Short Simulation Training Improves Objective Skills in Established Advanced Practitioners Managing Emergencies on the Ward and Surgical Intensive Care Unit

Joseph L. Pascual, MD, PhD, FRCPS(C), Daniel N. Holena, MD, FACS, Michael A. Vella, MD, Joseph Palmieri, MSED, Corinna Sicoutris, RN, MSN, CRNP, BC, Ben Selvan, MD, Adam D. Fox, DO, Babak Sarani, MD, FACS, Carrie Sims, MD, MS, FACS, Noel N. Williams, MB, BCh, FRCSI, FRCS(Gen), and Charles William Schwab, MD, FACS

Background: Several studies evaluating simulation training in intensive care unit (ICU) physicians have demonstrated improvement in leadership and management skills. No study to date has evaluated whether such training is useful in established ICU advanced practitioners (APs). We hypothesized that human patient simulator-based training would improve surgical ICU APs’ skills at managing medical crises.

Methods: After institutional review board approval, 12 APs completed ½ day of simulation training on the SimMan, Laerdal system. Each subject participated in five scenarios, first as team leader (pretraining scenario), then as observer for three scenarios, and finally, again as team leader (posttraining). Faculty teaching accompanied each scenario and preceded a debriefing session with video replay. Three experts scored emergency care skills (ABCs, recognition of shock, pneumothorax, etc.) and teamwork leadership/interpersonal skills. A multiple choice question examination and training effectiveness questionnaire were completed before and after training. Fellows underwent the same curriculum and served to validate the study. Pre- and postscores were compared using the Wilcoxon signed rank test with two-tailed significance of 0.05.

Results: Improvement was seen in participants’ scores combining all parameters (73% ± 13% vs. 80% ± 11%, p = 0.018). AP leadership/interpersonal skills (+12%), multiple choice question examination (+4%), and training effectiveness questionnaire (+6%) scores improved significantly (p < 0.05). Fellows teamwork leadership/interpersonal skills scores were higher than APs (p < 0.001) but training brought AP scores to fellow levels. Interrater reliability was high (r = 0.77, 95% confidence interval 0.71–0.82; p < 0.001).

Conclusions: Human patient simulator training in established surgical ICU APs improves leadership, teamwork, and self-confidence skills in managing medical emergencies. Such a validated curriculum may be useful as an AP continuing education resource.

Submitted for publication January 3, 2011.
Accepted for publication April 12, 2011.
Copyright © 2011 by Lippincott Williams & Wilkins

Key Words: Simulation, Advanced practitioners, ICU, Critical care, Human patient simulator.

The ever-increasing reductions in resident numbers and work hours1 have led many intensive care units (ICUs) to hire permanent advanced practitioners (APs) such as certified registered nurse practitioners (CRNPs), and physician assistants (PA-Cs). Even in academic centers where, historically, residents have provided the majority of day-to-day patient care, APs have been embedded side by side with, and in some cases have supplanted house staff. In general, acute care APs have up to 6 years of graduate training and can provide a greater continuity of care than frequently rotating resident teams.2 Since 1999, the University of Pennsylvania Trauma and Critical Care Health Network has employed APs in their surgical ICUs (SICUs). These APs admit patients, provide day-to-day care, and perform all bedside procedures (e.g., insertion of central venous lines, arterial lines, chest tubes). Although these providers have extensive knowledge and experience, maintaining the skill set to manage high-risk events that occur infrequently (e.g., extubation, development of tension pneumothorax, massive upper gastrointestinal bleeding) can be challenging. Currently, continuing medical education specifically targeted at this group of clinicians is modest outside webcast and web-based educational resources.

The data-rich environment of the SICU is ideal to design and implement a curriculum using high-fidelity human patient simulators (HPS). This is particularly underscored in two ways: (1) patients often have simultaneous monitoring of multiple physiologic parameters and (2) patient physiology can change rapidly and by a great magnitude. This setting is thus highly conducive for scenario-based simulation to follow trainee skills before, during, and after the implementation of training.

Although much has been published relating to simulation training of ICU medical students, residents, fellows, and attending physicians, the role of such training in APs remains unexamined. We thus developed a scenario-
based simulation curriculum targeted at established SICU APs to provide them the opportunity to experience high-risk/low-frequency events in a continuing medical education setting without risk to patients. As this training involved time away from their work, the curriculum had to be succinct enough to minimize the disruption of their work schedule. We hypothesized that a short, 5-hour simulation curriculum emphasizing medical emergencies would enhance APs’ teamwork, leadership, and clinical skills. We further postulated that they would find the exercise useful to gain confidence in managing these conditions.

METHODS

Trainee Population

After institutional review board approval and with the written consent of each trainee, 3 half-day training sessions were organized. Trainees were fully practicing APs that worked in the University of Pennsylvania Trauma and Critical Care Health Network at two sites: The Reading Hospital and Medical Center (TRHMC) and the Hospital of the University of Pennsylvania (HUP). At the time of the study, TRHMC APs (both CRNPs and PA-Cs) were independent and ran day-to-day care of patients with the attending physician. APs at HUP (CRNPs only) ran day-to-day care, independently assessing and caring for SICU and postanesthesia care unit patients and directly reporting to the attending intensivist.

Validation Cohort

To validate the curriculum, the complete cohort (n = 4) of recently graduated surgical critical care fellows were invited to participate in all facets of the curriculum to serve as the gold standard comparison group. All fellows shortly thereafter successfully completed the Surgical Critical Care American Board of Surgery examination.

Curriculum

Three half-day sessions were organized to train four participants (APs) each, at The Penn Medicine Clinical Simulation Center. One additional session was organized for the validation cohort. The HPS used were male and female Laerdal SimMan with technical manipulation using SimMan Software version 3.3.1 (Laerdal, Wappingers Falls, NY). Each 5-hour session began with a brief bedside introduction by the faculty and the simulation educator, giving a hands-on explanation of the simulation process and use of the mannequins. Each trainee functioned as team leader in a first scenario (pretraining scenario), observed three different scenarios where colleagues served as team leaders, and then finished the session by performing as team leader for a second time (posttraining scenario). To ensure performer/observer experience that was equal for all participants, the scheme in Table 1 was used. During the 15-minute scenario, a faculty member (JLP) served as the bedside nurse, following orders and performing requested tasks to ensure smooth forward flow. The simulation educator observed the performance from behind a one-way mirror and operated the simulator, following the scripted scenario choreography. Each scenario was videotaped using two strategically placed video cameras capable of capturing high-fidelity video and audio of the performance. At the end of each scenario, trainees (team leader and observers) would review the recorded scenario with faculty, each commenting on the favorable and less favorable aspects of the performance. Each postscenario debriefing lasted an average of 15 minutes. Thus, the core curriculum for each trainee consisted in a scenario performed as team leader (pretraining) followed by three scenarios as an observer—all accompanied by in-room faculty teaching and by postscenario video review and faculty debriefing. The curriculum ended with a second scenario performed by each trainee as team leader (posttraining; Table 1).

Scenarios

Five different scenarios were constructed by a panel of faculty including seven surgical intensivists (surgeons and anesthesiologists) and a senior acute care AP. The scenarios included relatively uncommon (but not rare) emergent occurrences requiring a rapid response call or an intervention in the ICU. Scenarios were devised on the premise that they required two “major” elements (e.g., tension pneumothorax, anaphylaxis, MI recognition) and three or four “minor” elements (e.g., asks for chest X-ray after intubation, checks hemoglobin in bleeding patient, administers intubation drugs). Each scenario was vetted and revised by the panel until difficulty levels were felt to be approximately the same between scenarios. The final five scenarios were (1) anaphylaxis with tension pneumothorax, (2) septic shock from *Clostridium difficile* colitis, (3) MI with diabetic ketoacidosis, (4) hemorrhagic shock with abdominal compartment syndrome, and (5) deteriorating traumatic brain injury with status epilepticus. Although certain procedures were required during the scenarios (e.g., needle thoracostomy, chest tube insertion, endotracheal intubation, pulmonary artery catheter insertion), they were not performed physically even though indications and basic tenants of the procedure were discussed. Laboratory tests, X-rays, electrocardiograms, and computed tomography scans required in the different scenarios were available on request to the trainees at clinically plausible time intervals.

### Table 1. Half-Day Simulation Session Schedule

<table>
<thead>
<tr>
<th>Team Leader</th>
<th>Session Type</th>
<th>Scenario</th>
<th>Observer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Pretraining</td>
<td>1</td>
<td>None</td>
</tr>
<tr>
<td>B</td>
<td>Pretraining</td>
<td>2</td>
<td>A</td>
</tr>
<tr>
<td>C</td>
<td>Pretraining</td>
<td>3</td>
<td>A, B</td>
</tr>
<tr>
<td>D</td>
<td>Pretraining</td>
<td>4</td>
<td>A, B, C</td>
</tr>
<tr>
<td>A</td>
<td>Posttraining</td>
<td>5</td>
<td>B, C, D</td>
</tr>
<tr>
<td>B</td>
<td>Posttraining</td>
<td>1</td>
<td>C, D</td>
</tr>
<tr>
<td>C</td>
<td>Posttraining</td>
<td>2</td>
<td>D</td>
</tr>
<tr>
<td>D</td>
<td>Posttraining</td>
<td>3</td>
<td>None</td>
</tr>
</tbody>
</table>

Note that there are four trainees, each performing first as team leader (pretraining) then as observer for three scenarios and finishing with a second performance as team leader (posttraining). All trainees observed three scenarios only and therefore only five different scenarios were needed. Observers were asked not to contribute to the performance but silently observe in the room.
Curriculum Assessment Tools

The participant’s pre- and posttraining performance was scored by three separate expert assessors using two separate assessment tools: Team Leadership-Interpersonal Skills (TLIS) and Emergency Clinical Care Skills (ECCS) score sheets. The TLIS assessment tool was adapted from the validated American College of Surgeons/Association of Program Directors in Surgery simulation curriculum but was altered to better conform to situational emergencies. It was subdivided into (1) teamwork (communication with team, task delegation, leadership), (2) decision making (plan making, prioritization, timeliness), and (3) situational awareness (calmness/assertiveness, team/distraction management, repeated reevaluation). Each subsection comprised five objectives that were rated on a binomial scale (i.e., adequate/inadequate). The ECCS tool was based on a score sheet developed by the National Registry of Emergency Medical Technicians and was composed of (1) universal objectives (UN; using universal precautions, calling for help, orderly progression through resuscitation ABCs, etc.) and (2) scenario specific objectives (SP) (recognition of shock or tension pneumothorax, initiation of transfusion, etc.). Additionally, each trainee completed two questionnaires before training. The first was a multiple choice question examination (MCQ) comprising of 18 questions related to different technical elements of each scenario. The same MCQ was then administered to trainees after all scenarios were completed. Participants were not allowed to consult resources to answer these questions. Although possible answers to questions could incidentally enter discussions during debriefings or in-room teaching, no specific effort was made to answer MCQ questions explicitly during training. The Training Effectiveness Questionnaire (TEQ) was also completed before and after training and was comprised of seven questions asking the participant to rate their own confidence level at leading different types of medical emergencies using a five-point Likert scale.

Finally, at the completion of training, a validated feedback questionnaire was administered to each AP evaluating their opinion on curriculum usefulness. This questionnaire was separated into four sections: (1) face validity (scenario realism, utility for management approaches), (2) use for training (scenarios useful for learning leadership and clinical skills), (3) use for assessment (utility for assessment of leadership and clinical skills), and (4) quality of feedback (faculty and educator feedback and teaching quality). Comments on how to improve or change the curriculum to better address educational needs of APs were also invited in this questionnaire.

Expert Assessors

Two board certified surgical intensivists (DH, AF) and a senior SICU CRNP (CS) scored all performances (pre- and posttraining). One of the assessors was present in the room and directly scored trainees whereas the remaining two scored them off-line using a password-protected web-based software (SimBridge Version 2.3, B-Line Medical, WA, DC), which allowed Internet access to the Simulation Center’s recorded footage. Through this software, all camera angles could be accessed together or each in full screen version (Fig. 1). However, the in-room assessor was unblinded to performance status (pre- or posttraining), and off-line assessors were blinded to the training status of the scenario performer. All scoring was performed independently by each reviewer to minimize the possibility of interrater influence.

Statistical Analysis

Continuous data were assessed for normality using the Shapiro-Wilk test. Initial unadjusted analyses for parametric variables were performed using either paired samples t test or
independent samples t test, as appropriate. Wilcoxon signed ranks test or Mann-Whitney test was used to test for differences between continuous nonparametric data. Chi square was used for categorical nonparametric data. Interrater reliability was evaluated using average measure intraclass correlation with a two way mixed effects model. Two-tailed significance was set at \( p < 0.05 \). Data management and statistical analyses were performed using SPSS Version 17 (2010 SPSS, Chicago, IL).

### RESULTS

**Study Population**

Trainee demographics are summarized in Table 2. APs from TRHMC and HUP were evenly intermixed among sessions with twice as many nurse practitioners (CRNPs) as PA-Cs participating. Less than half of trainees reported previous experience with simulator training.

Four recent graduates from the University of Pennsylvania Surgical Critical Care Training program were used as the gold standard cohort to prove construct validity. For all analyses, there were insufficient numbers to analyze differences between institution of origin (TRHMC vs. HUP) and years of experience or advanced training degree (CRNP vs. PA-Cs).

**Interrater Variability**

Interrater reliability for all scores was excellent (average measures intraclass correlation 0.91, 95% confidence interval, 0.88–0.93; \( p < 0.001 \)).

**Team Leadership/Interpersonal Skills**

The modified American College of Surgeons/Association of Program Directors in Surgery Surgical Skills Curriculum evaluation was used to assess teamwork and leadership.\(^3\) Percent scores of all trainees significantly improved in all spheres including teamwork, decision making, situational awareness as well as total scores (Fig. 2; \(* p < 0.01, † p < 0.05\)). Fellows were also evaluated with the TLIS assessment tool but their mean scores before and after training remained unchanged.

**Emergency Clinical Care Skills**

Emergency clinical skills were evaluated using an objective assessment tool scoring clinical skills that fulfilled UN and scenario SP, the sum of which yielded total scores. Improvements in UN, SP, and total scores were not significant in both trainees and fellows (Figs. 3 and 7).

**Multiple Choice Question and Training Effectiveness Questionnaires**

Trainees were evaluated by a multiple-choice questionnaire relevant to the scenarios administered, before and after training. APs scores improved by 5% \( (p = 0.027) \), whereas fellows’ scores did not change significantly (Fig. 4). AP TEQ self-reported scores improved by 8% \( (p = 0.048) \), whereas that of fellows did not improve significantly (Fig. 5). Evaluation of whether posttraining improvements in MCQ scores was diminished in later sessions revealed no differences indicating, perhaps, that trainees from previous sessions were familiar with the scenarios.

---

**TABLE 2.** Advanced Practitioner Trainee Demographics

<table>
<thead>
<tr>
<th>Subject</th>
<th>Institution</th>
<th>Education</th>
<th>Age (yr)</th>
<th>Sex</th>
<th>Years Experience</th>
<th>Previous Simulation Training</th>
<th>Rapid Responses Attended Per Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>HUP</td>
<td>CRNP</td>
<td>35</td>
<td>M</td>
<td>2</td>
<td>Y</td>
<td>0–5</td>
</tr>
<tr>
<td>1B</td>
<td>TRHMC</td>
<td>PA-C</td>
<td>34</td>
<td>M</td>
<td>5</td>
<td>Y</td>
<td>0–5</td>
</tr>
<tr>
<td>1C</td>
<td>HUP</td>
<td>CRNP</td>
<td>28</td>
<td>F</td>
<td>2.5</td>
<td>N</td>
<td>6–10</td>
</tr>
<tr>
<td>1D</td>
<td>TRHMC</td>
<td>PA-C</td>
<td>26</td>
<td>M</td>
<td>1</td>
<td>Y</td>
<td>0–5</td>
</tr>
<tr>
<td>2A</td>
<td>TRHMC</td>
<td>CRNP</td>
<td>27</td>
<td>F</td>
<td>1</td>
<td>Y</td>
<td>0–5</td>
</tr>
<tr>
<td>2B</td>
<td>TRHMC</td>
<td>PA-C</td>
<td>27</td>
<td>F</td>
<td>2.5</td>
<td>N</td>
<td>20+</td>
</tr>
<tr>
<td>2C</td>
<td>TRHMC</td>
<td>CRNP</td>
<td>30</td>
<td>F</td>
<td>6</td>
<td>N</td>
<td>0–5</td>
</tr>
<tr>
<td>2D</td>
<td>HUP</td>
<td>CRNP</td>
<td>32</td>
<td>F</td>
<td>4</td>
<td>N</td>
<td>0–5</td>
</tr>
<tr>
<td>3A</td>
<td>HUP</td>
<td>CRNP</td>
<td>36</td>
<td>F</td>
<td>2</td>
<td>N</td>
<td>0–5</td>
</tr>
<tr>
<td>3B</td>
<td>TRHMC</td>
<td>PA-C</td>
<td>25</td>
<td>F</td>
<td>1</td>
<td>Y</td>
<td>0–5</td>
</tr>
<tr>
<td>3C</td>
<td>TRHMC</td>
<td>CRNP</td>
<td>35</td>
<td>F</td>
<td>1</td>
<td>N</td>
<td>0–5</td>
</tr>
<tr>
<td>3D</td>
<td>HUP</td>
<td>CRNP</td>
<td>34</td>
<td>M</td>
<td>2</td>
<td>Y</td>
<td>0–5</td>
</tr>
</tbody>
</table>

Note that most APs were CRNP and had 1 year to 4 years experience. Five participants originated from HUP and seven from TRHMC. Half of trainees had undergone some form of simulation training in the past.
not likely discussing MCQ questions with trainees of later sessions outside the sessions themselves.

Feedback Trainee Evaluations

The Feedback Scoring tool demonstrated that the different curriculum elements were rated universally high by trainees as follows: face validity (85% ± 15%), use for training (88% ± 11%), use for assessment (78% ± 15%), quality of feedback (90% ± 10%), and the sum total (88% ± 11%). Scores given by fellows appeared slightly higher indicating a more favorable perception of the curriculum’s usefulness (face validity [91% ± 8%], use for training [93% ± 10%], use for assessment [85% ± 15%], quality of feedback [87% ± 13%], and the sum total [89% ± 10%]). Written comments from both cohorts were overwhelmingly favorable with occasional indications that it had been a mildly to moderately stressful experience for APs.

Curriculum Validation

To validate the curriculum, a complete session was conducted for four surgical critical care fellows that had completed their fellowship and were about to undergo the American Board of Surgery certification examination. This cohort of fully trained intensivists served as a gold-standard validation cohort. Their TLIS scores were compared with those of AP trainees before and after training (Fig. 6). Pretraining scores were significantly lower in APs than in fellows (70.3% ± 3.1% vs. 86.4% ± 1.6%, p < 0.001). However, posttraining TLIS scores were similar in both groups. The ECCS section demonstrated a trend to improvement in both fellow and AP scores. Fellows demonstrated higher ECCS scores than APs that approached significance pretraining (83.5% ± 2.2% vs. 73.6% ± 0.03%, p = 0.067), and posttraining (86.9% ± 2.5% vs. 79.1% ± 0.02%, p = 0.054) with AP scores never reaching fellow scores (Fig. 7). The MCQ and TEQ scores showed no differences between APs and fellows before and after training though scores were always at least 5% higher in fellows.
APs are increasingly staffing positions previously held by residents in trauma and acute care units across the United States. Many studies suggest that APs make a significant positive contribution to patient care, but continuing medical education resources targeted at these highly skilled clinicians may be disproportionately low when compared with those allocated for continuing physician education. The purpose of the present curriculum was to provide a continuing education resource using HPS simulating acute medical emergencies that are infrequent but associated with high patient risk. These conditions require rapid diagnosis and management that, fully trained, practicing APs were reasonably expected to render in the scope of their current practice. Use of the simulator allowed the opportunity to manage these conditions in a virtual, yet stressful environment without risk to actual patients. We found that the curriculum was rated highly by participants and was qualified as an effective training tool. Improvement in performance was seen in all spheres, most significantly in leadership/interpersonal skills and in the written questionnaires. The curriculum was best validated using the Teamwork/Leadership assessment tool (TLIS) where training rendered AP scores indistinguishable to those of a cohort of fully trained intensivists.

High-fidelity human patient simulator training offers the advantage of prospective and repeated experiential learning in select short-duration scenarios providing an almost limitless opportunity to practice managing high-stakes events in a risk-free setting. This is particularly valuable in critical care medicine, which lends itself poorly to traditional apprenticeship-type bedside teaching. Indeed, when the patient is unstable, the learner is often shifted to an observational role and the more experienced instructor takes the lead to minimize patient risk. The student then loses key learning opportunities to prioritize tasks, make decisive, time-sensitive management choices in a multidisciplinary setting where leadership is inherently difficult to assume. Medical emergency simulation using HPS provides the opportunity for real time and subsequent debriefing feedback while providing the trainee the opportunity to view and reflect on their own actions and reactions on video playback. Although most simulation training in critical care has centered in procedural skill acquisition, we chose instead to focus on the cognitive and leadership skills that are of paramount importance when caring for critically ill patients with time-sensitive conditions.

APs are increasingly staffing positions previously held by residents in trauma and acute care units across the United States. Many studies suggest that APs make a significant positive contribution to patient care, but continuing medical education resources targeted at these highly skilled clinicians may be disproportionately low when compared with those allocated for continuing physician education. The purpose of the present curriculum was to provide a continuing education resource using HPS simulating acute medical emergencies that are infrequent but associated with high patient risk. These conditions require rapid diagnosis and management that, fully trained, practicing APs were reasonably expected to render in the scope of their current practice. Use of the simulator allowed the opportunity to manage these conditions in a virtual, yet stressful environment without risk to actual patients. We found that the curriculum was rated highly by participants and was qualified as an effective training tool. Improvement in performance was seen in all spheres, most significantly in leadership/interpersonal skills and in the written questionnaires. The curriculum was best validated using the Teamwork/Leadership assessment tool (TLIS) where training rendered AP scores indistinguishable to those of a cohort of fully trained intensivists.

High-fidelity human patient simulator training offers the advantage of prospective and repeated experiential learning in select short-duration scenarios providing an almost limitless opportunity to practice managing high-stakes events in a risk-free setting. This is particularly valuable in critical care medicine, which lends itself poorly to traditional apprenticeship-type bedside teaching. Indeed, when the patient is unstable, the learner is often shifted to an observational role and the more experienced instructor takes the lead to minimize patient risk. The student then loses key learning opportunities to prioritize tasks, make decisive, time-sensitive management choices in a multidisciplinary setting where leadership is inherently difficult to assume. Medical emergency simulation using HPS provides the opportunity for real time and subsequent debriefing feedback while providing the trainee the opportunity to view and reflect on their own actions and reactions on video playback. Although most simulation training in critical care has centered in procedural skill acquisition, we chose instead to focus on the cognitive and leadership skills that are of paramount importance when caring for critically ill patients with time-sensitive conditions.

Although several studies have evaluated clinical decision-making using simulation, this study is the first to evaluate this in established APs. Simulation of perioperative scenarios has been found to improve anesthesia trainee performance in conducting emergent cesarean section anesthesia. In another study, attending and resident anesthetists demonstrated improvement in response time, management techniques and less deviation from accepted protocols after simulating hyperthermia and anaphylactic shock scenarios. In this study, we used simulation scenarios to both train and evaluate participants’ clinical management, skills. Additionally, the scenarios afforded the opportunity to assess their leadership skills and ability to work as a team.

Many simulation curricula evaluate training effect by subjective participant surveys or by comparing pre- and posttraining multiple-choice examinations. Although our study included this methodology, we also used objective rubrics. We first evaluated generic universal clinical essentials and while there was an improvement trend, this was not significant in either APs or fellows. This could have been due to the fact that trainees felt that these practices were not necessary in the setting of a simulation. Conversely, these practices may have been forgotten in the stress and urgency of the scenario, which is known to occur in real-life clinical emergencies. Ratings of the ability of APs to rapidly work through the scenario’s diagnoses and institute proper management strategies demonstrated an increased trend in post-training scores (81%) that still remained well below those of fellows (93%).

**DISCUSSION**

APs are increasingly staffing positions previously held by residents in trauma and acute care units across the United States. Many studies suggest that APs make a significant positive contribution to patient care, but continuing medical education resources targeted at these highly skilled clinicians may be disproportionately low when compared with those allocated for continuing physician education. The purpose of the present curriculum was to provide a continuing education resource using HPS simulating acute medical emergencies that are infrequent but associated with high patient risk. These conditions require rapid diagnosis and management that, fully trained, practicing APs were reasonably expected to render in the scope of their current practice. Use of the simulator allowed the opportunity to manage these conditions in a virtual, yet stressful environment without risk to actual patients. We found that the curriculum was rated highly by participants and was qualified as an effective training tool. Improvement in performance was seen in all spheres, most significantly in leadership/interpersonal skills and in the written questionnaires. The curriculum was best validated using the Teamwork/Leadership assessment tool (TLIS) where training rendered AP scores indistinguishable to those of a cohort of fully trained intensivists.

High-fidelity human patient simulator training offers the advantage of prospective and repeated experiential learning in select short-duration scenarios providing an almost limitless opportunity to practice managing high-stakes events in a risk-free setting. This is particularly valuable in critical care medicine, which lends itself poorly to traditional apprenticeship-type bedside teaching. Indeed, when the patient is unstable, the learner is often shifted to an observational role and the more experienced instructor takes the lead to minimize patient risk. The student then loses key learning opportunities to prioritize tasks, make decisive, time-sensitive management choices in a multidisciplinary setting where leadership is inherently difficult to assume. Medical emergency simulation using HPS provides the opportunity for real time and subsequent debriefing feedback while providing the trainee the opportunity to view and reflect on their own actions and reactions on video playback. Although most simulation training in critical care has centered in procedural skill acquisition, we chose instead to focus on the cognitive and leadership skills that are of paramount importance when caring for critically ill patients with time-sensitive conditions.

Although several studies have evaluated clinical decision-making using simulation, this study is the first to evaluate this in established APs. Simulation of perioperative scenarios has been found to improve anesthesia trainee performance in conducting emergent cesarean section anesthesia. In another study, attending and resident anesthetists demonstrated improvement in response time, management techniques and less deviation from accepted protocols after simulating hyperthermia and anaphylactic shock scenarios. In this study, we used simulation scenarios to both train and evaluate participants’ clinical management, skills. Additionally, the scenarios afforded the opportunity to assess their leadership skills and ability to work as a team.

Many simulation curricula evaluate training effect by subjective participant surveys or by comparing pre- and posttraining multiple-choice examinations. Although our study included this methodology, we also used objective rubrics. We first evaluated generic universal clinical essentials and while there was an improvement trend, this was not significant in either APs or fellows. This could have been due to the fact that trainees felt that these practices were not necessary in the setting of a simulation. Conversely, these practices may have been forgotten in the stress and urgency of the scenario, which is known to occur in real-life clinical emergencies. Ratings of the ability of APs to rapidly work through the scenario’s diagnoses and institute proper management strategies demonstrated an increased trend in post-training scores (81%) that still remained well below those of fellows (93%).
Other groups have investigated teamwork and leadership skills in emergencies; described by some as crisis resource management. Kim et al.²¹ have described a validated crisis resource management simulation rating scale for medical residents that is similar to our TLIS checklist—evaluating leadership skills, situational awareness, and decision making (problem solving) but also incorporating resource utilization. In our institutions, APs are often called emergently by bedside nurses to manage medical crises in the ward or ICU. We demonstrated that 5 hours of training with HPS using carefully selected high-stakes, high-risk, low frequency scenarios, resulted in demonstrable improvements in teamwork, decision-making, and situational awareness skills. Sample size was too small to find significant correlation in scores to years of experience or location of practice (HUP or TRHMC).

In simulation studies evaluating scoring of trainee skills, validation of assessment tools is sometimes present. One study examining situational awareness using simulation of advanced trauma life support-based scenarios found participants with a higher level of training to obtain higher scores relative to their less experienced colleagues.²² In a more complex curriculum, Holcomb et al.²³ assessed multidisciplinary military teams in simulated trauma scenarios and demonstrated a valid and reproducible evaluation system when comparing scores to those of expert trauma surgeons. Using a different validation scheme, another study assessed effect of experience of surgical and emergency medicine residents in managing four simulated critical care patient scenarios.²⁴ Trainees evaluated on completing essential clinical tasks, cognitive errors, and directionality of reasoning, obtained higher scores if they had rotated for >10 weeks in the ICU when compared with counterparts who had rotated for a lesser time. In this study, we used fully ACGME-trained SICU fellows to prove construct validity of the curriculum. Pretraining AP scores were significantly lower than those of fellows, whereas posttraining scores were similar in both groups using the TLIS assessment tool. This validated the curriculum as level-adequate for APs. However, improvement in ECCS AP and fellow scores were not significant. These latter results may indicate that in the selected characteristics evaluated, scores approached each other after some experience using simulators. Alternatively, posttraining score improvements in both groups may also have been due to greater familiarity and ease in interacting with a high fidelity human simulator.

After training, APs felt more confident in managing emergent conditions as they self-reported in the TEQ. Confidence in managing emergent ICU situations is an important quality to rapidly configure a plan and manage rapidly changing conditions.

This study has a number of limitations. The number of subjects was small. A greater number of participants may have rendered significant some of the improvements seen in ECCS scores. Also, many (50%) of trainees had no previous experience with simulation training and simulation discomfort may have contributed to lower pre-training scores. Other investigators have described the concept of “stage fright” when first faced with a simulated patient and note how trainees may not immerse themselves in the artificiality of simulation until repeated exposure.²³ We have now instituted a “warm-up scenario” that is performed by all trainees to familiarize them with the basic workings of scenario/simulation processes before beginning the training curriculum. Additionally, attempting to rate complex behavior such as that which surrounds the management of a critically ill patient is inherently fraught with difficulty. Some performance measures were rated as either inadequate or adequate; although we attempted to standardize definitions of these ratings; some degree of subjectivity is doubtless present. In addition, because it was not possible to blind all assessors to the identities of participants, the possibility of interpersonal bias in scoring is present. Furthermore, only three expert assessors were used to evaluate each trainee. The nature of video-recorded performances available for web evaluation may allow significantly more assessment input in future studies. Despite these limitations, we still found that there was a very high degree of interrater reliability in participant scores between the three assessors, suggesting that the application of the measurement tool was reliable.

In conclusion, we have demonstrated that a short, half-day curriculum evaluating five easily simulatable emergent ward/ICU scenarios can be useful in improving the skills of ICU APs. Such a curriculum may improve leadership and AP teamwork skills whereas at the same time increasing their confidence levels in managing high-risk scenarios. More generalized institution of this curriculum may better target continuing medical education needs for this group of experienced clinicians.

REFERENCES


AUTHOR PLEASE ANSWER ALL QUERIES

AQ1— Please specify what “ABC” denotes here.
AQ2— Kindly define MI.
AQ3— Please define ACGME.
AQ4— Please provide accessed date for the refs. 3 and 4.