Viewpoints: Why Neuroimaging Plays a Critical Role in Shaping the Future of Neurology

An integral part of clinical neurology and neurosciences, neuroimaging training must be better harnessed and incorporated into the educational spectrum of the specialty.

By Laszlo Mechtler, MD and Joseph Fritz, PhD

With its disciplined process of relating lesion visualization to symptoms, neuroimaging is central to neurology and used by most of its subspecialties. Many neurologists depend on their own interpretation of images rather than a written report to make treatment decisions because as clinicians, they assume medico-legal responsibility for their patients. Neurologists possess unique insights into the appropriate use of imaging, and are well positioned to contribute important advances in neurodiagnostics. For these reasons, an understanding of neuroimaging makes us better neurologists.

Unfortunately, diagnostic neuroimaging training for neurologists is insufficient to keep up with increasing need. The American Medical Association (AMA) has steadfastly supported "organ-specific imaging" by clinical subspecialists such as neurologists and cardiologists. AMA policy guidelines assert that: (1) individual character, training, competence, experience, and judgment should be the criteria for granting privileges in hospitals; and (2) physicians representing several specialties can and should be permitted to perform the same procedures if they meet these criteria.[1]

As our specialty continues to evolve, neuroimaging will play a critical role in our understanding of neurological disease and the delivery of care. Ahead, we will explain why a greater emphasis on neuroimaging—including improved access to training programs—is needed in order to achieve that.

NEUROIMAGING: HISTORY AND CURRENT USES

The history of neuroimaging rests on the shoulders of giants with a wide range of expertise, including neurology, neurosurgery, engineering, and physics. In 1895, physicist Wilhelm Roentgen demonstrated the first radiograph and opened a new window to medical diagnosis. His revolutionary discovery set the stage for progressive advances in general medical and neurological imaging. Walter Dandy, a neurosurgeon, first performed ventriculography and pneumoencephalography in 1918 and 1919.[2,3] Egaz Moniz, a neurologist, accomplished the first cerebral arteriogram in 1927.[4] Neurologist William Oldendorf patented the CT concept in 1961, leading to the clinical scanner development by electrical engineer Godfrey Hounsfield in 1973.[5,6] In the early 1970s, physicist Paul Lauterbur published the first spatially differentiated MRI images, and Raymond Damadian, an internist, recognized MRI's role in tumor detection.[7,8] In the early 1980s, the neurologist Ferdinando Buonanno was the first director of the first clinical MRI unit in the US, at the Massachusetts General Hospital.[9] His first fellow, Carl L. Kramer, is also a neurologist.

In recent years, neurologists have an even heightened reason to review images themselves. The combination of an increasing use of general radiologists and radiology assistants,[10] and regulations that mandate clinical access to images through certified Electronic Medical Record systems are placing increased legal risks on clinicians. There is a growing sensibility among neuroradiologists that if

general radiology continues interpreting neuro-diagnostic images, it will force neurologists and neurosurgeons into taking appropriate steps to uphold quality of care for their patients and protect themselves from medico-legal implications. Leading neuroradiologist Scott Atlas MD, has stated: "To continue having non-subspecialty-trained radiologists interpreting sophisticated, complex imaging studies on patients with diseases that are virtually always cared for by subspecialist referring doctors is unacceptable patient care."[11]

Neurologists who make urgent point of care decisions are particularly inclined to interpret directly from images; examples include neurohospitalists, stroke specialists, critical care neurologists, interventional neurologists, and practitioners who use teleneurology. In a 2002 international survey, 79 percent of neurologists stated that they made clinical decisions on stroke care based solely on their independent review of neuroimaging studies.[12] Imagine a neuro-oncologist or multiple sclerosis specialist making clinically pertinent decisions based solely on a general radiologist's interpretation.

Moreover, there is increasing reliance on functional imaging techniques that depend more on an understanding of neurophysiology than neuroanatomy. Examples include the use of white matter tractography, spectroscopy, perfusion, blood oxygenation functional imaging, and connectomics. In our organization, almost one-third of the MRIs ordered by experienced neurologists are reported after visual reading as either normal or having only incidental findings, even though the patient displayed suspicious symptoms. The underlying "functional" neurologic disorder may be better assessed by newer imaging methodologies. Advances in the burgeoning field of functional neuroimaging requires a greater depth of neuroscience training, and will certainly benefit from the active involvement of clinical and research neurologists who are also trained in neuroimaging.

Independent practice of neurology can also be improved by integrating imaging and neuroimaging experts into the team.[13] Private practices tend to offer more accessible, cost-effective care that strives to avoid hospitalization. Ironically, an unintended consequence of healthcare reform has been a fracturing of this very sector. Survival of the outpatient practice rests on its ability to affordably manage the complexities of healthcare affordably. Comprehensive outpatient services can offer economy of scale, improved coordination of care, better patient access, better quality control, and financial bundling opportunities. This contrasts with the very expensive bureaucratic hospital systems that are typically less able to focus on the needs of the patient and of the neurologist. Neuroimaging is a logical component of multispecialty neuroscience group practices, and its integration is maximally leveraged through a symbiotic relationship between clinical neurology and imaging science. Neurologists trained in neuroimaging offer tremendous value in such organizations.

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THE NEED FOR TRAINING

Given the historical and clinical case for neurology as an important participant in the imaging community, it is astounding that neurologist training in diagnostic neuroimaging is sorely lacking, thereby limiting clinical, research and business opportunities for the very subspecialty that most understands the neuroscience behind the technology, as well as downgrading the quality of patient care. Many neurology residency training programs offer inadequate and inconsistent formal education in diagnostic imaging, and often rely on rotations through radiology departments that are not fully integrated into a neuroscience curriculum. There are educational opportunities beyond residency, such as rotations and preceptorships at appropriate imaging centers; didactics and professional conferences; and formal fellowship programs. Fellowship programs of at least one year should be required for any neurologist interested in pursuing neuroimaging as a subspecialty.

To achieve any success in neuroimaging training efforts, a healthy respect for the complexity of imaging technology is needed. That encompasses recognizing how artifacts can mimic pathology, understanding how certain techniques can mask or highlight pathology, and learning the process for unbiased interpretation of images while concisely addressing the clinical question. Such training requires a combination of technical didactics and high volume of experiential learning. The United Council on Neurologic Subspecialties (UCNS) is responsible for accreditation of Neurology fellowship programs, including diagnostic neuroimaging. It is encouraging that UCNS approved sites have doubled in number in the last year, but more are still needed.

Interest level for imaging education is high among neurologists. The neuroimaging section of the American Academy of Neurology (AAN), established in 1977 as one of its five original clinical sections, currently has about 800 members.

Attendance at AAN and American Society of Neuroimaging (ASN) imaging education sessions continues to rise, most recently evidenced by standing room only crowds at the 2016 AAN Annual Meeting presentations. Anecdotal communications such as blog posts and personal letters of inquiry provide further examples of enthusiasm for more imaging education. This is especially true of next generation tech savvy medical students, residents and neurologists, many of whom are attracted to the renewed emphasis on developing novel, clinically meaningful neurodiagnostics (e.g., the Brain Initiative[14]), but express disappointment at the lack of opportunity to actually pursue an applicable clinical career.

Also concerning is the dangerous paucity of trained neurologist-neuroimager representation in guidelines development and advocacy. Under recently adopted legislation, physicians who order certain imaging studies will be penalized if they do not adhere to Appropriate Use Criteria (AUC), tracked through an approved clinical support system.[15] As of June 2016, there is no coordinated neurology representation among the eleven current Provider Led Entities (PLEs) that will steer AUC vetting, despite the fact that five of the eight proposed target areas for utilization control are neurologic conditions. This legislation will directly affect how every neurologist practices, yet neurology is not even at the decision-making table.

There is precedent for formal training of clinician imagers, perhaps most notably in the field of cardiology where fellowships in cardiovascular imaging using nuclear medicine, MRI and CT are commonplace. Presently there are over 29 American College of Cardiology Cardiovascular Imaging Training Programs offered in the US.[16] Most of these fellowships are at prestigious university centers or world renowned medical centers, such as Stanford, UCLA, Mayo Clinic, Cleveland Clinic, Yale, Baylor, Massachusetts General, just to name a few. These programs accept radiologists and cardiologists into their cardiovascular imaging educational programs, setting the stage for a multidisciplinary future. If "organ-specific imaging" has been accepted in the field of cardiac imaging, why would anyone fail to recognize the importance of "organ-specific imaging" in neurology? Is the heart a more complicated organ then the brain? In the early years of CT and MRI, neurology was a major player in clinical neuroimaging. But political turf and the economic gain of a few have played over reason, to the detriment of the proper care of the general public.

Experienced neuroimagers find the mix of clinical neurology and imaging to be fulfilling, and believe that such an integrated career can be an incentive for medical students to choose neurology as a specialty. Given the predictions of a dangerous shortfall in the US neurology workforce,[17] this lure should not be taken lightly. These exciting opportunities are subdued by practical realities. There is a lack of awareness by medical students and residents that neurologists can and do receive training and develop careers in neuroimaging. Disappointingly, we regularly hear from residents who are actively discouraged from such a career path by their attending radiologists or, even more sadly, some neurologists. Neurology leadership has always recognized the value of imaging training for neurologists, and residents need to know that they can indeed legitimately train in neuroimaging and be reimbursed for their efforts. For instance, in 1997 the AAN published guidelines for training[18] and for credentialing of neurologists to read brain and spine MRI and CT[19]; in 2008, the AAN approved a position statement "to play a leading role in the design, training, and provision of neuroimaging to ensure that the greatest potential and most efficient and ethically sound uses for these tools are realized." However, pressures by the larger and more lucrative departments of Radiology at academic medical centers have stifled teaching opportunities in neuroimaging.[20]

Neurologists are well equipped to oversee the patient-centered care platform, applying the most important test based on the information from the patient's history, neurological examination, and other tests that the patient may have undergone. They have seen the patients and therefore they can take the imaging results and directly apply them. Neuroradiologists are certainly skilled in reading these exams, but trained neurologist-neuroimagers offer a unique opportunity to apply their expertise in the nervous system to improve continuity of care for the patient.

A RIGHTFUL PLACE

Ultimately, neuroimaging must be better incorporated within clinical neurology departments than it is at the present time. It is an integral part of clinical neurology and neurosciences and is increasingly based on neurophysiological knowledge. External factors, including healthcare reform, reimbursement cuts and increasing health imaging scrutiny may accelerate the development of partnerships and blur traditional boundaries between specialties and departments. We envision the establishment of efficient multidisciplinary "neuro" departments that merge neurology, neurosurgery, clinical neurophysiology, neuroradiology, nuclear neurology and neurorehabilitation, according to which the equipment would be purchased and run on a service basis. This arrangement would optimize patient care, improve training, and expand opportunities for research. The evolution of anatomic and especially functional neuroimaging will dictate the need for neurologists to be sitting at the same table as our esteemed neuro-radiology colleagues. With the complete support of the AAN, ASN, UCNS, Association of University Professors of Neurology (AUPN), and ideally the American College of Radiology, Chairs of Neuroimaging must be created for neuroimaging trained neurologists

within academic neurology, more university based neuroimaging fellowships must be established, and neuroimaging incorporated as soon as possible as part of the training in neurology. Only within the domain of academic neurology departments can neuroimaging be rightfully recognized as a fundamental part of the practice of neurology.

We would venture to say that most neurologists do understand the importance of neuroimaging, but are unable to surpass the hurdles that have been placed in front of our profession. How many bright students and neurology residents have been deterred from entering the field of neurology and neuroimaging? It is so painful to witness our unintended neglect in establishing neuroimaging as a subspecialty. This is, first of all, a battle for our own leadership to focus on a subspecialty that has rightful presence in the domain of neurology. At the end of the day, it is best for our patients. ■

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