Neurosurgery Education: The Pursuit of Excellence

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The pursuit of excellence in education is a noble endeavor. Such has been the object of education and the goal of educators for eons. Neurosurgery education is no different from other domains in this regard. As with any discipline, this pursuit is complex and obligatorily multifaceted. It involves the use of what is often a broad and deep foundation of experience and knowledge. On this foundation, a modern and evolving infrastructure/suprastructure should be developed and nurtured. Once the infrastructure/suprastructure has taken form, a resident education plan can be derived. This plan, once enacted and executed, should be revisited, revised, and re-executed over and over again.

One should never become satisfied with the status quo. A continued search for strategies and tools that achieve improvements over prior renditions of the education plan is mandatory if we hope to perpetually upgrade our process of education. Neurosurgical educators should seek criticism, admit mistakes, and modify educational behaviors accordingly. A strategy for achieving these goals regarding the pursuit of excellence in neurosurgical education is described in the pages that follow.

The pursuit of excellence regarding the education of neurosurgeons is multifaceted. It requires the following key components: (1) the effective use of the existing foundation for neurosurgery education, (2) the nurturing and evolutionary development of the infrastructure/suprastructure of the education process (ie, process of our ''education collectiveness''), (3) the execution of a well-thought-out resident educational plan, and (4) the frequent revisitation and re-execution of this educational plan following critique– and self-assessment–driven modifications. The latter includes the identification of areas in which improvement is needed, followed by modification of the existing strategy and its re-execution.

The existing foundations of neurosurgery education include the fundamentals of education theory, an emphasis on discipline regarding learning and responsibility for patient care, and the application of ethical and moral principles to the education process. The establishment and nurturing of the infrastructure/suprastructure involve a focus on competency assessment, the use of the portfolio concept, a refinement of the didactic learning process, the establishment and use of interactive teaching skills, and the ''directed evolution'' of clinical education skills. The execution of the education paradigm so established must be accomplished with forethought and diligence. This requires vigilance on the part of both the educator and the learner.

Finally, the education process requires self-assessment, modification, and re-execution. Educators must assess, reassess, modify, implement, and repeat this process on an ongoing basis. They should seek criticism, admit mistakes, and modify educational behaviors accordingly.

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THE FOUNDATION

The ''nuts and bolts'' of postgraduate medical education have been extensively studied and are well known to seasoned neurosurgery educators. Essentially, all of us are both teachers and learners. Teaching, it is emphasized, involves much more than simply the transmission of information. The stage must be appropriately set to optimize the learning process. The subtleties of this ''stage-setting'' process are significant and nearly always unrecognized by the casual observer. During my residency, Sanford Larson, my mentor (Figure 1), was a master ''stage setter.'' The statement ''I cannot teach you anything. The most I can hope is that I cause you to learn,'' exemplifies his mastery of this component of the education process.

Regardless, the education of clinicians requires significant effort and energy, from which is derived immense enjoyment and reward. Neurosurgeons have traditionally used a tiered approach to education, which involves the faculty at the top of the tier, occasionally with fellows beneath the faculty, followed by chief residents and finally junior residents (Figure 2). In general, knowledge and skills pass from the top down (Figure 2). This fosters a similarly tiered, comprehensive approach to patient care. Within this tiered system, teaching responsibilities include technical (operative) skills, ward (inpatient) clinical skills, outpatient clinical skills, and other skills (such as system-based practice educational endeavors). They involve didactic education, hands-on education, and teaching by both example and observation. All must be coordinated during the aforementioned programmatic and calculated setting of the educational stage process.

FIGURE 1. Sanford Larson.

Repetitio est mater studiorum. Repetition is the mother of studies (learning). Literally translated, *repetition is good*. As learners, we retain 10% of what we read, 20% of what we hear, 30% of what we read and hear, 50% of what we hear and see, 70% of what we say ourselves, and 90% of what we do or teach. It is clear that through this iterative and repetitive process we secure information and skills. It is also clear that we must be cognizant of this process and formulate educational environments and strategies that optimize learning. We must begin with a baseline knowledge base. We then must add raw data and new information. This information must then be applied to clinical practice. Finally, we must add more data and information, reapply this to clinical practice, modify clinical and teaching behavior, reassess, and again reapply as we acquire experience in the educational arena. Hence, we ideally teach and learn in an enriched environment as we become better and better at the educational (and learning) process.

THE TEACHING OF WISDOM

■ *The most important human endeavor is the striving for morality in our actions. Our inner balance and even our existence depend on it. Only morality in our actions can give beauty and dignity to life. To make this a living force and bring it to clear consciousness is perhaps the foremost task of education.*

— Albert Einstein

Educators assume, whether they like it or not, an ethical and moral obligation to teach ''the right way'' to do things. As Einstein stated, this must become a ''living force'' and be brought to ''clear consciousness.'' The arguable father of postgraduate medical education, William Osler, was mindful of our moral obligations. He stated that we must:

[*b*]*egin early to make a threefold category—clear cases, doubtful cases, mistakes. And then learn to play the game fair. No self deception. No shrinking from the truth. Mercy and consideration for the other man, but none for yourself, upon whom you have to keep an incessant watch… It is only by getting your cases grouped in this way that you can make any real progress in your (continuing) education; only in this way can you gain wisdom from experience.*[1]

Indeed, we must learn from our doubtful cases and mistakes. We should not deceive ourselves, and we should not shrink from the truth. This requires self-scrutiny and honest self-assessment. This may not be as simple as it would appear to be. Friedrich Nietzsche stated, ''The most common lie is that which one lies to himself; lying to others is, relatively, an exception.'' Such self-assessments are essential. They must be practiced and they must be taught. Without such introspection, deviations from the norm can be expected.[2]

The ''self-deceit'' process, highlighted by Nietzsche, is exemplified by a poll taken at a recent medical meeting. At this meeting, a speaker with an audience of some 400 physicians armed with an audience response system presented a case and asked the audience members if they would recommend a surgical procedure for the patient described in a case presentation. Approximately 80% of the responders said they would. When asked during a subsequent polling of the same audience whether they themselves would have the surgery if they were the patient, only 20% responded affirmatively. This disparity in responses is both disturbing and damning. This disconnect between that which one would recommend for another and for oneself does not exemplify what most would consider wisdom. We must reinforce and teach the notion that a core ideology of ''patient first'' and ''patient-centricity'' is the key to our educational process. We must teach the incorporation of this ideology in each of our respective learning environments.

I had previously defined clinical wisdom as ''the ability to effectively assimilate data, observations and prior experiences for the purpose of optimizing clinical decision-making by using a patient-centric approach.''[3] The essence of the application of a patient-centric approach is manifested by always putting the patient first. One must ask, before making a surgical recommendation, ''Would I have this procedure, or

FIGURE 2. Tiered approach to neurosurgical education.

would I recommend this procedure to one of my family members?'' From a teaching and learning perspective, such an approach can be taught and hence learned, predominantly via a ''teach by example'' approach.

Evidence-based methodologies are defined by Sackett as ''The conscientious, explicit, and judicious use of the current best evidence in making decisions about the care of individual patients.''[4] However, as initially stated by Charles Wentworth Dilke and Benjamin Disraeli, and popularized by Mark Twain, ''There are three kinds of lies: Lies, damn lies and statistics.'' Henceforth, if we are to trust in our literature and use the literature to assist us in clinical decision making, we must first understand the nature of the literature. The literature is dominated by anecdotes, retrospective and uncontrolled prospective studies, biased prospective controlled studies, and investigational device exemption studies that are often designed to demonstrate noninferiority to an inferior strategy. Bias and the influence of the market and academic pressures on the validity of the academic process and the literature itself are manifest.

Bob Harbaugh, in his 2009 lecture at the Research Update in Neuroscience for Neurosurgeons course in Wood's Hole, Mass, stated that ''good clinical research requires clarity of thought and a deep understanding of the clinical problem, not manipulation of the data.'' He went on to state that ''the present algorithm of evidence-based medicine is badly flawed, particularly for surgical specialties'' and that ''data manipulation, no matter how sophisticated, cannot correct a systematic bias in a study. It is our understanding of the clinical problem that prevents us from being slaves to data manipulation.'' He emphasized the difference between accuracy and precision and that we desire both accuracy and precision from our clinical studies. Accuracy, however, is not readily achievable because the ''target'' is often unknown. When data are presented that appear precise (results clustered closely together), they may lack accuracy (the clustering may be off target). For example, the demonstration of an improved neurological outcome in an artificial cervical disk (treatment) group over a traditional spacer (control) group in a prospective randomized clinical trial comparing a cervical artificial disk with conventional anterior cervical diskectomy and fusion (ACDF) would appear illogical because the neurologic-related outcomes are not associated with the choice of spacer but rather the decompression component of the procedure itself.[5] Similarly, the return-to-work time frame in another artificial disk study comparing cervical disk replacement with ACDF was significantly different between treatment (artificial disk) and control (ACDF) groups.[6] The ACDF group did not return to work until >60 days postoperatively. This is at odds with the majority of the published ACDF literature and the personal experience of most surgeons in which the return to work is several weeks sooner. The cause of these aberrant and unexpected results is indeed multifactorial. A multitude of biases, conflicted interests, and inherent methodological study flaws may, at least in part, explain such deviations from the expected. With such unexpected results, one might be led to believe all other data emanating from the clinical trial to be aberrant and inaccurate (but perhaps, precise) as well. In these cases, the results may be clustered (precise) but may have shifted. Therefore, they indeed may be precise but not accurate. Harbaugh concludes in this regard, ''if our measurements show statistically significant differences in a way that makes no sense, we need to be 'wise' [quotation marks mine] enough to recognize such, and then determine 'where we went wrong.' ''

It appears to me, after extensive observations and careful assessments, that the literature is flawed. Sackett himself has emphasized the need to temper our enthusiasm regarding the meaningfulness of the literature. He states, ''Good doctors use both individual clinical expertise and the best available external evidence, and neither alone is enough. Without clinical expertise, practice risks becoming tyrannized by evidence, because even excellent external evidence may be inapplicable to or inappropriate for an individual patient. Without current best evidence, practice risks rapidly becoming out of date, to the detriment of patients.''[4]

One could conceptualize wisdom and intelligence as overlapping rings (Figure 3A). A wolf is cunning and, in many ways, wise but not intelligent. One could conceptualize the wisdom-intelligence relationship of a wolf as in Figure 3B. On the other hand, physicians who chose a treatment strategy that they would not choose for themselves might indeed be intelligent but not wise. In fact, they may be ''lying to themselves'' as per Nietzsche (Figure 3C). Figure 4 depicts an ancient writing. It is the first written documentation of what is

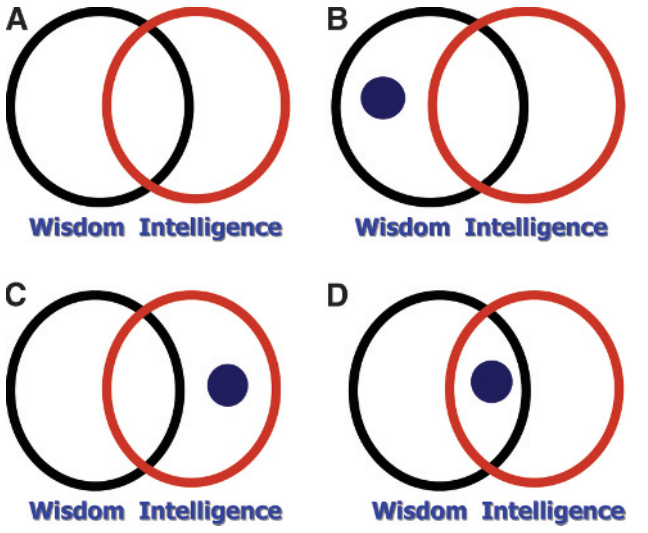

FIGURE 3. A, One could conceptualize wisdom and intelligence as overlapping rings. B, a wolf is cunning and arguably wise but not smart. C, a physician who ''lies to himself'' (a la Nietzsche) may be smart but not wise. D, we should strive to be smart and wise.

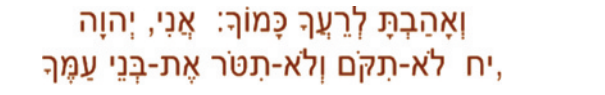

FIGURE 4. An ancient writing that depicts the first written documentation of what is now called The Golden Rule. ''You shall not take vengeance or bear a grudge against the sons of your own people, but you shall love your neighbor as yourself…'' (Leviticus 19:18).

now Called The Golden Rule. ''You shall not take vengeance or bear a grudge against the sons of your own people, but you shall love your neighbor as yourself.…'' (Leviticus 19:18).[7-10] What we as clinicians and neurosurgeons should strive for is to be both wise and intelligent (Figure 3D). We would then make decisions based on superior intelligence using a patient-centric approach to the decision-making process.

Kolb[11,12] defined wisdom as knowledge plus experience. Perhaps the new definition, as it pertains to the clinical arena, should include patient-centricity when focusing on the clinical decision-making process. Therefore, under these circumstances, wisdom should be considered to involve the triad of knowledge plus experience plus the application of The Golden Rule, hence providing substance for the previously established definition of clinical wisdom: ''The ability to effectively assimilate data, observations and prior experiences for the purposes of clinical decision-making by using a patient-centric approach.''[3]

An enriched educational environment, in which the teacher and learner interact, should involve data accumulation and assimilation and ample opportunity for observation and skill acquisition, both building on a previously acquired foundation of knowledge. The environment is enriched by the perpetual emphasis on patient centricity. When the teacher does unto others as he would have done unto himself, it is likely that the learner will follow.

THE INFRASTRUCTURE/SUPRASTRUCTURE

Postgraduate medicine, including neurosurgery, has undergone several generational educational process changes recent years. The first-generation paradigm began with the inception of modern neurosurgery nearly 100 years ago. This paradigm has persisted, in one form or another, to this day. It essentially uses an ''on-the-job training'' strategy that has proven to be effective but is not sufficient in the modern healthcare environment. This tradition of having been taught by example—and then teaching by the same example—and thus passing on the skills acquired from our mentors to our students is no longer acceptable as the ''sole'' education strategy.

In the early 2000s, as the new era of postgraduate medical education ensued, organized neurosurgery began grouping educational goals and objectives via the 6 core competencies. This second-generation paradigm was conceived and guided by Deborah Benzil. She and others championed the use of the portfolio, then a hard-copy document that contained substantial resident-derived information, reports (eg, resident-derived ethics reports), updated curriculum vitas, etc. This ''generation'' was ultimately thought, however, to be insufficient as a resident performance assessment and guidance tool. Hence, a third-generation paradigm emerged.

An initiative that endeavored to objectively quantify resident performance, based on each of the core competencies, subsequently emerged in the mid-2000s. This initiative constituted the third-generation paradigm of neurosurgical postgraduate education. This version included case summaries, a curriculum vitae, resident-specific goals and objectives for training, ethics case presentations, evidence-based methodology case presentations, documentation regarding a variety of accomplishments, information regarding system-based practice endeavors, etc. It was not universally used. With this paradigm, residents were tracked regarding objective information relating to their competency in each of the 6 core competencies (Figure 5), still using the portfolio concept. The portfolio itself was evolving into an electronic medium, thus facilitating data and information accumulation and assimilation. The true value of the third-generation paradigm, however, was questioned as well. On further reflection, the portfolio was thought to be valuable but to merely provide information regarding a resident-specific historical educational collectiveness. The objective information regarding resident performance and competency was interesting but not truly valuable for resident knowledge, skill acquisition, and performance optimization. What appeared to be of greatest value was feedback provided by faculty and 360° commentary. Hence, objective assessments and their associated metrics were judged to be of questionable utility.

The major issues associated with residency assessment in this relatively short-lived third-generation era were that the standards for education were not well-defined. There were no per-year distinctions for assessment (eg, tools and standards). In addition, self-assessment tools were either nonexistent or of limited value.

Neurosurgery, it appeared, needed to be thinking even further ''outside the box.'' A plan or strategy for residency competency assessment that transcends the board certification process to maintenance of certification and other endeavors, such as pay for performance, emerged as the goal. A strategy that does not simply benefit the resident during his training but also proves to be of value throughout the resident's career would be ideal. This strategy not only should enhance learning throughout the residency but also create a mechanism and an environment to enhance lifelong learning.

Enter the Fourth-Generation Paradigm

■ *Times change, knowledge increases, and our training programs should evolve with both.*

— Donlin Long

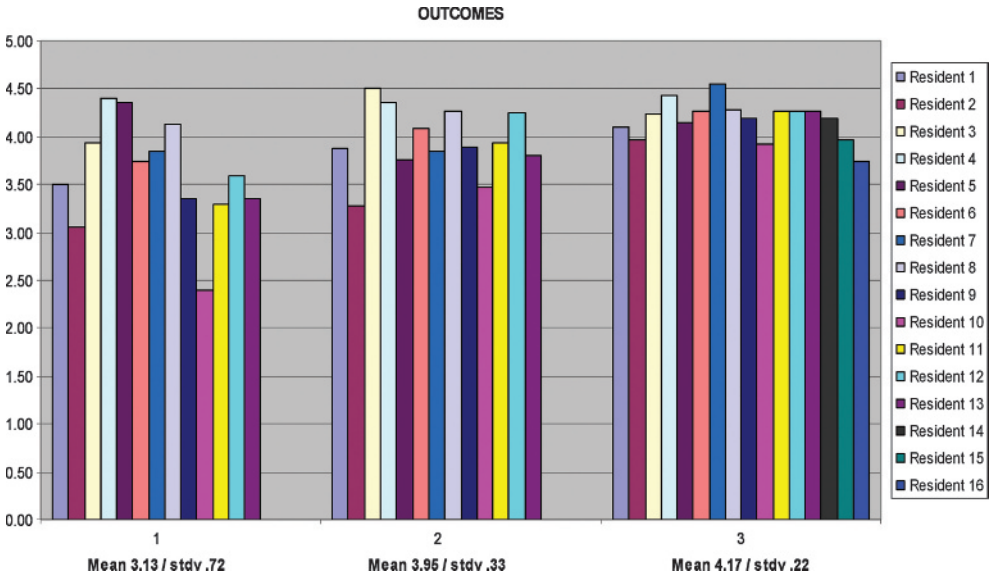

FIGURE 5. The objective tracking of resident performance parameters by semester. This strategy proved to provide objective but suboptimal usable information. Stdv, standard deviation.

In generation 4, the old hard-copy portfolio has evolved into an Accreditation Council for Graduate Medical Education (ACGME) competency-based learning portfolio. This system is a centralized electronic professional learning and development tool. It increases the accreditation emphasis on educational outcomes, and it supports the development of the self-directed habits of lifelong learning and reflective practice. This concept is not new. Harvey Cushing endeavored to record information by written word, photographs and illustrations pertaining to nearly all of his cases (Figure 6). William Osler also emphasized self-reflection by saying that we must:

[*b*]*egin early to make a threefold category—clear cases, doubtful cases, mistakes. And then learn to play the game fair. No self deception. No shrinking from the truth. Mercy and consideration for the other man, but none for yourself, upon whom you have to keep an incessant watch….It is only by getting your cases grouped in this way that you can make any real progress in your (continuing) education; only in this way can you gain wisdom from experience.*[1]

For neurosurgeons, the fourth-generation paradigm has been led and nurtured by Richard Schlenk, the first surgeon on the ACGME portfolio and assessment committee, the purpose of which is to develop and mature the learning portfolio and to create meaningful parameters and strategies for competency assessment in medical specialties. The alpha phase of the ACGME Learning Portfolio, a product of this committee's efforts, has been very revealing, albeit having been applied at only a few centers. Residents have been able to record interactions with faculty, learning experiences, and other activities while receiving constructive criticism and advice from other professionals, including peers and faculty. This tool has been used to create a meaningful journal of salient learning experiences. These experiences include inpatient, outpatient, and operating room encounters; research activities; publications; and simulated learning experiences. The tool has also provided a means for threaded discussions between residents and staff, thus providing ''on the fly'' feedback. It facilitates real-time meaningful formal resident evaluation feedback in all learning arenas (clinical, conference, academic, research, etc) and provides a venue for their assessment of their faculty and program. Finally, it provides rich feedback for program directors. They can use such information to improve the semiannual review process, to help identify targeted areas for improvement across the spectrum, and to document suboptimal performance when appropriate. Hence, the semiannual review can focus on resident accomplishments, goals, objectives, and performance while providing residents an opportunity to ''showcase their stuff'' on a twice-yearly basis.

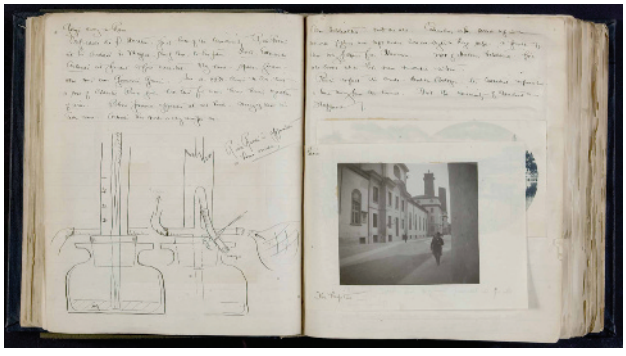

FIGURE 6. The portfolio concept as used by Harvey Cushing.

Simulator Learning

Simulators that mimic real-life operative experience and challenges are becoming increasingly effective as learning tools. This is perhaps more evident in the endovascular arena than in all other domains of neurosurgery (Figure 7). This tool has been used to teach/learn new techniques and strategies and to practice procedures before actually performing them. As this technology develops further, it will most assuredly spread to the other domains of neurosurgery.

How Can We Help You?

The fourth-generation paradigm of neurosurgery education has resulted in a shift from a mechanical on-the-job training educational process, in which ''servitude'' on the part of the resident was prevalent, to a ''How can we help you?'' mentality and process. Educators are assuming a greater responsibility for resident education, and residents are assuming a greater responsibility for their own training.

THE EXECUTION

The process outlined in the pages above, which has evolved into our emerging fourth-generation paradigm of neurosurgical education, requires thoughtful execution. This, in turn, requires vigilance. Such mandates that we not only maintain the foundations established and nurtured by our forefathers but always seek ways to further enrich the neurosurgical learning environment by an understanding of the importance of learning from our mistakes; an appreciation of self-deceit; an appreciation of the literature as it truly exists, in a raw and flawed form; and an appreciation of the importance of self-documentation and portfolio establishment and maintenance. Finally, truly effective execution involves an undying commitment to the ''application of morality to the education process.''

THE REVISIT AND RE-EXECUTION

Only through the establishment of a strategy, the enactment of that strategy, the reassessment of performance, the modification of the strategy based on said assessment, the implementation of a new strategy based on the modification, and the continuous repetition of this cycle can we improve our educational environment and educational process. We must seek criticism, admit mistakes, and modify our behavior accordingly. This is an iterative process. Faculty members must ask what they can do for residents. Residents must ask what they can do for their training program. All must participate in the process. All must provide constructive criticism with solutions. Criticism, without a suggested solution, accomplishes nothing. Yes, indeed, as Dorothy said to her little dog Toto, in The Wizard of Oz, ''We are not in Kansas anymore.'' We must reach a collective understanding of this fundamental fact and move forward with constructive and forward-thinking change in mind.

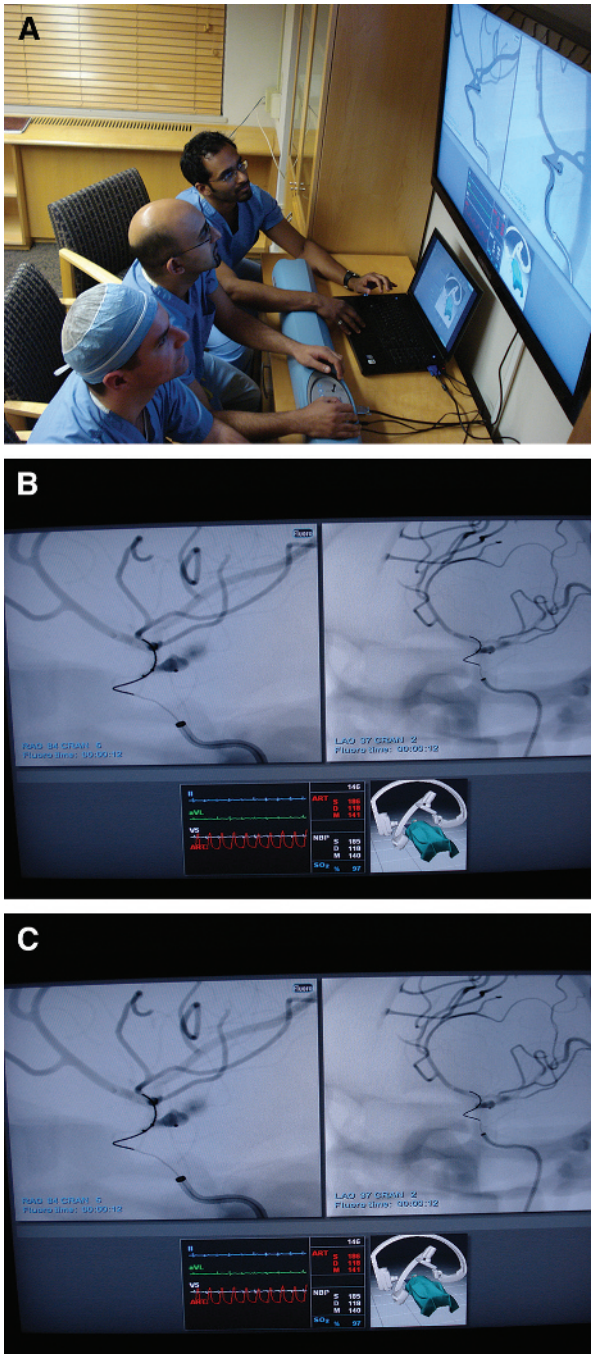

FIGURE 7. The Simbionix system simulates real-time state-of-the-art biplane angiography for neurointerventional procedures. A, residents and fellows approach a left posterior communicating artery aneurysm. Computed tomographic angiograms of real patient encounters can be uploaded into the software to provide residents a ''dress rehearsal'' for the intended procedure. B, biplanar fluoroscopic display and a patient monitor screen displays patient vitals as the microcatheter is introduced into the aneurysm and the first coil is deployed. C, intraprocedural rupture can occur in the simulation program, as demonstrated by the contrast extravasation and rise in blood pressure.

Disclosure

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