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Clinical Potpourri

Innovative strategies in critical care education☆

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ABSTRACT

The cadre of information pertinent to critical care medicine continues to expand at a tremendous pace, and we must adapt our strategies of medical education to keep up with the expansion. Differences in learners' characteristics can contribute to a mismatch with historical teaching strategies. Simulation is increasingly popular, but still far from universal. Emerging technology has the potential to improve our knowledge translation, but there is currently sparse literature describing these resources or their benefits and limitations. Directed strategies of assessment and feedback are often suboptimal. Even strategies of accreditation are evolving. This review attempts to summarize salient concepts, suggest resources, and highlight novel strategies to enhance practice and education in the challenging critical care environment.

1. Introduction

> Half of what you will learn in medical school will be proven wrong in 10 years. We just don't know which half.
>
> [C. Sidney Burwell (1893-1967)]

The totality of medical knowledge continues to increase at a dramatic pace [1,2], and each generation of learners has a greater deal of material to master than any preceding generation. In response, learning styles continue to develop as well, and effective educators should adapt their teaching strategies to accommodate their learners. The educational efforts of medical educators must be balanced with a duty to their patients. Increasingly, these are whittled by additional obligations, like administrative responsibilities, publication requirements, and an increasing proportion of time spent with documentation and billing. Care and education in the intensive care unit are certainly no exceptions. If anything, the acuity of care necessitates even more accurate and efficient educational methods. It has been recognized that this is an area with continued potential for improvement [3].

This review will provide an overview of educational principles and how emerging technology can augment them. Supporting evidence is provided when available. Critical care encompasses elements from all specialties; thus, many of the principles discussed are generalizable to medical education as a whole. Rather than providing a blueprint, the intention is to provide a framework, from which educators can understand and improve their curricula and teaching strategies.

2. Adult learning (andragogy)

> Education is not the learning of facts, but the training of the mind to think.
>
> [Albert Einstein (1879-1955)]

The physician historically operated as an independent, autonomous authority. In an increasingly interdisciplinary and sophisticated system, this role of a "personally expert sovereign physician" is no longer tenable [4]. No longer can one individual become a master of every element of anatomy, physiology, pharmacology, and the panoply of other components of complex medical care. With a variety of resources constantly (and literally) at our fingertips, we no longer need to function as a data repository. Instead, we recognize ourselves as a *learned intermediary*, one who acts as a bridge between a patient and the vast body of constantly improving medical knowledge. Consequently, medical education is shifting toward *application* rather than *acquisition* of knowledge. Many schools have integrated problem-based learning classes into the curriculum to facilitate this transition. Rather than focusing on teaching information, we can improve methods of teaching *how to find* information. These skills are still predicated on an underlying knowledge base; thus, transmission of knowledge remains an important component of medical education. In addition, acquisition of practical skills like interpersonal communication, procedural competency, and critical thinking remains imperative.

Pedagogy (from the Greek *paidos* "child" and *ágō* "lead," literally "to lead a child") has been colloquially equated with teaching. More recently, however, the term *andragogy* has gained popularity to distinguish

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adult learning [5]. Indeed, adult learning differs from childhood learning in several important ways (Table 1).

Although expensive textbooks may still line the offices of many physicians, they can no longer keep pace with the rapid evolution of medical knowledge and have been largely supplanted by other forms of media. In addition to marked increases in the capacity to store information, improvements in technology have improved the way we share this information. Physicians more remote from medical school graduation are less likely to use technology compared with their more contemporary counterparts [6,7]. This may not seem surprising, but it does highlight a potential disconnect between a generation that is teaching and another that is learning.

Learners from different backgrounds and environmental influences may receive and assimilate information differently. An increasingly recognized distinction is the difference in learning styles between learners born into different generations (Table 2) [8–11]. For example, learners from *Generation X* (those born from approximately 1965 to 1980) tend to be more self-oriented, pragmatic, and skeptical. They may respond better to individual learning environments and self-directed activities. In contrast, learners from the *Millennial Generation* (born 1981-1999) tend toward more community-focused, societal problem solving. They may learn better from collaborative environments and group activities. Of course, there is great potential for overlap between these groups, and no one learning style is ideal for all learners.

3. Flipped classroom

The traditional classroom model of education consists of a lecture conducted in front of a group audience, followed by application and problem solving ("homework") performed individually. In terms of Bloom's educational taxonomy [12,13], this presents a situation in which lower-level cognitive functioning like knowledge acquisition occurs in a group setting, whereas higher-level functions like application of knowledge occur individually, when assistance may not be available (Fig. 1). The "flipped classroom" model (also called "flip teaching" or "blended teaching") [14,15] proposes to have the less interactive lecture-style portions of the curriculum performed individually (eg, an online video), followed by group sessions in which application of the concepts and problem solving can be performed with the instructor's help.

This strategy also provides a distinct advantage for learners progressing at different paces. Independently, learners can watch, rewind, or slow down instructional videos. The classroom experience provides an environment to ask for clarification, or pursue more advanced topics. Clintondale High School in Michigan demonstrated successful implementation of this flipped-classroom education strategy throughout their curriculum [16]. This model is particularly well suited for adult learners, and some medical education curricula have already started to use this model [17].

Table 1
Attributes of adult learners

Previous knowledge	Building from a preexisting cache of knowledge may enhance the educational experience, but may pose a challenge when introducing new information conflicting with previously held conceptions, or a barrier with illusory superiority [58].
Self-motivated	Adult learners are often self-selected for advanced learning opportunities, in contrast to children who may be "required" to attend school.
Problem-centered	Adult learners tend to focus on more pragmatic aspects of education (problem-solving) and often have difficulty with rote learning.
Time-constrained	Adults often have more demands on their time outside the learning environment (family, work, etc), which may compromise the time they have to dedicate to learning. Although this may pose a negative influence, it also may cultivate a sense of efficiency.

4. Simulation

We have a duty to provide patient care in accord with our educational goals and must find a balance between "learning opportunities" and optimal patient care. The development of mastery is predicated upon the suggestion that a learner does not inherently have adequate skill to act autonomously. Development takes time, and mistakes may occur [18,19]. In order to mitigate these effects on patient care, one strategy has been to simulate patient encounters.

Following the lead of the military and airline industry, evidence for medical simulation demonstrates improved resident performance compared with traditional clinical didactics and can do so in a shorter time frame [20,21]. Beyond clinical management, simulation of procedures may increase knowledge retention and lead to improved patient outcomes [22,23]. The term *medical simulation* encompasses multiple modalities, including high-fidelity mannequin simulators, partial task trainers, computer-based virtual reality, simulated patients, and simulated environments [24]. The choice of equipment follows teleologically from learning objectives as well as practical issues like cost, availability, and technical support. Medical simulation can be used to support the transmission of tacit knowledge, the translation of explicit knowledge, and the teaching of nontechnical skills such as teamwork, communication, and leadership. It can also be a powerful tool in the assessment of learners [25,26].

Effective simulation is grounded in current educational theory. As an adjunct to clinical experiences and traditional teaching methods, simulated scenarios may provoke emotional activation that ingrains the learning experience [27]. It provides additional opportunities to move through the Kolb cycle of experiential learning (active experimentation leading to concrete experiences, followed by reflective debriefing and the solidification of abstract concepts) [28], without risk of adversity to a patient (Fig. 2). Furthermore, simulation gives educators the ability to offer a comprehensive clinical education, not subject to the variability of time and chance encounters [27]. Every student can be afforded the chance to primarily manage critical patients and rare pathology under the controlled and scheduled tutelage of an instructor [29]. Cases can be graduated and repeated, pushing students through zones of development toward mastery [30]. Finally, it has been demonstrated that simulation as a version of deliberate practice can lead to more effective and lasting results than traditional methods [31,32].

In practice, medical simulation is commonly divided into 3 main phases—prebriefing, simulation, and debriefing [31]. The learning process relies on creating a conducive environment, often described as a "safe" learning space. The prebriefing is pivotal in creating this environment and priming learners for engagement. The simulation scenarios themselves provide the setting for participants to demonstrate and probe the limits of their knowledge, skills, and abilities while the educator observes. Finally, the debriefing phase brings the learner and educator together to discuss reactions and facts, explore knowledge gaps, and provide an opportunity to bridge these gaps. In addition to summative assessment, the feedback given during the debriefing process can be one of the educator's most powerful tools for formative assessment [33]. Unfortunately, there is not yet a great deal of convincing evidence to support or refute the use of simulation for medical education [34]. And simulation is not without its limitations. Over-reliance on simulation may cause exaggerated confidence and deter learners from questioning their decisions. Simulated scenarios may be simplified and miss subtle but important elements. It is not possible to predict or simulate every situation, thus it should be considered an adjunct to other teaching methods.

5. Personal portable electronic devices

Personal portable electronic devices (eg, "smartphones" or electronic tablets), with their associated software applications ("apps"), have become ubiquitous in our society. There are more