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Introduction

The science of practice: addressing the challenges of modern health care

Anthony L. Asher, M.D.,[1,2]
Paul C. McCormick, M.D., M.P.H.,[3]
and Douglas Kondziolka, M.D., M.Sc.[4]

[1]*Carolina Neurosurgery and Spine Associates;* [2]*Department of Neurological Surgery, Carolinas Medical Center, Charlotte, North Carolina;* [3]*Department of Neurological Surgery, Columbia University College of Physicians and Surgeons; and* [4]*Department of Neurological Surgery, New York University, New York, New York*

> *Begin early to make a threefold category—clear cases, doubtful cases, mistakes. And 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 education; only in this way can you gain wisdom with experience.*
>
> Sir William Osler[9]

Professional growth emerges from the practice of neurosurgery in large part via contact and communication with peers and patients. When information derived from our practice experiences is accumulated, analyzed, and made accessible, the progress Osler described becomes powerful. In this issue of *Neurosurgical Focus*, the science of that process is described.

The Importance of Analysis of Experience

Educational visionaries have long understood the importance of learning through systematic analyses of daily experience. The importance of this activity has been highlighted over the last few decades though the work of scholars of expert thought in modern society. These researchers have shown that high-performance knowledge workers, such as engineers, scientists, and physicians, habitually engage in the following activities: they constantly reflect on their own experience, identify gaps in their knowledge, and take steps to remedy any deficiencies. The quality described by these activities, metacognition, is necessary for the nonroutine problem-solving activity that defines knowledge work.[2,10,11]

Learning through experience can promote the development of deep conceptual understanding.[2,5] Perhaps more importantly, experiential learners are generally not merely knowledge consumers, but also knowledge producers, because an important by-product of the analysis of experience is often the generation of new insights—and therefore new knowledge.[7,11]

A mechanism by which new knowledge can arise through an analysis of experience was described by the cognitive psychologist David Kolb, who developed a model of learning based on the brain's natural tendency to make sense of concrete experiences, which he called the "learning cycle."[14]

In Kolb's cycle, active analysis (or what he termed "reflection" on experience) initiates a series of cognitive activities that lead to abstraction, which is essentially the process of forming new ideas or concepts. The transition between reflection and the development of new mental arrangements is what Kolb called the "transformation of experience." This transformation is where learners advance from passive recipients of information to active producers of knowledge.

Kolb and his colleagues recognized that experiential learners tend to actively apply new insights to subsequent experiences. By then evaluating the impact of that application, the cycle repeats itself, iteratively producing continuously enhanced outcomes. The educational theorist Eduard Lindeman captured the essence of this process by stating that the chief purpose of learning is to "discover the meaning of experience."[12]

The idea that daily experience should be routinely analyzed to promote meaningful learning and knowledge generation is revolutionizing professional activity throughout society. Knowledge workers in a variety of professional domains are consistently harnessing information from daily experience to facilitate individual and collective quality and outcome improvement. In doing so, they are driving their disciplines and industries forward. Corporate quality control, technology innovation, and industrial safety all rely on processes that follow a similar pattern of activities:[6] 1) critical reflection on experience (self-assessment), 2) acquisition of data from experience, 3) analysis of those data, 4) generation of new insights and knowledge, and 5) application of knowledge to performance improvement.

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It is not coincidental that this modern profession-based quality-improvement cycle shares its essential features with the cognitive processes of Kolb's learning cycle. Both reflect experiential processes common among high-functioning individuals in modern society.

Medicine is clearly behind other industries in using the analysis of experience to drive professional growth and change, but that will and must change.[1]

The Science of Practice

A scientific elite, representing a very small percentage of physicians, has traditionally produced the vast majority of new medical knowledge. By contrast, the much larger population of health care providers, and by extension their patients, have served as knowledge consumers.

Our society created substantial financial and societal incentives for the translation of medical knowledge into new drugs, devices, and procedures, and medical discovery and the application of novel techniques have became a top health care priority in the US. That priority spawned an unprecedented scientific and industrial enterprise that defined health care progress for the latter part of the 20th century.

Progress, however, is relative. Although few doubt that traditional emphases on discovery and technological innovation have produced significant tangible benefits, most health care stakeholders currently believe that our medical system, while technologically sophisticated, is economically unsustainable and has an inadequate capacity for self-assessment and improvement.

Analysts predict that within a decade US health care costs will exceed 20% of the gross domestic product.[4,8] Americans still value and expect medical innovation, but priorities have shifted dramatically toward issues of cost, safety, and quality. Private insurers, federal and state governments, advisory councils, employer groups, the media, and patients are all demanding that individual physicians and groups objectively account for the value of care they provide. Specifically, they are demanding high-quality information about the real-world therapeutic effectiveness and cost-effectiveness of medical and surgical interventions. Unfortunately, traditional clinical and translational science has thus far largely failed to produce that information.

In the US, Medicare and Medicaid will soon require all health care professionals to produce data related to health care quality and safety.[13] Regulatory agencies now require that individual physicians show evidence of continuous self-assessment and improvement (http://www.abms.org/maintenance_of_certification/MOC_competencies.aspx). Private payers now require substantiation that medical and surgical interventions produce measureable benefit with acceptable risk (http://www.bcbs.com/why-bcbs/blue-distinction/) (http://www.uhc.com). The federal government has allocated well over a billion dollars for studies that compare the relative outcomes, effectiveness, and appropriateness of medical interventions.[3] In short, data derived from daily practice will be central to the largest transformation of health care processes in modern history.

Traditional incentives for expanding production and utilization of increasingly costly health care services are giving way to incentives for objective documentation of safety, quality, and cost-effectiveness. Similarly, medicine's previous reliance on a small scientific elite for the generation of most novel health care information is giving way to a requirement that all physicians engage in scientific inquiry and quality improvement through the acquisition and analysis of practice data.

In the near future, most individual physicians will routinely use such data to promote clinical efficiencies and achieve improved outcomes in daily practice. They will work with other physicians to pool and collectively interpret clinical data for the purposes of defining specialty-wide standards for health care value, safety, and effectiveness.

These interdependent clinical and scientific responsibilities will necessitate a novel and radically expanded methodology for science based in "real-world" clinical practice, a new "science of practice" involving, in varying degrees, all clinicians in all practice settings.

Three key features define this new "science of practice": 1) the habitual and systematic collection of data inseparable from clinical activity, 2) the analysis of practice data to generate new knowledge, and 3) the application of that knowledge to processes of change in health care.

These 3 essential activities—collecting information from daily experience, using that information to generate new knowledge, and applying that knowledge to practice improvement, self-education, and other uses—are grounded in a modern informatics society in which technical knowledge permeates all spheres of life and in which modern experts manage and produce information as their primary activity. As mentioned in the preceding section, these activities are not only habitually practiced by contemporary experts in a variety of disciplines but are also intimately associated with the cognitive processes identified with deep understanding and knowledge generation. The latter observation, in particular, should resonate with neurosurgeons who, as a professional group, possess a singularly cogent perspective on human functional neuroanatomy and cognitive architecture.

Leveraging radical advances in computer technology, information has become the global currency of the 21st century. Those who control essential data and who use these data to generate new knowledge and facilitate improvement are able to adapt, effect change, and prosper. In this regard, the science of practice is not simply a response to abstract or irrelevant external requirements but an opportunity to survive—and indeed thrive—amidst the increasing competitive demands of the informatics age. Adopting the skills necessary to critically analyze practice, determine opportunities for improvement, and generate new knowledge will make individual neurosurgeons, and our specialty, better.

Early evidence of extension of these processes into medicine can be found in the core competency of practice-based learning and improvement (PBLI). PBLI is heavily emphasized by health care education stakeholders because it encourages the transformative and self-generative nature of training each individual practitioner to be a knowledge worker, dedicated to quality and

outcomes improvement. In many respects, PBLI serves as the extension of Kolb's learning cycle specifically to medicine. It promotes continuous learning embedded in the fabric of our professional lives and requires metacognition applied to the daily practice of medicine.

The Science of Neurosurgical Practice

Neurosurgery has recently embarked on an ambitious mission to develop national competency in the science of neurosurgical practice. As described in many of the following articles, a coalition of neurosurgical professional societies is collaborating to advance the quality of care and meet the research needs of a broad range of health care stakeholders. Central to these efforts are the creation of nationally coordinated practice data collection platforms, targeted support of scholarship and research in outcomes methodology, and educational programs to advance the understanding of practice science. Each of these activities will support a fundamental shift in professional culture, embedding quality improvement into the fabric of daily practice and harnessing the collective scientific potential of neurosurgeons in all practice settings.

In the collection of papers that constitute this issue of *Neurosurgical Focus*, various contributors discuss new and existing methods for the collection and analysis of practice data that will revolutionize medicine and allow physicians to more adequately address the daunting challenges facing our modern health care system. Groman and Rubin provide a review of the major societal forces that are driving the quality revolution in health care; Asher and McGirt and colleagues describe in a series of papers the National Neurosurgery Quality and Outcomes Database (N^2QOD)—an unprecedented national effort designed to measurably improve the quality of care, allow for the more efficient allocation of health care resources, and advance the science of neurosurgical care; Berkowitz et al. and Angevine and McCormick describe, in 2 papers, their experience with a large single-institution clinical registry and novel approaches to the design, conduct, and analyses of clinical studies; an additional paper by Asher and colleagues describes the regulatory challenges involved in implementing clinical registries; finally, Selden et al. provide a summary of future applications for data derived from clinical practice.

In summary, the evidence that neurosurgeons need to improve care and shape the future of our profession is created in daily practice. Tremendous scientific and economic potential resides untapped within our routine clinical activities. The methods for realizing that potential now exist. The promise of those methods can only be fulfilled through concerted effort and organized action.

Every neurosurgeon should embrace practice science as an essential component of modern neurosurgical practice and the creation of a sustainable health care system. By doing so, we will define the relevance of neurosurgical practice within the broader realm of medicine, surgery, and society.

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Disclosure

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