Virtual Mentor
American Medical Association Journal of Ethics
January 2015, Volume 17, Number 1: 33-36.

MEDICAL EDUCATION

Evaluating Simulation as a Teaching Tool in Neurosurgery

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The term “simulation” is not foreign to the medical community. For decades, medical students, residents, and practicing physicians have all had the opportunity to hone their skills using medical simulation [1]. Whether it be simulated office visits with “standardized patients” or the cutting-edge technology of virtual reality simulators, the medical field has not only welcomed but relied on simulation for physician training in its ever-present goal of providing high-quality, cost-effective, and efficient care.

Key initiatives have noted the benefits of simulation in surgical training, most specifically general surgery [2]. Neurosurgery has lagged somewhat behind. Given the complexity of the anatomy of the central nervous system and the correspondingly complex nature of the procedures performed, simulation has not yet found a niche in training for neurosurgical procedures [3, 4].

There are numerous options for use of simulated neurosurgery [4-6]. Here we hope to highlight important ethical and institutional questions regarding the use of simulators. We’ve identified two sets of considerations for discussion. The first relates to the evaluation of neurosurgeons who use simulators and how it pertains to the expected outcomes for procedures performed after simulation has been completed. The second relates to access to simulators and institutional policies regarding their use. We believe that, with the advancement of simulation technology and adequate means for evaluating competency and outcomes, simulators will prove beneficial for neurosurgery training.

Data from many disciplines has demonstrated that simulation can be an effective educational tool [1, 7-12]. Neurosurgery must determine how to evaluate simulation’s effectiveness in our field: first, does the use of a simulator provide a false sense of security for an ill-prepared or under-experienced surgeon? And second, do successful outcomes in a simulation prove competency?

A major distinction between medicine and other fields such as flight instruction that use simulation in training is the predictability of circumstances and consequences [13]. Consider, for example, intracranial aneurysm treatment. Aneurysms of the same size, configuration, and location can have different susceptibilities to rupture during a procedure. With available imaging technology it is impossible to predict and recreate the exact wall strength of an aneurysm for a specific patient. Hence wall strength cannot be modeled in the patient-specific manner necessary for realistic rehearsal. Thus success in simulated surgery may lead to a false sense of security, a fact that has been noted in other surgical fields [14, 15].

Defining competency is another challenge. Simulators are being evaluated for their ability to provide an experience as close to reality as possible, but the metrics by which "competency" is defined must also be further refined if we are to equate simulator proficiency with actual surgical capability [16]. The American College of Surgeons now uses simulation as a tool for competency assessments before surgeons are permitted to perform laparoscopic surgery on patients [17, 18]. Stefanidis and colleagues agree and suggest that training to expertise, rather than just competency, should be the standard for all simulation efforts [18]. Establishing objective standards for competence or expertise will no doubt be valuable in the training and continuing education of neurosurgeons, but thoughtful crafting of these standards will be necessary to their success. It is likely that the critical factors for success differ, for example, in laparoscopic procedures and in the microsurgical clipping of an intracranial aneurysm. Current laparoscopic simulation tools may be able to assess competency in general, rather than enable patient-specific rehearsal, but the validity of competency assessment with aneurysm clipping requires further evaluation. This is not to say that simulation is unnecessary in neurosurgical training, but rather to highlight the need for continued evaluation of competency-based, patient-specific simulation.

The second set of questions pertains to the institutional cost of and access to simulators. In theory, all institutions should ensure that every surgeon has access to the best training tools available. By providing these instruments, the institutions further the agenda of high-quality, cutting-edge care. But the investment necessary is costly in both dollars and time and resources. Will an institution be expected or mandated to incur these training costs? Should patients or their insurance companies be billed for the use of simulators? These critical areas of concern need to be carefully evaluated before requiring simulation as a training modality in neurosurgery.

For over a century now, surgeons have acquired their skills through apprentice-based mentoring in residency programs based on Halstedian principles [19]. This has produced generations of skilled surgeons. Now, in an era of consumer-driven care, we must consider whether patients have the right to expect that their surgeon has had access to a simulator to rehearse their surgery before performing it on them. Although there is no clear consensus regarding outcomes associated with the use of neurosurgery simulators [20], we remain vigilant in our efforts to advance the technology and the science by which we evaluate their use. Currently, the Congress of Neurological Surgeons Bootcamp for young neurosurgeons [21] and many medical centers like ours are making the investment in model-based simulation for residency training because we believe in its potential. Given the history of the success of simulation across other disciplines, we know it holds value [1, 2]. Bob Dylan may have said it best: "you don't need a weatherman to know which way the wind blows" [22].

As stated above, in numerous disciplines simulators have been shown to improve end-user skills and are now considered standard in training. The best-documented example is in pilot training with flight simulators [12]. Every passenger expects that his or her pilot has flown a simulator successfully. Patients should have the same expectations, and therefore simulators in neurosurgery should strive to satisfy these same standards of effectiveness and usefulness. So, although the wind is clearly blowing, and we have seen early adoption, we owe it to our specialty, our patients, and ourselves to strive to document effectiveness in skill acquisition and outcome, so that we can better understand the true professional and institutional impact of simulators in neurosurgical training and practice.

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