

# AMERICAN ACADEMY OF NEUROLOGY

## *Neuroimaging Training Guidelines*

- **Background and Scope of Neuroimaging**
- **Guidelines for Neuroimaging Training During Neurology Residency**
- **Neuroimaging Fellowships**

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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 neurological disorders. Neuroimaging, unlike some of the more specialized neurophysiological techniques, is often integrated in the neurological evaluation and therefore it 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 neurological 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 to operate 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 neuroimaging 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 enable the graduate of a neurology program to interpret neuroimaging studies of all common neurological disorders. This experience may include all those modalities that are used in the practice of neurology (e.g., MRI, MRA, 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 three 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:
      - (1) Modality utilized and technical specifications of the study (e.g., MRI with and without gadolinium).
      - (2) Anatomic localization of the lesion(s).
      - (3) Morphology of the lesion(s).
      - (4) Differential diagnosis.
      - (5) 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 in order to recognize physicians' skills in any given area. For this reason, it is recommended that a record be kept of the number of images read by each of the neurology

- residents as part of his/her clinical work. Several formats are suggested in order to facilitate record keeping:
- (1) A log book to be carried by each resident, where the supervisors will enter their initials and date for each study.
  - (2) Procedure booklets, similar to prescription pads, with sheets listing the various procedures to be learned during residency. One sheet is completed for each procedure and entered in a database.
  - (3) Tally of procedures and resident by the medical records department of the hospital, with periodic record sampling by designated faculty to ensure compliance. Studies are credited to the residents directly caring for the patient, both at the junior and senior levels.
2. Early instruction on multiplanar anatomy of the brain and spine is essential in order to provide the residents with the background they need to read neuroimaging studies. Ideally, this instruction should be provided in the first three to six months of residency. Multiple avenues 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 video discs, 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 one 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 intra-cranial cerebrovascular ultrasound, the clinical role and indications for these studies, their interpretation and the elements necessary for ongoing quality assurance, including comparison to 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 neuropathological 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, prior to the brain-cutting conference, enables presentation of microscopic as well as gross findings at neuropathology 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. Video discs or CD's 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 neurological disorders, as well as instances of rare conditions, and 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 complete teaching files described under subheading #D2, accessible through the Internet. These resources may be made available on other computerized media, such as CD's or floppy disks, depending on the demand by neurology residency training programs.
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 as well as outside cases, carried in electronic files that are much more economical 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 covering CT, MRI, neurosonology, and SPECT.

### III. Neuroimaging Fellowships

#### A. Fellowship Objectives

1. Two different objectives may be accomplished in a one-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, neuro-oncology, stroke or dementia. The concept of integrating neuroimaging as part of the complete evaluation of the neurological 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, as well as to neurosurgeons. Neuro-ophthalmology 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. Some of the suggested nomenclature for these programs include:

- 1) Brain PET or SPECT fellowship
- 2) Functional brain imaging
- 3) 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, neuro-oncology, 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, some of the following alternatives may be used:

1. Off-site neuroimaging centers may be utilized for the training of neurology fellows. Quality control and an adequate supervision by the academic institution are important.
2. An inter-institutional file of teaching cases (described above under subheading II-D-3, ) has been organized by the Neuroimaging Section of the AAN and is accessible through the Internet.
3. 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 as well as outside cases, carried in electronic files that are much more economical than the regular film files.
4. 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 who can be of help with research and consultative work.

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 to provide core support to research efforts in multiple areas of departmental activity, such as stroke, dementia, multiple sclerosis, etc.