



American Academy of Neurology neuroimaging training guidelines

Joseph C. Masdeu, MD, PhD, for the AAN Workshop on Neuroimaging Training

These guidelines are intended to reflect the content of neuroimaging training in many neurology programs. They emphasize the importance of neuroimaging in the training of neurologists. These guidelines are not intended to replace or supplement the Essentials for Residency Training Programs promulgated by the Neurology Residency Review Committee of the Accreditation Council for Graduate Medical Education.

I. Background and scope of neuroimaging

- A. Neuroimaging is an integral part of the clinical evaluation of patients with neurologic disorders. Neuroimaging, unlike some of the more specialized neurophysiologic techniques, is often integrated in the neurologic evaluation and therefore is best learned by the residents and fellows as part of their clinical experience.
- B. Three levels of competence in neuroimaging can be defined:
 1. Diagnostic expertise for most neurologic disorders. This level is generally achieved by the end of residency training in neurology.
 2. Expertise in all clinical and basic aspects of a given modality. Depending on specific circumstances, this degree of expertise allows operation of an imaging laboratory independently. This level will usually require fellowship training.
 3. Research expertise in a particular aspect of neuroimaging. It is advisable for neurology residents and imperative for neuroim-

aging fellows that they conduct research in some area of neuroimaging.

II. Guidelines for neuroimaging training during neurology residency

- A. Given the central role of neuroimaging in the practice of neurology, it is highly desirable that the residency training experience enables the graduate of a neurology program to interpret neuroimaging studies of all common neurologic disorders. This experience may include all those modalities that are used in the practice of neurology (e.g., MRI, magnetic resonance angiography, CT, neurosonology).
- B. Neuroimaging curriculum for the residency
 1. Neuroimaging is best learned as an integrated aspect of the clinical evaluation of a given patient. Most of the neuroimaging experience of the resident will be acquired during the 18 months of required adult neurology rotations and during the 3 months of required pediatric neurology rotations or the corresponding rotations in child neurology fellowships. Ongoing consultation with a neuroradiologist or team of neuroradiologists is desirable.
 - a. Residents should review their own patients' studies. It is advisable that they write their interpretation in the chart. This interpretation may include:
 - Modality utilized and technical specifications of the study (e.g., MRI with and without contrast enhancement);
 - Anatomic localization of the lesion(s);

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- Morphology of the lesion(s);
 - Differential diagnosis;
 - Additional studies recommended and reasons for obtaining them, taking into account cost considerations.
- b. Written interpretations by the residents may be read by the neurology attending, neuroradiologist, or qualified chief resident after having reviewed the images with the resident and any pertinent notes added.
 - c. Many accrediting bodies and other health care agencies require documentation of training to recognize physicians' skills in any given area. For this reason, it is recommended that a record is kept of the number of images read by each neurology resident as part of his or her clinical work.
2. Early instruction on multiplanar anatomy of the brain and spine is essential to provide the residents with the background they need to read neuroimaging studies. Ideally, this instruction should be provided in the first 3 to 6 months of residency. Multiple venues can be used to facilitate neuroanatomy learning.
 - a. Review of a programmed text, followed by interactive conferences with instructors where the different structures are named and described by the residents.
 - b. Participation in medical school neuroanatomy courses.
 - c. Use of videodiscs; electronic teaching files, including those available on the Internet; or some other type of computerized interactive teaching tool for instruction in multiplanar anatomy.
 3. A formal rotation through neuroradiology is very desirable. Here the resident should be exposed to invasive procedures, such as angiography; learn about their potential complications; and have an opportunity to become better acquainted with the technical aspects of neuroimaging modalities. During daily reading of imaging studies with a neuroradiologist, the neurology resident can help integrate the imaging findings with the rest of the clinical data. This rotation is 1 month long in many programs.
 4. It is desirable that residents have an opportunity to train in neurovascular ultrasound. Their experience may include exposure to the physics and principles of ultrasound, cerebrovascular anatomy, hemodynamics and pathophysiology, the techniques of extra- and intracranial cerebrovascular ultrasound, the clinical role and indications for these studies, their interpretation, and the elements necessary for ongoing quality assurance, including comparison with other imaging modalities and clinical outcome. Ideally, their experience would include actual hands-on scanning experience and interpretation of at least 100 cases under supervision.
5. Clinical and neuropathologic conferences, where neuroimaging is presented and discussed in the light of the whole patient's management (integrated neuroimaging) are highly recommended. Many programs have weekly clinical conferences, often combined with neurosurgery and neuroradiology, and weekly brain-cutting conferences. Sampling of brain tissue, guided by neuroimaging, before the brain-cutting conference enables presentation of microscopic and gross findings at neuropathologic conferences.
- C. Faculty. Neurology faculty are often well qualified to read neuroimaging studies. In addition, neuroradiologists can contribute very substantially to the training of neurology residents. There are resources, including those provided by the American Academy of Neurology (AAN), to identify experts in the different neuroimaging modalities who can be of help with research and consultative work.
- D. Ancillary teaching tools
 1. Videodiscs or CDs with characteristic images of different disorders.
 2. A teaching file with complete cases, including history, examination, all pertinent neuroimaging and neurophysiology, and histologic slides, if available. They should include multiple examples of common neurologic disorders and instances of rare conditions and should be well organized for easy access.
 3. The AAN has coordinated the organization of a Neuroimaging Library to be used as a resource by neurology residency and fellowship training programs. The Library provides teaching files described under subheading number 2, accessible through the Internet (<http://www.med.harvard.edu/AANLIB/home.html>).
 4. Training can be enhanced by the availability of workstations in the clinical areas. These workstations can be used to display clinical cases from the institution itself and from outside cases, carried in electronic files that are much more economic than the regular film files.
 - E. Evaluation. In-training examinations. The AAN and the American Neurological Association offer a yearly in-training to neurology residents. About 12% of the items of this examination are focused on neuroimaging. In

addition, the American Society of Neuroimaging may provide in the future a yearly examination for residents covering CT, MRI, neurosonology, and other neuroimaging modalities.

III. Neuroimaging fellowships

A. Fellowship objectives

1. Two different objectives may be accomplished in a 1-year neuroimaging fellowship:

a. To acquire expertise in all clinical and basic aspects of a given modality. This degree of expertise is generally needed to operate an imaging laboratory independently.

b. To gain more extensive training in neuroimaging procedures by reviewing under supervision a number of neuroimaging studies in addition to the experience acquired during neurology residency. Neuroimaging experience can be obtained while concentrating on a disease-specific fellowship, such as epilepsy, neurooncology, stroke, or dementia. The concept of integrating neuroimaging as part of the complete evaluation of the neurologic patient is again applied in this situation.

2. In both instances, the fellowship experience should contain a research component.

B. Neuroimaging training may ideally be provided in combined programs with radiology. Both neurologists and radiologists would benefit from the cross-fertilization in fellowship programs open to graduates from both specialties and to neurosurgeons. Neuroophthalmology fellowships provide an example of cross-specialty training. Training in neurovascular ultrasound may be combined with radiology, neurosurgery, vascular surgery, cardiology, or other training programs.

C. Training in neuroimaging can be accomplished in combined programs with nuclear medicine, where the emphasis is on integrated neuroimaging. Structural imaging should complement functional neuroimaging in these programs. Suggested nomenclature for these programs include:

- Brain PET or SPECT fellowship;
- Functional brain imaging;
- Functional neuroimaging.

D. Excellent additional training in neuroimaging after a neurology residency can be obtained in syndrome-oriented fellowships with a strong neuroimaging component, such as epilepsy, neurooncology, stroke, or dementia. For future accreditation, careful documentation of the neuroimaging experience is particularly important in programs designed in this manner.

E. Access to imaging equipment is highly desirable for clinical and particularly research purposes. In institutions where neurology lacks ready access to imaging equipment, the following alternatives may be used:

1. Off-site neuroimaging centers may be used for the training of neurology fellows. Quality control and adequate supervision by the academic institution are important.

2. An interinstitutional file of teaching cases (described under subheading II.D.3) has been organized by the Neuroimaging Section of the AAN and is accessible through the Internet.

3. Setting up research centers on a given aspect of neuroimaging, for instance PET centers, or research protocols with a substantial imaging component, like MR spectroscopy in stroke.

F. Faculty. Fellowship faculty should have a high level of expertise in the modality emphasized in a given program. The AAN maintains an updated list of experts in the different modalities and of fellowships in neuroimaging open to neurologists.

G. Incentives for fellowship training. A clinical neurologist with additional training in neuroimaging can be an important addition to an academic department of neurology. This person can be of great help in providing core support to research efforts in multiple areas of departmental activity, such as stroke, dementia, and multiple sclerosis.

IV. Combined training programs in diagnostic radiology, neuroradiology, and neurology. Since 1996, combined programs have existed that qualify the trainees for application to certification by the American Board of Psychiatry and Neurology (Neurology) and by the American Board of Radiology. Information is available from the American Board of Psychology and Neurology, Inc., 500 Lake Cook Road, Suite 335, Deerfield, IL 60015.

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