 2010, President Barack Obama released a presidential memorandum regarding patient visitation policies.3 In response to this memorandum, the Centers for Medicare and Medicaid Services developed new regulations requiring hospitals to adopt written visitation policies that clearly identify visitation restrictions and the rationale for those restrictions.4 Open visiting guidelines allowing patient-tailored visitation is the recommended model in critical care settings.5 Still, many critical care units continue to impose visitation restrictions without regard to patients’ expressed interests.6-8

Although open or flexible visitation is an important component of patient- and family-centered care,2 many nurses and physicians continue to express concerns about this visitation model. Patient and staff safety, staff workload, patient privacy, and adverse changes in patients’ physiology have all been cited as concerns related to open visitation.7,8,10 Numerous studies have demonstrated that liberalization of visitation hours can lead to improved satisfaction of patients’ families,10-14 patients,12,14,15 and nurses10,11,12 without adverse effects on clinical outcomes. Some studies have even demonstrated that family visitation can lead to improved cardiovascular outcomes for patients.16,17 However, no studies to date have simultaneously assessed whether a change from a minimally restrictive policy (ie, restricted for 3 hours per day) to a completely unrestricted policy (ie, open at all hours depending on the patient’s preference and clinical status) influences satisfaction of both patients’ families and nurses.11 We sought to determine whether such a transition in visitation hours in a mixed-profile intensive care unit (ICU) would improve the satisfaction of family members, whom we defined as family members or friends. Secondly, we sought to determine whether the transition from minimally restrictive to unrestricted visitation influences satisfaction among nurses.

Materials and Methods

The study was conducted in the 24-bed shock trauma ICU of Intermountain Medical Center, a tertiary-care academic hospital in the Western United States. The pre-policy-change phase of the study was conducted from January 16 to January 26, 2012. The post-policy-change phase of the study was conducted from August 13 to October 9, 2012. The post-policy-change phase was significantly longer than the pre-policy-change phase because the patient census was lower during the post-policy-change period. The visitation guidelines were changed on February 6, 2012, from restricted visiting during the hours of 7 AM to 8:30 AM and 7 PM to 8:30 PM for nursing hand-off report, to open visitation with no restrictions 24 hours a day dependent on patients’ or family spokespersons’ preference and clinical status. Whereas the restricted policy limited the number of visitors to 2 at a time per patient, the new policy placed no universal maximum on the number of visitors allowed at 1 time; rather, the number of visitors was determined by the patient’s or the family spokesperson’s preference and clinical status.

About the Authors

At the time this article was researched Diane K. Chapman was a staff nurse in the shock trauma intensive care unit and a member of the Center for Humanizing Critical Care at Intermountain Medical Center, Murray, Utah. Dave S. Collingridge is a statistician in the Statistical Data Center, Intermountain Healthcare, Murray, Utah. Lorie A. Mitchell is a nurse manager of the shock trauma intensive care unit and a nursing researcher in the Center for Humanizing Critical Care. Elizabeth S. Wright was assistant nurse manager of the shock trauma intensive care unit at Intermountain Medical Center. Ramona O. Hopkins is a health psychologist in the Center for Humanizing Critical Care; a professor in the Psychology Department and Neuroscience Center, Brigham Young University, Provo, Utah; and a researcher in the Department of Medicine, Pulmonary and Critical Care Division, Intermountain Medical Center. Jorie M. Butler is a health psychologist in the Center for Humanizing Critical Care; associate director for education and evaluation at GRECC, core investigator at the IDEAS 2.0 at the Salt Lake Veterans Affairs Medical Center, Salt Lake City, Utah; and an assistant professor in the Division of Geriatrics, Department of Internal Medicine, School of Medicine, University of Utah, Salt Lake City, Utah. Samuel M. Brown is director of the Center for Humanizing Critical Care, Intermountain Healthcare, Murray, Utah; an assistant professor in the Department of Pulmonary and Critical Care Medicine, University of Utah, Salt Lake City; and an intensivist in the Department of Medicine, Pulmonary and Critical Care Division, Intermountain Medical Center.

Corresponding author: Samuel M. Brown, MD, ShockTrauma Intensive Care Unit, Intermountain Medical Center, 5121 South Cottonwood Street, Murray, UT 84107 (e-mail: samuel.brown@imail.org).
The study was approved by the institutional review board at Intermountain Medical Center. Informed consent was provided by all participants at the time of survey completion.

**Family Satisfaction**

We included English-speaking persons over the age of 18 years who were visiting patients admitted to the study ICU. We used a convenience sampling technique and invited all family members present at the time of survey administration to participate. Consent forms were given surveys and instructed to return completed surveys to the ICU secretary in a sealed envelope. We measured family satisfaction by using the visitor version of the validated survey instrument, "Questionnaires Measuring Satisfaction With Old and New Visitation Policies." In addition to this survey instrument’s 13 Likert-scale questions, to evaluate nursing satisfaction with a change in the visitation policy, we included the following demographic questions: age, years of experience as a nurse, years of experience in critical care, personal history of hospitalization, previous hospitalization of a family member or close friend, and highest degree obtained (see Table). We included nurses employed in the ICU during the study period. Higher scores indicated greater satisfaction.

**Statistical Analyses**

We separately analyzed nurse and visitor questionnaires by using principal components analysis. Principal components analysis allowed us to determine which common constructs, if any, the questionnaires were measuring. Principal components analysis also helped establish questionnaire validity by determining which underlying constructs were measured. Next, we checked the reliability of the questions loading onto each component with a Cronbach's test of internal consistency. Components with a Cronbach's α of at least 0.70 or higher were retained for further analysis. Questions loading onto the same components were aggregated to create overall component values. Aggregation was carried out by adding the responses to questions representing a specific component, then dividing by the number of questions that comprised that component. Aggregated component values were then compared with tests of statistical significance. Our use of principal components analysis thus allowed us to perform additional instrument validation and limit the number of comparisons, as opposed to using the raw, item-level responses to the full questionnaires.

Because of the relatively small sample size, we lacked statistical power to adequately compare multiple component measures across time periods using the Hotelling multivariate \( t^2 \) test. Thus we compared single-component measures before and after the visitation policy change by using univariate \( t \) tests. Finally, we evaluated associations between nurse demographics and survey satisfaction component measures by using analysis of variance. All analyses were performed in IBM SPSS version 19.0.

**Results**

**Family Satisfaction**

During the prechange period, 61 family surveys were distributed and 50 (82%) were returned. During

**Table**

Demographic data for nurses responding to survey before and after change in visitation policy

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>No. (%) of nurses</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before (n = 61)</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
</tr>
<tr>
<td>20-30</td>
<td>13 (21)</td>
</tr>
<tr>
<td>31-40</td>
<td>23 (38)</td>
</tr>
<tr>
<td>41-50</td>
<td>13 (21)</td>
</tr>
<tr>
<td>51-60</td>
<td>12 (20)</td>
</tr>
<tr>
<td>Years in nursing</td>
<td></td>
</tr>
<tr>
<td>1-3</td>
<td>9 (15)</td>
</tr>
<tr>
<td>&gt; 3-5</td>
<td>11 (18)</td>
</tr>
<tr>
<td>&gt; 5-10</td>
<td>14 (23)</td>
</tr>
<tr>
<td>&gt; 10-15</td>
<td>12 (20)</td>
</tr>
<tr>
<td>&gt; 15-20</td>
<td>3 (5)</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>12 (20)</td>
</tr>
<tr>
<td>Years in critical care</td>
<td></td>
</tr>
<tr>
<td>&lt; 1</td>
<td>4 (7)</td>
</tr>
<tr>
<td>&gt; 1-3</td>
<td>11 (18)</td>
</tr>
<tr>
<td>&gt; 3-5</td>
<td>13 (21)</td>
</tr>
<tr>
<td>&gt; 5-10</td>
<td>12 (20)</td>
</tr>
<tr>
<td>&gt; 10-15</td>
<td>9 (15)</td>
</tr>
<tr>
<td>&gt; 15-20</td>
<td>3 (5)</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>9 (15)</td>
</tr>
<tr>
<td>Hospitalization history</td>
<td></td>
</tr>
<tr>
<td>Critical care</td>
<td>7 (11)</td>
</tr>
<tr>
<td>Area other than critical care</td>
<td>37 (61)</td>
</tr>
<tr>
<td>Never hospitalized</td>
<td>17 (28)</td>
</tr>
<tr>
<td>Family member hospitalized</td>
<td></td>
</tr>
<tr>
<td>Critical care</td>
<td>40 (66)</td>
</tr>
<tr>
<td>Area other than critical care</td>
<td>17 (28)</td>
</tr>
<tr>
<td>Never hospitalized</td>
<td>4 (7)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
</tr>
<tr>
<td>Certificate</td>
<td>1 (2)</td>
</tr>
<tr>
<td>Associate degree</td>
<td>11 (18)</td>
</tr>
<tr>
<td>Bachelor's degree</td>
<td>42 (69)</td>
</tr>
<tr>
<td>Graduate degree</td>
<td>6 (10)</td>
</tr>
</tbody>
</table>
the postchange period, 64 family surveys were distributed and 53 (83%) were returned. We identified 3 components within the family surveys representing 34.7%, 14.1%, and 9.7% of the variance in the responses. The 3 components accounted for 58.6% of the total variance. These 3 components were waiting room ambience (eg, "the waiting room is restful and quiet," a total of 5 questions), visitation hour time and convenience (eg, the visitation hours "are convenient for my schedule," a total of 4 questions), and interactions with hospital staff (eg, "I feel like I am in the way," a total of 3 questions). Reliability analysis produced a Cronbach α of 0.81 for waiting room ambience, 0.83 for visitation hour time and convenience, and 0.53 for interactions with hospital staff. Removing questions did not significantly increase Cronbach α values. Because the Cronbach α for interactions with hospital staff was low (0.53), indicating low internal consistency, this component was excluded from further analysis.

Comparing component scores before and after the policy change by using t tests, we found that measures of visitation hour time and convenience were significantly higher after the change in visitation policy (4.41 vs 3.87, \( P < .001 \)), and measures of waiting room ambience was significantly higher after the change in visitation policy (3.53 vs 3.17, \( P = .02 \)).

### Nurse Satisfaction

During the prechange period, 83 nurses worked in the study ICU. Of these, 61 (73%) responded to the prechange survey. During the postchange period, 87 nurses worked in the study ICU. Of these, 67 (77%) responded to the postchange survey. Of all nurses invited to participate in the study, 80 were employed during both before and after the change in visitation policy. The nurse respondents during the prechange period did not completely overlap with respondents during the postchange period. Three nurses who were employed during the prechange period were not employed during the postchange period. Seven nurses employed in the study unit during the postchange period had not been employed on the unit during the prechange period.

Three components for the nurses’ responses were identified, representing 32.4%, 18.3%, and 9.3% of the variance, accounting for 59.98% of the total variance. These 3 components were family interference (eg, "I think visitors interfere with the time I need to do patient care," a total of 5 questions), perceived visitor satisfaction (eg, "visitors do not seem satisfied with the amount of time for visiting hours," a total of 3 questions), and keeping visitors informed (eg, "I feel that I do a good job of keeping the family informed of the patient’s condition," a total of 2 questions). Reliability analysis produced a Cronbach α of 0.81 for family interference, 0.74 for perceived visitor satisfaction, and 0.53 for keeping visitors informed. Removing questions did not significantly improve the Cronbach α values. Because the Cronbach α for keeping visitors informed was low (0.53), this component was excluded from further analysis.

Comparing component scores before and after the policy change with t tests, we found that nurses’ perception of visitor satisfaction was significantly higher after the change in visitation policy (3.94 vs 3.60, \( P = .03 \)). The family interference component score did not change significantly (3.34 vs 3.35, \( P = .94 \)).

Finally, we found that nurse demographics (see Table) were predictive of nurse component measures. Nurses who had been hospitalized perceived that families were less satisfied than did nurses who had not been hospitalized (3.35 vs 3.81, \( P = .03 \)). Nurses with 15 to 20 years of nursing experience were more likely to perceive families as interfering with clinical care than were nurses of all other levels of experience (2.10 vs 3.28, \( P < .001 \); lower scores indicate worse perception of family interference).

### Discussion

Eliminating even minimal visitation restrictions was associated with significant improvement in family satisfaction, both with the convenience of visitation hours and the waiting room ambiance. Although improved family satisfaction with less restrictive visitation policies is consistent with results of prior studies,2,7,10-14 improvement in the waiting room experience has not previously been demonstrated. One reason for the improved satisfaction may be that family members who spend less time in the waiting room may perceive it more favorably.

We also discovered that changes in visitation guidelines significantly improved nurses’ perceptions of family satisfaction with the visitation policy. This finding is consistent with a prior study evaluating family and nursing satisfaction with a liberalized visitation policy.15 No statistically significant change was found in nurse-reported family interference with their clinical care. Notably, the few nurses with 15 to 20 years of experience perceived more family interference than did nurses with all other levels of experience on both the prechange and the postchange assessments. This difference may be a reflection of a particular phase in a nurse’s career or a training difference during the time these nurses were trained; this might also reflect chance variation, as few nurses...
were in that category. Further study is required to answer this question.

Nurses who had previously been hospitalized felt that patients’ families were less satisfied with the visitation policy than did nurses who had never been hospitalized in both the prechange and postchange periods. The reasons for this difference are unknown, but it could be related to increased empathy among nurses with history of a prior hospitalization or it could reflect nurses’ extrapolation from their personal experience.

The results from this study support unrestricted visitation within the ICU and demonstrate that even ICUs with minimal visitation restrictions would most likely observe improved family satisfaction (without adversely affecting nurse satisfaction) by further liberalizing their visitation policies. The generalizability of these findings to other critical care and hospital environments is, however, limited by this study’s small sample size and convenience sampling techniques. Because we did not collect demographic data on patients’ families, we could not evaluate possible relationships between demographics and satisfaction among family members. Because our nurse samples included respondents who may have responded to only 1 survey, we used t tests of independence when comparing component values across prechange and postchange periods. In addition, our study population differed slightly (we do not treat patients after cardiac surgery) from the population for which the nurse and visitor versions of the “Questionnaires Measuring Satisfaction With Old and New Visitation Policies” were developed. However, because we were able to establish validity by using principal components analysis and reliability by using Cronbach α, we believe that this instrument was appropriate for our setting.

Conclusions

Changing from minimally restricted to unrestricted visitation improved family satisfaction in a large, mixed-profile ICU. Nursing perceptions of family satisfaction with the unit’s visitation policy also improved. The change in visitation guidelines did not adversely or positively affect nurse-reported interference with their clinical care. Consistent with recent guidelines, our findings support unrestricted visitation as part of patient- and family-centered critical care.

ACKNOWLEDGMENT

The views expressed in this article are those of the authors and do not necessarily reflect the position or policy of the Department of Veterans Affairs or the United States government.

FINANCIAL DISCLOSURES

None reported.

REFERENCES


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Caring for Families and Patients

By Linda Bell, RN, MSN

Care for families has often been secondary to patient care. However, Ellis and colleagues found evidence that nurses who are able to support family members as well as patients can actively help improve family resilience during the patient’s hospital stay. Ahluwalia and colleagues point out that nurses can help to improve communication with families during family meetings, and Chapman and colleagues found that as family visitation hours were increased, family satisfaction also increased. Integrating care for families into care for the patient can increase stress experienced by nurses, however, and this must be considered during policy and practice changes.

Here’s what you can do:

• Evaluate nurse and family satisfaction with your institution’s current visiting policy.
• Identify barriers, especially in communication, among the care team and with families.
• Assess nurse competency in sharing information with families.
• Develop role-play scenarios that allow family-type interactions in a safe environment to help nurses build communication skills.
• Review the research on family needs for information while a family member is a patient.
• Use the family needs inventory to develop a short script for nurses who are less comfortable talking with families.
• Mentor newer nurses who are dealing with difficult families to help decrease their stress while communicating with families.
• Identify a champion for integrating family members into your unit.
• Debrief staff members after experiences where families have been included or excluded from being present.

Other helpful resources:


Based on material from and published as a supplement to the articles by Ellis and colleagues, “Empowering the “Cheerers”: Role of Surgical Intensive Care Unit Nurses in Enhancing Family Resilience” (American Journal of Critical Care. 2015;25:39-45), the article by Ahluwalia and colleagues, “Nurses as Intermediaries: How Critical Care Nurses Perceive Their Role in Family Meetings” (American Journal of Critical Care. 2015;25:33-38), and the article by Chapman and colleagues, “Satisfaction With Elimination of all Visitation Restrictions in a Mixed-Profile Intensive Care Unit” (American Journal of Critical Care. 2015;24:46-50).
Background Intensive care unit survivors often have diminished health-related quality of life.

Objectives To describe health-related quality of life of former intensive care patients and identify associated factors 6 months after hospital discharge.

Methods Six months after discharge, 193 patients from an intensive care unit completed the Short Form-36 Health Survey; measures of sleep; Intensive Care Experience Questionnaire; Depression, Anxiety and Stress Scales; and Posttraumatic Stress Disorder Checklist. Norm-based scores were calculated for the Short Form-36. Bivariate associations with health-related quality of life (P < .05) were scores on the Acute Physiology and Chronic Health Evaluation II, hospital length of stay, awareness of surroundings and frightening experiences, depression, anxiety, stress, posttraumatic symptoms, and sleep quality at 2 and 6 months. In linear regression, scores on the Acute Physiology and Chronic Health Evaluation II, hospital length of stay, and sleep quality at 6 months were independently associated with Short Form-36 physical summary scores (P < .001); depression and stress were independently associated with mental summary scores (P < .001).

Conclusion Sleep, depression, and stress are potential targets for interventions to improve health-related quality of life and improve recovery. (American Journal of Critical Care. 2016;25:52-58)
Health-related quality of life (HRQOL) in critically ill patients who survive treatment in an intensive care unit (ICU) is lower than that of the general population.\(^1,2\)

A systematic review\(^1\) of 21 studies with a total of 7320 adult medical and surgical ICU survivors followed up for at least 6 months after discharge indicated that HRQOL was reduced in almost all assessed domains. The HRQOL often was lower than the patients’ HRQOL before the index critical illness. However, the HRQOL of some patients before ICU admission, assessed by using a proxy or a retrospective self-report, was also lower than that of the general population.\(^1\) Clinically meaningful improvements in most domains of HRQOL are often observed 6 to 12 months after discharge, but scores remain lower than matched population norms for many patients.\(^1\) Several more recent studies\(^3-8\) have also indicated that lower quality of life is a persistent problem for many survivors of critical illness and ICU treatment.

Lower than normal HRQOL in former ICU patients is associated with marked difficulty for them individually, as well as for their families and caregivers, the health care system, and society.\(^8-10\) A study\(^8\) of patients with multiple organ failure in 22 ICUs in the United Kingdom indicated that diminished HRQOL had an adverse effect on family employment and income; one-third of the families required support from government sources. In addition, one-quarter of the patients had decreased independence in activities of daily living and an increase in the use of health services.

Patient-related factors associated with reduced HRQOL in survivors of critical illness and intensive care have been reported.\(^4,10\) In a single-center investigation,\(^4\) various aspects of HRQOL were associated with both nonmodifiable factors (age, previous employment status, life orientation optimism, acute disease category, and severity of illness) and potentially modifiable factors such as signs and symptoms of posttraumatic stress and anxiety. Age, sex, previous health status, and severity of illness at the time of admission to the ICU have also been reported as risk factors for reduced HRQOL.\(^10\) This limited focus on risk factors for reduced HRQOL after intensive care treatment highlights a need for further investigation in this area both to characterize survivors of critical illness who would most benefit from targeted rehabilitation and support and to identify factors that are potentially modifiable during and after ICU treatment.

The purpose of this research therefore was to describe HRQOL 6 months after ICU treatment and to identify factors associated with HRQOL at 6 months. The specific aims were to describe HRQOL of critically ill patients who were treated in an ICU and to identify factors associated with the HRQOL of former ICU patients 6 months after discharge from the hospital. This study was part of a larger cohort study\(^11\) on patients’ self-reported sleep quality in the ICU, after transfer from the ICU, and after discharge from the hospital, including factors associated with sleep quality 6 months after discharge. In this article, we provide detailed previously unpublished data on the HRQOL outcomes of the study sample.

**Methods**

**Study Design**

This investigation was a prospective observational study of patients admitted to 3 ICUs in Royal North Shore Hospital, a tertiary referral hospital in Sydney, Australia. In addition to measures of sleep quality,\(^11\) patients completed self-report instruments on the intensive care experience 2 months after discharge and on psychological health and quality of life 6 months after discharge. The study was approved by the human research ethics committees of the Northern Sydney Local Health District and the University of Technology Sydney.

**Study Setting and Participants**

The general, cardiothoracic, and neurological ICUs of the hospital comprised a total of 36 beds.
The hospital is a state-wide referral center for spinal and burn injuries. The ICUs were closed units with an accredited intensive care specialist physician responsible for management of all patients. The registered nurse to patient ratio was 1 to 1 for patients treated with mechanical ventilation and 1 to 2 for patients who required high-dependency care. The nurse performed all nursing care for the patient (including respiratory and ventilator care and renal dialysis, if required) and was supported by ancillary staff such as patient services assistants and unit clerks.

Patients were eligible to participate if they were 18 years or older; had an ICU length of stay of 2 or more nights; had adequate vision, hearing, and comprehension of the English language to complete study instruments; had been declared ready for discharge from the ICU; and were able to give informed consent. Capacity to give consent was assessed in discussion with the patient’s nurse and on the basis of the patient’s ability to understand the approved patient information sheet and sign the consent form. No systematic assessment for delirium was performed. Mechanical ventilation in the ICU was not an eligibility criterion. Patients who had a known history or evidence of sleep disorder, had not for resuscitation or escalation of treatment in place, or were receiving palliative care were excluded. All participants gave written informed consent in the ICU by using the approved information sheet and consent form; continuing consent was sought verbally at each data collection time after ICU discharge.

Measures and Data Collection

The Medical Outcomes Trust Short Form-36 Version 2 Health Survey was used. The Medical Outcomes Trust Short Form-36 Version 2 Health Survey was used.

The instrument is a validated generic measure with 1 item on current general health and 8 domains: physical functioning, physical role, bodily pain, general health, vitality, social functioning, emotional role, emotional health, and mental health. Norm-based scores for the scales are reported with published Australian population norms available, calculated on the basis of a distribution with a mean of 50 and an SD of 10.13 Physical (PCS) and mental component summary (MCS) scores are derived by weighting all of the 8 individual domain scores by using coefficients from studies in the general population. Scores range from 0 to 100 for the domain subscales and component summary scores. Use of this instrument in survivors of critical illness has been reported widely, and the tool is recommended for studying this population.14

The Intensive Care Experience Questionnaire (ICEQ)15 was completed 2 months after discharge from the hospital. The instrument has 4 domains: awareness of surroundings (scores 9-45), frightening experiences (scores 6-30), recall of experiences (scores 5-25), and satisfaction with care (scores 4-20). Higher scores indicate greater awareness, more frightening experiences, better recall of experiences, and greater satisfaction with care. The questionnaire has satisfactory reliability and demonstrated concurrent and predictive validity in former ICU patients. In this study, the Cronbach α values were 0.83, 0.73, 0.76, and 0.56, respectively, for the 4 domains.

The Depression Anxiety and Stress Scales (DASS-21)16,17 are used to assess patients for depression, anxiety, and stress. Scores for each scale are from 0 to 21 and are doubled to correspond to the 0 to 42 range of the original DASS. The scales have established validity and reliability.18 In this study, the Cronbach α values were 0.91 for stress, 0.74 for anxiety, and 0.92 for depression. The Posttraumatic Stress Disorder Checklist for a Specific Event (PCL-S)19,20 contains 17 items that correspond to the criteria of the Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition)20 for posttraumatic stress disorder exhibited as reexperiencing, avoidance, and increased arousal. Total Total severity scores are reported on a continuous scale. The PCL-S has established reliability and validity. In this study, the Cronbach α value was 0.92.

The instruments used to assess sleep included the Insomnia Severity Index (ISI),21 validated for reporting on prehospital sleep quality. Scores range from 0 to 28; higher scores reflect worse sleep; scores of 15 or greater indicate moderate to severe insomnia. In this study, the Cronbach α value was 0.90. The Richards Campbell Sleep Questionnaire (RCSQ), validated for use in critically ill patients,24 was used for patients’ self-reports of sleep in the ICU and in the hospital. The questionnaire has five 100-mm visual analog scales for depth of sleep, falling asleep, wakefulness, going back to sleep, and overall sleep quality. Scores are averaged to obtain an overall score; higher scores indicate better sleep. In this study, the Cronbach α values were 0.91 in the ICU and 0.90 in the general hospital unit. The Pittsburgh Sleep Quality Index (PSQI), validated for use in community-dwelling respondents,25 was completed by patients after discharge from the hospital to report sleep quality and habits during the preceding month. Higher scores indicate worse sleep; scores between 5 and 7 indicate poor sleep quality. In this study, the Cronbach α values were 0.71 at 2 months and 0.79 at 6 months.

In the ICU, patients completed the ISI on prehospital sleep quality and the RCSQ on their previous...
Patients completed the Pittsburgh Sleep Quality Index after discharge.

Table 1
Demographic and clinical characteristics of participants on enrollment (n = 193)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>59.0 (16.2)</td>
</tr>
<tr>
<td>APACHE II score on day 1 of admission, mean (SD)</td>
<td>13.0 (5.6)</td>
</tr>
<tr>
<td>Days of mechanical ventilation, median (IQR)</td>
<td>0.5 (0-1)</td>
</tr>
<tr>
<td>Days in intensive care unit, median (IQR)</td>
<td>3 (2-5)</td>
</tr>
<tr>
<td>Days in hospital, median (IQR)</td>
<td>12 (8-20)</td>
</tr>
<tr>
<td>Female sex, No. (%)</td>
<td>68 (35.2)</td>
</tr>
<tr>
<td>Operative, No. (%)</td>
<td>139 (72.0)</td>
</tr>
<tr>
<td>Diagnosis, No. (%)</td>
<td></td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>83 (43.0)</td>
</tr>
<tr>
<td>Respiratory</td>
<td>12 (6.2)</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>16 (8.3)</td>
</tr>
<tr>
<td>Neurological</td>
<td>43 (22.3)</td>
</tr>
<tr>
<td>Trauma</td>
<td>17 (8.8)</td>
</tr>
<tr>
<td>Sepsis</td>
<td>4 (2.1)</td>
</tr>
<tr>
<td>Other</td>
<td>18 (9.3)</td>
</tr>
</tbody>
</table>

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; IQR, interquartile range.

Procedure
Screening for eligible patients was done daily on weekdays for 8 months by using patient records and by consulting with the bedside nurses. Eligible patients were approached in the ICU before transfer to a general unit and were given verbal and written information about the study. Screening, recruitment, and data collection were conducted by 3 investigators (M.F., R.E., and S.M.). Consenting patients were assisted to complete the ISI on their prehospital sleep at home and the RCSQ on their sleep on the previous night; demographic and clinical data recorded were age, sex, score on the Acute Physiology and Chronic Evaluation (APACHE) II, diagnostic category, and length of stay. Patients again completed the RCSQ on their previous night’s sleep 1 to 2 nights after transfer to a general unit. After discharge from the hospital, the 2-month and 6-month questionnaires were mailed to participants along with return prepaid envelopes. If questionnaires were not returned within 2 weeks of the due date, participants were reminded by telephone and were assisted in completing the questionnaires by telephone if they preferred.

Data Analysis
Descriptive statistics, means and standard deviations, medians and interquartile ranges (IQRs), and frequencies and percentages were used to describe the sample and the results of quality-of-life, sleep self-reports, intensive care experiences, and psychological health. Norm-based scores were calculated for the 8 SF-36 subscales. Bivariate tests of factors related to quality of life 6 months after discharge were conducted by using the Pearson bivariate correlation or t tests. Factors found in bivariate analyses to be significantly associated with HRQOL (P < .05) were entered into 2 multiple linear regression analyses (enter method) with PCS and MCS scores of the SF-36 at 6 months as the dependent variables.

Results
Of 344 patients who satisfied the inclusion criteria, 65% were enrolled, and 193 respondents completed the SF-36 at 6 months (the number who completed the various instruments after ICU discharge varied). Patients’ clinical and demographic characteristics are shown in Table 1. Respondents’ mean age was 59 years, and approximately one-third were women. The mean APACHE II score at admission was 13; the main reasons for admission to the ICU were cardiovascular and neurological diagnoses.

Six months after discharge from the hospital, participants reported on the SF-36 that, in general, their health was excellent (8.8%), very good (19.7%), good (41.5%), fair (16.3%), or poor (8.3%). The percentages and norm-based scores on the 8 domains of the SF-36 are shown in Table 2, together with the Australian population normative data for percentages and norm-based scores, including PCS and MCS scores.

Mean scores for patients’ experiences in the ICU (ICEQ) were 36.9 (SD, 5.8) for awareness of surroundings, 13.0 (SD, 4.7) for frightening experiences, 17.2 (SD, 4.4) for recall of experiences, and 14.6 (SD, 2.9) for satisfaction with care. Mean scores on the DASS were 9.17 (SD, 9.7) for depression, 5.6 (SD, 6.3) for anxiety, and 9.2 (SD, 9.7) for stress; the mean PCL-S score was 26.4 (SD, 10.7) for posttraumatic stress signs and symptoms. The mean ISI score for sleep at home was 7.7 (SD, 7.1); the mean RCSQ sleep quality scores were 47.2 (SD, 28.1) in the ICU and 54.3 (SD, 24.4) in the general unit; and the mean PSQI sleep scores were 7.9 (SD,
Severity of illness, length of stay, and quality of sleep 6 months after discharge were associated with quality of life.

Bivariate associations for HRQOL (PCS and MCS) with clinical, demographic, and psychological factors; intensive care experiences; and sleep are shown in Table 3. Significant correlations with the PCS were as follows: day 1 APACHE II scores: hospital length of stay; ICEQ awareness of surroundings and frightening experiences; DASS depression, anxiety, and stress; PCL-S total scores; PSQI total sleep quality at 2 months; and PSQI total sleep quality at 6 months. Higher ICEQ awareness of surroundings was associated with higher PCS scores; all other relationships were negative; PCS scores decreased in relation to each of the significant variables. Significant positive correlations with the MCS were ICEQ awareness of surroundings, recall of experiences, and satisfaction with care. Significant negative associations with MCS were female sex; ICEQ frightening experiences; DASS depression, anxiety, and stress; PCL-S total scores; PSQI total sleep quality at 2 months; and PSQI total sleep quality at 6 months.

Factors reported in Table 3 that were significantly associated ($P < .05$) with the PCS and MCS scores were entered into 2 separate multiple linear regression analyses. Preliminary analyses indicated no violations for assumptions of normality, linearity, multicollinearity, and homoscedasticity. The PCS model was significant ($F = 9.337; P < .001$) and accounted for 37% of the variance ($r^2 = .367$); day 1 APACHE II scores ($\beta = -0.147$; $P = .03$), hospital length of stay ($\beta = -0.310; P < .001$), and PSQI sleep quality at 6 months ($\beta = -0.362; P = .001$) were significant. The MCS model was also significant ($F = 24.303; P < .001$), explaining 63% of the variance ($r^2 = 0.626$); DASS depression ($\beta = -0.568; P < .001$), and DASS stress ($\beta = -0.251; P = .003$) were significant. Thus, APACHE II scores, hospital length of stay, and sleep quality were independently negatively associated with PCS, whereas depression and stress were independently negatively associated with MCS.

**Discussion**

The HRQOL of former ICU patients in this study was lower in all domains than that of the Australian population as indicated by normative data. We found bivariate associations of the PCS with severity of illness on ICU admission, awareness of surroundings and frightening experiences in the ICU, depression, anxiety, stress, and posttraumatic stress signs and symptoms reported 6 months after discharge and self-reported quality of sleep 2 months after discharge. The MCS was positively associated with awareness of surroundings and recall of experiences and satisfaction with care in the ICU, whereas negative associations were noted for female sex, frightening experiences in the ICU, depression, anxiety, stress, and posttraumatic stress signs and symptoms and for self-reported sleep quality 2 and 6 months after discharge. Severity of illness, length of stay in the hospital, and quality of sleep at 6 months were independently associated with physical health; mental health was independently associated with depression and stress at 6 months.

**Table 2**

Percentage and norm-based scores 6 months after hospital discharge from the study participants ($n = 193$) and Australian population normative data for domains of the Medical Outcomes Trust Short Form-36 Version 2 Health Survey.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Percentage scores</th>
<th>Norm-based scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Study, 6 months</td>
<td>Australian norms</td>
</tr>
<tr>
<td>Physical functioning</td>
<td>62.98 (32.30)</td>
<td>84.64 (21.86)</td>
</tr>
<tr>
<td>Role-physical</td>
<td>57.71 (32.84)</td>
<td>81.41 (25.13)</td>
</tr>
<tr>
<td>Bodily pain</td>
<td>67.09 (28.68)</td>
<td>76.45 (21.24)</td>
</tr>
<tr>
<td>General health</td>
<td>59.41 (25.38)</td>
<td>71.90 (21.88)</td>
</tr>
<tr>
<td>Vitality</td>
<td>53.79 (23.37)</td>
<td>61.12 (20.80)</td>
</tr>
<tr>
<td>Social functioning</td>
<td>72.28 (28.65)</td>
<td>86.19 (22.33)</td>
</tr>
<tr>
<td>Role-emotional</td>
<td>71.50 (30.05)</td>
<td>91.59 (17.50)</td>
</tr>
<tr>
<td>Mental health</td>
<td>73.63 (19.88)</td>
<td>80.63 (16.99)</td>
</tr>
<tr>
<td>Physical component summary</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Mental component summary</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

Abbreviation: NA, not applicable.

*From Hawthorne et al.\(^{13}\)* All values are mean (SD).
scores were in the domains of physical functioning, role-physical (effect of physical health on role) and role-emotional (effect of emotional health on role), with differences of 20 or more on the percentage scores and 10 or more on norm-based scores. A PCS difference of almost 9 between the study score and population norms was also noted.

The norm-based HRQOL scores 6 months after discharge were similar to those in other recent Australian studies1,7 with reports of SF-36 scores at 6 months in which the scores were similar in all domains and scores related to physical function were the lowest. Notably, in those studies,5,7 participants had higher severity of illness, with APACHE II scores on ICU admission of 20 and 18, and longer lengths of stay in the ICU and hospital. In contrast, markedly lower SF-36 physical functioning and role-physical scores were reported in a recent multicenter study8 in the United Kingdom; the APACHE II mean scores were 30 or higher, median length of ICU stay was 8 days, and median length of hospital stay was 29 days.

The independent associations of HRQOL physical function with severity of illness at ICU admission and length of stay are consistent with the findings of previous studies.1,3,4,10 Association of sleep after ICU treatment with HRQOL has also been reported,11,27 including association specifically with physical function.26,29 Association of poor sleep or insomnia with reduced HRQOL has been reported in many populations; the patterns observed suggest that sleep problems adversely affect HRQOL, after adjustments are made for physical and mental health comorbid conditions.30 However, the direction and potential mechanisms of this association have not been studied in ICU survivors and require further investigation.

Depression is common in survivors of critical illness,2,31 including associations with HRQOL.31,32 However, signs and symptoms of stress after critical illness have been reported infrequently, most likely because stress is less often specifically measured.2,33 In one study,11 the level of stress 1 week after hospital discharge was associated with mental health at 6 months. In our study, depression and stress at 6 months were both associated with mental health at 6 months. Because few studies have been done in critically ill patients with stress as a specific outcome measure, further research on this construct may ultimately benefit these patients.

Our study had some limitations, including use of a single center and a sample with relatively low severity of illness scores and short ICU stays. The self-report measures we used have inherent limitations; however, all of the measures have been validated for the purposes for which they were used and were feasible for addressing the aims of the study. Factors in the ICU potentially relevant to HRQOL outcomes, such as pain, sedation, and delirium, were not measured. Chronic health and organ failure status were also not determined and therefore could not be controlled for during analyses. These factors may have influenced our findings, although clearly the ICU length of stay for this cohort suggests that organ failure and comorbid conditions probably were not a clinically meaningful issue. Importantly, despite the limitations, we found significant deficits in HRQOL. Our study is one of few on prospective measurement of potentially modifiable patient factors that affect HRQOL in ICU survivors; thus, our findings are an important contribution to the small amount of knowledge on this topic.

Table 3
Bivariate associations of SF-36 physical component summary and mental component summary scores with clinical and demographic characteristics, intensive care experiences, depression, anxiety, stress, posttraumatic stress symptoms, and sleep

<table>
<thead>
<tr>
<th>Variable</th>
<th>SF-36 score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Physical</td>
</tr>
<tr>
<td></td>
<td>component</td>
</tr>
<tr>
<td></td>
<td>r</td>
</tr>
<tr>
<td>APACHE II score</td>
<td>-0.187</td>
</tr>
<tr>
<td>ICU length of stay</td>
<td>-0.130</td>
</tr>
<tr>
<td>Hospital length of stay</td>
<td>-0.330</td>
</tr>
<tr>
<td>ICEQ</td>
<td></td>
</tr>
<tr>
<td>Awareness</td>
<td>0.170</td>
</tr>
<tr>
<td>Frightening</td>
<td>-0.198</td>
</tr>
<tr>
<td>Recall</td>
<td>0.140</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>0.051</td>
</tr>
<tr>
<td>DASS</td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td>-0.289</td>
</tr>
<tr>
<td>Anxiety</td>
<td>-0.350</td>
</tr>
<tr>
<td>Stress</td>
<td>-0.215</td>
</tr>
<tr>
<td>PCL-S total</td>
<td>-0.331</td>
</tr>
<tr>
<td>ISI prehospital</td>
<td>-0.068</td>
</tr>
<tr>
<td>PSQI 2 months</td>
<td>-0.346</td>
</tr>
<tr>
<td>PSQI 6 months</td>
<td>-0.456</td>
</tr>
</tbody>
</table>

| Sex               |             |              |
|                   | Mean (SD)   | P            |
| Male              | 42.97 (11.82)| .01          |
| Female            | 39.76 (11.31)| .07          |

| Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; DASS, Depression, Anxiety and Stress Scales; ICEQ, Intensive Care Experience Questionnaire; ICU, intensive care unit; ISI, Insomnia Severity Index; PCL-S, Posttraumatic Stress Disorder Checklist for a Specific Event; PSQI, Pittsburgh Sleep Quality Index, SF-36, Medical Outcomes Trust Short Form-36 Version 2 Health Survey.

Conclusion and Implications for Practice

Our results further characterize survivors of critical illness who would most benefit from rehabilitation and support, helping identify subgroups of patients who should be targeted for early
rehabilitation interventions, as recommended by some investigators.14,15 We also identified factors that are potentially modifiable during and after an ICU stay, including sleep, depression, and stress, as potential targets for interventions to improve the quality of life and reduce the difficulty of recovery for survivors of a critical illness.

ACKNOWLEDGMENTS
This work was performed in the intensive care unit at Royal North Shore Hospital. We thank the clinical nursing staff of the unit for their assistance in identifying and recruiting patients eligible for the study.

FINANCIAL DISCLOSURES
None reported.

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REFERENCES

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Evidence-Based Review and Discussion Points

By Ronald L. Hickman, RN, PhD, ACNP-BC

Evidence-Based Review (EBR) is the journal club feature in the American Journal of Critical Care. In a journal club, attendees review and critique published research articles: an important first step toward integrating evidence-based practice into patient care. General and specific questions such as those outlined in the “Discussion Points” box aid journal club participants in probing the quality of the research study, the appropriateness of the study design and methods, the validity of the conclusions, and the implications of the article for clinical practice. When critically appraising this issue’s EBR article, found on pp 52-58, consider the questions and discussion points outlined in the “Discussion Points” box. Visit www.ajcconline.org to discuss the article online.

Survivors of an episode of critical illness suffer from significant reductions in their health related quality of life (HRQOL) long after hospital discharge. When compared to populations of community-dwelling adults with chronic conditions, survivors of critical illness often report markedly lower states of HRQOL, which is presumed to be associated with the previous life-sustaining care delivered in an intensive care unit (ICU). The lower levels of HRQOL among survivors of critical illness are well recognized and this is a phenomenon that impacts critically ill patients worldwide. However, there is a need for further investigation in this area, both to characterize survivors of critical illness who would most benefit from targeted rehabilitation, and to support and identify factors that are potentially modifiable during and after ICU treatment.

In an effort to address this significant scientific gap, the authors sought to describe the effects of modifiable patient factors, in particular psychological distress and sleep quality, on HRQOL among adults recovering from an episode of critical illness.

To address their primary aim, the authors conducted a prospective observational study and recruited 193 participants from the general, cardiothoracic, and neurological ICUs of a tertiary hospital in Sydney, Australia. Eligible patients were aged 18 and older, spent at least 2 nights in an ICU, and were scheduled for ICU discharge. Participants completed self-report measures for HRQOL, intensive care experience, psychological distress (e.g., symptoms of depression, anxiety, and stress), and sleep quality, which were administered on the day they provided informed consent, and at 2 and 6 months following their hospital discharge.

The authors found several modifiable patient factors that were linked to states of HRQOL among survivors of critical illness. When asked to reflect on her journey from assembling a team of investigators to publication, McKinley says, “It is important that the investigative team have good communication, access to the study population, and a strong commitment to the aims of the project.” With a common interest in improving care and outcomes of critically patients, McKinley and her coauthors focused on the conduct of high-quality research and leveraged the expertise of the investigative team for the benefit of improving patient care.

According to McKinley, the findings of this study raise new research questions and suggest recommendations to enhance both care delivered in the ICU and the HRQOL of patients recovering from an episode of critical illness. She advises future nurse scientists to remain up-to-date on the emerging areas of critical care rehabilitation and sleep research because these may offer new strategies to improve states of HRQOL and diminish the psychological distress commonly experienced among survivors of critical illness.

Investigator Spotlight

This feature briefly describes the personal journey and background story of the EBR article’s lead investigators, discussing the circumstances that led them to undertake the line of inquiry represented in the research article featured in this issue.

Sharon McKinley, RN, PhD, is a nurse scientist at the Royal North Shore Hospital in Sydney, Australia. She has experience as a clinical nurse in an adult ICU. Driven by her curiosity to better understand the experiences of critically ill patients, McKinley has conducted several qualitative and quantitative studies that informed her recent focus on the modifiable patient factors that affect HRQOL among survivors of critical illness.

When asked to reflect on her journey from assembling a team of investigators to publication, McKinley says, “It is important that the investigative team have good communication, access to the study population, and a strong commitment to the aims of the project.” With a common interest in improving care and outcomes of critically patients, McKinley and her coauthors focused on the conduct of high-quality research and leveraged the expertise of the investigative team for the benefit of improving patient care.

According to McKinley, the findings of this study raise new research questions and suggest recommendations to enhance both care delivered in the ICU and the HRQOL of patients recovering from an episode of critical illness. She advises future nurse scientists to remain up-to-date on the emerging areas of critical care rehabilitation and sleep research because these may offer new strategies to improve states of HRQOL and diminish the psychological distress commonly experienced among survivors of critical illness.

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survivors of critical illness. Notably, this sample of participants had lower states of HRQOL compared to population norms, which aligns with prior research. They also reported that the severity of illness scores, hospital length of stay, and sleep quality were predictors of HRQOL at 6 months after the participant's hospital discharge. The authors conclude that sleep quality and depressive and stress symptoms are potential targets for future interventions to improve HRQOL among survivors of critical illness.

**Information From the Authors**

Sharon McKinley, RN, PhD, lead author on the article, provides additional information about the study. She says this study builds on her previous work that examined the experiences of critically ill adults, and the input of clinical nurses who saw a need to evaluate the HRQOL after hospital discharge, psychological impact of the patient's exposure to ICU care, and sleep quality among survivors of critical illness.

McKinley believes that this study adds to the evidence regarding the influence of ICU sleep quality on outcomes after hospital discharge. “This study provides evidence of the problems of sleep disruption in patients in an ICU and demonstrates its impact on the patient’s recovery, and physical and psychological well-being,” she says.

Given the impact of sleep quality, psychological distress, and hospital length of stay on HRQOL after discharge, McKinley urges critical care nurses to be mindful of the factors that disrupt sleep and enhance psychological distress. “Critical care staff should be mindful of environmental noise, machine alarms and conversations that potentially disrupt a patient’s sleep,” she advises.

**Implications for Practice**

McKinley encourages readers of the *American Journal of Critical Care* to be thoughtful about the patient's ICU experience and its influence on the patient's recovery. McKinley recognizes the limitation of her research and notes that self-report measures of sleep quality are easily administered compared to the “gold-standard” of polysomnography. Despite multifaceted guidelines to improve sleep in ICU patients, these guidelines have little to no effect on polysomnography or self-report measures of sleep quality. According to McKinley, the science in this area remains rather underdeveloped. She adds, “There is a great need for further exploratory work on this problem and how sleep quality can affect a patient’s recovery after the hospital stay.”

**Discussion Points**

A. Description of the Study

- What are the major concepts of the study?
- What is the purpose of the study?

B. Literature Evaluation

- What factors are known to influence post-discharge HRQOL among survivors of an episode of critical illness?
- What is the evidence base on nonmodifiable patient factors that influence HRQOL, and why did the authors focus on these factors?

C. Sample

- Who was eligible to participate in this study?
- What is a plausible rationale for the authors’ selection of an ICU length of stay of 2 days or more as an inclusion criterion?

D. Methods and Design

- What is the research design and how were data collected?
- Describe the limitations of using self-report measures of sleep quality.

E. Results

- What were the major findings of this research?
- How can you use the findings of this research to improve the quality of your nursing care?
Retention of Baseline Electrocardiographic Knowledge After a Blended-Learning Course

By Carol Ann Brooks, RN, BSN, CCRN, CSC, Nancy Kanyok, RN-BC, MSN, CNS, Colin O’Rourke, MS, and Nancy M. Albert, PhD, CCNS, CCRN, NE-BC

Background
Among nurses, skill retention after an electrocardiography blended-learning course is unknown.

Objectives
To compare 3- and 8-week electrocardiography test scores, compare scores by nurse and work characteristics and self-assessed electrocardiographic competence, and compare 1-year work retention with 3- and 8-week scores and change in scores from week 3 to week 8.

Methods
Data were collected on demographics, comfort with electrocardiography expectations, electrocardiography competence levels, and 1-year work retention. Correlational and comparative statistics were used in analyses.

Results
Of 69 nurses, 58% were somewhat comfortable with interventions for abnormal rhythms. Test scores were higher at 3 weeks than at 8 weeks: mean difference, 26%; \( P < .001 \). Scores at 8 weeks reflected intermediate skill retention and were not associated with nurse characteristics, electrocardiography background, comfort with rhythms and measurements, or 1-year work retention. Nurses with greater comfort for intervening when rhythm abnormalities occurred had higher median 8-week scores (\( P = .01 \)) than did nurses with less comfort, and perceptions of electrocardiographic competence were associated with 8-week scores (\( r = 0.28; P = .02 \)). Reduction in scores at 8 weeks was less severe in nurses with greater comfort at 3 weeks in measuring electrocardiographic intervals (\( P = .008 \)) and applying therapeutic interventions (\( P = .009 \)).

Conclusions
Skill retention and competence in electrocardiographic interpretation were intermediate and correlated with baseline self-assessment. Electrocardiographic interpretation, measurement, and interventions should be reinforced at the bedside. (American Journal of Critical Care. 2016;25:61-67)
Electrocardiographic (ECG) competence is expected of all nurses caring for patients who have ECG monitoring. In previous research, when nurses’ knowledge was assessed before and after ECG education, scores improved, regardless of the learning environment (classroom or electronic learning) and methods used (instructor debriefing and study time). However, when confidence in ECG interpretation was assessed, nurses who were not given study time did not have significantly improved posttest scores. When ECG competency was studied among third-year nursing students according to the method used for teaching (lecture plus interactive discussion vs a 6-stage method that involved pattern recognition followed by interactive discussion), no differences were noted in initial scores on examinations taken immediately after completion of the course or scores obtained 1 month later. Although reports are available on ECG testing among physician assistants and resident physicians, we found no contemporary research on hospital nurses’ ECG competence according to different learning environments and teaching methods.

Nurses’ skill retention of ECG interpretation is important because they must be able to quickly and correctly identify and interpret ECG abnormalities and intervene in a timely manner. We found few research references on nurses’ competency in ECG abnormalities and anticipated interventions over time after the nurses’ completion of an ECG course. When researchers compared nursing students’ scores obtained immediately after completion of a course with scores obtained 1 month later (no matter the teaching method), a significant decrease in scores was detected. Thus, it is unknown if nurses’ competence in ECG interpretation is retained over time and if work area (intensive care, cardiac telemetry, and medical-surgical units) is a factor in retention after a nurse has successfully passed an ECG test.

Nurse retention on a work unit that demands ECG competency may be important. Nurses with low confidence in their ECG competency skills may leave the unit at 1 year to find a better fit. Nurses with high confidence in their ECG skills may feel comfortable leaving the unit at 1 year to pursue new challenges. Information is not available on 1-year retention on the work unit where ECG competency was obtained.

Our primary aim in this study was to assess differences in nurses’ basic ECG competence at week 3 of orientation (baseline test scores) and at week 8 of orientation (clinical ECG competence scores). Nurses’ ECG competence was defined as ability to measure ECG intervals, interpret ECG rhythms, and apply therapeutic interventions on the basis of ECG findings. Secondary aims were to determine if 8-week ECG clinical competency scores were associated with nurse demographics, work environment, self-assessed comfort with each ECG component (ECG intervals, ECG rhythm interpretation, and applying therapeutic interventions) and overall level of ECG competence at baseline. In addition, we wished to determine if week 3 ECG test scores, week 8 ECG test scores, and change in ECG test scores from week 3 to week 8 follow-up were associated with 1-year work retention on the unit of orientation.

Methods
A prospective, comparative, pretest-posttest, single cohort design and convenience sampling were used for the study. Nurse participants served as their own controls. The appropriate institutional review board deemed the study an internal quality improvement activity with the intent to improve patient care operations and procedures. Human subject regulations were not applicable, and the board closed the research application.

Setting and Sample
The study was completed at the Cleveland Clinic, a 1400-bed quaternary care medical center in Cleveland, Ohio. The sample consisted of newly hired or transferred (from nonmonitored to monitored units) registered nurses who completed a basic ECG interpretation course and passed the standardized ECG interpretation test in the first attempt. Nurses were excluded if they had previous clinical ECG experiences and passed the basic ECG interpretation test without completing the ECG interpretation course.
**Intervention**
A 2-day ECG interpretation course was initiated on week 2 of orientation and used a blended-learning approach that involved 4 hours of computer technology (both mornings) and 4 hours of classroom learning (both afternoons). Learning via computer technology involved logging into computer modules to review heart rhythm pathophysiology, ECG interpretation basics (interpreting ECG intervals by using ECG paper), measuring ECG intervals, interpreting waveforms, and applying therapeutic interventions. The ECG rhythms included normal sinus rhythm; atrial, junctional, and ventricular dysrhythmias; asystole; heart blocks; pulseless electrical activity; and bundle branch blocks. Computer modules were completed at a pace selected by the nurse with a caveat that the nurse would be prepared for classroom coursework sessions and to take a written test on a date specified at the beginning of the basic ECG course. The curriculum for computer technology learning was developed by several nurse educators who were experts in interpreting ECG rhythms. Classroom learning was focused on clarification of concepts covered in the online modules, practice in interpreting ECG strips, discussions of case studies, answers to students’ questions, and reinforcement of optimal application of therapeutic interventions according to ECG rhythm and patient scenarios. Classroom learning was facilitated by a clinical instructor with competence in ECG interpretation and computer technology learning.

**Outcomes and Measurement**
Baseline ECG competency was measured at 3 weeks by using the sum score of a 50-item multiple-choice test that consisted of rhythm strip interpretation, medical treatment, and nursing interventions. The test was developed by 2 research investigators (C.A.B. and N.K.) and other cardiac clinical nurse specialists and educators. Because a composite score of 80% was required for successful completion of the ECG course, all nurses who participated in this research had a baseline ECG test score of 80% or higher. The test has been used for many years. Item analysis and interrater reliability were assessed early after test development.

The 8-week basic ECG clinical competency test involved nurses’ responses to 9 clinical ECG case studies: 3 cases each at the beginner, intermediate, and advanced levels. Each case included a short paragraph of a patient’s history; current vital signs and medications, if indicated; and a 6-second ECG strip. For each case, nurses were asked to measure ECG intervals by responding to the following ECG attributes: regular or irregular rhythm, presence of p waves, heart rate in beats per minute, and PR, QRS, and QT intervals. Clinical ECG rhythm interpretation and clinical interventions were written out by using a blank space (no format). The test was developed by study investigators. Researchers graded the 9 ECG cases on a scale of 0% to 100% by simply counting the number of correct responses per the total possible responses. For the clinical interventions section, a list of expected correct responses was developed for scoring. Testing of content validity was completed by 8 nurses, who provided feedback on each of the 9 ECG cases and the expected clinical interventions associated with each case. The content validity index, determined by using the Lynn method, of ECG cases (including measurement intervals and rhythm interpretation) was 1.0 for beginner, intermediate, and advanced levels and 0.955 for expected clinical interventions. Before the test was used in practice, some expected clinical interventions were modified on the basis of expert advice provided during validity assessment.

Demographic information included 7 items: age, sex, highest nursing degree, years as a nurse, years as a nurse at current hospital, years as a nurse on the current unit, and work status (full or part time). Items were completed by using fill-in-the-blank or check boxes. Work environment was assessed by using a single question with 7 check-box response options that included intensive care, cardiac telemetry, medical and surgical units, emergency care, and postanesthesia care. Previous experiences with ECG education (in nursing school and work life and as self-study; 3 items) and previous work experiences in monitoring and interpreting ECG waveforms (1 item) were assessed by using yes-no dichotomous responses. Self-assessed comfort with identifying ECG rhythm abnormalities; measuring PR interval, QRS width, and QT interval; and applying therapeutic interventions was determined by responses on a 5-option Likert scale, from very uncomfortable to very comfortable. The final question on the nurses’ self-assessed ECG competency level consisted of a 4-option check-box format for beginner, advanced beginner, intermediate, and advanced.

Work retention was assessed by contacting unit nurse managers 1 or more years after participants completed the 8-week ECG competency test. Work status (1-year retention; yes-no) and date of leaving were collected.

**Data Collection**
A study investigator approached all full- or part-time (worked 20-35 h/wk) nurses who met inclusion criteria at 8 weeks of orientation on the
clinical unit or during a midorientation follow-up session. All nurses who were approached agreed to participate. Nurses completed the 9-item basic ECG clinical competency test and demographics, work environment, and self-assessed ECG comfort and competency questions individually in a quiet area.

**Data Analysis**

Before creating a competency grade for the 8-week basic ECG clinical competency test, the investigators developed a scoring sheet to ensure a systematic, consistently applied scoring process. After data collection was completed, 8-week basic ECG clinical competency tests were separated into 2 groups. Two investigators (C.A.B. and N.K.) graded tests separately. Then, they shared test grades to ensure grading reliability. Investigators discussed areas of discrepancy before creating final grades on each test.

Competency scores were described by using means, standard deviations, and summaries. Associations between 8-week basic ECG clinical competency scores and continuous or ordinal variables were tested and described by using the Spearman rank correlation. Associations between 8-week basic ECG clinical competency scores and nominal variables were described by using medians and interquartile ranges and tested by using either Wilcoxon rank-sum or Kruskal-Wallis rank-sum tests. Pairwise comparisons of 8-week basic ECG clinical competency score and self-assessed ECG competency levels were made by using Wilcoxon rank-sum tests. For these comparisons, multiple testing was accounted for by using a Bonferroni correction to control the family-wise error rate at the stated level. Associations between ECG test scores and work retention were tested by using Cox proportional hazards models. All analyses were performed by using R software, version 2.15.2 (R Project for Statistical Computing). A significance level of .05 was used for all analyses.

**Results**

The sample consisted of 69 nurses with a mean age of 26.9 years (SD, 6.4). Table 1 gives other demographic data and work environment factors. At the 8-week testing, 43 participants (62%) were somewhat or very comfortable in identifying ECG rhythm abnormalities; 51 (74%) were somewhat or very comfortable in measuring PR intervals, QRS widths, and QT intervals, and 40 (58%) were somewhat or very comfortable in applying therapeutic interventions. Other ECG experiences are presented in Table 1.

**ECG Clinical Competency at 3 Weeks and 8 Weeks**

Compared with baseline clinical competency at 3 weeks of orientation, the 8-week ECG clinical competency test scores decreased from a mean of 89% (SD, 4.7) to 63% (SD, 12.1), (P < .001). The level of decrease in 8-week scores compared with baseline scores varied according to the participant’s comfort level with ECG components (Figure 1). Of 8-week

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Table 1

<table>
<thead>
<tr>
<th>Nurse and work factors</th>
<th>n</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), years</td>
<td>68</td>
<td>26.9 (6.4)</td>
</tr>
<tr>
<td>Female sex</td>
<td>68</td>
<td>55 (81)</td>
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<td>Degree</td>
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<td>Associate/ diploma</td>
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<tr>
<td>Bachelor’s</td>
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<tr>
<td>Master’s</td>
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<tr>
<td>Experience as a registered nurse, mean (SD), years</td>
<td>68</td>
<td>0.9 (2.1)</td>
</tr>
<tr>
<td>Full-time work schedule</td>
<td>69</td>
<td>67 (97)</td>
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<tr>
<td>Work environment</td>
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</tr>
<tr>
<td>Cardiac telemetry/intermediate care</td>
<td>17 (25)</td>
<td></td>
</tr>
<tr>
<td>Cardiotoracic/cardiac medical or surgical intensive care unit</td>
<td>19 (28)</td>
<td></td>
</tr>
<tr>
<td>Medical telemetry unit</td>
<td>14 (20)</td>
<td></td>
</tr>
<tr>
<td>Noncardiac intensive care unit</td>
<td>6 (9)</td>
<td></td>
</tr>
<tr>
<td>Surgical telemetry unit</td>
<td>13 (19)</td>
<td></td>
</tr>
</tbody>
</table>

**ECG experiences**

| ECG course in nursing school, yes | 69 | 34 (49) |
| Previous ECG course at previous work, no | 68 | 56 (82) |
| ECG interpretation experience, no | 67 | 55 (82) |
| Since completing the hospital ECG course, ECG interpretation or measurement self-study completed, yes | 69 | 36 (52) |

**Self-assessment of ECG capabilities**

<table>
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<tr>
<th>Comfort with rhythm abnormalities</th>
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<tr>
<td>Very or somewhat uncomfortable</td>
<td>13 (19)</td>
</tr>
<tr>
<td>Not comfortable or comfortable</td>
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</tr>
<tr>
<td>Somewhat comfortable</td>
<td>33 (48)</td>
</tr>
<tr>
<td>Very comfortable</td>
<td>10 (14)</td>
</tr>
<tr>
<td>Comfort with measurements</td>
<td>69</td>
</tr>
<tr>
<td>Very or somewhat uncomfortable</td>
<td>12 (17)</td>
</tr>
<tr>
<td>Not comfortable or comfortable</td>
<td>6 (9)</td>
</tr>
<tr>
<td>Somewhat comfortable</td>
<td>22 (32)</td>
</tr>
<tr>
<td>Very comfortable</td>
<td>29 (42)</td>
</tr>
<tr>
<td>Comfort with therapeutic interventions</td>
<td>69</td>
</tr>
<tr>
<td>Very or somewhat uncomfortable</td>
<td>14 (20)</td>
</tr>
<tr>
<td>Not comfortable or comfortable</td>
<td>15 (22)</td>
</tr>
<tr>
<td>Somewhat comfortable</td>
<td>34 (49)</td>
</tr>
<tr>
<td>Very comfortable</td>
<td>6 (9)</td>
</tr>
<tr>
<td>ECG competency level</td>
<td>69</td>
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<tr>
<td>Beginner</td>
<td>26 (38)</td>
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<tr>
<td>Advanced beginner</td>
<td>33 (48)</td>
</tr>
<tr>
<td>Intermediate</td>
<td>10 (14)</td>
</tr>
<tr>
<td>Advanced</td>
<td>0 (0)</td>
</tr>
</tbody>
</table>

2The “n” varies because data were missing for 1 or 2 respondents for some factors. Values are number (percentage) unless otherwise indicated in first column. Because of rounding, not all percentages total 100.
Changes in electrocardiographic (ECG) competency between week 8 and baseline (week 3 of orientation) by self-assessed comfort with each ECG testing component. At 8-week competence assessment, all scores decreased, as noted by the vertical axis that represents percentage change in competence scores. The top of the figure represents 0% change in 8-week score compared with baseline score. Nurses who assessed themselves as comfortable had higher 8-week competency scores than did nurses who assessed themselves as uncomfortable in each of the 3 ECG testing components.

Decrease in 8-week competence score compared with baseline competence score

Applying therapeutic interventions

ECG measurements

Identifying rhythm

Comfortable

Uncomfortable

Figure 1 Changes in electrocardiographic (ECG) competency between week 8 and baseline (week 3 of orientation) by self-assessed comfort with each ECG testing component. At 8-week competence assessment, all scores decreased, as noted by the vertical axis that represents percentage change in competence scores. The top of the figure represents 0% change in 8-week score compared with baseline score. Nurses who assessed themselves as comfortable had higher 8-week competency scores than did nurses who assessed themselves as uncomfortable in each of the 3 ECG testing components.

Associations With 8-Week Basic ECG Test Scores

Nurses’ characteristics, work environment, and previous ECG education were not significantly associated with the 8-week ECG clinical competence score. There was marginal but nonsignificant evidence that younger nurses had higher scores compared with older nurses: Spearman $r = -0.21$ (95%CI, -0.45 to 0.03); $P = .08$. Nurses who assessed themselves as having beginner competency (mean, 60%; SD, 13) had numerically lower ECG competence scores at 8 weeks than did nurses who assessed themselves as having advanced beginner (mean, 63%; SD, 13) or intermediate level (mean, 69%; SD, 8) competencies; however, no pairwise comparisons were significantly different (all $P > .05$). Table 2 provides the associations between 8-week ECG competence scores and nurses’ self-assessment of ECG comfort and ECG competency level. Nurses’ self-assessment of higher comfort in applying therapeutic interventions was associated with higher scores at 8 weeks (Table 2). When self-assessed comfort and 8-week ECG competence scores were compared by components (interpreting ECG rhythms, measuring intervals, and applying therapeutic interventions; Table 3), most notable was that higher self-assessed comfort in applying therapeutic interventions was associated with higher 8-week competence scores in all 3 components.

ECG Clinical Competency at 3 Weeks and 8 Weeks and 1-Year Work Retention

Of the 69 nurses, 10 (14%) left their work unit at 1 year after hire, and 21 (30%) left during the 22-month assessment period. For each ECG testing period (3 weeks and 8 weeks), the association between ECG test scores and 1-year work retention was investigated by determining the hazard ratio, which was scaled to compare nurses with higher scores with nurses who had lower scores and nurses who had larger changes with nurses who had smaller changes (all were decreases) from 3-week to 8-week scores, on the basis of the 75th and 25th percentiles. No differences in work retention according to high or low 3-week ECG scores, high or low 8-week ECG competence scores, or the amount of decrease in test scores from 3 weeks to 8 weeks were detected (Table 4).

Discussion

Overall, initial mean ECG competency scores after the ECG course were good; however, from week 3 to week 8, test scores decreased. Our results resemble those of others who assessed retention of ECG competency test score components, nurses scored highest for identifying ECG rhythm abnormalities and lowest for applying correct interventions (Figure 2). Among the participants, 2 had extremely low scores for measurement of ECG intervals.

Figure 2 Electrocardiographic (ECG) clinical competence at 8 weeks, by ECG component scores. Each ECG competence component had a standardized score from 0% to 100%; black circles represent each participant’s score.
who were randomized to different ECG education methods, ECG retention scores were reduced at 1 month and 8 weeks, compared with initial testing after the education, regardless of the educational method used. Of note, nursing students’ initial test scores after education exceeded the scores of medical students and were similar to the scores for the nurses in our sample. In a comparison of change in ECG competency scores over time of our nurses with the change in scores of nursing students and medical residents, nursing students had the smallest reduction in ECG competency scores. Perhaps the time from test 1 to test 2 was important. Nursing students completed their retention assessment at 4 weeks, our nurses completed it at 5 weeks, and medical students completed it at 8 weeks. In nursing practice, it may be important to assess ECG competency multiple times after completing the initial course and passing the baseline ECG test. Because other reports involved only nursing and medical students, more research is needed. As evidence of the need for ongoing assessment of nurses’ ECG skills, in a study in which nurses’ knowledge and ability to monitor QT intervals were assessed, baseline ability to monitor QT intervals was poor. Scores improved after the ECG course; however, errors in monitoring persisted.8

Although individual nurse characteristics were not associated with 8-week competency scores in our study, there was a trend of higher scores among younger nurses. In a study by Varvaroussis et al, third-year undergraduate nursing students who were tested on cardiac arrhythmias at 2 different times had significantly lower scores at retest than at baseline; however, the students’ characteristics were not assessed. Further research is needed to determine if nurses’ characteristics are predictive of changes in follow-up ECG competency scores over time. If demographic and other characteristics are associated with changes in competency scores, nurse educators can be proactive in developing and implementing ECG case studies and dysrhythmia practice strips or other ECG learning strategies to maintain initial knowledge of and competency in applying correct interventions.

In our study, decreases in scores were associated with self-assessed comfort with ECG measurements. The factor that correlated most closely with ECG competency was nurses’ self-assessed comfort with application of therapeutic interventions. Of the test score components, nurses scored highest for interpreting ECG rhythms and lowest for applying correct therapeutic interventions. These results are novel. In one report, physician assistants who were more confident in their ability to accurately interpret ECGs had better examination scores. However, we found no reports of comfort with ECG interval

### Table 2

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>8-week ECG competence score</th>
<th>Spearman $\rho$</th>
<th>CI</th>
<th>$P$</th>
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<tr>
<td>Self-assessed comfort</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identifying rhythm abnormalities</td>
<td>0.22</td>
<td>(-0.02 to 0.45)</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td>Measuring intervals</td>
<td>0.22</td>
<td>(-0.01 to 0.46)</td>
<td>.07</td>
<td></td>
</tr>
<tr>
<td>Applying therapeutic interventions</td>
<td>0.35</td>
<td>(0.13-0.58)</td>
<td>.003</td>
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<tr>
<td>Self-assessed ECG competency level</td>
<td>0.28</td>
<td>(0.05-0.51)</td>
<td>.02</td>
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</tr>
</tbody>
</table>

### Table 3

<table>
<thead>
<tr>
<th>Self-assessed comfort</th>
<th>Level</th>
<th>No.</th>
<th>Interpreting ECG rhythms $P$</th>
<th>Measuring ECG intervals $P$</th>
<th>Applying interventions $P$</th>
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<tr>
<td>Identifying rhythm abnormalities</td>
<td>UC</td>
<td>26</td>
<td>77.8 (69.4, 88.9)</td>
<td>.55</td>
<td>75.9 (68.5, 81.0)</td>
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<tr>
<td></td>
<td>C</td>
<td>43</td>
<td>88.9 (77.8, 88.9)</td>
<td>79.6 (75.9, 83.8)</td>
<td>33.0 (20.7, 46.7)</td>
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<tr>
<td>Measuring intervals</td>
<td>UC</td>
<td>18</td>
<td>77.8 (69.4, 88.9)</td>
<td>.47</td>
<td>72.2 (59.7, 79.6)</td>
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<tr>
<td></td>
<td>C</td>
<td>51</td>
<td>88.9 (77.8, 88.9)</td>
<td>79.6 (75.9, 83.3)</td>
<td>33.0 (20.7, 45.7)</td>
</tr>
<tr>
<td>Applying therapeutic interventions</td>
<td>UC</td>
<td>29</td>
<td>77.8 (66.7, 88.9)</td>
<td>.05</td>
<td>75.9 (68.5, 79.6)</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>40</td>
<td>88.9 (77.8, 91.7)</td>
<td>79.6 (75.9, 83.8)</td>
<td>34.1 (24.1, 47.4)</td>
</tr>
</tbody>
</table>

8-week ECG competency score, median (IQR)$^a$

| Self-assessed ECG competency level$^c$ | 69    | 0.06 (-0.18 to 0.3) | .61 | 0.27 (0.03-0.50) | .03 | 0.20 (-0.04 to 0.44) | .10 |

Abbreviations: C, comfortable; IQR, interquartile range; UC, uncomfortable;

$^a$ Wilcoxon rank sum test.

$^b$ Spearman rank correlation.

$^c$ Values applied to 4 levels from beginner to advanced; a positive correlation reflects higher self-assessed competency and higher 8-week test score.
measurements and ability to apply therapeutic interventions according to self-assessed comfort. Among nursing students in the study by Varvaroussis et al,3 dysrhythmias with the highest failure rates were ventricular tachycardia, atrial fibrillation, and supraventricular tachycardia, all of which were considered more advanced dysrhythmias on our 8-week ECG competency test. After completing an initial ECG competency test, nurses continue to need guidance and support from preceptors or coaches to ensure safe, competent practice. Continual ECG self-assessment reinforces clinical competencies and skill retention. Preceptors and coaches are pivotal in facilitating new nurses’ application of acquired knowledge and in ensuring successful transition to independent, safe patient care.

We found that work retention did not differ by ECG test scores or the amount of decrease in test scores from baseline to follow-up. Our hypothesis that nurses with the smallest decreases (relatively high 8-week test scores) and those with the greatest decrease at 8 weeks would both have lower 1-year work retention was not validated, reflecting that work retention factors were unrelated to ECG competency. Future research is needed to learn if factors associated with ECG competency lead to retention of nurses. For example, no information is available in the literature on whether or not quality improvement programs meant to enhance ECG competency, such as exposure and experiences in responding to medical emergencies, interdisciplinary discussion of advanced ECG recordings, nurse teamwork and mentorship in identifying ECG alarms, and ECG education and case study presentations led by unit nurses, improve ECG retention.

Limitations

Our study had limitations. It was completed at a single, large medical center in an urban setting. Initial ECG testing was done at week 3 of orientation after a blended-learning ECG education that involved both computer technology and classroom learning. Results may not apply to nurses working in other hospitals that use different ECG training methods. We developed the paper-and-pencil 8-week ECG test that included identifying rhythms, measuring ECG intervals, and applying therapeutic interventions. Although the tool was assessed for content validity before it was used, tool reliability should be assessed over time. Inclusion of different rhythms and different testing methods could alter results.

Conclusions

Among nurses working on various intensive care and telemetry units, 8-week ECG test scores decreased by 26%, reflecting a decrease in competency from initial ECG testing. Nurses should be assessed for their comfort in measuring ECG intervals and applying therapeutic interventions, because self-assessments of ECG skills were generally associated with 8-week test scores. Unit preceptors and coaches need to reinforce identification of ECG rhythms, measurement of ECG intervals, and, most importantly, application of therapeutic interventions to reinforce ECG information presented during orientation and to ensure safe patient care.

FINANCIAL DISCLOSURES

Funding for this study was provided by the Cleveland Clinic Nursing Institute.

REFERENCES


Table 4

<table>
<thead>
<tr>
<th>Variable</th>
<th>Levela</th>
<th>Hazard ratio</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 3 test score</td>
<td>High</td>
<td>0.93</td>
<td>0.59-1.45</td>
<td>.74</td>
</tr>
<tr>
<td>Week 8 test score</td>
<td>High</td>
<td>1.16</td>
<td>0.81-1.68</td>
<td>.42</td>
</tr>
<tr>
<td>Change score</td>
<td>High</td>
<td>0.82</td>
<td>0.56-1.21</td>
<td>.33</td>
</tr>
</tbody>
</table>

a ECG high-level test score refers to the 25th percentile, and low-level test score refers to the 75th percentile.

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Objective To compare the utility of a multiplex polymerase chain reaction system (SeptiFast) and blood cultures for detecting bacteria and fungi in blood samples from patients with severe sepsis or septic shock.

Methods In a prospective observational study, whole blood samples for SeptiFast testing and for culture were collected on admission from all patients with severe sepsis or septic shock admitted to the intensive care unit between July 2011 and September 2012. SeptiFast results were compared with blood and other culture results.

Results The probability of at least 1 microorganism being isolated at 6 hours was 13-fold higher with the SeptiFast test than with blood cultures (relative risk, 13.5; 95% CI, 5.05-36.06). Unlike culture results, SeptiFast test results were not associated with previous antibiotic consumption. The median time to the first positive blood culture result was 17 hours; SeptiFast results were available in 6 hours. SeptiFast detected genetic material from potentially multiresistant microorganisms in patients whose blood cultures showed no growth at all.

Conclusions The SeptiFast test provided quicker microbiological diagnosis and identified significantly more microorganisms than blood cultures did, particularly when samples were collected after antibiotic therapy had started or infections were due to resistant bacteria and yeast. (American Journal of Critical Care. 2016;25:68-75)
Sepsis is among the most common causes of death in hospitalized patients worldwide, and its incidence is steadily increasing.1 Rapid and correct initial antimicrobial therapy is crucial for successful treatment of patients with sepsis.2 Rates of positive blood cultures (showing growth of microorganisms) in patients with different types of sepsis vary greatly depending on the severity of the disease.3-5 Another marked limitation of conventional blood culture is the time to diagnosis, as positive results are not obtained until the organisms have grown. Subsequently, identification and data testing usually take at least 48 to 72 hours from the time the sample is obtained. In these circumstances, changes in empirical antibiotic therapy are more frequently guided by clinical response than by culture results. Furthermore, the sensitivity of blood culture is greatly reduced when samples are obtained after antimicrobial therapy has started.6,7

Molecular methods allow rapid detection of the microorganisms involved in severe infections, leading to more efficient and more accurately targeted early therapeutic interventions, which could mean major clinical benefits for patients.4 The LightCycler SeptiFast Test (SeptiFast, Roche Diagnostics) is a multipathogen probe-based real-time polymerase chain reaction (PCR) system targeting DNA sequences of bacteria and fungi in blood samples, and it is considered to be a potentially valuable complementary tool in the management of patients with suspected sepsis.9-11 However, the superiority of the SeptiFast system to blood culture for identifying pathogens in sepsis remains unclear. A recently published meta-analysis12 of 34 studies with a total of 6012 patients showed suboptimal sensitivity of SeptiFast. However, the subgroup with bacteremia was highly heterogeneous, suggesting the need for further studies.

We hypothesize that SeptiFast’s yield is comparable or superior to that of blood culture, and that SeptiFast may be a valuable adjunct to traditional methods for diagnosing bloodstream infections in critically ill patients. The purpose of this study, therefore, is to compare the diagnostic yield of both techniques in this population.

About the Authors
Borja Suberviola and Alvaro Castellanos-Ortega are intensivists and Alicia Márquez-López and Carlos Fernández-Mazarrasa are microbiologists at University Hospital Marqués de Valdecilla-IDIVAL, Santander, Spain. Miguel Santibañez is an assistant professor, Fundación Marqués de Valdecilla-IDIVAL, University of Cantabria, School of Nursing, Santander, Spain. Luis Martínez Martínez is a microbiologist at University Hospital Marqués de Valdecilla-IDIVAL and an assistant professor, Department of Molecular Biology, School of Medicine, University of Cantabria, Santander, Spain.

Corresponding author: Borja Suberviola, PhD, Intensive Care Department, University Hospital Marqués de Valdecilla-IDIVAL, Avenida de Valdecilla SN 39008, Santander, Spain (e-mail: bsuberviola@yahoo.es).

Patients and Methods

Study Population
We conducted a single-center prospective observational study between July 2011 and September 2012. The study was performed in a 30-bed medical-surgical intensive care unit (ICU) at Marqués de Valdecilla University Hospital in Santander, Spain. Patients aged 18 years or older were considered for enrollment if, at admission, they had a confirmed or suspected source of infection and met accepted definitions for severe sepsis and septic shock.13 Patients in cardiac arrest on arrival or who had a do-not-attempt-resuscitation order were excluded.

Clinical and demographic characteristics of all patients were recorded, including age, sex, comorbid conditions, immunosuppression, Acute Physiology and Chronic Health Evaluation II score at 24 hours,14 and Sequential Organ Failure Assessment score15 at admission. Organ dysfunctions were defined according to the 2001 International Sepsis Definitions Conference.13

An ethics committee approved the research protocol, and participants gave written informed consent.

Blood Collection, Sample Preparation, and Interpretation of Results
Blood samples were collected on admission to the ICU. A single venipuncture was used to inoculate aerobic/anaerobic bottles of Bactec Plus (Becton Dickinson) with 10 mL whole blood per bottle and sterile Vacuette EDTA K2E tubes (Greiner Bio-One) with 3 mL of whole blood for PCR testing.

At least 1 pair of bottles (aerobic/anaerobic) was inoculated per patient. Blood culture samples were processed in the clinical microbiology department. Bottles were briefly incubated in the Bactec FX 200 (Becton Dickinson) automated blood culture
system. Identification and preliminary antimicrobial agent susceptibility testing were performed by using the Vitek 2 system (using GN, GP, AST-P 626, AST-P 589, AST-243 and AST-245 test cards). Each blood culture was incubated for up to 7 days. Isolates of typical contaminants (including coagulase-negative staphylococci, Streptococcus spp, Propionibacterium spp, and Bacillus spp) were classified as such following predefined criteria and were excluded from the diagnostic yield assessment. Certain factors indicated a high likelihood of real infection: (1) both blood culture bottles in a set showed growth of the same microorganism, (2) the same microorganism was found in prior and subsequent blood cultures or other culture specimens (ie, urine, catheter, wound), and (3) growth of microorganisms occurred in less than 24 hours.

For PCR sample preparation, DNA was extracted from 1.5 mL of potassium ethylenediaminetetraacetic acid (K-EDTA) whole-blood samples. Mechanical lysis was performed by using the SeptiFast Lys Kit and the MagNALyser instrument (Roche Diagnostics). DNA was extracted using the MagNa pure Compact Nucleic Acid Isolation Kit and the MagNa pure instrument (Roche Diagnostics) according to the manufacturer’s instructions. Real-time detection of PCR products was performed by using the LightCycler 2.0 instrument (Roche Diagnostics). Full descriptions of the procedure, as well as the target microbial species of the SeptiFast test, have previously been reported.16

Each sample included an internal control. In order to amplify gram-positive bacteria, gram-negative bacteria, and fungi, a negative control and 3 different reagent controls were included in each identification series. The SeptiFast test was recorded as negative when the internal control was positive and no other signals were detected. SeptiFast samples with a negative internal control (as a sign of potential inhibition) were recorded in the study as negative results. PCR testing was performed retrospectively on specimens that had been stored at -20°C; therefore, the results of the SeptiFast test were not used to guide clinical treatment.

Statistical Methods

The McNemar test was used for testing differences between paired proportions. Isolated microorganisms were compared by using χ² tests. The Cohen κ index was estimated as a measure of concordance between blood culture at 6 and 72 hours and the SeptiFast test. Likewise, sensitivity and specificity of blood cultures were calculated by using the SeptiFast test as the reference standard. In addition, in order to estimate the incidence of positive results with the SeptiFast test in comparison with blood culture, relative risk and 95% CIs were calculated. The 95% CI of all the measurements was calculated by using the Wilson method. The level of statistical significance was set at .05, and all tests were 2-tailed. All analyses were performed with SPSS v21.0.

Results

During the study period, 127 patients were admitted to the medical-surgical ICU. Five patients refused participation, and of the remaining 122 patients, 119 (19 with severe sepsis and 100 with septic shock) met the study’s inclusion criteria, with samples for blood cultures and SeptiFast samples being obtained simultaneously.

The following pairs of bottles (aerobic/anaerobic) for blood culture were obtained per patient: 1 pair in 40 patients (33.6%), 2 pairs in 58 patients (48.7%), and 3 pairs in 21 patients (17.6%). No significant differences were observed between the rates of positive blood cultures, final outcome, or length of ICU or hospital stay with respect to the number of bottles obtained for blood culture.

The blood culture contamination rate was 3.4% (4/119), and the contamination rate for SeptiFast was 2.5% (3/119). After contaminants were excluded, the positivity rate using blood culture at 72 hours or more was 28.7% (33/115) and using SeptiFast was 46.6% (54/116). The characteristics of the study population according to SeptiFast and blood culture results are shown in Table 1.

Statistically significant differences were found between SeptiFast and blood culture isolates at both 6 hours and 72 hours (P<.001; Table 2). The probability (risk) of isolating at least 1 microorganism was 13 times higher when the SeptiFast test was used than when blood culture at 6 hours was used (relative risk, 13.5; 95% CI. 5.05-36.06; Table 3). Table 4 shows the concordance and indicators of diagnostic validity of blood culture at 6 hours and 72 hours, respectively, compared with the reference standard SeptiFast test. Concordance and sensitivity was low, above all at 6 hours (κ = 0.079; false-negative rate, 92.6%; 95% CI, 82.4-97.1).

Median time to the first signal of a positive blood culture (time to Gram stain) was 17 hours (interquartile range [IQR], 10-20 hours), and median time to final species identification was 144 hours (IQR, 72-228 hours). For the most frequent pathogens, Escherichia coli, Enterococcus faecalis, and Staphylococcus aureus, the median times to first positive blood culture signal were 17 hours (IQR, 18-20 hours), 12.5 hours (IQR, 11-14 hours), and 7 hours (IQR, 4-10 hours), respectively. The time to signal of positive blood culture was less than 6 hours in only 4 of 33 (12.1%) isolates from blood cultures.

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Table 1
Characteristics of the study population

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>All patients (N=119)</th>
<th>SeptiFast&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Blood cultures&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (SD), y</td>
<td>63.5 (12.8)</td>
<td>63.8 (13.2)</td>
<td>62.1 (12.5)</td>
</tr>
<tr>
<td>Sex (male)</td>
<td>75 (63)</td>
<td>31 (57)</td>
<td>42 (68)</td>
</tr>
<tr>
<td>Source of infection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peritonitis</td>
<td>49 (41)</td>
<td>25 (46)</td>
<td>25 (41)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>28 (23)</td>
<td>9 (17)</td>
<td>14 (23)</td>
</tr>
<tr>
<td>Urinary tract</td>
<td>24 (20)</td>
<td>15 (28)</td>
<td>11 (18)</td>
</tr>
<tr>
<td>Skin, soft tissues</td>
<td>10 (8)</td>
<td>3 (6)</td>
<td>6 (10)</td>
</tr>
<tr>
<td>Others</td>
<td>9 (8)</td>
<td>1 (2)</td>
<td>6 (10)</td>
</tr>
<tr>
<td>Comorbid conditions</td>
<td>76 (63)</td>
<td>36 (64)</td>
<td>39 (63)</td>
</tr>
<tr>
<td>Septic shock</td>
<td>100 (84)</td>
<td>48 (89)</td>
<td>49 (79)</td>
</tr>
<tr>
<td>Immunosuppression</td>
<td>35 (29)</td>
<td>16 (30)</td>
<td>19 (31)</td>
</tr>
<tr>
<td>No. of samples for blood culture, mean (SD)&lt;sup&gt;c&lt;/sup&gt;</td>
<td>3.6 (1.4)</td>
<td>3.7 (1.4)</td>
<td>3.6 (1.3)</td>
</tr>
<tr>
<td>Antibiotics before blood culture</td>
<td>54 (45)</td>
<td>34 (63)</td>
<td>44 (71)</td>
</tr>
<tr>
<td>Organ dysfunction, mean (SD)&lt;sup&gt;d&lt;/sup&gt;</td>
<td>2.9 (1.1)</td>
<td>3.2 (1.0)</td>
<td>2.7 (1.1)</td>
</tr>
<tr>
<td>APACHE II score, mean (SD)</td>
<td>20.3 (6.6)</td>
<td>22.1 (6.8)</td>
<td>18.8 (6.1)</td>
</tr>
<tr>
<td>SOFA score, mean (SD)</td>
<td>8.3 (2.7)</td>
<td>8.8 (3.1)</td>
<td>7.8 (2.3)</td>
</tr>
<tr>
<td>Need of mechanical ventilation</td>
<td>53 (44)</td>
<td>25 (46)</td>
<td>26 (42)</td>
</tr>
<tr>
<td>Acute respiratory distress syndrome</td>
<td>36 (30)</td>
<td>14 (26)</td>
<td>20 (32)</td>
</tr>
<tr>
<td>Continuous venovenous hemodiafiltration</td>
<td>15 (13)</td>
<td>9 (17)</td>
<td>6 (10)</td>
</tr>
<tr>
<td>Procalcitonin, mean (range), ng/mL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.3 (2.5-72.8)</td>
<td>30.1 (6.9-81.6)</td>
<td>11.9 (2.0-64.4)</td>
</tr>
<tr>
<td>C-reactive protein, mean (range), mg/dL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>16.6 (9.7-28.0)</td>
<td>16.2 (9.1-27.1)</td>
<td>16.8 (10.0-29.7)</td>
</tr>
<tr>
<td>Leukocyte count, mean (range), /µL&lt;sup&gt;a&lt;/sup&gt;</td>
<td>10 000 (3900-16 100)</td>
<td>9750 (3450-16 750)</td>
<td>10 000 (4700-16 100)</td>
</tr>
</tbody>
</table>

Abbreviations: APACHE, Acute Physiology and Chronic Health Evaluation; SOFA, Sequential Organ Failure Assessment.
SI conversion factor: To convert C-reactive protein to nanomoles per liter, multiply by 95.24.
<sup>a</sup> Numbers in table are number (percentage) of patients unless otherwise indicated in this column.
<sup>b</sup> After excluding contaminants.
<sup>c</sup> Number of blood bottles obtained.
<sup>d</sup> Number of organ dysfunctions based on the 2001 International Sepsis Definitions Conference.

Prior initiation of antibiotic treatment did not influence results obtained by using SeptiFast (<i>P</i> = .42), whereas with blood cultures, the risk of showing no growth of microorganisms was significantly associated with prior antibiotic consumption (relative risk, 1.91; 95% CI, 1.10-3.34; Table 1, Table 5). Thus, in patients who had already begun antibiotic treatment, the sensitivity of blood cultures was lower, and the false-negative rate was higher (Table 6).

A single microorganism was detected in all positive blood cultures that had no contaminants. However, SeptiFast detected polymicrobial infection in 9 cases (in 8 cases with 2 microorganisms and in 1 case with 3 microorganisms). The source of infection for these 9 patients was peritonitis (7 patients), urinary tract (1 patient), and soft tissue (1 patient). Three isolates were positive on blood culture and negative on SeptiFast test, all but 1 (<i Actinobaculum schaalii</i>) of which were included in the list of...
Table 2
Blood culture results after 6 hours and 72 hours, in relation to SeptiFast test

<table>
<thead>
<tr>
<th>Timing of blood culture</th>
<th>SeptiFast Negative</th>
<th>SeptiFast Positive</th>
<th>Contaminant</th>
<th>Total</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>62</td>
<td>50</td>
<td>3</td>
<td>115</td>
<td>&lt;.001a</td>
</tr>
<tr>
<td>Positive</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>54</td>
<td>3</td>
<td>119</td>
<td></td>
</tr>
<tr>
<td>72 hours</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>55</td>
<td>25</td>
<td>2</td>
<td>82</td>
<td>&lt;.001a</td>
</tr>
<tr>
<td>Positive</td>
<td>3</td>
<td>29</td>
<td>1</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Contaminant</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>54</td>
<td>4</td>
<td>119</td>
<td></td>
</tr>
</tbody>
</table>

*P value according to McNemar test when contaminants excluded.

Table 3
Probability (risk) of a positive result in SeptiFast test compared with blood culture at 6 hours and 72 hours

<table>
<thead>
<tr>
<th>At least 1 microorganism isolated</th>
<th>Yes</th>
<th>No</th>
<th>Totala</th>
<th>Relative risk</th>
<th>95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood culture (6 h)</td>
<td>4</td>
<td>112</td>
<td>116</td>
<td>1</td>
<td>5.05-36.06</td>
</tr>
<tr>
<td>SeptiFast test</td>
<td>54</td>
<td>62</td>
<td>116</td>
<td>13.5</td>
<td></td>
</tr>
<tr>
<td>Blood culture (72 h)</td>
<td>32</td>
<td>80</td>
<td>112</td>
<td>1</td>
<td>1.19-2.39</td>
</tr>
<tr>
<td>SeptiFast test</td>
<td>54</td>
<td>58</td>
<td>112</td>
<td>1.69</td>
<td></td>
</tr>
</tbody>
</table>

*a Contaminants have been excluded.

Discussion

In this study, the yield of the SeptiFast test was superior to that of blood culture: with SeptiFast, more pathogens were isolated, more potentially resistant pathogens were detected, diagnosis was speedier, and results were less influenced by antibiotic use.

The percentage of blood cultures that show growth in patients with sepsis varies widely across studies.17,18 Although the likelihood of a culture that shows growth of microorganisms increases in proportion to the severity of the infection, blood cultures that show growth are obtained from only around 40% of patients with severe sepsis or septic shock.17,19 According to previous studies, the use of PCR diagnostic techniques such as SeptiFast could help increase this percentage significantly.10,11,20,21

In this study, we observed that blood cultures that showed growth were obtained in only 28.6% of the evaluated patients, which is largely consistent with the findings reported for other studies.18 In comparison with SeptiFast, blood culture showed moderate sensitivity at 72 hours (53.7%); however, this sensitivity is higher than that observed in similar studies.22 When complementing blood culture with 1 PCR test per episode, the number of clinically relevant positive microbiological findings was twice as high as the number for blood culture alone. Furthermore, more than half of the remaining microorganisms identified with SeptiFast (but not isolated after blood culture) were also found in routine culture samples taken from the presumed sites of infection. In other studies, the results obtained using SeptiFast were quite varied. In some of these studies, the SeptiFast assay was found to be clearly superior,9,11,21,22 whereas in other studies, both methods displayed either similar sensitivities or the SeptiFast assay compared unfavorably with respect to blood culture.12,23-25 Differences between studies in terms of patients’ characteristics, the spectrum of microorganisms that the SeptiFast assay can detect. In 25 cases, the SeptiFast test was positive and the blood culture was negative. In 8 cases, these isolates were consistent with results obtained in the same patients from clinical samples other than blood culture, and in 6 cases they were nonconcordant (a positive result for another pathogen was obtained). In the remaining cases (n = 11), culture results were negative. Among these pathogens identified solely by SeptiFast assay, several potentially multiresistant pathogens, including Acinetobacter baumannii, Aspergillus fumigatus, Candida albicans, and Pseudomonas aeruginosa were isolated. The SeptiFast assay isolated a significantly higher rate of Escherichia coli and Klebsiella pneumoniae/oxytoca.
of microorganisms detected, the number of blood culture sets collected, the volume of blood collected for culture, and the presence or absence of ongoing antibiotic therapy at the time of sampling may account for these discrepancies.

Inappropriate antimicrobial treatment or delays in starting appropriate treatment are both associated with increased morbidity and mortality in sepsis, particularly in severe cases. In septic shock, inadequate antimicrobial therapy is associated with mortality rates approaching 40%. In this study, sample processing and analysis time using the PCR method was quicker than with traditional blood culture. PCR samples were not processed in real time except in 15-patient batches. Considering this, and bearing in mind that the SeptiFast results could have been available at 6 hours, only 4 of the 33 cases of bacteremia (12%) would have been detected in that period of time with blood cultures, and SeptiFast would have provided useful information in the remaining cases. Furthermore, if SeptiFast had been performed on a once-daily basis, the median time saved from time of sample to microbiological pathogen identification would have been 11 hours (IQR, 4-14 hours) compared with blood cultures. In this study, as is the case in most studies to date, the SeptiFast samples were processed in batches in order to minimize the costs associated with the technique. However, similar studies carried out in real time support our findings. SeptiFast detects the microorganism responsible for bloodstream infections significantly earlier than blood cultures in different clinical settings, and its use has yielded a significant increase in gained treatment days. Increased costs derived from performing the test in real time could be recouped, as SeptiFast would improve the quality of patients’ treatment, reducing the number of resources needed for longer ICU and hospital stays, and the costs of antibiotic treatment.

Despite the recommendations from the Surviving Sepsis Campaign about obtaining blood samples for culture before starting treatment with broad-spectrum antibiotics, many clinicians still postpone bacteriological diagnostic tests. Consequently, between 50% and 70% of patients in septic shock receive antibiotics before blood samples are collected for culture. Antibiotic treatment before sampling reduces the effectiveness of blood cultures.

The advantage of a DNA-based detection system is that the microorganism causing sepsis does not have to be live at the time of sampling. In our research, detection of pathogens by SeptiFast was not affected by start of antibiotic treatment before sampling. In contrast, in the case of blood culture, antibiotic administration reduced the probability of pathogen isolation by half. This finding is consistent with results reported by other researchers and supports the usefulness of SeptiFast in cases where antibiotic therapy has already been started and shows its advantages over blood cultures.

Another reason to consider use of SeptiFast is the detection of potentially multiresistant organisms. These pathogens are not always correctly treated by using initial empirical antibiotic therapy and are an important cause of treatment failure and increased mortality in patients with sepsis. In particular, the detection of yeast and filamentous fungi in blood is

### Table 5

<table>
<thead>
<tr>
<th>Test</th>
<th>Previous antibiotic consumption</th>
<th>Relative risk</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood culture (72 hours)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Yes</td>
<td>60</td>
<td>22</td>
</tr>
<tr>
<td>Positive</td>
<td></td>
<td>17</td>
<td>16</td>
</tr>
<tr>
<td>SeptiFast</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative</td>
<td>Yes</td>
<td>44</td>
<td>18</td>
</tr>
<tr>
<td>Positive</td>
<td></td>
<td>34</td>
<td>20</td>
</tr>
</tbody>
</table>

* At least 1 microorganism isolated. Contaminants have been excluded.

### Table 6

<table>
<thead>
<tr>
<th>Antibiotic consumption</th>
<th>Value, mean (95% CI), %</th>
<th>K^a^</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sensitivity</td>
<td>False negatives</td>
</tr>
<tr>
<td>No</td>
<td>0.465</td>
<td>65.0 (43.3-81.9)</td>
</tr>
<tr>
<td>Yes</td>
<td>0.493</td>
<td>47.1 (31.5-63.3)</td>
</tr>
</tbody>
</table>

* Kappa when contaminants excluded.
limited because of their specific capacity for growth. In our research in DNA-based detection systems, we found genetic material from *P. aeruginosa*, *A. baumannii*, and *A. fumigatus* in patients with blood cultures that showed no growth. This finding does not seem to depend on the characteristics of the patients, as it has also been reported in other studies focused on immunosuppressed patients, transplant recipients, and patients with sepsis. 

SeptiFast has some disadvantages, including false-negatives and problems derived from the technique itself. In 3 cases (2.5%) in our study, microorganisms that theoretically should have been found by using SeptiFast were identified by blood cultures. This false-negative rate is relatively low, as the percentage is usually around 4% or 5% in tests performed in batches. In our case, the absence of leukocytosis in the aforementioned range suggests that the low false-negative rate is due to low-level bacteremia. Furthermore, DNA was not amplified in 15% of episodes, which is consistent with findings from other studies. This lack of amplification was more likely due to either inhibition of the PCR reaction or inappropriate preparation of the sample. This study has some limitations: it was a single-center observational study that included a high proportion of abdominal infections, a factor that limits the generalizability of the findings. However, on the whole, the results are consistent with those reported by other investigators, suggesting that these findings may be extrapolated to other populations. Finally, the variability of the number of blood culture sets collected and the high rate of patients with only 2 bottles of blood samples for culture obtained could have influenced the sensitivity of the technique. Nevertheless, no significant differences were observed between rates of blood cultures that showed growth, final outcome or length of ICU/hospital stay, and the number of bottles collected for blood culture. Results of several studies indicate that assaying larger volumes of blood increases the likelihood of detection of bacteremia, and based on these results, international guidelines for management of sepsis recommend that 2 or more blood samples be collected for culture. However, it is well known that in clinical practice these recommendations are often not strictly followed. Our study probably reflects this imperfect real-life clinical scenario.

Conclusions

The SeptiFast test provided quicker microbiological diagnosis of bloodstream infections and identified a significantly higher rate of microorganisms than did blood cultures in patients with severe sepsis or septic shock. This difference was particularly apparent in cases in which antibiotic therapy had already been started at the time of sampling and in the case of infections due to resistant bacteria and yeast.

FINANCIAL DISCLOSURES

This work was supported by Instituto de Investigación-IDIVAL (Santander, Spain) and Roche Diagnostics (Mannheim, Germany; research funding, reagents, and equipment).

References


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; e-mail, reprints@aacn.org.
During the past year, studies were published that will lead to practice change, address challenges at the bedside, and introduce new care strategies. This article summarizes some of this important work and considers it in the context of previous research and practice. Examples of research-based practice changes include the performance and assessment of septic shock resuscitation, and the integration of tourniquets and massive transfusions in civilian trauma. Care challenges addressed include ethical considerations in light of the Ebola epidemic, infection prevention associated with chlorhexidine bathing, bedside alarm management, evidence to enhance moral courage, and interventions to mitigate thirst in critically ill patients. Research that portends future care includes a discussion of fecal microbiota transplant for patients with refractory infection with Clostridium difficile. (American Journal of Critical Care. 2016;26:76-84)
In the past year, research studies were published that will lead to practice change, address challenges at the bedside, and introduce new care strategies. This article summarizes some of this important work and considers it in the context of previous research and practice. Examples of research-based practice changes include the performance and assessment of septic shock resuscitation and the integration of tourniquets and massive transfusions in civilian trauma. Care challenges addressed include ethical considerations in light of the Ebola epidemic, infection prevention associated with chlorhexidine bathing, bedside alarm management, enhancement of moral courage, and the mitigation of thirst in critically ill patients. Research that portends future care includes fecal microbiota transplant for patients with refractory infection with *Clostridium difficile*.

**Alarm Safety and Alarm Fatigue**

In 2013, The Joint Commission announced a National Patient Safety Goal on Alarm Management. The 2014 elements of performance of this safety goal included establishing alarm system safety as a hospital priority and identifying the most important alarm signals to manage. Beginning in January 2016, two additional performance elements will be implemented: (1) the establishment of policies and procedures specific to the alarms identified, including specific policies on which alarms can be disabled or turned off and who can change alarm parameters, and (2) the education of staff and licensed independent providers on alarm system operation.

Currently the AACN practice alert on alarm management cites primarily level E evidence (theory-based evidence from expert opinion or multiple case reports) related to alarm management. Several important studies on alarm management were recently published. In 2014, Funk et al reported on a study comparing differences in nurses’ perceptions of alarms in 2006 and 2011. A major finding was that in both time periods nurses identified the frequency of false alarms as the most important factor. In 2015, Honan et al published a secondary analysis of comments from nurses on the 2011 survey. The analysis identified 6 major themes: (1) dissonance and desensitization, with respondents referring to a “cry wolf” situation where the nurse no longer trusts the alarm; (2) pollution, panic, and pathology, which reflects the effect of the noise on the patient; (3) calling for accountability at all levels of the profession, from personal to organizational accountability; (4) calling for authority of nurses; (5) clinical alarm management is crucial but not a panacea, and (6) hope for the future. These studies reflect the long-standing importance of alarm management to nurses and their call for action.

A study published in October 2014 by Drew et al strengthens the level of evidence available to inform tailoring of alarms. In this observational study, all alarms and alarm settings from an electrocardiography (ECG) system and additional monitors (eg, arterial blood pressure, pulse oximeter) were collected from 461 patients in 31 days. During this month, there were 2,556,760 unique alarms, with 381,560 audible alarms, which translates into 187 audible alarms per bed per day.

The most common alarms were arrhythmia alarms (premature ventricular contractions and atrial fibrillation), followed by technical alarms (artifact, lead failure) and vital sign parameter alarms (eg, too high or too low). An important aspect of this study was determining which alarms were treatable according to practice guidelines. For example, according to the 2006 American Heart Association guidelines for ventricular arrhythmias, the investigators characterized accelerated ventricular rhythms as not “actionable” (eg, no antiarrhythmic therapy required); thus this alarm was changed from audible to visual only. What is important about this study is that in addition to describing the alarm burden, it demonstrates how to make decisions about tailoring specific alarms.

**About the Authors**

Elizabeth Bridges is a clinical nurse researcher and associate professor at the University of Washington Medical Center/School of Nursing, Seattle, Washington. Margaret McNeill is a clinical nurse specialist, peri-anesthesia, Department of Professional and Clinical Development, Frederick Regional Health System, Frederick, Maryland. Nancy Munro is senior acute care nurse practitioner, Critical Care Medicine Department, National Institutes of Health, Bethesda, Maryland.

**Corresponding author:** Elizabeth Bridges, RN, PhD, CCNS, FCCM, FAAN, Clinical Nurse Researcher/Associate Professor, University of Washington Medical Center/School of Nursing, 1959 NE Pacific, Box 357266, Seattle WA 98195 (e-mail: ebridges@u.washington.edu).
Alarm safety strategies include alarm tailoring, discussion of safety concerns, and outlining organizational initiatives. Systematically on the basis of practice guidelines, and it identifies strategies for addressing technical alarms. Several recent papers have also summarized systematic performance improvement initiatives to tailor and decrease alarms. \(^{4,9}\) These papers are important as they all report similar strategies to inform alarm tailoring, in addition to discussing safety concerns related to alarm management and outlining organization level initiatives to address this safety goal.

Another priority area for critical care is infection prevention. Disposable ECG lead wires have been found to decrease ECG wire contamination,\(^{10}\) but this reduced contamination was not associated with a reduction in infections.\(^{11}\) Despite these equivocal results, disposable ECG lead wires have been recommended as infection prevention measures.\(^{12}\) A potential consequence of using disposable lead wires is related to alarms.

In a 2015 study, Albert et al\(^{13}\) examined the differences in alarm events between disposable and reusable ECG lead wires. This randomized controlled trial (RCT), which involved 1611 patients, asked 2 questions: First, is one type of ECG lead wire non-inferior (eg, disposable leads are noninferior [not much worse] than the reusable leads), and if the disposable leads are noninferior, are they superior? Results (Table 1) indicated that disposable lead wires were both noninferior and superior to reusable lead wires for alarms related to "no telemetry," "leads off," and "lead fail." The disposable leads were also non-inferior (but not superior) for artifact monitoring alarms, and all false alarms, but there were no differences between the lead types for false crisis or true crisis alarms. This study is important as the decision to use disposable versus reusable ECG lead wires must be based on evidence related to both infection prevention and alarm management. A decrease in alarms will maintain patient safety, while decreasing overall alarm rates and alarm fatigue.

### Chlorhexidine Bathing

In January 2015, in a single-center study, Noto et al\(^{14}\) found no significant decrease in a composite infection measure (central catheter–associated blood-stream infections [CLABSI], catheter-associated urinary tract infections [CAUTI], ventilator-associated pneumonia [VAP], and Clostridium difficile infection [CDI]) in patients who received 2% chlorhexidine baths (2.86 infections/1000 patient days) versus baths using nonantimicrobial cloths (2.9 infections/1000 patient days). Additionally there was no difference in hospital-acquired bloodstream infections (5.4 vs 5.4/1000 patient days), multidrug resistant organisms (MDROs, 4.84 vs 5.41/1000 patient days), or blood culture contamination (4.84 vs 5.45/1000 patient days). Specific infection rates, including CAUTI, CLABSI, and CDI, did not differ significantly between the 2 groups. The conclusion of the study was that the use of 2% chlorhexidine bathing was not supported. However, these results are in contrast to results of a multicenter study by Climo et al\(^{15}\) where infections rates in the 2% chlorhexidine group were significantly lower than in the nonantimicrobial washcloth group for MDROs (5.1 vs 6.6 cases/1000 patient days, \(P = .03\)), hospital-acquired bloodstream infections (4.8 vs 6.6/1000 patient days, \(P = .007\)), and CLABSI (1.5 vs 3.3/1000 catheter days, \(P = .004\)).

Similarly, in another intensive care unit (ICU) study, there was a 2-fold (1.3-2.5) increase in odds of hospital-acquired infections in ICU patients bathed with soap and water versus 2% chlorhexidine cloths,\(^{16}\) and in pre-post studies, chlorhexidine bathing was associated with decreased transmission of methicillin-resistant *Staphylococcus aureus* (MRSA) infection (4.01 to 1.33 cases/1000 patient days)\(^{17}\) and MRSA acquisition (2.84 to 2.63 cases/1000 patient days) in ICU patients\(^{18}\) and CLABSI in trauma patients (12.1/1000 central catheter day to 3.2/1000 central catheter day).\(^{19}\)

Several factors must be considered when interpreting these contradictory results. For example, in the study by Noto et al,\(^{14}\) the CLABSI infection rates were very low in both the experimental and control groups (0.19 vs 0.21/1000 patient days) in contrast to the studies such as the one by Climo et al,\(^{15}\) where CLABSI rates were higher (1.5 vs 3.3/1000 catheter days). Thus, the decision to use chlorhexidine bathing must include knowledge of local infection rates. Consideration should also be given to the types of infections that may be more susceptible to the effects of chlorhexidine (eg, CLABSI, MRSA, and skin contamination), in contrast to VAP or CAUTI, for which there is less evidence.\(^{20}\)

### Table 1

Alarms with disposable versus reusable electrocardiography lead wires

<table>
<thead>
<tr>
<th>Alarm criteria</th>
<th>Disposable wires were</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Noninferior</td>
</tr>
<tr>
<td>No telemetry leads fail, fall off</td>
<td>Yes</td>
</tr>
<tr>
<td>Monitoring</td>
<td>Yes</td>
</tr>
<tr>
<td>False crisis</td>
<td>No</td>
</tr>
<tr>
<td>All false</td>
<td>Yes</td>
</tr>
<tr>
<td>True crisis</td>
<td>No</td>
</tr>
</tbody>
</table>

\(^{a}\) Based on information from Albert et al.\(^{13}\)
In terms of nursing clinical practice, researchers in a recent quality improvement project reported that although chlorhexidine bathing was the standard of care at a large academic medical center, the compliance was low (63%). A majority of the respondents (nurses and nurses aides) knew that chlorhexidine should be used versus soap and water; however, more respondents stated that soap and water bathing was very/extremely important compared with chlorhexidine bathing (85% vs 63%, \( \kappa = 0.27 \)). These results, and the potential benefit of chlorhexidine bathing in appropriate populations of patients, leads to the question, should bed baths be considered a comfort measure or therapy? If chlorhexidine bathing is a therapy, what are the required practice changes, including system changes to support bathing, education on the importance of chlorhexidine bathing as a therapy, and how to correctly perform a chlorhexidine bath.

**Compassion Fatigue and Satisfaction**

In July 2015, the editors of the *American Journal of Critical Care* discussed moral distress and moral courage. There is a link between moral distress and burnout, and moral distress leaves clinicians with feelings of anger, fear, confusion, and powerlessness. Moral courage, which is the partner to moral distress, can be exercised and strengthened with cognitive strategies.

Recently several authors have studied the related topics of futile treatment, ethical situations leading to conflict, and compassion fatigue and compassion satisfaction. In their study on perceptions of nurses and physicians of futile care, Neville et al found that agreement between the professions was low and providing futile treatment to patients is related to moral distress in nurses. Pavlish et al evaluated an ethics screening and early intervention tool as a proactive approach to ethical conflicts, which may alleviate moral distress. One finding was that nurses who witnessed patients’ suffering and deterioration were likely to initiate the screening process. Early indicators of ethical conflicts included signs of patient’s suffering, unrealistic expectations, and the provider’s own moral distress.

Hinderer et al described the relationship between burnout and compassion fatigue and secondary traumatic stress in 128 trauma nurses. Among these nurses, burnout was found in 35.9%, compassion fatigue in 27.3%, and secondary traumatic stress in 7%. Compassion fatigue was seen more often in nurses who worked more hours per shift (8 versus 12 hours). Compassion satisfaction was higher in nurses with lower secondary traumatic stress. Interestingly, researchers in this study found that 78.9% of the sample had above average compassion satisfaction. Strategies related to positive compassion satisfaction scores included the use of exercise and meditation. Stronger support systems and positive coworker relationships were also reported for those individuals with higher compassion satisfaction scores. Sacco et al used the same tool to measure compassion fatigue, compassion satisfaction, secondary traumatic stress, and burnout in critical care nurses, in addition to focusing on organizational characteristics. There were higher levels of burnout and secondary traumatic stress among nurses who experienced a recent change in management or major system/practice change, or worked on a unit with mixed-acuity (eg, ICU/progressive care and general care) compared to single-acuity (eg, ICU only). Future research should focus on interventions to support compassion satisfaction, moral courage, ethical conflict resolution, and interdisciplinary approaches to futile care, as elements of a healthy work environment.

**Ebola and the Ethics of Research**

The devastating Ebola virus disease (EVD) epidemic in West Africa has presented a scientific “emergency.” Efficient supportive care with aggressive fluid and electrolyte resuscitation has been shown to decrease EVD mortality from approximately 90% to 31%, but treatments and vaccines are urgently needed. How can these goals be achieved safely and effectively?

Discussion regarding the best research model continues. Although RCTs are considered the “gold standard,” they require a large sample size and randomized placebo control groups, which may prolong the research process in the face of lethal EVD progression. Other researchers maintain that “alternative” trial designs including monitored emergency use of unregistered and experimental interventions, and other trial designs, such as randomized selection or adaptive trials are more useful. Many publications have argued for either perspective, but the relevant question remains, Will the treatment or vaccine add to supportive care?

History can serve as a valuable resource in this situation. Experience with the AIDS epidemic can provide valuable lessons. The AIDS trials demonstrated that the first trials did not deliver the ultimate answer, but that a series of trials whose design was influenced by evidence from previous trials led to safe and effective treatments. Community advocates who were knowledgeable about the scientific process also helped educate trial designers during
the AIDS epidemic. With the potential EVD epidemic of a similar proportion, all perspectives must be considered. Another ethical question regarding EVD that received much media attention was the case of Kaci Hickox, the nurse who defied quarantine in New Jersey and Maine. Her perseverance ultimately caused Maine to reexamine their policy and conform to the recommendations of the Centers of Disease Control and Prevention. This case may provide a framework for health care workers who experience the pain of public fear.

Fecal Microbiota Transplant

The microbiota, or the community of microorganisms, in the human gastrointestinal tract is playing a more prominent role in health care. The use of fecal microbiota transplant (FMT) as an intervention for recurrent or relapsing _Clostridium difficile_ infection (CDI) has become more common, as summarized in a 2010 consensus statement. The FMT process infuses fecal material from a pathogen-free healthy donor to repopulate the gut microbiota of an individual with dysbiosis (alteration in normal microbiota). The fecal material is emulsified in a blender, usually with normal saline, and is infused either into the upper or lower gastrointestinal tract by using a nasogastric tube, endoscopic methods, or a rectal tube. Recommended screening of donors includes a questionnaire similar to the one used to screen blood donors. If eligible, the donor stool will be tested for viruses, bacteria, and parasites using serologic and molecular testing. Short-term side effects include diarrhea, abdominal pain, and bloating, but long-term side effects have not been described.

Only 1 RCT has been done to study the duodenal infusion of donor feces for recurrent CDI. Researchers in that study reported an 81% resolution of recurrent CDI in the patients treated, which triggered the safety board to terminate the study early. However, the sample size was very small (41 patients completed the protocol), which could mean that serious adverse events could still occur in 1 in 6 patients. The study design incorporated vancomycin dosing as well as FMT, which could also have affected the study results. Multiple variables, including method of infusion and donor screening processes, need further evaluation, and monitoring for long-term side effects was not mentioned. Unique to the interpretation of this study is the perception by the public that FMT is a “natural cure,” which could appeal to desperate patients with CDI. Social media provides a “do-it-yourself” method of FMT, which could influence future patient outcomes. Caution should be used when extrapolating these limited results into practice.

Massive Transfusions and Blood Product Ratios

The ratio of 1:1:1 for units of plasma to platelets to red blood cells, coined by military trauma experts as “damage control resuscitation,” is included in a Department of Defense Clinical Practice Guideline on massive transfusions that was first published in 2004. Since 2004, several studies have been done to evaluate the outcomes related to different massive transfusion practices, with mixed results. Many of the studies had methodological issues given the nature of trauma research, especially in a war zone. Thus, clinicians do not have definitive guidance on the correct ratio or safety of massive transfusions. In February 2015, the results of the Pragmatic Randomized Optimal Platelet and Plasma Ratios (PROPPR) clinical trial were published. The PROPPR trial was the first large multisite study in which blood product ratios in massive transfusion protocols for treatment of the severely injured were examined prospectively. Mortality at 24 hours or 30 days and safety issues did not differ significantly between patients receiving plasma, platelets, and red blood cells in a 1:1:1 ratio compared with a 1:1:2 ratio. However, hemostasis was higher and death due to exsanguination by 24 hours was lower in the patients in the 1:1:1 group. This study supports the practice of 1:1:1 blood product ratios in the initial resuscitation of patients requiring a massive transfusion.

Sepsis/Septic Shock

In the past 18 months, 3 randomized controlled trials of early goal-directed therapy (EGDT) for severe sepsis and septic shock were published. No significant 90-day mortality benefit from EGDT compared with nonprotocolized care was found in any of the studies. In a subsequent meta-analysis, primary mortality, 90-day mortality, and ICU length of stay did not differ significantly between the EGDT group and the control group. Based on these results, the 6-hour bundle in the Surviving Sepsis Guidelines was revised. One component of the 6-hour bundle is the requirement for reassessment of volume status and perfusion. One reassessment option includes vital signs and cardiopulmonary and capillary refill test (CRT) and pulse and skin findings. Although this practice change is required, no description of how to specifically perform or interpret the components of this assessment bundle is...
Thirst

The 5 most common symptoms experienced by critically ill patients are pain, anxiety, dyspnea, thirst, and poor sleep quality. Among these symptoms, pain, dyspnea, and thirst are the most prevalent, intense, and distressing for ICU patients.60 In a study of 206 ventilator patients, thirst was 1 of the 3 most frequently remembered ICU experiences.61 One patient noted “My mouth was like a desert; I was so thirsty... it was the only thing in my mind, it was the most unpleasant thing of all that I remember of my stay.”61(p78) In both patients receiving mechanical ventilation and ICU patients at risk of dying, 70% reported thirst,62,63 and in 36 chronically critically ill patients with a tracheostomy, 80% reported moderate to severe thirst.64 The incidence and severity of thirst in ICU patients identifies an area requiring evidence-based solutions, as indicated by a 2015 publication that identified thirst as one of the symptoms that should be routinely assessed in critically ill patients.65

Two excellent review papers have recently been published on the multidimensional concept of thirst.66,67 In a 2015 study by Stotts et al,68 predictors of the presence, intensity, and distress of thirst in 353 ICU patients were described. Among these patients, the presence of thirst was higher for patients receiving opioids (≥ 50 mg opioid equivalents in 24 hours), furosemide (> 60 mg), and selective serotonin reuptake inhibitors. Thirst intensity was highest in patients who were not taking anything by mouth or who had a gastrointestinal diagnosis. Finally, predictors of thirst distress included mechanical ventilation, a negative fluid balance, antihypertensive medications, and a gastrointestinal diagnosis. Of note, only 17 patients were being treated with mechanical ventilation; thus additional research is needed in this population. The article by Stotts et al68 is important because it delineates some of the factors that may aid in the identification of patients at increased risk for thirst.

Despite the frequency, intensity, and distress associated with thirst, research on interventions to mitigate thirst is limited. Puntillo et al69 completed an RCT of an intervention to decrease thirst intensity and distress. This study used standardized 1 to 10 scales to assess thirst intensity (“How intense is your thirst?”; 0 = no thirst to 10 = worst possible thirst) and thirst distress (“How distressing [or bothersome] is your thirst?”; 0 = no distress

---

**Table 2** Lower extremity mottling score**a**

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No mottling</td>
</tr>
<tr>
<td>1</td>
<td>Modest mottling area (coin size) localized to center of knee</td>
</tr>
<tr>
<td>2</td>
<td>Moderate mottling area that does not exceed superior edge of kneecap</td>
</tr>
<tr>
<td>3</td>
<td>Mild mottling area that does not exceed middle thigh</td>
</tr>
<tr>
<td>4</td>
<td>Severe mottling area that does not exceed fold of groin</td>
</tr>
<tr>
<td>5</td>
<td>Extremely severe mottling area that exceeds fold of groin</td>
</tr>
</tbody>
</table>

**a Based on information from Ait-Oufella et al.53,55**
to 10 = very distressing). The oral care intervention included moistened oral swabs, and spraying the mouth with previously frozen sterile water. The procedure was repeated 3 times in 15 minutes followed by an application of lip balm. Compared with the 125 patients in the control group, the 127 patients in the intervention group had significantly lower thirst intensity and distress and were less likely to report a dry mouth. This study is important because it introduces a relatively simple intervention to decrease the intensity and distress associated with thirst. The study was limited by the small number of intubated patients. Further research is also needed on the frequency or dosing of this intervention, whether this intervention can be safely performed in patients unable to communicate or protect their airway, and if family members could assist with this comfort measure.

Tourniquets in Trauma

In recent years, the use of tourniquets has mounted a negative reputation, given the demonstrated lifesaving role of tourniquets in extremity injuries in Iraq and Afghanistan. Recent civilian mass casualty events, with war-like mechanisms of injury, have resulted in the consideration of tourniquet use for traumatic hemorrhage management in the civilian community. The Hartford Consensus, which created a “National Policy to Enhance Survivability from Intentional Mass-Casualty and Active Shooter Events,” advocated for the use of tourniquets and other bleeding control measures to save lives in such civilian events. The Hartford Consensus proposed the colocation of automatic external defibrillator and bleeding control bags, which include tourniquets to treat hemorrhage. In 2015, the largest analysis of civilian prehospital tourniquet use was published by Schroll et al. In this analysis, tourniquet use in 197 civilian patients was analyzed, with overall mortality and limb amputation rates significantly lower than seen in a 2009 analysis of tourniquet use in military casualties. In 2 smaller studies, which included 56 and 87 patients, respectively, researchers reported that tourniquets were effective for hemorrhage control in the civilian prehospital setting and that they had a low complication rate. These results demonstrate the safety and effectiveness of tourniquets for use in civilian trauma and support the public health initiative recommended by the Hartford Commission. Although tourniquets were used extensively for casualties of the Boston marathon bombing, a review revealed that all 27 of the tourniquets used were improvised, rather than commercially developed and purpose-designed tourniquets, which suggests an area for practice improvement. In response to this review, Kue et al pointed out that Boston Emergency Medical Service (EMS) has long used the rubber tubing/Kelly clamp tourniquet system introduced as a result of experiences in Vietnam, and it is likely that some of the patients had this type of tourniquet, which was skillfully applied by EMS personnel. However, improvised tourniquets have been reported to be ineffective in military casualties, and the article by King et al calls for adoption of well-designed tourniquets. Although there is disagreement about what conclusions can be drawn from an analysis of the prehospital care, and the exact requirements for tourniquets, there is agreement on the civilian adoption of military methods for controlling extremity bleeding.

FINANCIAL DISCLOSURES
None reported.

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50. Supple L. Chlorhexidine only works if applied correctly: use of a simple colorimetric assay to provide monitoring and feedback on effectiveness of chlorhexidine application. Infect Control Hosp Epidemiol. 2015;36(10):1283-1286.


CRITICAL ILLNESS–INDUCED IMMUNE SUPPRESSION: CURRENT STATE OF THE SCIENCE

By Kristin C. Greathouse, MS, CPNP-AC, and Mark W. Hall, MD

Abstract
Critical illness comprises a heterogeneous group of serious medical conditions that typically involve an initial proinflammatory process. A compensatory anti-inflammatory response may occur that, if severe and persistent, places the patient at high risk for adverse outcomes including secondary infection and death. Monitoring strategies can identify these patients through measurement of innate and adaptive immune function. Reductions in monocyte HLA-DR expression, reduced cytokine production capacity, increased inhibitory cell surface molecule expression, and lymphopenia have all been associated with this immune-suppressed state. Intriguing data suggest that critical illness–induced immune suppression may be reversible with agents such as interferon-γ, granulocyte macrophage colony-stimulating factor, interleukin 7, or anti–programmed death-1 therapy. Future approaches for characterization of patient-specific immune derangements and individualized treatment could revolutionize how we recognize and prevent complications in critically ill patients. (American Journal of Critical Care. 2016;25:85-92)

The immune system plays a major role in the acute phase of critical illness, as well as late manifestations that result in morbidity and mortality. It comprises a complex network of barriers, cells, and mediators that are activated upon injury or cellular stress and functions to detect and destroy pathogens. Once activated, several cellular and molecular events ensue that involve the innate and adaptive immune systems. These systems have separate functions, yet are intricately interconnected. Innate immune cells respond rapidly and serve to identify broad classes of pathogens, ingest and kill them, and digest them into antigenic peptides for display on antigen-presenting molecules. In addition, innate immune cells produce cytokines and chemokines to make the local environment favorable for fighting infection and to recruit other immune cells to the area. These cells include neutrophils, dendritic cells, natural killer (NK) cells, monocytes, and macrophages.

The adaptive immune response is generated by lymphocytes, including T cells, which are responsible for cytokine production and cytotoxic activity, and B cells, which are responsible for antibody production. These cells have highly antigen-specific receptors and typically require presentation of that antigen by a member of the innate immune system in order to become activated. Lymphocytes can persist for life, providing immunologic memory and the capacity for rapid response in the event of reexposure to the same pathogen. The first response of a naïve lymphocyte to a pathogen, however, can take days to manifest fully. Accordingly, the initial immunologic response to critical illness is often mediated by the innate immune system with the adaptive response most likely being more prevalent in the subacute phase of illness.

Many diagnoses that require intensive care unit (ICU) support involve an acute injury that results in.
Critical illness–induced immune suppression is most likely a multifactoral process.

an overwhelming systemic inflammatory response syndrome (SIRS). This syndrome is characterized by the release of proinflammatory mediators into the systemic circulation and manifests clinically as the classic symptoms of fever, vasodilation, tachypnea, and tachycardia. Indeed, high levels of proinflammatory mediators such as interleukin (IL)-6 and IL-8 have long been associated with increased risks for adverse outcomes from adult and pediatric critical illness.1-3

The compensatory anti-inflammatory response syndrome (CARS) has evolved to serve as a counter-regulatory mechanism in the face of systemic inflammation. This syndrome involves the elaboration of anti-inflammatory mediators such as IL-10, which serves to down-regulate the proinflammatory response and inhibit leukocyte function. If the CARS state is severe and persistent, it represents a form of secondary immune deficiency that can profoundly affect both innate and adaptive immune function (Figure 1).

Critical illness–induced immune suppression has been demonstrated in children and adults with a variety of diagnoses, including trauma,4,5 sepsis,6-8 pancreatitis,9,10 severe viral infections,11,12 and following cardiopulmonary bypass.13,14 The clinical consequences of immune suppression in the ICU setting include increased risk of multiple organ dysfunction syndrome,15 increased susceptibility to secondary bacterial infections,5,16 reactivation of latent viruses,17 susceptibility to opportunistic organisms,18,19 and increased risk of death.6,7,20 Now that most critically ill patients are surviving the acute phase of their illness as the result of advances in supportive care, many patients are facing the subacute or chronic phases of their illness bearing the additional burden of secondary immune suppression.

What Causes Critical Illness–Induced Immune Suppression?

Critical illness–induced immune suppression is likely a multifactorial process. Overall, 3 broad categories of factors appear to contribute to its incidence and severity: patient-related factors, illness-related factors, and treatment-related factors.

Patient-Related Factors

It has been convincingly demonstrated in family studies that the predisposition to a pronounced CARS response is indeed a heritable trait.21 The identification of specific genotypes or polymorphisms that confer this risk, however, has been difficult so far. It also appears that epigenetic factors may play an important role in promoting the immune-suppressed phenotype. Specific histone methylation patterns, for example, have been

About the Authors

Kristin C. Greathouse is a doctoral student in nursing at The Ohio State University and an advanced practice nurse in the Cardiothoracic Intensive Care Unit at Nationwide Children’s Hospital, Columbus, OH. Mark W. Hall is the chief of the Division of Critical Care Medicine at Nationwide Children’s Hospital and an immunobiology researcher in the Center for Clinical and Translational Research at The Research Institute at Nationwide Children’s Hospital, Columbus, OH.

Corresponding author: Mark W. Hall MD, FCCM, Critical Care Medicine, Nationwide Children’s Hospital, 700 Children’s Dr, Columbus, OH 43205 (e-mail: mark.hall@nationwidechildrens.org).
Evidence strongly suggests that critical illness–induced immune suppression has the potential to be reversed.

Diagnosis of Critical Illness–Induced Immune Suppression

The use of plasma proteins to identify patients with immune suppression has been challenging given that levels of both proinflammatory and anti-inflammatory mediators are commonly elevated at the same time. White blood cell gene expression data in critically ill patients have suggested upregulation of innate immune signaling and suppressed adaptive immune signaling in several studies, although this finding has not been universally observed. Functional immune monitoring offers an opportunity to quantify the degree of immune compromise in ICU patients. Although many of these tests are not currently available in the clinical laboratory in the United States, they have the potential to inform our understanding of the immunobiology of critical illness in the research setting (Table 1).

Innate Immune Monitoring

Monocytes display antigens on their cell surfaces via human leukocyte antigen (HLA)-DR molecules. HLA-DR expression can be easily measured by flow cytometry. More than 90% of healthy monocytes express HLA-DR, and they do so at a density of more than 8000 molecules per cell. Suppressed monocytes internalize their HLA-DR molecules. If less than 30% of monocytes strongly express HLA-DR, or if the expression level is fewer than 8000 molecules per cell, multiple investigators have demonstrated increased risks for adverse outcomes from critical illness.

Adaptive Immune Monitoring

Perhaps the most readily available marker of adaptive immune function in critical illness is the absolute lymphocyte count. Lymphocyte apoptosis, with resultant lymphopenia and cellular dropout in lymphoid organs, has been repeatedly associated with severe immune suppression following cardiopulmonary bypass in children. The degree to which a patient is at risk for critical illness–induced immune suppression may well be influenced by other patient factors including age, sex, and race, although large-scale evaluation of these factors has not yet been undertaken.

Illness-Related Factors

It has been observed across multiple diagnostic categories that the degree of initial inflammation observed with a critical illness or injury often correlates with the severity of subsequent immune suppression. In the case of traumatic injury, the severity of the initial injury is often associated with the development of impaired immune function in the ICU. Moreover, certain types of injury are prone to greater degrees of immune suppression. Brain injury, for example, has long been known to severely impair host defense, most likely through neuroendocrine mechanisms. Last, in the case of illnesses related to infection, it appears that some pathogens may promote immune suppression in the host more than others. Secondary infection with Staphylococcus aureus, for example, was associated with dramatically increased risks for immune suppression developing in a cohort of critically ill children with influenza when compared with children co-infected with other organisms.

Treatment-Related Factors

Many of the therapies employed in the ICU have overt or unintentional immunomodulatory properties. Patients with malignant neoplasms, autoimmune disease, and transplants receive exogenous immune suppressants, including glucocorticoids, calcineurin inhibitors, and antineoplastic agents that promote or worsen critical illness–induced immune suppression. Indeed, tapering of doses of these medications can be an important strategy when managing these patients in the ICU. It is also important to acknowledge, however, that many medications routinely used in the ICU for other reasons may have immunosuppressive effects. Examples include sedatives, opioids, catecholamines, and some antibiotics. Transfusion of blood products, particularly red blood cells with long storage durations, has also been suggested to be immunosuppressive in the setting of critical illness. Last, for patients requiring surgical intervention, surgery itself has been linked to reduced immune responses in the postoperative period.
with mortality and secondary infection risk in adults and children with sepsis.39-41 The function of the remaining T cells is poor in some circumstances, with the degree of T-cell dysfunction predictive of adverse outcomes.42-44 Lymphocytes can also express high levels of negative costimulatory cell surface molecules, such as programmed death (PD)-1, in critical illness.45,46 These molecules, when ligated, promote apoptosis or cellular deactivation. Patients with sepsis whose cells demonstrate increased cell surface inhibitory molecule expression are at increased risk for secondary infections and mortality, providing evidence for another distinguishing marker of immune suppression.47,48 Last, regulatory T cells are a highly immunosuppressive subset of T cells that are known to produce large quantities of anti-inflammatory cytokines. They appear to be resistant to apoptosis and can predominate in the subacute phase of sepsis in adults although this has not been seen in children.42

### Table 1
Common laboratory abnormalities associated with immune suppression in critically ill patients

<table>
<thead>
<tr>
<th>Innate immunity</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>↓ Monocyte HLA-DR expression</td>
<td>↓ Antigen-presenting capacity</td>
</tr>
<tr>
<td>↓ Capacity to produce proinflammatory cytokines, such as TNF-α, when whole blood or isolated monocytes are stimulated ex vivo with LPS or other stimulants</td>
<td>↓ Ability of innate immune cells to respond to a new challenge, such as nosocomial infection</td>
</tr>
<tr>
<td>↑ Cell-surface expression of inhibitory, negative costimulatory molecule ligands such as PD-L1 and PD-L2 on antigen-presenting cells</td>
<td>Active inhibition of lymphocytes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adaptive immunity</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lymphocyte apoptosis resulting in lymphopenia and depletion of lymphoid organs (eg, spleen)</td>
<td>↓ Ability to sustain an immune response to pathogens</td>
</tr>
<tr>
<td>↓ Capacity to produce proinflammatory cytokines, such as IFN-γ, when whole blood or isolated lymphocytes are stimulated ex vivo with PHA or other stimulants</td>
<td>↓ Ability of lymphocytes to respond to a new challenge, such as nosocomial infection</td>
</tr>
<tr>
<td>↑ Cell surface expression of inhibitory, negative co-stimulatory molecules on lymphocytes including PD-1, CTLA-4, and BTLA</td>
<td>Promotion of lymphocyte apoptosis or deactivation</td>
</tr>
<tr>
<td>↑ Proportion of inhibitory regulatory T cells</td>
<td>↑ Expression of anti-inflammatory cytokines and direct deactivation of lymphocytes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plasma biomarkers</th>
<th>Consequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>↑ Plasma IL-10 levels</td>
<td>Deactivation of innate and adaptive immune cells</td>
</tr>
<tr>
<td>↑ Plasma TGF-β levels</td>
<td>Deactivation of innate and adaptive immune cells</td>
</tr>
</tbody>
</table>

Abbreviations: BTLA, B- and T-lymphocyte attenuator; CTLA, cytotoxic T-lymphocyte-associated protein; HLA, human leukocyte antigen; IFN, interferon; LPS, lipopolysaccharide; PD, programmed death; PHA, phytohemagglutinin; TNF, tumor necrosis factor; TGF, transforming growth factor.

With mortality and secondary infection risk in adults and children with sepsis.39-41 The function of the remaining T cells is poor in some circumstances, with the degree of T-cell dysfunction predictive of adverse outcomes.42-44 Lymphocytes can also express high levels of negative costimulatory cell surface molecules, such as programmed death (PD)-1, in critical illness.45,46 These molecules, when ligated, promote apoptosis or cellular deactivation. Patients with sepsis whose cells demonstrate increased cell surface inhibitory molecule expression are at increased risk for secondary infections and mortality, providing evidence for another distinguishing marker of immune suppression.47,48 Last, regulatory T cells are a highly immunosuppressive subset of T cells that are known to produce large quantities of anti-inflammatory cytokines. They appear to be resistant to apoptosis and can predominate in the subacute phase of sepsis in adults although this has not been seen in children.42

### Treatment of Critical Illness–Induced Immune Suppression

Recent evidence strongly suggests that critical illness–induced immune suppression has the potential to be reversed through agents known to stimulate either innate or adaptive immune function. Table 2 provides a summary of the evidence available from human trials.

### Innate Immune-Stimulating Agents

**Granulocyte Macrophage Colony-Stimulating Factor (GM-CSF).** GM-CSF is a cytokine that accelerates the production of neutrophils and monocytes from the bone marrow and enhances the activity of these cells in circulation and in tissues. GM-CSF is approved by the Food and Drug Administration for bone marrow reconstitution following chemotherapy and bone marrow transplant and has been used off-label for immunomodulation in critically ill adults and children.7,18-62 Taken as a whole, these studies suggest that GM-CSF can promote restoration of monocyte HLA-DR expression, improve neutrophil function, and increase TNF-α production capacity. Potential clinical benefits include resolution of infection, prevention of nosocomial infection, and shorter durations of mechanical ventilation, ICU stays, and hospital stays, although these outcomes have yet to be evaluated in large trials. Of note, no serious adverse events were ascribed to GM-CSF in any of these studies, nor did GM-CSF therapy result in increased systemic inflammation as measured by plasma IL-6 levels.
Interferon Gamma (IFN-γ). IFN-γ is a cytokine that plays a major role in activating lymphocytes, NK cells, monocytes, and macrophages. It has therefore been identified as a candidate drug to stimulate innate and adaptive immune function in critical illness. Use of IFN-γ has been associated with improvements in both monocyte HLA-DR expression and cytokine production capacity and was associated with lower incidence of ventilator-associated infection after severe trauma and improved clearance of invasive infections in fungal sepsis in several small studies.35,50-54 In 1 large randomized controlled trial (RCT) of 416 injured adults, IFN-γ or placebo was given for 21 days or until hospital discharge, with those in the IFN-γ group demonstrating a

Table 2
Selected human studies evaluating drugs targeting innate and adaptive immune suppression in critical illness

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Population</th>
<th>N</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>INF-γ</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polk et al,50 1992</td>
<td>RCT</td>
<td>Severely injured adults</td>
<td>193</td>
<td>↑ mHLA-DR expression in treated group.</td>
</tr>
<tr>
<td>Dries et al,51 1994</td>
<td>RCT</td>
<td>Severely injured adults</td>
<td>416</td>
<td>↓ Incidence of infection-related mortality in treated group</td>
</tr>
<tr>
<td>Döcke et al,52 1997</td>
<td>Nonrandomized, interventional</td>
<td>Adults with sepsis, low mHLA-DR expression</td>
<td>9</td>
<td>↑ mHLA-DR expression and TNF-α production capacity after treatment</td>
</tr>
<tr>
<td>Wasserman et al,52 1998</td>
<td>RCT</td>
<td>Adults with severe burn injury</td>
<td>216</td>
<td>No differences in infection-related mortality</td>
</tr>
<tr>
<td>Nakos et al,53 2002</td>
<td>RCT (inhaled IFN-γ)</td>
<td>Severely injured adults</td>
<td>52</td>
<td>↑ alveolar macrophage HLA-DR expression and lower rates of ventilator pneumonia in treated group</td>
</tr>
<tr>
<td>Delsing et al,54 2014</td>
<td>Nonrandomized, interventional</td>
<td>Adults with severe invasive fungal sepsis</td>
<td>8</td>
<td>Increased mHLA-DR expression and enhanced anti-fungal pro-inflammatory cytokine production</td>
</tr>
<tr>
<td>GM-CSF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bilgin et al,55 2001</td>
<td>RCT</td>
<td>Neonates with sepsis and neutropenia</td>
<td>60</td>
<td>↓ Mortality in treatment group</td>
</tr>
<tr>
<td>Drossou-Agakidou et al,56 2002</td>
<td>RCT</td>
<td>Neonates with sepsis</td>
<td>56</td>
<td>↑ mHLA-DR in GM-CSF treated group compared to G-CSF or placebo</td>
</tr>
<tr>
<td>Presneill et al,57 2002</td>
<td>RCT</td>
<td>Adults with sepsis, pulmonary dysfunction</td>
<td>18</td>
<td>↑ Neutrophil function and improved oxygenation in treated group</td>
</tr>
<tr>
<td>Nierhaus et al,58 2003</td>
<td>Nonrandomized, interventional</td>
<td>Adults with sepsis, low mHLA-DR expression</td>
<td>9</td>
<td>↑ mHLA-DR expression and TNF-α production capacity after treatment</td>
</tr>
<tr>
<td>Rosenbloom et al,59 2005</td>
<td>RCT</td>
<td>Adults with sepsis</td>
<td>33</td>
<td>↑ mHLA-DR expression and faster resolution of infection in treated group</td>
</tr>
<tr>
<td>Orozco et al,60 2006</td>
<td>RCT</td>
<td>Adults with abdominal sepsis</td>
<td>58</td>
<td>↓ Hospital stay and ↓ infectious complications in treated group</td>
</tr>
<tr>
<td>Meisel et al,61 2009</td>
<td>RCT</td>
<td>Adults with sepsis and low mHLA-DR</td>
<td>38</td>
<td>↑ mHLA-DR expression and ↓ durations of mechanical ventilation and ICU stay in treated group</td>
</tr>
<tr>
<td>Hall et al,62 2011</td>
<td>RCT</td>
<td>Children with MODS and low TNF-α production capacity</td>
<td>14</td>
<td>Enhanced TNF-α production capacity and lower incidence of nosocomial infection in treated group.</td>
</tr>
<tr>
<td>Paine et al,63 2012</td>
<td>RCT</td>
<td>Adults with ALI/ARDS</td>
<td>132</td>
<td>No difference in ventilator-free days</td>
</tr>
<tr>
<td>IL-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Venet et al,64 2012</td>
<td>Ex vivo (cell culture)</td>
<td>Adults with septic shock</td>
<td>10</td>
<td>↑ Lymphocyte proliferation and INF-γ production</td>
</tr>
<tr>
<td>Anti-PD-1 antibodies</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chang et al,65 2014</td>
<td>Ex vivo (cell culture)</td>
<td>Adults with sepsis</td>
<td>43</td>
<td>↑ INF-γ production and decreased lymphocyte apoptosis</td>
</tr>
</tbody>
</table>

Abbreviations: ALI, acute lung injury; ARDS, acute respiratory distress syndrome; G-CSF, granulocyte colony-stimulating factor; GM-CSF, granulocyte macrophage colony-stimulating factor; IFN-γ, interferon gamma; IL, interleukin; mHLA-DR: monocyte HLA-DR expression, MODS, multiple organ dysfunction syndrome; PD, programed death; RCT, randomized controlled trial; TNF, tumor necrosis factor.
lower rate of infection-related mortality. In a similar study of 216 critically ill adult burn patients, IFN-γ administration was associated with no difference in outcomes. To date, no large RCTs using IFN-γ in critical illness have been performed in sepsis.

**Adaptive Immune Stimulating Agents**

*Interleukin-7.* IL-7 is a lymphocyte-stimulating cytokine required for T-cell development and for maintenance and restoration of mature T cells. Recombinant human IL-7 (rhIL-7) therapy has been evaluated in preclinical sepsis models, and data suggest beneficial effects, including increased cytokine production capacity, T-cell proliferation, prevention of lymphocyte apoptosis, and improved survival. Ex vivo treatment of lymphocytes from patients with sepsis with IL-7 significantly improved T-cell proliferation, up-regulation of anti-apoptotic proteins, and IFN-γ production capacity. Whereas rhIL-7 is currently being evaluated in patients with chronic viral infection and cancer, to date it remains unstudied in vivo in the setting of critical illness.

*PD-1 and CTLA-4 Blocking Antibodies.* In addition to immunostimulatory cytokine therapy, an alternative approach to restore adaptive immune function involves blocking inhibitory molecules such as PD-1 or cytotoxic T-lymphocyte-associated protein (CTLA)-4. Preclinical studies have shown improved lymphocyte survival, cytokine production capacity and improved survival in murine models of bacterial and fungal sepsis that eliminate or block PD-1 or CTLA-4. Both anti-PD-1 and anti-CTLA-4 antibody therapy have been studied in vivo in humans as adjuvant therapies for malignant neoplasia and may have a role in future clinical trials in sepsis.

**Future Directions in Diagnosis and Treatment of Critical Illness–Induced Immune Suppression**

Given the heterogeneity of conditions and the complexity of the immunologic response to critical illness, each patient will be different in presenting characteristics and response to treatment. It is therefore likely that different approaches will be necessary, with the same patient potentially requiring different treatments at various points in time. It is similarly likely that multiple diagnostic approaches will need to be employed in the ICU. Such an immune monitoring regimen could include an initial risk assessment with genetic and epigenetic determinants, once identified, being evaluated upon admission (Figure 2). Serial measurement of innate and adaptive immune function using a combination of cell surface marker analysis and stimulation studies could inform the use and timing of immunostimulatory agents. Patients with clearly identified innate and/or adaptive immune dysfunction would then be appropriately stratified into treatment groups based on their individual immunological deficits. Furthermore, the patient’s individual response to treatment would be longitudinally monitored and adjustments to immunomodulatory therapies made accordingly. Throughout, attention would be paid to avoid immunosuppressive therapies in at-risk patients in favor of an immune-friendly treatment plan. This comprehensive and highly dynamic
approach to immune function has the potential to provide patient-specific immunomodulation to improve outcomes in critical illness.

FINANCIAL DISCLOSURES

None reported.

eLetters

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SOCIAL MEDIA AND FREE OPEN ACCESS MEDICAL EDUCATION: THE FUTURE OF MEDICAL AND NURSING EDUCATION?

By Christopher L. Carroll, MD, MS, Kristi Bruno, BA, and Michael vonTschudi, RN, PhD

It has become cliché to say that the Internet has changed everything, but it did, fundamentally transforming how we communicate and interact.1-6 All the world’s knowledge and experiences are available at any time with just a click of the mouse. Information is easily accessible and free to anyone with a computer, and communication across continents is as easy as e-mailing someone next door. In 1995, just 14% of American adults used the Internet, but by 2014, 87% were regular Internet users.7 Today, organizations and private citizens in all areas have taken to the Internet to entertain, to inform, and to advocate.1-6

As the Internet expanded into our homes, there was a growing expectation of free and open access to information.1-3 Because information was so easily accessible on so many sites, there developed an expectation that all information should be free. In the 1990s, there was an expectation of free music downloads. In the 2000s and 2010s, there was an expectation of free videos, movies, and television shows. And in higher education, universities began offering free online courses in an effort to grow their online presence and expand reach and goodwill. Currently, 64% of American adults have a smartphone equipped with Internet access, up from just 35% in spring of 2011.8 Users have the tools to communicate and interact with anyone at any time literally in the palm of their hands. With these advances in technology, digital interactions became more commonplace and more mainstream, and the social use of these tools began to explode in popularity.

What Are Social Media?

Social media are broadly defined as the use of platforms of electronic communication through which users create online communities.1-6 Social media use is common; 74% of Internet users spend time on social networking sites, with 71% of online adults using Facebook and 23% using Twitter.12 Women currently outpace men in social media use, with a recent survey finding 74% of women were users of social media compared with 62% of men.13

These online communities are used to share information, ideas, personal messages, and other content.1-6 A variety of social media platforms comprise these communities, including Twitter, Facebook, YouTube, and blogs. Each social media platform has slightly different characteristics that depend on the nature of that platform, which result in different user bases and functions. For example, Twitter is a brief, fast-paced microblogging platform that allows just 140 characters per post and requires extreme brevity and a flair for great writing. Facebook is slower paced and visually oriented, and the communities feel more insular to the end user. Blogs are generally static forums, but allow for longer-form content. And YouTube provides a forum for videos that can entertain as well as inform. Each platform offers different services and methods for connecting, and multidisciplinary communities of providers and patients form organically within each of these spaces.1-6

On some platforms including Twitter, Instagram, and Facebook, users connect through the use of “hashtags.” These
searchable keywords, indicated by the # sign, allow for users of similar interests to aggregate and connect. Some examples of online communities include #hcsrn for health care social media, #pulmCC for pulmonary and critical-care medicine, and #FOAMed for free open access medical education. Symplur’s Healthcare Hashtag Project has collected and organized more than 8000 health care hashtags, each representing a disease state, medical conference, or group of people interested in the topic.14

Social media have also become an integral tool for medical societies, hospitals, and advocacy groups.1-6 These groups are using social media to engage, teach, and connect, and they play an important role in providing accurate, vetted health information. Additionally, organizations have realized that encouraging live-tweeting or blogging of conferences provides opportunities for wide dissemination of content that far surpasses in-person attendance.15

State of Medical/Nursing Education Today
It has been said that we are drowning in data, but starving for knowledge. The amount of knowledge and information required for health care providers today is staggering. The need for continuing education is more important than ever before. Social media platforms can help supplement traditional knowledge. Students and learners of all levels routinely check the Internet for facts about disease states, therapies, and physiology. Although these platforms can supplement and enhance learning, it is important to realize that they cannot replace fundamental education and experience.

What is FOAM?
The Free Open Access Medical Education (FOAM) movement is an online community that provides medical education through a variety of social media platforms.10,16-21 The FOAM community is organized primarily around the #FOAMed hashtag but includes several other related hashtags including #FOAMcc (FOAM critical care), #FOANed (free open access nursing education) and #FOAMrn (FOAM nursing). Content is posted on blogs, YouTube videos, podcasts, Twitter feeds, and Facebook groups. Like many social media communities, FOAM has no official leader. Content is created organically by individuals in a variety of disciplines and subspecialties and from all over the world. The quality of the content is vetted in real time by the users.

The story goes that the term FOAM was coined in a bar over a pint of Guinness by Mike Cadgoan in 2012.20 But the movement that was later to be called FOAM can also be traced to informal groups of multiprofessionals who joined together in e-mail listservs and chat rooms to discuss difficult cases, to learn, and to generally commiserate. Among the earliest of these was David Crippen’s CCM-L, the International Internet Critical Care Medicine Group.7 Spurred on by an increased connectivity and ease of participation through improvements in computing technology, coupled with a growing cultural expectation of free and open access in the digital age, the open access medical education movement was born.

How Do People Use FOAM?
FOAM is used to communicate and educate.10,16-21 Users can search Twitter for articles, listen to podcasts for the latest in evidence-based medicine, read blogs for summaries and commentaries, and watch YouTube for video instruction. These pieces are typically more dynamic, less formal, and more conversational than traditional educational materials. All can be done at the user’s own time, or asynchronously from the author.

One of the central benefits of FOAM is the low barrier to entry. Twitter accounts are free to set up and use, and by attaching an appropriate hashtag, users can join in and begin to build a community. When we consider geographic and economic barriers that currently exist in medical education, FOAM becomes even more attractive. Users share interesting content, often free of charge, seek out free content from publishers, and debate topics. Location is of little importance—in Los Angeles, London, or Laos, users are able to learn, share and contribute.

Social media users follow a spectrum of involvement in social media that ranges from low to high involvement.22 Will Hill of AT&T Laboratories first outlined the idea of participation inequalities in the 1990s when reviewing early forms of social media such as Usenet newsgroups and CompuServe

About the Authors
Christopher L. Carroll, is a pediatric critical care physician at Connecticut Children’s Medical Center, Hartford, CT. Kristi Bruno is pursuing a master’s degree in New Media Studies, DePaul University, Chicago, IL, and Michael vonTschudi is a nurse intensivist, at the Central Florida Critical Care Group, Orlando, FL.

Corresponding author: Christopher L. Carroll, MD, MS, Division of Pediatric Critical Care, Connecticut Children’s Medical Center, 282 Washington Street Hartford, CT 06106 (email: ccarrol@connecticutchildrens.org).
message boards. The 90-9-1 Rule for Participation outlines the inequality in social media and online communities and states that 90% of members of an online community exclusively lurk and never contribute; 9% contribute a little, and 1% of users account for almost all the action. In a Nielsen Norman blog post by Jakob Nielsen, it is noted that blogs have an even more drastic participation inequality. Nielsen estimates the rule shifts to 95-5-0.1 when applied to blogs, a major outlet for FOAM content creators.22

What is the Future of FOAM and Medical/Nursing Education?

The danger in all social media is that well-informed participants with important ideas must be strong self-promoters or risk their voices going unheard, whereas the voices of those with popular views or sponsors (or in the market for sponsorship) rise above all the others simply because of their skill at self-promotion. The problem is that sometimes ego outweighs talent, unbeknownst to the reader or listener. Thousands of followers or “likes” are not necessarily indicative of an individual who seeks to contribute to the knowledge base or refine the practice.

Content producers cannot assume that their followers are erudite; they may simply be inexperienced and searching for a mentor. All who seek knowledge, regardless of the medium, must attempt to curate high-quality information and accurate content amid the din of popular content. Therein lies the conundrum. The content will only be as good as the audience demands. In much the same way that social media can claim small victories in correcting statistical errors in published studies, the same attention to detail becomes paramount when the evidence outweighs the enthusiasm for practice changes supported by the most ubiquitous voices in social media.

Regarding the quality of online nursing content, we see that often, instead of talking about issues that affect the collective and the patients, the conversation revolves around products. Presumably this is because these posts trend well. However, there is a new generation of nurses who may be insecure in their practice and want access to information and knowledge beyond the very general education provided in nursing school.

Whereas physicians fresh out of medical school have 3 years (at a minimum) to augment their knowledge and hone their skills, with oversight and guidance from a more experienced physician, before the full burden of patient care is theirs alone to bear, a new registered nurse (RN) will be given 12 weeks, often less, of orientation with another RN, who may also be quite inexperienced. Further, many smaller hospitals lack the resources to provide the cutting-edge education modern nurses require to adequately provide care to the patient populations they serve. Quality educational offerings, and those who curate them, are available online from many sources, only a click or a follow away, at no cost to the learner other than the time it takes to filter and process them. This is the true potential benefit of social media.

Unfortunately, many nurse leaders, with years of experience in this multifaceted profession, have yet to join the conversation on social media. Therefore, the conversation is often led by novices in the field, simply because leaders are absent. As bedside nurses, we must attempt to convince nurse leaders that the conversations begun in nursing school are ongoing; they have simply relocated from the physical classroom to the burgeoning virtual classroom.

Limitations of FOAM

But there is a potential downside to this open access. The quality of the content on social media and the Internet is dependent solely on the members of the online community. Although there may be real-time peer review to critique misleading or incorrect information, the quality of that content may be variable. Additionally, social media forums necessitate brevity. Forcing brevity is a excellent way to facilitate understanding by the author and reader. But the downside is that some things are not simple and deserve further explanation. Nuance and complexity can be lost behind pithy statements.

Also, since FOAM does not follow a curriculum, there is a risk of failing to cover potentially important topics. In social media, there is a heavy focus on areas of emerging treatments such as point-of-care ultrasound, bronchoscopy, and the use of technology and data in patient care. Other less glamorous but still important basic topics may get missed by beginning learners who rely solely on social media for their educational content.

Conclusions

Social media are here to stay. Social media platforms, and in particular the FOAM movement, have the potential to be a novel way to augment your education and to connect with other leaders in health care. But social media cannot fully take the place of traditional education methods. Health care providers have an obligation to participate in the active discussions taking place on these social media platforms. As stewards of health care, it is our responsibility to help educate the next generation of providers.

FINANCIAL DISCLOSURES

None reported.
REFERENCES


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QRS Amplitude Variation During Monitoring

By Mary G. Carey, RN, PhD, Salah S. Al-Zaiti, RN, PhD, CRNP, Teri M. Kozik, RN, PhD, CNS, CCRN, Hildy Schell-Chaple, RN, MS, CCNS, and Michele M. Pelter, RN, PhD

Scenario: The image below is a bedside monitor view from a 40-year-old female orthopedic patient admitted to the preoperative unit. She has no cardiac history and is spontaneously breathing and resting quietly. Of note, the nurse increased the gain of the electrocardiograph (ECG) signal (2x) to improve his visualization of the ECG waveforms and notices the varying QRS wave amplitude in V1 and he wonders if this variation is normal.

Interpretation Questions:

1. Is the ECG properly calibrated (10 mm) and are leads properly placed? If no, interpret cautiously.
   • Yes
   • No
   • NA
2. Is this a sinus rhythm (one P wave preceding every QRS complex)?
   • Yes
   • No
   • NA
3. Is the heart rate (R-R interval) normal (60-100/min)?
   • Yes
   • No
   • NA
4. Is the QRS complex narrow (duration < 110 milliseconds [ms] in V1)?
   • Yes
   • No
   • NA
   If no, check for bundle branch blocks (BBBs), pacing, or ventricular arrhythmias.
5. Is the ST segment deviated (> 2 mm in V2-V3, or > 1 mm in other leads)?
   • Yes
   • No
   • NA
   If yes, check for similar deviations in contiguous cardiac territories.
6. Is the T wave inverted in relation to the QRS (> 0.5 mV)?
   • Yes
   • No
   • NA
   If yes, check for ST deviation or conduction abnormalities.
7. Is the QT interval lengthened (>450 ms [women] or >470 ms [men])?
   • Yes
   • No
   • NA
   If yes, check for ventricular arrhythmias or left ventricular hypertrophy.
8. Is R- or S-wave amplitude enlarged (S wave V1 + R wave V6 > 35 mm)?
   • Yes
   • No
   • NA
   If yes, check for axis deviation or other chamber hypertrophy criteria.

Mary G. Carey is associate director for clinical nursing research, Strong Memorial Hospital, Rochester, New York. Salah S. Al-Zaiti is an assistant professor at the Department of Acute and Tertiary Care Nursing, University of Pittsburgh, Pennsylvania. Teri M. Kozik is a nurse researcher at St. Joseph’s Medical Center, Stockton, California. Hildy Schell-Chaple is a clinical nurse specialist and Michele M. Pelter is an assistant professor at the the Department of Physiological Nursing at University of California, San Francisco, California.

©2016 American Association of Critical-Care Nurses doi: http://dx.doi.org/10.4037/ajcc2016791
Answers:
1. The gain is double as indicated by the 2x next to the ECG lead II label.
2. Yes, the rhythm is sinus.
3. No, the heart rate is fast at 110/min.
4. Yes, the QRS duration is normal.
5. No, the ST segments are not deviated, but cannot be accurately evaluated due to the increased gain.
6. No, the T wave is not inverted.
7. No, the QT interval is not lengthened.
8. Unable to assess because V5 is not displayed.

Interpretation
The cardiac rhythm is sinus tachycardia at 110/min. During inspiration, as seen in the respiratory waveform (bottom), the QRS amplitude is diminished in lead V1.

Rationale
QRS amplitude variation during respiration are almost always present, yet most often they are so small they are difficult to detect. Because the heart is not fixed in the chest cavity, the precordial chest lead V1 becomes more distant from the heart during inspiration, which can result in a diminished QRS amplitude. Generally, the respiratory rate is obtained from 2 of the ECG electrodes that measure changes in the electrical impedance of the patient’s thorax caused by breathing. However, this method can be problematic and lead to false positive apnea alarms. To improve the reliability of respiratory detection, monitoring companies are now developing software to measure respiratory rate using QRS changes, as seen in this example.

Management
Varying QRS amplitude, secondary to breathing, is considered a normal variant; however, attention should be brought to the patient’s tachycardia. Preoperative tachycardia is a major contributor to myocardial ischemia, myocardial infarction and reinfarction. Beta blockers are used to protect the heart from perioperative infarction or injury because of their heart-rate lowering effect. However, before pharmacological management is used, consider the numerous pathologies that underlie preoperative tachycardia so efforts can be made to identify why this patient has tachycardia at rest, because its presence can compromise surgical outcomes.

In this example, although her oxygenation saturation is normal, note the low grade fever at 38.3°C with an accompanying low blood pressure of 92/53 mm Hg. These signs are ominous because the patient’s status of “nothing by mouth” can lead to dehydration and, with an accompanying fever and tachycardia, further instability of her vital signs can occur; thus, a comprehensive examination should be performed before continuing to the operating room.
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**FLORIDA**
Miami
2-Day CCRN/PCCN Review Course
Date: February 12-13, 2016. Place: Nova Southeastern University Miami Campus. Address: 8585 SW 124th Ave, Miami, FL 33183. Sponsor: Greater Miami Area Chapter of AACN. Keynote Speaker: Cammy House-Fancher. Contact: Lee Fong Hong. Phone: (305) 586-7285. E-mail: lfonghong@gmail.com. Fee: Members, $140; nonmembers, $170, groups of 3 or more, $130 per person (applies only if all 3 applications are received together); 1 day course fee all attendees, $100. Registration deadline, 1/29/2016. Credits: 14 CEUs.

Miami
2-Day Trauma Certified RN (TCRN) Review Course
Date: February 12-13, 2016. Place: Nova Southeastern University Miami Campus. Address: 8585 SW 124th Ave, Miami, FL 33183. Sponsor: Greater Miami Area Chapter of AACN. Keynote Speaker: Kendra Menzies Kent. Contact: Ruth Salathe. Phone: (305) 886-4203. E-mail: ruthsalathe@gmail.com. Fee: Members, $180; nonmembers, $195, groups of 3 or more, $165 per person (applies only if all 3 applications are received together); 1 day course fee all attendees, $100. Registration deadline, 1/29/2016. Credits: 14 CEUs.

Miami
29th Annual Visions Spring Symposium
Date: March 3-4, 2016. Place: Harrah’s North Kansas City. Sponsor: Greater Kansas City Chapter of AACN. Keynote Speakers: Lisa Riggs, Michael Ackerman, Tom Ahems, Nicole Kupchick. Contact: Cheryl Rader. E-mail: cvrn_911@hotmail.com. Fee: TBA.

**ILLINOIS**
Itasca
2016 Midwest Critical Care Conference
Date: March 21-22, 2016. Place: Eaglewood Resort and Spa. Address: 1401 Nordic Rd, Itasca, IL 60143. Sponsor: Northwest Chicago Area Chapter of AACN. Contact: Jenny A. Zaker. Phone: (847) 309-0662. E-mail: zakjer46@gmail.com. Fee: Similar to 2015. TDB. Credits: TDB, CERPs.

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