Education of trainees in the intensive care unit

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The focus on improving education in critical care medicine must begin early in medical school training and further be promoted during residency if there is to be an increase in intensivists in the hospital workforce. This is "critical" to healthcare reform movements that are endorsing full-time critical care coverage in U.S. urban intensive care units. There is, therefore, a need for more novel approaches in educating trainees in critical care medicine to better prepare future physicians to manage acutely ill patients and improve patient safety. This article will review methods to improve educational designs in teaching critical care medicine to medical students, residents, and fellows, including the use of simulation technology to enhance cognition and procedural skills. (Crit Care Med 2007; 35[Suppl.]:S117–S121)

KEY WORDS: medical education; critical care; intensive care unit training; medical student curriculum; resident education; critical care fellowship; simulation education; intensivist

Since the inception of critical care training in the specialty of anesthesiology more than four decades ago, to its acceptance as a subspecialty of Internal Medicine, Surgery, and Pediatrics during the ensuing 20 yrs, and with its current recognition by the four respective American Boards of Medical Specialties, the education of trainees in critical care medicine (CCM) has continuously evolved to meet the increasing societal demands for dedicated intensivists directing the care of critically ill patients. Reform movements such as the Leapfrog Group (1), a coalition of major corporations who purchase health care for their employees and who focus on improving quality of care and patient safety within hospitals, project that with the use of computerized physician order entry, evidence-based hospital referral, and the institution of full-time intensivist coverage for all urban U.S. hospitals, >65,000 lives may be saved, >900,000 medication errors may be prevented, and more than $40 billion in healthcare costs may be conserved.

Scientific data support the notion that the quality of care and mortality rates for critically ill patients are dramatically improved when they are managed or co-managed by board-certified intensivists (2, 3), thus supporting the imperative to train more critical care physicians. The most recent data citing the number of current trainees participating in Accreditation Council for Graduate Medical Education–accredited CCM fellowships are listed in Table 1 (4). The paucity of anesthesiologists enrolled in anesthesia-CCM fellowship training may be reflective of a number of factors (5). First, and probably foremost, relates to the fact that only a minority of U.S. medical schools require students to formally participate in anesthesiology or intensive care unit (ICU) electives (6). As will be discussed, this lack of early medical school exposure has been shown to clearly influence future career choices. Second, this may be related to the lack of compensation for both clinical time and supervisory teaching when compared with operative anesthesia (7).

The other medical specialties face the challenges of mandated duty hour restrictions thereby limiting the time spent caring for critically ill patients and forcing many residency programs, especially in surgery, to curtail ICU rotations. Medical school administrators and residency and fellowship program directors will undoubtedly be forced to adopt novel educational techniques intended to expedite the advancement from novice to skilled and knowledgeable intensivists if they are to continue to attract students and residents to the subspecialty. The following article reviews educational designs for medical students, residents, and fellows in CCM.

Medical School Curricula in CCM

In 1994, the Council on Graduate Medical Education cited the need to promote a generalist curriculum, thus encouraging medical students to pursue primary care careers (8). Ambulatory care experiences were emphasized for all core clerkships, and hospital-based, subspecialty care was further relegated to elective rotation status. Mastering basic concepts of CCM is still not a mandatory requirement of medical school training. Therefore, as Cohen and Sprung (9) stated, "It seems unlikely that critical care . . . will be provided dedicated time in the form of core clerkships or dedicated courses in the preclinical years." It has been suggested, rather, that critical care educators rely less on traditional techniques of bedside teaching and classroom lectures and focus on developing problem-based learning discussions and objective structural clinical examinations and promote the use of standardized patients and simulated scenarios to advance medical school education in CCM (10, 11). During the first years of medical school training, education has traditionally been considered passive (i.e., consisting primarily of formal lectures and standardized written examinations). Preclinical courses such as pathology, pharmacology, physiology, and pathophysiology may touch on CCM topics, but in general, it is not until the clinical rotations of the third and fourth years of training when active or cooperative learning may enhance the student's body

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Table 1. Accreditation Council for Graduate Medical Education-accredited critical care medicine (CCM) fellowships, 2004–2005

Specialty	No. of Programs	No. of Positions	No. of Fellows
Anesthesiology	51	107	51
Internal medicine	31	192	154
(Pulmonary-CCM)	154	1,235	1,095
Pediatrics	58	360	288
Surgery	81	173	119
Totals	221	725	612

Data from the Accreditation Council for Graduate Medical Education (http://www.acgme.org).

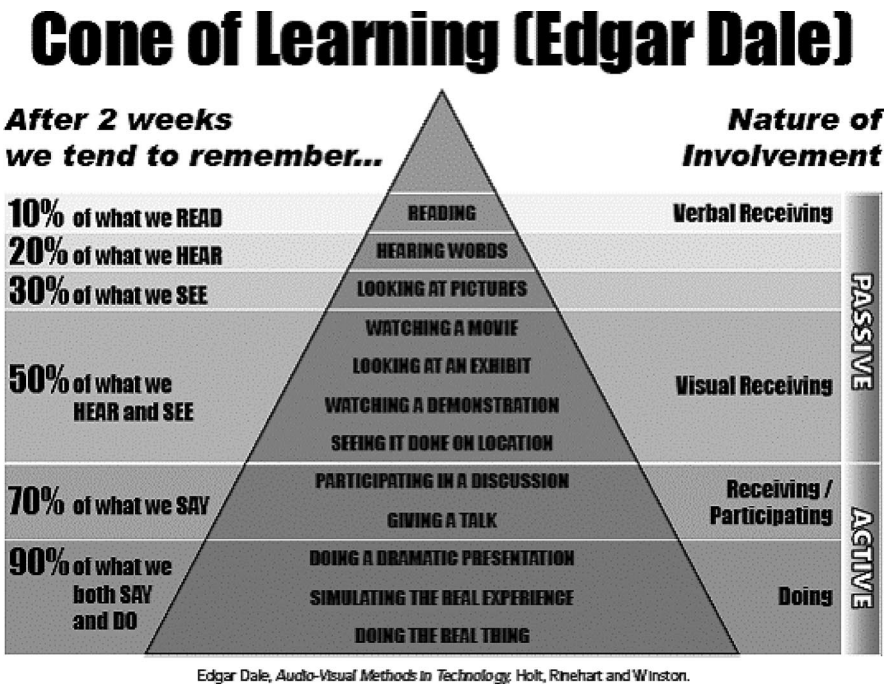

Figure 1. Cone of learning. Reproduced with permission from The Foundation Coalition (www.foundationcoalition.org).

of knowledge in the field. The so-called cone of learning, devised in 1969 by Dale (12), describes the most effective means by which knowledge is retained (Fig. 1) and forms the foundation by which CCM education can be built on. Frankel et al. (13) studied current methods of educating U.S. medical students in the principles of acute medical care. Approximately 90% of U.S. medical schools were either surveyed or had Web-based curricula available for review. Of these schools, 45% had formal undergraduate critical care curricula, 80% of which was specific to elective critical care–ICU rotations. In addition, four of the article's authors, who were members of the Society of Critical Care Medicine's (SCCM) Undergraduate Medical Education Committee, were allowed to review sample questions of the step 2 of the U.S. Medical Licensing Examination to ascertain the extent of the examination's focus on critical care content. Remarkably, 19% of the 1,200 questions reviewed pertained to critical organ dysfunction or life-threatening processes, the majority of which related to cardiovascular or respiratory disease. The authors justifiably recommended requiring critical care–ICU rotations to be part of all undergraduate curricula not only for the sake of education, but also for patient safety, citing the need for students to receive education not only in basic cardiopulmonary resuscitation skills, but also in more sophisticated concepts and procedures so that they could deliver safe and effective acute care as the residents of the future.

By increasing the exposure of medical students to CCM, we may begin to stimulate interest in pursuing careers as intensivists. The American College of Chest Physicians, in conjunction with the American Thoracic Society and the Society of Critical Care Medicine, formed a committee to investigate the future manpower needs for the respective subspecialties. Based on current and future demands for CCM services, the Committee on Manpower for Pulmonary and Critical Care Societies forecasted that without an increase in intensivists entering the workplace, there would be a shortage of critical care specialists of 22% by 2020 and 35% by 2030 (14). These projections, coupled with the increased life expectancy of the baby boomer generation, are factors that need to be considered by medical school deans and administrators who still believe in guiding students toward residencies in primary care specialties (15). Perhaps the time has come to mandate CCM as a core clerkship to improve the quality of medical education, endorse patient safety, and hopefully influence students and residents toward careers as intensivists.

If this is to happen, the CCM experience will need to be of high quality, given, as Williams et al. (16) have noted, "clerkship learning climates that are perceived by medical students as supporting their autonomy facilitate students' feeling competent at and being interested in the corresponding medical specialty, which in turn predicts students' being more likely to choose a career in that specialty." As the authors note in their study, the most profound factor in students' career choice was instructor stimulation of student interest in the problems most affecting the respective discipline. Several studies have examined medical school CCM rotations in an attempt to identify the most ideal methods of stimulating medical student interest in the subspecialty. A survey by Shen et al. (17) examined curricula of current CCM rotations and then formulated an undergraduate intensive care syllabus based on the responses. Topics noted included management of cardiopulmonary arrest, circulatory failure, respiratory failure, coma, sepsis, communication skills, and ethics in respect to end-of-life issues. Imparting this knowledge, however, must be done by utilizing innovative methods. As has been alluded to, this includes incorporating problem-based learning discussions or objective structural clinical examinations to better inspire more open discussion and knowledge retention. Rogers et al. (18) utilized the objective

structural clinical examination method in evaluating 40 fourth-year medical students before and after a critical care rotation. Students in general had a very poor grasp of CCM knowledge before a 1-month ICU rotation. However, cognition markedly improved after the rotation as assessed by five different critical care objective structural clinical examinations. Finally, medical student knowledge of and enthusiasm toward CCM can be enhanced by employing microsimulation with computer-based virtual reality programs such as fiberoptic bronchoscopy (19) or, more recently, with macrosimulation utilizing full human patient simulators (11, 20). Simulation is ideally suited for CCM, allowing for demonstrations of many CCM scenarios, including rare events such as malignant hyperthermia and more common situations such as ventilatory management of acute respiratory distress syndrome. Simulation allows for errors to occur in a controlled environment that eliminates the concern for patient safety, permits repetition and structural debriefing, and eliminates the "see one, do one, teach one" model that has been an accepted practice for decades in training programs. Future studies will continue to validate this technology as a viable tool in medical student education and evaluation.

Residency Curricula in CCM

Residency programs that require rotations in the ICU include anesthesiology, surgery, internal medicine, pediatrics, and emergency medicine. Other residencies, such as obstetrics and gynecology, neurology, and neurologic surgery, may also require CCM, or they may offer CCM training on an elective basis. Residents in CCM, in a similar fashion to third- and fourth-year medical students, acquire knowledge primarily through processes of active learning, by participating in daily bedside teaching rounds and by administering patient care, and by passive learning in the forms of lectures, morbidity and mortality conferences, and journal clubs. ICU rotations remain stressful due to the demands of caring for critically ill patients, irrespective of the aforementioned Accreditation Council for Graduate Medical Education restriction on duty hours. In this regard, the American College of Critical Care Medicine created guidelines for CCM training and continuing medical education to promote excellence in CCM education (21). It is recommended that an environment be created "in which excellence in patient care is the foundation for learning to care for the critically ill and injured patient" and that the ICU be intensivist-directed, multiprofessional, and collaborative in its approach to patient care. These guidelines also include direction for clinical training, research, and administrative duties. Unlike medical student curricula, however, resident and fellow education must address administrative issues and research mentoring (discussed below). To achieve these goals, the traditional educational framework previously discussed must be revised. Lim et al. (22) noted that by simply altering the time of didactic sessions in the medical ICU from after daily rounds (usually in the afternoon) to early in the morning markedly improved retention of knowledge in their residents. Studies that examine changes in instructional design are also crucial to advance cognitive skills and promote the specialty. Human patient simulation is another method that, in addition to partial task simulators (e.g., airway mannequins, central vein models) and virtual reality simulators, can enhance resident and fellow learning in CCM. In addition to evaluating the cognitive performance of residents, residency program directors must now be able to measure overall professional performance. In 2002, the Accreditation Council for Graduate Medical Education initiated core competencies that must be taught and evaluated by each residency program (4). In addition to compassionate patient care and medical knowledge, residents must develop: effective interpersonal and communication skills, ability to commit to life-long learning with demonstrative understanding of evidence-based investigative skills, awareness of systems-based practices, and professionalism, including practicing in an ethical and culturally sensitive manner. This is especially important as it relates to critically ill patients who, along with their families, are often faced with end-of-life decisions. Residency programs are responsible for developing methods to evaluate these core competencies in each resident and may include computer-based self-study, objective structural clinical examinations, standardized patients, or simulated scenarios. Glick (23) describes the process of "evidence-guided" education rather than evidence-based education as a way to influence curricular changes by utilizing not only outcome studies, but also patient safety data and continuous quality improvement analyses. Rosenbaum et al. (24) reviewed methods of teaching residents and medical students skills for delivering bad news, primarily by means of standardized patients and role modeling. This is an invaluable method of teaching end-of-life issues and can be incorporated into the simulation of a death scenario. Imperative to these types of encounters is the *postmortem* process of debriefing, an essential component of any form of standardized patient or simulation evaluation.

Fellowship Curricula in CCM

The American College of Critical Care Medicine guidelines for residency education and CCM also include recommendations for fellowship training (21). These guidelines are divided into the three broad categories of clinical, research, and administrative duties. In the clinical realm, fellows are expected to identify numerous critical conditions and initiate appropriate treatment. In addition to providing resuscitative efforts, fellows are expected to instruct healthcare providers and the lay public in theory and techniques of cardiopulmonary resuscitation, act as the ICU team leader, and initiate discussions involving ethical issues when making treatment plans. From an administrative standpoint, it is advised that fellows participate in ICU hospital policy evaluation and improvement, triage critically ill patients to optimize delivery of care within the institution, develop programs for patient safety monitoring and error reduction, and understand advanced concepts for reimbursements of critical care services and contractural issues related to providing such services. Fellows must develop as leaders within the hospital and learn to cope with the responsibilities of being an intensivist. The full guidelines are comprehensive, but this abbreviated list provides the framework for fellowship programs providing more than an education related solely to clinical care of critically ill patients.

One of the noticeable differences between residency and fellowship education is the role of the fellow as teacher. Kempainen et al. (25) recently reviewed a teaching proposal for pulmonary–critical care fellows at the University of Washington School of Medicine. Fellows who are mentored by faculty members led small groups of second-year medical students

for a 6-wk period in conferences related to respiratory pathophysiology. Weekly faculty instruction and frequent feedback was provided to each fellow by his or her faculty mentor. On completion of this course, fellows received evaluations both from their faculty mentor and medical students. The authors then surveyed fellows who had graduated from the program between 1987 and 1997 who were currently practicing intensivists, noting the predominant sentiment that their teaching assistant role was of great value and continued to provide benefit to their current practices.

Another area that is vital to fellowship training is, as was previously mentioned, dealing with the ethical dilemmas at the end-of-life. Fellows must receive formal education on end-of-life issues and become comfortable with initiating discussions with patients and families during the course of their training. Attending physicians and faculty mentors can provide guidance on how to approach these topics; however, it is often difficult to allow fellows to "practice" in a time of crisis. As was previously mentioned in the section on teaching residents on how to deliver bad news, this is another area in which simulation education may be useful. Scenarios may be written and administered in a controlled environment that allows the fellow to address these difficult questions and be given feedback on performance during debriefing sessions.

Finally, although all Accreditation Council for Graduate Medical Education–approved CCM fellowships require "research exposure," the definition of this has been loosely interpreted by most fellowship program directors. Powner and Thomas (26) surveyed fellowship programs in 1996 and found most programs to be in compliance with research experience requirements; however, most expressed significant hardships in achieving compliance with these recommendations. Areas of concern voiced by program directors in this survey included: 1) decreased funding to support fellow research, 2) insufficient time to perform meaningful research, 3) the amount of faculty time consumed as mentors, 4) objection to forcing fellows who may not wish to participate in research projects, and 5) difficulty balancing educational opportunities vs. clinical experience vs. research projects. The problems faced by CCM fellowships today are not vastly different from those voiced 10 yrs before this study. Research training during fellowship is vital, however, to the growth of the specialty and must be supported by training programs, with a need perhaps to standardize objectives for fellowship research experience among the four specialty training programs. This may also assist in the diminishing number of manuscripts being submitted to CCM-related publications (27).

At the conclusion of subspecialty training in CCM, fellows are expected to apply for and pass an American Board of Medical Specialties certifying examination. These Certificates of Special Competence examinations may provide insight into the ability of a fellow to recall facts; however, it provides limited insight into higher levels of cognition and problem-solving abilities. To assess these attributes, future Boards may consider employing simulation as a means of testing such proficiencies before certification.

Conclusion

Patient safety is at the forefront of medical practice, and nowhere is this more important than in the field of CCM. Therefore, improving the educational goals of both undergraduate and graduate training in CCM should be a mandate of all medical schools and residency training programs to ensure that we have competent and dedicated intensivists able to deliver quality medical care to all critically ill patients.

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