Resident and Nurse Education in Pediatric Intensive Care Unit

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Girish G. Deshpande, Gwen J. Lombard, and Adalberto Torres Jr.

Abstract

In the current age of exponential increase in medical knowledge, advances in technology, and electronic data gathering, education of resident physicians and nurses in Pediatric Intensive Care is imperative. Resident physicians are spending less time caring for critically ill patients due to restricted work hours, mandatory didactics attendance and continuity clinics. Attending physicians have less protected time dedicated to education due to administrative and research demands. Nurses working in Pediatric Intensive Care are required to possess extensive clinical skills that are increasingly complex. Educators need to explore new avenues of providing training to both resident physicians and nurses. Using different modalities of simulation appears to be the most appealing solution by providing necessary training in safe and effective environment. This chapter explores several different avenues of improving education in Pediatric Intensive Care.

Keywords

Resident Education • Nurse Education • Pediatric Intensive Care Unit • Web-based education • Simulation training • Factors impacting resident education

To study the phenomenon of disease without books is to sail an uncharted sea; while to study books without seeing patients is not to go sea at all. – Sir William Osler

Introduction

Learning is a lifelong process; and this is especially necessary in medicine, which continues to evolve each day. Dreyfus and Dreyfus [1] described the stages of learning that individuals go through during their professional lives. These five stages are novice, advanced beginner, competent, proficient, and expert. Brenner applied this model in a study of the nursing profession. Expertise develops when the clinician tests, and refines propositions, hypotheses, and principle-based expectations in actual practice situations [2]. Hands on experience is essential for the development of the physician or nurse. In professional education, learners grow into teachers and teachers continue to be learners. The medical student becomes the first year resident and also a teacher of other medical students. More senior residents are teaching their juniors. The ever-changing practice of medicine requires physicians and nurses to engage in continued learning. Newer Accreditation Council for Graduate Medical Education (ACGME) guidelines intended to

G.G. Deshpande, MD
Department of Pediatrics, Children's Hospital of Illinois,
530 NE Glen Oak Ave, Peoria, IL 61637, USA
e-mail: girish@uic.edu

G.J. Lombard, PhD, RN
Department of Neurosurgery, University of Florida,
100 S. Newell Drive, 100265,
Gainesville, FL 32610-0265, USA
e-mail: lombard@neurosurgery.ufl.edu

A. Torres Jr., MD, MS (✉)
Department of Pediatrics, Nemours Children's Hospital,
13535 Nemours Pkwy, Orlando, FL 32827, USA
e-mail: altorres@uic.edu

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promote safe and effective patient care delivery, to improve quality and professionalism, and to promote resident well being, have created challenges in providing education to the trainees especially those in the Intensive Care Unit (ICU) environment [3, 4]. We as educators need to create new avenues and re-explore old ones to promote training in the ICU environment.

Uniqueness of Pediatric Intensive Care Units

Pediatric intensive care units (PICUs) are unique learning environments in several respects, including (1) the wide patient age range, (2) the patient illness severity, (3) the need for rapid treatment of unstable patients, (4) seasonal variations in workload and training opportunities, (5) continually changing technology and medications, and (6) the wide range of provider experience level. Patient age range varies from preterm neonates to adults. For example, adults undergoing repair for congenital heart disease may be admitted to a PICU if preferred by their cardiovascular surgeon. Many adults with life-long pediatric illnesses or conditions such as cystic fibrosis, cerebral palsy etc., may be admitted to the PICU because of their small size, familiarity with the PICU staff, or the referral preference of their primary physician.

Seasonal variations of certain diseases, especially infectious illnesses, cause large fluxes in both workload and learning opportunities for residents and new nurses. For example, the residents rotating through the PICU during respiratory syncytial virus season have a greater chance of performing tracheal intubations and learning respiratory pathophysiology than residents rotating through in the summer, which are more likely to see near-drowning or trauma.

Teaching PICUs are generally located in the regional referral institutions and therefore, they often attract more complex and severely ill patients from local community hospitals. Illnesses range from status asthmaticus to smoke inhalation, from diabetic ketoacidosis to adrenal crisis, from meningitis to head injury, and from sepsis to child abuse. Often a rapid deterioration in a patient's condition demands rapid interventions limiting time spent discussing therapeutic options with the resident or nurse.

The constantly evolving technology and endless introduction of new medications also make the PICU more challenging for learners who have to understand the basic principles while trying to conquer new information. Learners in the PICU face a daunting task of acquiring both new skills and knowledge while simultaneously caring for critically ill patients. They are also expected to develop self-directed and life-long learning skills [5]. At any time in the PICU there is a wide variety of professionals in training, which adds to the learning environment complexity. Although, to new residents and nurses, the PICU may appear alarmingly chaotic, intimidating, unforgiving, and unnerving, it offers a unique learning experience where they can expand their knowledge base, sharpen their clinical skills, and learn the value of a good clinical team.

Resident Education Techniques

Residents receive training and education through different formats such as patient care rounds, morning reports, didactics (conferences, grand rounds), small group discussions, mock codes and organized focused courses such as Pediatric Advanced Life Support provider course. Didactics, the most widely used format, has been well documented to be unsuccessful in changing physician performance and patient outcomes [6, 7]. Hence, medical educators have moved on to more interactive formats such as problem based learning (PBL) and computer assisted learning (CAL). Problem-based learning is designed for small groups that work together and independently on information gathering and problem-solving. The instructor (facilitator) selects the clinical scenario to enhance learner's cognitive and problem-solving abilities. Studies have shown PBL has a little effect on self-directed learning [8–10]. David and Patel provide an excellent review of PBL in pediatrics [11].

Advances in computer technology and accessibility combined with Internet access for medical resource have pushed CAL to the forefront of medical education format. One of the most informative and useful Web sites of pediatric intensive care is PedsCCM (http://www.pedsccm.org). Besides providing clinical tools, evidence-based reviews of applicable literature, and clinical guidelines pertaining to care of critically ill children, it also gives links to other informative websites, e.g. eMedicine.Medscape (http://emedcine.medscape.com/pediatrics_cardiac), a free online reference for Pediatric Critical Care topics [12].

The Pediatric Resident Committee, a subcommittee of the Pediatric Section of the Society of Critical Care Medicine (SCCM), developed a PICU Course to form a core curriculum for medical students and residents in pediatric critical care medicine. The slide presentations, authored by members of the Resident Education Committee are available for download at a nominal fee to computer/server from a new SCCM website, LearnICU.org [13]. Originally, the presentations were designed to provide a template for attending led didactic sessions. The presentations have been modified for self-learning to provide residents flexibility to view as many presentations as possible during time that is convenient to them. This site also offers a pre and post-test to registered users, but composite scores of the residents are not available to respective program directors. Evaluation of this resource's impact on resident learning is lacking. Although there is insufficient evidence to assert that CAL is more effective

than traditional methods, learners perform better when CAL supplements traditional methods [14]. Learners must possess basic computer literacy to take full advantage of this valuable and growing resource [15].

An active learning strategy that has been incorporated into medical school education for greater than 10 years [16] and is now being implemented into resident training is team-based learning (TBL). TBL fosters individual and group accountability as small group of learners work together to solve clinical problems. TBL employs three-phases: (1) advanced preparation by individuals, (2) readiness assurance via individual and group testing, and (3) problem-solving in small groups. Although there are no published reports of TBL being applied in pediatrics, there is evidence of TBL maintaining a learned clinical skill, i.e. patient alcohol screening and brief intervention, in family medicine residents [17].

Mock codes offer an opportunity to teach important critical thinking skills. Regular participation in mock codes prepares the resident to perform in crisis situations when there is little time to discuss therapeutic options and assistance with team building. Mock codes allow residents to participate not only in different roles but also in different settings. A successful mock code program has several benefits, one of which is working with nurses during a *crisis* when the consequences of mistakes are removed from patients [18].

Resident Education in Pediatric Critical Care

For more than 100 years, medical education has occurred in community settings. In the mid-nineteenth century, physicians were educated through preceptorships and apprenticeships. With the introduction of the full-time university post-Flexner model (1910), education shifted to the universities and their teaching hospitals, where most pediatric education was teacher centered [19]. In 1987, in a summary of a report by the American Board of Pediatrics regarding the future training of pediatricians, Cleveland and Brownlee [20] commented that the current training programs did not adequately prepare pediatric residents for practice and recommended emphasis on ambulatory or community-based training.

The *Final report of the FOPE (Future of Pediatric Education) II Pediatric Generalists of the Future Workgroup (2000)* describes the core attributes, skills, and competencies of the future generalist pediatrician and outlines implications of these requirements for residency training and continuing medical education [21]. The authors state that residents must be assured excellent training in the stabilization of critically ill or injured children to manage their problems appropriately in an acute care setting. This expectation requires sufficient experience in critical care medicine with older infants and children to be able to provide leadership to a team stabilizing a critically ill patient. A working knowledge of pediatric advanced life support and advanced pediatric life support techniques and algorithms, in addition to the knowledge base to construct a differential diagnosis for further care, is essential [21].

The ACGME guidelines group the intensive care experience of both Neonatal ICU and PICU together to be a minimum of 5 and a maximum of 6 months, of which minimum 3 and maximum 4 block months in NICU (level II or III) and 2 block months in PICU. Any additional call hours in PICU are not included in calculation of intensive care time. Guidelines also state that the curricula in PICU must be structured to, (1) familiarize residents with the special multidisciplinary and multi-organ implications of fluid, electrolyte, and metabolic disorders; (2) trauma, nutrition, and cardiorespiratory management; (3) infection control; and (4) recognition and management of congenital anomalies in pediatric patients. It must also be designed to teach the following:

1. recognition and management of isolated and multi-organ system failure and assessment of reversibility;
2. understanding organ system dysfunction variation by patient age;
3. integration of clinical assessment and laboratory data to formulate management and therapeutic plans for critically ill patients;
4. invasive and noninvasive techniques for monitoring and supporting pulmonary, cardiovascular, cerebral, and metabolic functions;
5. participation in PICU admission, discharge, and patient transfer decision making;
6. resuscitation, stabilization, and transportation of ICU patients;
7. understanding appropriate physician roles for the pediatrician and intensivist in these settings;
8. participation in preoperative and postoperative management of surgical patients, including understanding appropriate physician roles for the pediatrician and the intensivist in this settings;
9. evaluation and management critically ill patients following traumatic injury [3].

Residents are expected to use the on-line log provided by the ACGME for documentation of all procedures. The program directors must be able to show the competence of each resident for each procedure using this document. In addition to PALS training, the residents must have sufficient training in the following skills: (1) basic and advanced life support; (2) endotracheal intubation; (3) placement of intraosseous lines (demonstration in a skills lab or PALS course is sufficient); (4) placement of intravenous lines; (5) arterial puncture; (6) venipuncture; (7) umbilical artery and vein catheterization; (8) lumbar puncture; (9) bladder

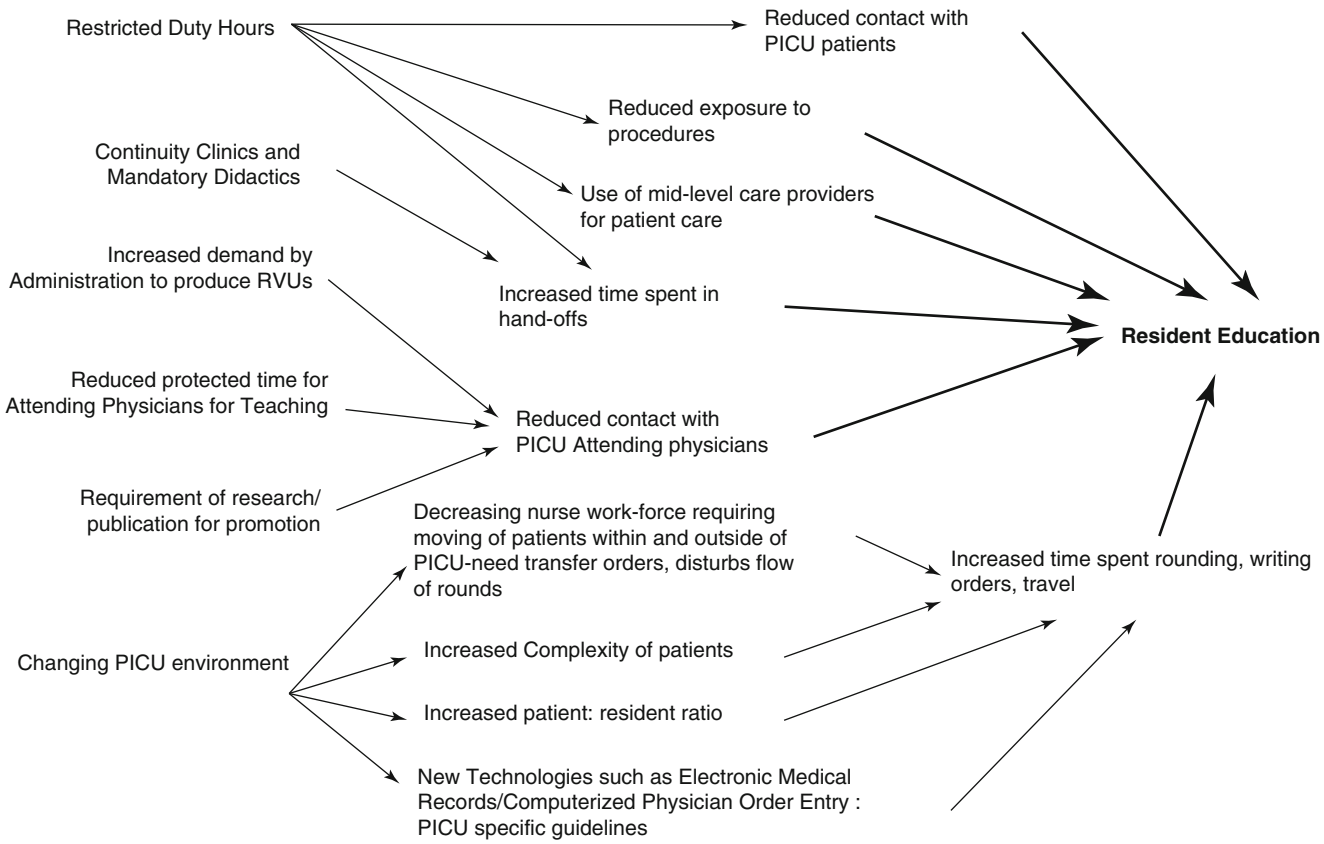

Fig. 12.1 Factors impacting resident education in pediatric critical care unit

catheterization; (10) wound care and suturing of lacerations; (11) procedural sedation and pain management; (12) chest tube placement and thoracentesis [3]. The remaining procedures listed in the ACGME document are more applicable outside of the PICU.

In July 2010, the ACGME implemented new standards for supervision and duty hours for residency programs. The 80-h work week averaged over 4-weeks is unchanged for all residents. The duty period of first year residents must not exceed 16 h in duration, while the intermediate and senior residents may be scheduled to a maximum of 24 h of continuous duty, with an additional 4 h permitted for handing off patients to another practitioner or, in unusual circumstances, remaining with an acutely ill patient. The new guidelines strongly suggest "strategic napping" especially after 16 h of continuous duty between 10 PM and 8 AM [22]. Resident education has been impacted by these changes overall but especially in intensive care units. The survey of program directors by Chudgar et al. showed resident availability, clinical workload, lack of faculty protected time for and lack of education funding as perceived education barriers. Resident delivered patient care, a core teaching method, has also suffered by reducing continuity of care, and increasing patient care transitions [4]. Figure 12.1 summarizes various factors that impact today's resident education in PICU; most have negative effects on training. Introduction of new technologies such as electronic medical records, computerized order entry, and introduction of new guidelines may both improve care safety and consistency but may also demand more resident time [23]. The service needs for ICUs have been increasing over the past several decades, with advances in technology, improved monitoring, and the survival of more chronically ill and technology dependent children. Increasing complexity of care provides educational opportunities, but may increase the time spent in rounding [23].

An emphasis on ambulatory and community pediatric rotations has occurred over past decade, with pediatric residents spending less time caring for hospitalized patients. The new duty hours rule from the Residency Review Committee [22] limits residents to spend 80 h per week (averaged over a 4-week period) in clinical and academic activities. Residents' continuity clinics also significantly reduce (10–30 %) inpatient care time. In addition, housestaff are expected to attend morning reports, didactic conferences, and grand rounds all of which require them to be relieved of patient care responsibilities. Other responsibilities of residents in the PICU include admitting patients, managing care inclusive of some procedures, collecting patient or clinical data (laboratory, imaging, and other tests), clarifying pharmacy data, participating in nursing discussions/clarifications, and making

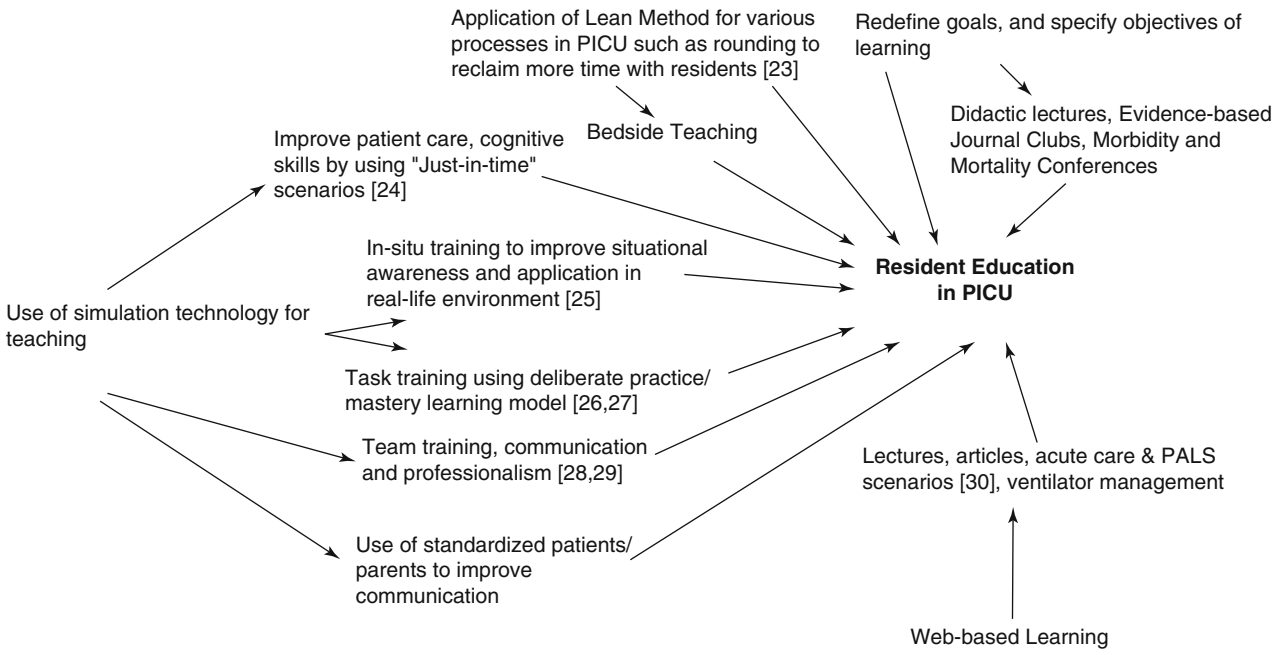

Fig. 12.2 Solutions proposed to enhance education in PICU

home care arrangements at the time of discharge of patients. Application of Lean Methodology geared towards resident education may be beneficial [23]. For example, having mid-level care providers to perform some repetitive responsibilities such as writing of total parenteral nutrition may free residents for other activities. Figure 12.2 offers some solutions implemented by educators in various fields to ameliorate current educational barriers [23–30]. One approach taken to meet PICU service needs has been to hire mid-level care providers or physician extenders such as advanced nurse practitioners and physician assistants. However, this alternative can be expensive, and has been reported to shift hospital support from resident education to service needs [31]. In addition, training these allied health professionals creates competition for learning opportunities between the housestaff and the physician extenders in smaller or slower PICUs.

Evaluation of Residents

Resident performance is assessed in six areas to the level expected of a new practitioner: patient care, medical knowledge, interpersonal skills and communication, practice-based learning and improvement, professionalism, and system-based practice. The ACGME website [32] also provides several tools to evaluate resident performance. The expectations for the residents in these six areas are as follows:

Patient care: Residents must be able to provide family-centered patient care that is culturally effective, developmentally and age appropriate, compassionate, and effective for the treatment of disease and the promotion of health.

Medical knowledge: Residents must demonstrate knowledge of established and evolving biomedical, clinical, epidemiologic, and social–behavioral sciences and application of this knowledge to patient care.

Practice-based learning and improvement: This involves the investigation and evaluation of care of patients, the appraisal and assimilation of scientific evidence, and improvements in inpatient care.

Interpersonal and communication skills: Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange and teaming with patients, their families, and professional associates.

Professionalism: Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to diversity.

System-based practice: This is manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care, as well as the ability to call effectively on other resources in the system to provide optimal health care.

Educating New Graduate Nurses

Nurses require ongoing education to face challenges related to increased care complexity including new medication education, electronic medical charting, in-servicing new

technologies such as ventilators and monitoring devices, and learning new care guidelines. Nurses often must learn while carrying a full clinical workload. New graduate nurses in the PICU have to simultaneously learn hospital policies and procedures and the pathophysiologies of the wide array of pediatric illnesses, while acquiring practical bedside skills (e.g., invasive catheter care). Clinical demands during periods of high census, high acuity, and/or inadequate staffing can disrupt the preceptor–novice relationship and create stress on the novice nurse that can be potentially detrimental to both learning and patient safety [33].

Strategies used to facilitate critical care learning by nurses include formal orientation programs, PBL, concept mapping, nursing narratives, learning contracts, and reflective practices [34–37]. The major limiting factor for learning identified by PICU nurses was time constraints [38]. Students had a strong preference for courses in which theory and content were related to practice, making learning more relevant. A nurturing environment with knowledgeable preceptors, peer support, flexible work schedule, and multiformat educational approach (e.g., lectures, videos, case studies) has been successful in improving graduate nurse retention in the PICU [39, 40]. To meet regulatory standards, hospital orientation and annual competency validation, nurse educators often use a skills lab or fair to assess knowledge and psychomotor skills. This however does not address integration of clinical judgment. Simulation based education can offer opportunities to develop decision-making skills and integration of critical care procedures and concepts into the employee competency curriculum [41]. Computer-assisted learning resources are available for critical care nurses [42] and can even facilitate learning critical nursing skills [43]. Interested readers are referred to excellent references that deal with conceptual [44, 45] and practical [46–48] learning principles for critical care nurses.

Nursing care in the PICU requires meticulous attention to detail and good communication skills to provide the best care to the critically ill child. Patients are treated with a multitude of medications and infusions; a small error in calculation, composition, or administration could cause morbidity or mortality. The graduate nurse discovers early in their PICU education whether she or he possesses the ability to thrive in this highly challenging environment.

Use of Simulators in Medical Education

Experiential learning or learner-centered teaching has been accepted as a useful strategy for educators in the PICU to employ. According to Kolb [49], it is through repeated learning experiences that learners' thoughts are formed and reformed. Guided practice allows learners to assimilate key concepts, attitudes, and skills. Skills to be learned in the PICU are hands on, procedural, or problem solving. Problem-solving skills include making decisions when adequate information is not available or in the presence of conflicting information. Occasionally, clinical problems are encountered that come with little guidance from the literature or experience to help manage the case.

Medical education has been based on apprenticeship techniques since the era of Hippocrates. Medical simulation offers the potential for the evolution of new teaching paradigms for the new millennium [5]. The use of human patient simulators and reflective practice has recently come to the forefront of critical care education [5, 15, 50]. High-fidelity simulators are full-bodied mannequins that breathe, talk, blink, have a palpable pulse, make urine, and have audible bowel sounds similar to patients [50]. Simulators such as those made by METI (Medical Education Technology Inc., Sarasota, FL; www.meti.com) and Laerdal (Laerdal Medical Corp., Wappingers Falls, NY; www.laerdal.com) are becoming increasingly available in large academic medical centers. High-fidelity simulators provide ideal opportunities for experiential learning and hands-on practice with use of real instruments with real-time patient reactions to students' actions. The simulators provide a number of prescribed cases for students. In addition, real patient cases and data can be used to create scenarios that recreate what happened in the unit. Simulators can also be used to maintain skills that may be used rarely in the PICU, such as cardiopulmonary resuscitation [51]. Simulators can create adverse situations such as esophageal intubation or dislodged endotracheal tubes that in real life could be life threatening and hence cannot be deliberately created. It is mandatory that physicians recognize such situations immediately and manage them correctly and swiftly. Reducing error in high-risk situations (i.e., codes) can be addressed through strategies such as crisis resource management training using simulation [52].

Simulators are educational tools that allow students to learn new skills in a safe environment. Scenarios can be played out so that learners can see the results of their actions without having the attending or instructors having to step in and correct their actions or decisions. The use of videotape provides an objective, time-coded record of trainee communication and actions and creates a powerful stimulus for learning during facilitated debriefing. Because the activities in the simulator pose no risk to patients or to professional liability, trainees are allowed to witness the natural evolutions of mistakes without the need for intervention by senior faculty [53]. Simulators can also be used for learner assessment and evaluation [54, 55]. This is especially important for the competencies in residency education and being able to document a resident's ability to perform critical skills and procedures [56]. Thus, in a new era of exponentially increasing medical knowledge and ever-decreasing patient contact,

simulation may offer an answer. According to Christine McGuire, Professor of Medical Education at the University of Illinois, simulation offers an opportunity to leverage the advantages of experiential learning and reflective practices through three defining characteristics: simulation imitates but does not duplicate reality, offers almost limitless opportunities to *go wrong*, and provides corrective feedback as a guide to future action [55]. Yager et al. has recently published an excellent review of simulation literature regarding its use in pediatric critical care and emergency medicine [57]. Andreatta et al., in their recent study showed progressive improvement in patient survival following pediatric cardiopulmonary arrest associated with an increase in number of mock codes over the 4-year study period [58]. This is the first study to link pediatric simulation based teaching to an important clinical outcome.

Conclusion

The PICU offers a unique learning environment. There are several models for adult learning, and success depends on the learner stage, methods used, and skill of the instructor/facilitator. Teaching residents all the knowledge base and procedural skills required by ACGME during their limited work hours is a challenge being faced by intensivists across the country. A combination of the many available educational approaches should be tailored to meet local educational needs while conforming to national standards. High-fidelity simulators appear to be a safe and effective way to teach and evaluate residents, fellows, and nurses inside or outside of the PICU environment.

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