Core curriculum guidelines for a required clinical neurology experience

Joseph E. Safdieh, MD,* Raghav Govindarajan, MD,* Douglas J. Gelb, MD, PhD,* Yazmin Odia, MD, and Madhu Soni, MD

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Correspondence
Dr. Safdieh
jos9046@med.cornell.edu

Abstract

Physicians in most specialties frequently encounter patients with neurologic conditions. For most non-neurologists, postgraduate neurologic education is variable and often limited, so every medical school's curriculum must include clinical learning experiences to ensure that all graduating medical students have the basic knowledge and skills required to care for patients with common neurologic symptoms and neurologic emergencies. In the nearly 20 years that have elapsed since the development of the initial American Academy of Neurology (AAN)–endorsed core curriculum for neurology clerkships, many medical school curricula have evolved to include self-directed learning, shortened foundational coursework, earlier clinical experiences, and increased utilization of longitudinal clerkships. A workgroup of both the Undergraduate Education Subcommittee and Consortium of Neurology Clerkship Directors of the AAN was formed to update the prior curriculum to ensure that the content is current and the format is consistent with evolving medical school curricula. The updated curriculum document replaces the term clerkship with experience, to allow for its use in nontraditional curricular structures. Other changes include a more streamlined list of symptom complexes, provision of a list of recommended clinical encounters, and incorporation of midrotation feedback. The hope is that these additions will provide a helpful resource to curriculum leaders in meeting national accreditation standards. The curriculum also includes new learning objectives related to cognitive bias, diagnostic errors, implicit bias, care for a diverse patient population, public health impact of neurologic disorders, and the impact of socioeconomic and regulatory factors on access to diagnostic and therapeutic resources.

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*These authors contributed equally to this work.

From the Department of Neurology (J.E.S.), Weill Cornell Medicine/New York Presbyterian Hospital, NY; Department of Neurology (R.G.), University of Missouri, Columbia; Department of Neurology (D.J.G.), University of Michigan Medical School, Ann Arbor; Miami Cancer Institute (Y.O.), FL; and Department of Neurological Sciences (M.S.), Rush University Medical Center, Chicago, IL.

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Glossary

DALY = disability-adjusted life-year.

Neurologic disorders are common and are the leading cause of disability-adjusted life-years (DALYs), accounting for 10.2% of global DALYs and 16.8% of global deaths.[1] Diseases of the nervous system accounted for 9% of the primary diagnoses at office visits in the United States in 2014, according to the National Ambulatory Medical Care Survey.[2] Of the top 13 causes of DALYs in the United States in 2016, 6 (low back pain, Alzheimer disease, migraine, neck pain, ischemic stroke, and falls) are conditions that require the clinician to be able to perform and interpret a neurologic examination.[3] Furthermore, projections suggest that due to aging of the American population, the number of US neurologists will be insufficient to provide care to this growing segment of patients.[4]

As a result, primary care and emergency physicians are—and will routinely be—called upon to evaluate and manage patients with neurologic disease. In addition, physicians in many other specialties need to recognize neurologic emergencies. Thus, physicians require a firm understanding of the general principles of clinical neurology. The most suitable setting in which to lay the foundation for that understanding is during the clinical phase of medical school.

Although a clinical neurology experience should be required of all medical students, the format of that experience may vary, depending on the organization of the overall curriculum at any given medical school. This document builds upon the 2002 Gelb et al.[5] neurology clerkship core curriculum and outlines the key components of a clinical neurology experience. The purpose is not to define the specific structure of that experience or to dictate mandatory content. Rather, this curriculum is intended to provide the principles underlying the required clinical neurology experience and its fundamental content, as well as the procedural and analytical skills that medical students, regardless of their ultimate field of practice, should master by the time they graduate from medical school.

Goals and objectives of the clinical neurology experience

Definition of clinical neurology experience

A clinical neurology experience provides medical students with the opportunity to learn how to care for patients with neurologic symptoms and disorders through practical contact and observation. The experience should be centered on direct patient care, and should also provide formal education sessions and assessments. While most medical schools still provide this experience in a traditional clerkship format, some have introduced nontraditional models such as multidisciplinary clerkships or longitudinal experiences.[6] These curriculum guidelines apply to a clinical neurology experience of any type, whether a traditional clerkship or an innovative format.

Goal

To teach the principles and skills necessary to recognize and manage the neurologic diseases a general medical practitioner is most likely to encounter in practice.

Objectives

The goal of teaching students to recognize and manage neurologic disease encompasses 2 categories of objectives: the procedural skills necessary to gather clinical information and communicate it and the analytical skills needed to interpret that information and act on it.

1. To teach and reinforce proficiency in the following procedural skills:
   a. Interviewing to obtain a complete and reliable neurologic history
   b. Performing a reliable neurologic examination (table 1)
   c. Examining patients with altered level of consciousness or abnormal mental status (table 2)
   d. Delivering a clear, concise, and thorough oral presentation of a patient's neurologic history and examination
   e. Preparing clear, concise, and thorough documentation of a patient's neurologic history and examination
   f. Communicating empathetically with patients and families
   g. [Ideally] Performing a lumbar puncture under direct supervision, or using simulation
2. To teach and reinforce proficiency in the following analytical skills:
   a. Recognizing symptoms that may signify neurologic disease (including disturbances of consciousness, cognition, language, vision, hearing, equilibrium, motor function, somatic sensation, and autonomic function)
   b. Identifying symptoms that may represent neurologic emergencies
   c. Distinguishing normal from abnormal findings on a neurologic examination
   d. Localizing the likely sites in the nervous system where a lesion may produce a patient's symptoms and signs
   e. Formulating a differential diagnosis based on lesion localization, time course, and relevant historical and epidemiologic features
   f. Explaining the indication, potential complications, and interpretation of common tests used in diagnosing neurologic disease

Table 1 Guidelines for a comprehensive neurologic examination

Mental status
Level of alertness
Language function (fluency, comprehension, repetition, naming, reading, writing)
Memory (short-term and long-term)
Attention
Calculation
Visuospatial processing
Abstract reasoning
Cranial nerves
Vision (visual fields, visual acuity, funduscopic examination)
Pupillary light reflex
Eye movements
Facial sensation
Facial strength (muscles of facial expression)
Hearing
Palatal movement
Speech
Neck and shoulder movements (head rotation and shoulder elevation)
Tongue (bulk, voluntary movement, presence of any involuntary movements at rest)
Motor function
Bulk
Tone (resistance to passive movement)
Pronator drift
Strength (shoulder abduction, elbow flexion/extension, wrist flexion/extension, finger flexion/extension/abduction, hip flexion/extension, knee flexion/extension, ankle dorsiflexion/plantar flexion)
Involuntary movements
Reflexes
Deep tendon reflexes (biceps, triceps, brachioradialis, patellar, Achilles)
Plantar responses
Sensation
Light touch
Pain or temperature
Proprioception
Vibration
Romberg
Coordination
Fine finger movements
Rapid alternating movements
Finger-to-nose (or finger-to-chin) and heel-knee-shin
Gait
Casual
Toes and heels
Tandem

All medical students should be able to perform the outlined components of the neurologic examination. The emphasis should be on students acquiring the core examination skills required by any physician, rather than expecting specialized examination techniques that might be performed by a neurologist.

g. Demonstrating awareness of the principles underlying a systematic approach to the management of common neurologic diseases
h. Describing timely management of neurologic emergencies
i. Developing, presenting, and documenting a succinct, appropriate assessment and plan for the neurologic problem list
j. Recognizing situations in which it is appropriate to request neurologic consultation
k. Reviewing, interpreting, and applying pertinent medical literature to patient care
l. Understanding cognitive biases and their implications for diagnostic errors
m. Developing skills needed to deliver patient-centered, compassionate neurologic care with emphasis on diversity, inclusiveness, and recognition of implicit bias
n. Applying principles of medical ethics to patient care
o. Identifying socioeconomic and regulatory issues and other health disparities that may influence accessibility of affordable diagnostic and therapeutic resources
p. Explaining the public health impact of neurologic disorders

Curriculum content

Any complex topic can be organized in a variety of ways, and there is no perfect order in which to teach the topic. For example, the traditional preclerkship curriculum at many medical schools is organ-based and students learn the anatomy, physiology, histology, and pathophysiology of one organ followed sequentially by instruction on the other organs. Other medical schools employ a discipline-based preclerkship curriculum, in which students study anatomy of all organs throughout the body, followed by the physiology, histology, and so on. Each approach has its advantages and disadvantages.[7,8]

Similarly, neurology educators have traditionally advocated a variety of approaches to organizing topics when teaching clinical neurology. Some stress the primacy of the neurologic

Table 2 Guidelines for the neurologic examination in patients with altered level of consciousness

Mental status
Level of arousal
Response to auditory stimuli (including voice)
Response to visual stimuli
Response to noxious stimuli (applied centrally and to each limb individually)
Cranial nerves
Response to visual threat
Pupillary light reflex
Vestibulo-ocular reflex
a. In response to oculocephalic (doll's eyes) maneuver
b. In response to ice water caloric testing
Corneal reflex
Gag reflex
Respiratory drive (spontaneous, ventilator-assisted/controlled)
Motor function
Voluntary or purposeful movements
Reflex withdrawal
Spontaneous, involuntary movements
Tone (resistance to passive movement)
Reflexes
Deep tendon reflexes
Plantar responses
Sensation (to noxious stimuli in limbs)

examination and present clinical topics in the context of normal and abnormal examination findings. Others emphasize the importance of localization, and specifically the differentiation between focal and diffuse disease processes. Others maintain that the curriculum should center on a set of "scripts" for addressing a collection of common symptom complexes. Still others advocate pathophysiologic categories as the organizing principle. The following four sections represent alternative ways of organizing the same subject matter. Course directors may choose to emphasize some of these approaches more than others. The current curriculum guidelines are not meant to prescribe a particular way of presenting or organizing the material. However, all of the topics included in the following sections should be covered in some way.

The neurologic examination

As an integral component of the general medical examination:

1. Perform a pertinent, thorough neurologic examination (table 1)
2. Perform a screening neurologic examination sufficient for detecting major neurologic dysfunction in asymptomatic patients (table 3)
3. Perform a neurologic examination on patients with an altered level of consciousness (table 2)
4. Know how to adapt the neurologic examination in young children (table 4)
5. Recognize and interpret abnormal findings on the neurologic examination
6. Demonstrate the use of techniques that ensure patient safety during the examination: some strategies include appropriate hand and instrument cleaning, single use of pins to test sensation, stabilizing position of the patient during muscle strength testing, and standing near the patient during the Romberg and gait examination

Localization

General principles differentiating lesions at the following levels:

1. Cerebral cortical and subcortical structures
2. Posterior fossa (brainstem and cerebellum)
3. Spinal cord

Table 3 Guidelines for a screening neurologic examination

Mental status (level of alertness, appropriateness of responses, orientation to date and place)
Cranial nerves
Visual acuity
Pupillary light reflex
Eye movements
Hearing
Facial strength (eye closure and smile)
Speech
Motor function
Strength (shoulder abduction, elbow flexion/extension, wrist extension, finger abduction, hip flexion, knee flexion/extension, ankle dorsiflexion)
Reflexes
Deep tendon reflexes (biceps, patellar, Achilles)
Plantar responses
Sensation (one modality at toes—can be light touch, pain, temperature, vibration, or proprioception)
Coordination (fine finger movements, finger-to-nose or finger-to-chin)
Gait (casual and tandem)

All medical students should be able to perform a brief screening neurologic examination that is sufficient to detect significant neurologic disease even in patients with no neurologic symptoms. Although the exact format of such a screening examination may vary, it should contain at least some assessment of mental status, cranial nerves, strength, reflexes, sensation, coordination, and gait. One example of a screening examination is given here. If there is reason to suspect neurologic disease based on the patient's history or the results of any components of the screening examination, a more complete examination is typically necessary.

Table 4 Tips for performing challenging components of the neurologic examination in a child

Cranial nerves
Visual acuity: present toys of various sizes and colors and monitor fixation/recognition
Visual fields: place a toy in the field of vision and note the location at which the child turns to look towards the toy
Eye movements: assess ocular movements to the sound of a bell or toy
Hearing: monitor whether the child's head turns toward a bell sound on each side
Motor function: observe posture and simple maneuvers such as playing with a ball or toy; observe for withdrawal to light bony pressure in the upper and lower extremities
Reflexes: test primitive reflexes in infants, and know the ages when each reflex is normally present
Sensation: observe for withdrawal to light bony pressure in the hands and feet
Coordination: assess how accurately the child reaches for and manipulates toys

Performance of certain components of the neurologic examination may need to be adapted in children to assess function. This table provides some suggestions that may be helpful.

4. Anterior horn cell
5. Nerve root/plexus
6. Peripheral nerve (mononeuropathy, polyneuropathy, and mononeuropathy multiplex)
7. Neuromuscular junction
8. Muscle

Symptom complexes

A systematic approach to the evaluation and differential diagnosis of patients who present with:

1. Acute, subacute, or episodic changes in mental status or level of consciousness
2. Gradual cognitive decline
3. Aphasia
4. Headache or facial pain
5. Neck or back pain
6. Blurry vision or diplopia
7. Dizziness
8. Dysarthria or dysphagia
9. Weakness (focal or generalized)
10. Involuntary movements
11. Numbness, paresthesia, or neuropathic pain
12. Urinary or fecal incontinence/retention
13. Unsteadiness, gait disturbance, or falls
14. Sleep disorders
15. Delay or regression in developmental milestones

Approach to specific conditions

General principles for recognizing, evaluating, and managing the following neurologic conditions as important prototypes, or potentially disabling or life-threatening conditions:

1. Conditions that require prompt response
   a. Acute stroke (ischemic or hemorrhagic) or TIA
   b. Acute vision loss
   c. Brain death
   d. CNS infection
   e. Encephalopathy (acute or subacute)
   f. Guillain-Barré syndrome
   g. Head trauma
   h. Increased intracranial pressure
   i. Neuromuscular respiratory failure
   j. Spinal cord dysfunction
   k. Status epilepticus
   l. Subarachnoid hemorrhage
2. Alzheimer disease
3. Bell palsy
4. Carpal tunnel syndrome
5. Epilepsy
6. Essential tremor
7. Headache (tension, migraine, cluster)
8. Multiple sclerosis
9. Myasthenia gravis
10. Myopathy
11. Parkinson disease
12. Polyneuropathy

Prerequisites for the trainee

Successful completion of the foundational curriculum of medical school should be demonstrated, including clinically relevant neuroanatomy, neuropathophysiology, neuropharmacology, and physical diagnosis.

Personnel needed for the training

Essential personnel

1. Course director (preferably board-certified or board-eligible neurologist)
2. Additional full-time academic faculty
3. Administrative coordinator for the course director

Desirable personnel

1. Adjunct clinical faculty
2. Neurology house staff
3. Advanced practice providers
4. Neuroscience nurses

Facilities needed for the training

Clinical sites (primary institution or other) for both outpatient and inpatient care should be available with adequate time and space to permit patient evaluation, teaching sessions, and performance assessments.

Methods of training

As with curriculum content, there are various teaching formats, each with its own advantages and disadvantages. For

example, educational experiences that revolve around actual patient contact have obvious relevance to the clinical issues students will encounter as practicing clinicians, but these experiences cannot be fully standardized. Simulated experiences, in contrast, can be standardized but they are inherently artificial. Patients who are "ideal" from the standpoint of having multiple abnormalities on neurologic examination may have rare neurologic diseases that are not immediately relevant to the types of conditions that most physicians will have to manage. There is no single ideal training format. The fundamental requirement is that at least some of the training must occur in the setting of actual patient care, under the supervision of teachers who specialize in neurology and who can apply the details of the individual patients to teach broader neurologic principles.

Essential

1. Required clinical encounters (appendix 1)
2. Supervised patient care encounters
3. Assessment of oral presentations and documentation
4. Teaching sessions
5. Material for independent study, including one or more of the following:
   a. Locally generated syllabus
   b. Published textbooks/references
   c. Online resources

Optional

1. Formal lectures
2. Standardized patients
3. Simulation

Timetable for training

For adequate training, at least 4 weeks during the clinical phase of medical school is necessary. Ideally, students should be required to complete the neurology experience within the first 12 months of the clinical phase (e.g., in the traditional 4-year curriculum, a required, 4-week neurology experience in the third year is optimal).

Methods of summative evaluation of the trainee

Summative evaluation of medical student performance on clinical experiences should be multidimensional and at a minimum should include clinical performance evaluations and a knowledge assessment. Tools to evaluate students may include nationally written standardized examinations, locally developed examinations, locally developed clinical assessment forms with behavioral anchors based on learning objectives, bedside assessment evaluation forms, and oral presentation rubrics.[6,9] The following list contains suggestions for various methods of evaluation.

Clinical performance evaluations by the trainers assessing:

1. Oral presentations and documentation
2. Fund of knowledge and clinical reasoning
3. Management skills and professionalism
4. Direct observation of the student interviewing and examining real patients or standardized patients

Examinations including one or more of the following:

1. Written
2. Online
3. Oral
4. Observed

Projects/assignments incorporating one or more of the following:

1. Self-directed learning
2. Evidence-based medicine
3. Graded history and physical

Methods of evaluation of the training process

In order to assess program effectiveness for departmental and institutional purposes, as well as for national accreditation, the clinical experience must be evaluated. This may be accomplished in several ways, which may be institution-specific or based on nationally administered examinations or questionnaires.

A. Student performance on standardized examinations
B. Student evaluations of the trainers
C. Student evaluations of the training experience

Mechanisms for formative feedback

Formative feedback should be timely, frequent, specific, and constructive, focused on performance and not character. Methods include:

A. Informal, spontaneous verbal discussion
B. Scheduled session with supervisors
C. Formal midrotation email or in-person session highlighting strengths and areas for improvement; any student performing below expected level should receive in-person feedback
D. Written comments on performance (e.g., on written presentations, via feedback cards)
E. Verbal comments on oral presentations

Faculty/resident orientation, instruction, and development

Personnel engaged in supervising students must receive information about the clinical experience including the goals,

Table 5 List of suggested clinical encounters

Clinical presentation	Encounter type (live vs simulated)
Transient neurologic event	Live
Examples: abnormal involuntary movement, dizziness, migraine aura, seizure, sleep disorder, syncope, TIA	
Cognitive impairment, acute or chronic	Live
Examples: acalculia, agnosia, altered mental status, amnestic syndrome, aphasia, apraxia, dementia, developmental disability, dyslexia, visuospatial dysfunction	
Focal or diffuse motor disturbance, acute or chronic	Live
Examples: abnormal movement, ataxia, diplopia, dysarthria, dysphagia, gait impairment, urinary or fecal incontinence, weakness	
Pain, acute or chronic	Live
Examples: back pain, facial pain, headache, neck pain, neuropathic pain, thalamic pain	
Sensory dysfunction (hypesthesia or paresthesia)	Live
Examples: central causes of sensory disturbance, neuropathy, plexopathy, radiculopathy	
Neurologic emergencies	Live or simulated
Examples	
a. Acute stroke (ischemic or hemorrhagic) or TIA	
b. Acute vision loss	
c. Brain death	
d. CNS infection	
e. Encephalopathy (acute or subacute)	
f. Guillain-Barré syndrome	
g. Head trauma	
h. Increased intracranial pressure	
i. Neuromuscular respiratory failure	
j. Spinal cord dysfunction	
k. Status epilepticus	

Modified from Merlin LR, Horak HA, Milligan TA, et al. A competency-based longitudinal core curriculum in medical neuroscience. *Neurology* 2014;83: 456–462.[11]

objectives, and expectations, as well as information that will enhance their roles as teachers and evaluators.

A. Annual distribution of course goals, objectives, and curriculum to all teachers
B. Development and review of expectations for residents to be involved with teaching (residents as teachers)
C. Periodic faculty development activities
D. Regular (at least annual) review by course director of student evaluations for faculty and resident performance
E. Biannual or annual report of faculty and resident performance to chair and residency program director, respectively

Appendix 1. Required clinical encounters for neurology experiences

Background

The Liaison Committee on Medical Education (LCME) accreditation standards contain the following language:

> *The faculty of a medical school define the types of patients and clinical conditions that medical students are required to encounter, the skills to be performed by medical students, the appropriate clinical settings for these experiences, and the expected level of medical student responsibility.*[10]

The LCME mandates that a system be established to specify the types of patients or clinical conditions that students must encounter and to monitor and verify the students' experiences with patients so as to remedy any identified gaps. The system, whether managed at the individual clerkship level or centrally, must ensure that all students have the required experiences. For example, if a student does not encounter patients with a particular clinical condition (e.g., because it is seasonal), the student should be able to remedy the gap by a simulated experience (such as standardized patient experiences or online or paper cases), or in another clerkship.

Recognizing that each medical school and clinical neurology experience will have individual needs and objectives, this resource is an American Academy of Neurology (AAN) recommendation. It provides support and guidance for required neurology clinical encounter standards that are reflective of the AAN Core Curriculum Guidelines for Required Clinical Neurology Experience. Table 5 contains types of clinical presentations listed in 6 categories. A specific patient may satisfy more than one presentation category. Clerkship directors, in consultation with their local curriculum committees, may select any or all encounters from this list and may select other clinical experiences that are not on this list if they meet local needs.

Original work group members: Tracey Milligan, MD (work group leader); David Geldmacher, MD; Richard Isaacson, BA, MD; Rama Gourineni, MD; Daniel Menkes, MD, FAAN; Imran Ali, MD; Amy Pruitt, MD; James Owens, MD, PhD; Nancy Poechmann (AAN staff).

Updated by Joseph E. Safdieh, MD, FAAN; Yazmin Odia, MD; Douglas Gelb, MD, PhD, FAAN; Raghav Govindarajan, MD, FAAN; Madhu Soni, MD, FAAN.

Appendix Authors

Name	Location	Role	Contribution
Joseph E. Safdieh, MD, FAAN	Weill Cornell Medicine/New York Presbyterian Hospital, New York	Author	Manuscript concept and design; drafted the manuscript for intellectual content
Raghav Govindarajan, MD, FAAN	University of Missouri, Columbia	Author	Manuscript concept and design; drafted the manuscript for intellectual content
Douglas J. Gelb, MD, PhD, FAAN	University of Michigan Medical School, Ann Arbor	Author	Manuscript concept and design; drafted the manuscript for intellectual content
Yazmin Odia, MD	Miami Cancer Institute, FL	Author	Drafted the manuscript for intellectual content
Madhu Soni, MD, FAAN	Rush University Medical Center, Chicago, IL	Author	Manuscript concept and design; drafting; critically revised the manuscript for intellectual content

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