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Neurosurgeon as educator: a review of principles of adult education and assessment applied to neurosurgery

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Traditionally, neurosurgical education is carried out by academically inclined neurosurgeons at teaching institutions. For the most part, these neurosurgeons are excellent role models who teach by example, but who lack formal instruction in adult educational principles; however, increasing pressure for more formalized educational methods in resident training exists.17,81 This pressure to increase the efficacy of neurosurgical education has developed for several reasons, including resident duty-hour restraints, public concerns about supervision of trainees, and the realization that the ever-increasing fund of knowledge required by a practicing neurosurgeon mandates acquiring lifelong learning skills.8,41,43,58,72 Furthermore, the contemporary neurosurgeon is expected to be the leader of a medical team that includes advanced practice clinicians, operating room nurses and technicians, and staff in the intensive care and surgical wards. Part of this leadership role involves the instruction, supervision, and assessment of those involved in caring for patients with neurological illnesses. Furthermore, a neurosurgeon is responsible for the education of patients and patient families before treatment plans can be formulated. The goal of this paper is to review the literature regarding education in neurosurgery and to identify principles of adult learning and assessment that should be woven into the framework of neurosurgery education.

Principles of Adult Learning

A complete and comprehensive review of how adults learn can be found elsewhere.85 This report aims to focus on those elements most relevant to neurosurgical education, emphasizing basic tenets that should be understood by all neurosurgery educators. Learning includes the acquisition of 3 domains: knowledge, skills, and attitudes. Becoming a member of the neurological profession not only demands the acquisition of knowledge and skills but also involves a process of growing into the professional community.85 The literature contains a number of models of learning, including 4 that appear to be particularly relevant to neurosurgical education: constructionism, scaffolding, the traditional Miller’s pyramid, and cognitive apprenticeship. A constructionist viewpoint, in which learning is the process of constructing new knowledge on the foundations of what the learner already knows,85,88 seems to be most relevant for neurosurgical education. For example, when a neurosurgeon sees a patient with a new disease process or hears a lecture on that disease, he or she compares this with what is already known and reflects on the difference. This can be exemplified by the experiential learning model proposed by Kolb.51,85 In Kolb’s scheme (Fig. 1), the learner has a concrete experience (observation of a new procedure) upon which he/she reflects (reads and studies the details of the procedure). Through reflection, the learner formulates abstract concepts and makes appropriate generalizations (begins to perform the procedure under direct supervision). The learner then consolidates his/her understanding by testing the implications of this knowledge in new situations (performs this procedure and similar procedures with decreasing levels of supervision), which provides a concrete experience, and the cycle continues.85

The term “scaffolding” refers to an educational structure that guides learners through the process of understanding how new information is part of the whole.85 Scaffolding includes curriculum organization, specific reading assignments, topic lectures, and planned experiential learning in the clinic and operating room, and it makes explicit the overall objectives and intended learning outcomes for the neurosurgical learner. Probably the best example of this within organized neurosurgery is the
Matrix Curriculum developed by educational and academic leaders in the field aiming to establish a “core curriculum” for resident training that will be discussed later in this review.

A third relevant model is Miller’s pyramid (Fig. 2). In this model, the learner (1st- or 2nd-year resident) obtains factual knowledge as a prerequisite for future experiences—this is the “knows” level of the pyramid. In the neurosurgical setting, this includes the basics of neuroanatomy, neurophysiology, etc., and is measured by written neurosurgical board examinations and with basic questions on rounds. The next step on the pyramid is the “knows how” level, which is manifested by the ability of the learner (midlevel resident) to manipulate or apply this knowledge to a specific patient’s disease process. As one transcends to the “shows how” stage (senior resident), all acquired knowledge and skill are put to test in a somewhat independent yet supervised environment. Finally, the highest level of Miller’s pyramid is the “does” stage, which corresponds to the practicing neurosurgeon. To the traditional scheme of Miller could be added the capstone “does better,” in which, with further experience, innovation, and research, the “life-long learner” improves practice and moves the field forward.

Finally, there is the concept of the cognitive apprenticeship model of Collins et al. In this model, the novice engages with more experienced individuals performing a given task or solving a problem. The model involves 5 elements: demonstration of the thinking process (Modeling), assisting and supporting learner activities by methods including scaffolding (Coaching), self-analysis and assessment (Reflection), verbalizing the result of the reflection (Articulation), and formation and testing of own theory (Exploration). The fundamental premise in this model is making the thinking process visible to the learner rather than observational.

**Principles of Assessment**

In general, assessment of medical and surgical trainees is competency based. This means that the trainee achieves a set of predefined criteria during his/her training before moving to the next level of instruction. The assessment of skills at each level is very important. In neurosurgery, this is particularly challenging because trainees need to be evaluated in several different environments (e.g., operating room, emergency room, clinic, and patient wards) on a broad range of skills and knowledge (e.g., operative, interpersonal, cognitive, organizational, leadership, and ethics).

An effective assessment tool should fulfill 5 important criteria. The assessment process and tool must be 1) appropriate for goal of the assessment; 2) feasible for the rater to use and easily understandable; 3) economical and cost effective; 4) objective with very limited subjectivity of the rating; and 5) reliable and valid. Reliability refers to whether a test is consistent in its outcome (inter-item consistency, inter-rater reliability, and inter-test reliability). If an instrument is not reliable it cannot be valid (Table 1). Validity is defined as the property of being true, correct, and in conformity with reality. Validity answers the question “Does our assessment measure what we think it measures?” Construct validity is the ability of a measurement scale to score as predicted compared with other measurement scales. Predictive validity, which refers to the extent to which a test predicts future performance, would be the most desired type of validity for surgical practice. For example, predictive validity would indicate what score on the oral neurosurgical board ex-