

**American Academy of Neurology  
Neuroimaging Section  
Resident Core Curriculum**

**10/01/01**

**Introduction**

Neuroimaging plays a major role in the evaluation of patients with neurological disorders. The utility of the various neuroimaging methods is rapidly increasing in both the clinical and research settings. In order to provide best patient care, all neurologists should learn about the technical aspects, indications, and interpretation of these studies. The major neuroimaging modalities include computed tomography (CT), magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT), positron emission tomography (PET), carotid and transcranial ultrasound, as well as interventional neuroimaging, which includes catheter angiography and myelography.

Neurology residents should learn neuroimaging in conjunction with patient care experiences, since correlating clinical, neurophysiological, neuroanatomical, neurochemical, neuropharmacological, neuropathological, and cerebrospinal fluid findings with neuroimaging findings in one's patients is the most valuable source of training. Thus, neuroimaging training should occur throughout the three years of residency training, across both in-patient and out-patient settings. Residents should formulate their own interpretations and then correlate these with the official reading, or the reading of the attending, and keep a log of each study reviewed. Such case-based learning should also be supplemented with formal rotations during which the resident spends a month dedicated to a specific neuroimaging modality, or may require formal lectures and independent study. The specific curricular content is modality specific. Personnel responsible for training should maintain a teaching file of 100 representative cases for each modality, including case histories and images. This may require cooperation by non-neurological departments that should be arranged by the neurology program director. Facilities should handle a large volume of patient material so that residents may learn by repetition. In order to obtain adequate practical experience in a given modality, for credentialing purposes, the suggested minimum number of studies performed and interpreted under supervision during residency for the specific modalities should be 100 carotid ultrasound studies, 100 TCD studies, 150 CT exams, 250 MRI studies, 150 SPECT studies, 250 PET studies, and 100 catheter angiographic studies.

On-going evaluation in neuroimaging might include regular assessment of performance and interpretation skills by training personnel or faculty, assessment of interpretation skills using multiple choice questions and case reviews, assessment of performance on the neuroimaging section of the residency in-service training examination, and performance on the American Society of Neuroimaging certification examinations.

**Learning Objectives:**

1. Upon completion of neurology residency, residents **should** be able to:
  - a. Discuss key elements of the principles and physics, bioeffects, clinical applications, indications, interpretation, and quality improvement for each of the major neuroimaging modalities.
  - b. Describe the integration of neuroimaging studies into clinical practice for best patient care.
  - c. Provide a log of cases performed or interpreted under supervision for all applicable neuroimaging modalities.
  - d. Discuss the expected neuroimaging findings for the major disease categories as outlined in the curriculum.
  
2. Upon completion of neurology residency, residents **could** be able to:
  - a. Demonstrate eligibility for the certification examination in one or more neuroimaging modalities.
  - b. Demonstrate successful fulfillment of credentialing criteria for the performance or interpretation of neuroimaging studies.
  - c. Independently perform and interpret specific neuroimaging studies.

**Key Documents/Guidelines:**

1. Masdeu JC, for the AAN Workshop on Neuroimaging Training. *Neurology* 1997;49:1738-40.
2. Gomez C, Kinkel PR, Masdeu JC, et al. Credentialing Guidelines for Neuroimaging. *Neurology* 1998;49:1734-37.

**Key Links:**

American Society of Neuroimaging ([www.asnweb.org](http://www.asnweb.org))  
Whole Brain Atlas ([www.med.harvard.edu/AANLIB/home.html](http://www.med.harvard.edu/AANLIB/home.html))  
Intersocietal Commission for Accreditation of Vascular Laboratories ([www.icavl.org](http://www.icavl.org))  
Intersocietal Commission for Accreditation of Magnetic Resonance Laboratories ([www.icamrl.org](http://www.icamrl.org))  
Neuroimaging self study site ([www.medscape.com/Medscape/Neurology/journal/public/columns/index-NeuroCase.html](http://www.medscape.com/Medscape/Neurology/journal/public/columns/index-NeuroCase.html))

**Broad Categories of Modality Specific Content:**

**I. MR/CT/and Nuclear Neurology (SPECT/PET)**

1. Technical Aspects
2. Clinical Aspects
  - a. Primary tumors/masses/cysts
  - b. Cerebrovascular disease
  - c. Vascular lesions/malformations

- d. Infectious/Granulomatous diseases
- e. Hemorrhage/trauma
- f. Toxic/Metabolic diseases
- g. Degenerative diseases
- h. Seizures/Epilepsy
- i. Hydrocephalus/CSF disorders
- j. Psychiatric disorders (SPECT/PET)
- k. Neurocutaneous syndromes
- l. Demyelinating/Inflammatory diseases
- m. Metastatic diseases
- n. Congenital Anomalies/Developmental disorders
- o. Miscellaneous disorders

## **II. Neurosonology (Carotid ultrasound and transcranial Doppler ultrasound)**

1. Basic principles and physics of Doppler (pulsed wave, continuous wave), spectral analysis, B-mode imaging, duplex sonography, color flow imaging, power mode imaging, embolus detection.
2. Ultrasound artifacts, equipment/hardware, bioeffects and safety.
3. Cerebrovascular hemodynamics, anatomy, and pathophysiology for the extra and intracranial carotid, vertebral and basilar arterial systems.
4. Clinical applications of carotid ultrasound, conventional TCD, and transcranial color duplex imaging.
5. Interpretation and criteria for carotid ultrasound and TCD studies, including flow velocity criteria for stenosis or vasospasm, occlusions, collateral flow patterns, hyperemia, plaque measurement and characteristics, evoked flow testing, and embolus detection.
6. Quality improvement in the neurosonology laboratory
7. Lab accreditation and physician certification in the neurosonology laboratory

## **III. Interventional neuroimaging (angiography)**

1. Technical aspects of angiography
  - a. Basic principles of catheterization
  - b. Cerebrovascular anatomy
    - i. Normal brain arteries
    - ii. Normal brain veins and venous sinuses
    - iii. Normal spinal circulation
    - iv. Normal variants
  - c. Arterial access: Advantages and disadvantages
  - d. Tactical vs. comprehensive cerebral angiography
  - e. Physical risks of catheter angiography
  - f. Contrast materials: Pharmacology and utilization
2. Clinical aspects of angiography
  - a. Indications and contraindications
  - b. Role in lesion definition and therapeutic planning

- c. Risks of angiography
- d. Methods for decreasing the risk of angiography
- 3. Interventional techniques
  - a. Therapeutic microcatheterization
  - b. Intra-arterial thrombolysis
  - c. Balloon angioplasty
  - d. Neurovascular stenting
  - e. Coiling of aneurysmal lesions
  - f. Embolization of vascular malformations and tumors