Massachusetts General Hospital Child Neurology Residency Program

Curriculum

Acquisition of basic science information as it applies to the nervous system and clinical neurology is essential to the training of the child neurologist and to the informed care of patients. Curriculum aims to give extensive exposure to clinico-pathophysiologic correlations. Specific training is directed to the following basic areas:

1. Neuroanatomy/Neuropathology with emphasis on basic neuroanatomy and clinicopathological correlations particularly as taught through brain cutting and case-based conferences where gross and microscopic neuropathology are presented in context of clinical diagnostic categories.
2. Neurophysiology with emphasis on basic neurophysiology and theory with an introduction to the techniques used to assess these parameters in clinical patient evaluation.
3. Neuropharmacology, neurochemistry, developmental neurobiology, molecular neurogenetics are taught through didactic lectures and by specific pathway discussion through case-based learning.

Clinical adult neurology is taught through patient-oriented approach to learning on inpatient neurology at both the Massachusetts General Hospital [CMF stroke service and Raymond D. Adams general neurology service] and Brigham and Women’s Hospital, the intensive care unit, the emergency room, neurosurgical inpatient service and outpatient clinic.

Clinical child neurology is taught through an inpatient child neurology service which functions as both consult service to Mass General Hospital Pediatrics and Pediatric Neurosurgical service, the Neonatal Intensive Care Unit [NICU], the Pediatric Intensive Care Unit [PICU], the Shriners Burn Institute and the Spaulding Pediatric Rehabilitation service and as a direct admission service for primary child neurology diagnoses and child neurology staff patients. Child neurology cases are seen in the Mass General’s Pediatric emergency room on consultant basis.

The components of the patient-oriented approach to neurological disorders include six areas of assessment and competency:

1. History taking – The resident must learn to take a comprehensive history from the patient [within age and developmental constraints], parents, family members, involved professionals/educators. This is the cornerstone of assessment, particularly for the global assessment of development but also for the critical issues of the presenting complaint, especially for those symptoms which are episodic or complaints which are subjective.
2. Neurologic and general examination – General physical, as well as specific neurologic abnormalities underlying the evaluation of the patient’s symptoms/complaints and may give clues to diagnosis. The neurologic examination may be more sensitive than ancillary diagnostic procedures in localizing lesions and determining diagnoses. Complete familiarity with the following is essential:

- Higher cortical function including evaluation of confusion, delirium, dementia, emotional or psychiatric state
- Cranial nerves
- Motor function
- Sensation
- Reflex function
- Gait, stance, balance
- Developmental milestones
- Special circumstances including: comatose patient, patient in status epilepticus, acutely psychotic or depressed patient.

3. Anatomic [lesion] localization and pathophysiologic correlation – This is the logical result of a careful and comprehensive history and physical examination. Lesion localization is critical to the production of a reasonable differential diagnosis and formulation of a plan for ancillary diagnostic procedures. The resident should understand normal neurophysiology and neuroanatomy including at a minimum:

- Motor system [motor unit and corticospinal tract]
- Basal ganglia
- Cerebellum
- Sensory pathways
- Cranial nerves
- Hypothalamus and pituitary
- Limbic system
- Cerebral cortex
- Visual system
- Auditory system
- Autonomic system
- Cerebrospinal fluid pathways
- Neurophysiology of the above systems including: CNS neurotransmission; neuromuscular transmission; muscle contractile processes, neuronal excitation, inhibition and release; cortical activation and inhibition; seizure production; molecular neurobiology and neurogenetics of disorders of these systems.

4. Differential diagnosis generation and evaluation/testing plan – The resident should be able to use the thorough history, his/her detailed physical examination and the localization of the lesion coupled with his/her understanding of the pathophysiology of the pertinent nervous system components/systems to prepare a list of diagnostic possibilities. The resident should then be able to use this
differential diagnosis to generate a rational plan for the use of ancillary diagnostic procedures to include or exclude specific disorders on this differential list.

5. Formulation and management plan – The primary goal of this residency is for the resident to learn to treat pediatric patients of all ages with neurologic disorders. The trainee should learn the appropriate standard of care for neurologic disorders and should have learned a general approach which will allow for vigilance for evolving changes in thinking and practice regarding treating these disorders. The practice of child neurology requires continuous learning as well as sufficient practical experience in communicating with patients, families, referring physician’s, allied health care professionals, educators and patient/family counselors.

In addition to being thoroughly competent in the art and science of history and physical examination, in formulating an evaluation and management plan and in communicating this to patient, family and involved professionals, the resident should also be completely familiar with the indications, interpretation, techniques, contraindications and risks of the following neurodiagnostic tests:

- Lumbar puncture
- EEG
- Visual, auditory, somatosensory evoked potentials
- CT [CNS and spine]
- MRI, MRI and MRS [cranial and spine]
- EMG and NCV
- Cerebral and spinal angiography
- Nerve, muscle and skin biopsy
- PET and MEG

The resident should be able to assess and manage at least the following specific symptoms in all pediatric age groups:

- Paroxysmal disorders
  * Distinguish:
    - Seizures from syncope
    - Jitteriness from seizures
    - Seizures and epilepsy
    - Typical from atypical febrile seizures
  * Understand the international classification of seizures
  * List common causes of seizure in:
    - Neonate
    - Infants
    - Older children
  * Describe routine evaluation and treatment indications in new onset seizures
  * Know the standard dosing and side-effects of anticonvulsants
  * Define status epilepticus
    - Outline initial evaluation and management
    - List medications and doses to treat status
*Sleep disorders
  o Define parasomnias, narcolepsy, cataplexy and sleep apnea

• Coma and altered consciousness
  o Describe major disease categories that cause lethargy and coma including metabolic, toxic, infectious, traumatic and vascular

• Increased intracranial pressure
  o Describe differences between communicating and noncommunicating hydrocephalus and give etiologic examples
  o Discuss side effects of ventriculoperitoneal and ventriculoatrial shunts
  o Describe the most common brain tumors in children
  o Discuss the presentation of supratentorial and infratentorial brain tumors
  o List the most common organisms causing bacterial meningitis in neonates and children
  o List factors commonly predisposing to pyogenic brain abscess in children
  o Discuss pseudotumor cerebri
  o Discuss metabolic and toxic cases of ICP
  o Discuss treatment of acute and chronic ICP

• Ataxia and other gait disorders
  o Discuss differential diagnosis, evaluation and management of acute and subacute ataxia in children

• Movement disorders
  o Discuss differential diagnosis of chorea, dystonia and tremor
  o List medications that can cause movement disorders
  o Define Tourette syndrome, comorbid associations and treatment

• Headache
  o Describe headache features of migraine, ICP and tension
  o Be familiar with the international classification of headache criteria
  o List indications and medications for headache treatment

• Mental retardation
  o Discuss normal motor and cognitive development
  o Discuss consequences of tobacco, alcohol and other commonly abused drugs [marijuana, cocaine, heroin]

• Neurogenetic disorders
  o Discuss common manifestations of:
    • Neurofibromatosis
• Tuberous Sclerosis
• Leukodystrophies
• Von Hippel Lindau

• Neurologic regression

Be familiar with:
  o Lysosomal storage disorders
  o Peroxisomal disorders
  o Mitochondrial disorders
  o Amino acidopathies
  o Organic acidopathies
  o Disorders of carbohydrate metabolism
  o Disorders of neurotransmitters
  o Chromosomaldisorders
  o Dysmorphic syndromes

• Weakness [peripheral, central, cranial nerve]

Be familiar with:
  o Spinal muscular atrophies
  o Duchenne/Becker muscular dystrophy
  o Myasthenia gravis
  o Acute inflammatory demyelinating polyneuropathy
  o Peripheral neuropathy [hereditary and nonhereditary
  o Stroke
  o Spinal dysraphism
  o Discuss significance of sacral dimple, hairy patch, port wine
    stain
  o Cerebral palsy
  o Discuss causes of facial weakness and evaluation and
    treatment of Bells palsy

• Disorders of sensation

• Visual disorders
  o Discuss congenital nystagmus and spasmus nutans
  o List causes for congenital cataracts
  o Describe several causes of acquired ophthalmoplegia
  o Discuss the differential of optic atrophy
  o Discuss the differential of retinitis pigmentosa
  o Discuss causes of strabismus

• Hearing and vestibular
  o Discuss evaluation of child with hearing loss
  o Discuss differential diagnosis of congenital hearing loss
Discuss evaluation of vertigo

- Abnormalities of head growth
  - Discuss causes and evaluation of macrocephaly and microcephaly
  - Discuss craniosynostosis

- Disorders unique to newborn infants

- Learning disorders and disorders of higher cognitive function
  - List common causes of learning disabilities
  - Discuss approach to a child with:
    - Delayed speech
    - Impaired attention
    - Poor academic performance

- Speech and language disorders

- Behavioral disorders
  - Discuss approach to evaluation, differential diagnosis and treatment

- Neuropsychiatric disorders
  - Discuss approach to evaluation and differential diagnosis

The resident should have honed skills in the appropriate prescription of neuropharmacologic agents including indications and spectrum of use; full understanding of side effect profiles and adverse effect assessment; therapeutic monitoring methodologies and available adjunctive laboratory testing.

6. Outcome assessment – The resident should develop an approach to the follow-up monitoring of response to therapy and a method of approaching the unsuccessful response. It is extremely important to learn to critically read the literature and the resident should develop these skills through participation in journal clubs and through the development of strategies for continuing education and self-assessment.

Through the initial evaluation, diagnostic planning, management and treatment work the resident develops a comprehensive approach to the assessment and care of straightforward and more complex neurologic disorders.

All cases are presented for review and discussion to the attending staff physician on the service. Resident admission notes and daily follow-up notes are written and placed in the digital medical record and reviewed by the attending staff physician. These serve to help the resident learn the principles of comprehensive evaluation, efficient and concise formulation and documentation. Interpretation of ancillary diagnostic procedures is essential to developing proficiency in the clinical aspects of child neurology. Patient cases afford the opportunity to participate in the procedures and interpret CSF studies,
EEG and evoked potential testing, EMG/NCV studies as well as neuroimaging studies including cranial ultrasound, CT scan [cranial and spinal], CTA, cranial and spinal MRI/MRA/MRS, brain PET and MEG. Broader learning is supported by weekly case conferences in pediatric EEG, pediatric neuroimaging and neuropathology. Proficiency in lumbar puncture and skin biopsy is expected of the residents and taught by staff physicians.

Common disorders occurring in adulthood should be the focus of training and learning and include: epilepsy, headache, stroke and vascular disorders, dementia, multiple sclerosis, movement disorders, neuromuscular disorders and late-onset neurogenetic disorders. The resident should be familiar with less common neurologic disorders. This learning will take place through case conferences, clinico-pathologic correlation conferences, reading of textbooks and through didactic conferences.

Common disorders of childhood with which the resident should be very familiar include: seizures and epilepsy syndromes, non-epileptic paroxysmal disorders, cerebrovascular disorders, acute and chronic dysmyelinating disorders, headache, sleep disorders, learning/developmental/cognitive disorders, disorders causing mental retardation, neuromuscular disorders, acute encephalopathies, infections of the nervous system, disorders of the term and pre-term infant, neurotrauma, complications of systemic disease, neurogenetic and neurometabolic disorders and coma/brain death and the persistent vegetative state.

Clinical outpatient child neurology learning is directed toward the comprehensive assessment, diagnostic evaluation, management and therapy of a broad range of general child neurology clinical issues. All ages are seen in the Mass General Pediatric Neurology Clinics: from the premature neonate, infant, younger and older child, adolescents, to the age of 21. The goal of the resident training is to prepare the resident as a qualified practicing child neurologist and to present the future child neurologist researchers a wide scope of exposure to the challenges of the developing nervous system and its dysfunction.

Residents maintain primary relationship with the patients in this continuity clinic. Increasing responsibility is given throughout the 3 years of residency even as the staff physicians maintain knowledge of, interaction and clinic note review on all patients. This approach allows continued teaching at increasingly sophisticated manner for these cases.

The learning of subspecialty approach to diagnosis, evaluation and management, care and treatment is critical to developing a broad-based child neurology education and to the identification of particular career interests. Working directly with staff physicians specialized in these areas, both in the clinic and through their research programs, the residents learn by doing initial intake, formulation and diagnostic planning for a number of the patients seen in these clinics. Follow-up appointments afford the resident the opportunity for case review and observation of ongoing management as delivered by the staff physicians. Ample time is afforded in the clinic scheduling to allow for direct case-
based teaching. The five core rotations required of the child neurology residents during PGY4/5 years are:

1. Neuropathology
2. Epilepsy
3. Pediatric Psychiatry/Psychology & Rehabilitation
4. Neurophysiology & Neuroradiology
5. Subspecialty including outpatient clinics:
   a. Seizure Disorders Clinic, Ketogenic/Hypoglycemic Diet Clinic
   b. Behavioral Disorders Clinic
   c. Cerebral Dysgenesis Clinic
   d. Learning Disorders Clinic
   e. Autism and PDD Clinics
   f. Developmental Neurogenetics Clinic
   g. Mitochondrial/Energy Metabolism Disorders Clinic
   h. Specialized clinics for: Tuberous Sclerosis, Fragile X, Angelman Syndrome, Neurofibromatosis [NF1 and NF2], Stroke, Neuro-oncology/Radiation Therapy

Through formal and informal sessions the residents should become familiar with the issues of ethics in medicine; palliative care and end-of-life issues; issues of quality assurance and assessment; health care organization and practice management; health care financing and public health policy; and be familiar with the use of digital medical resources and information systems.