



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

**BASIC TOPICS**

**Guidelines for Neuroanatomy**

**Unit Objectives** – Demonstrate knowledge of anatomy that is pertinent to the diagnosis of diseases of the nervous system and the practice of neurological surgery.

**Competency-based Knowledge Objectives:**

*Junior Level:* During the first two years the resident should have a basic knowledge of neuroanatomy. The following should serve as a guide.

- I. General
  - A. Embryology
    1. Review the embryological development of the brain, cerebellum, brain stem, glial elements, spinal cord, conus medullaris, cauda equine, sympathetic and parasympathetic nervous systems and the peripheral nervous system.
    2. Discuss the embryological development of the skull, craniovertebral junction, and spine.
  - B. Histology
    1. Describe and differentiate different types of neurons
    2. Discuss the microanatomy of the neuron including the:
      - a. cell body
      - b. dendritic process
      - c. axonal process
    3. Diagram and describe the microanatomy of the synapse.
    4. List the microglial elements and review their microanatomy:
      - a. astrocytes
      - b. oligodendrocytes
      - c. microglia
      - d. ependyma
      - b. choroid epithelium
    5. Discuss the anatomical basis for the blood-brain barrier in detail.
  - C. Vascular anatomy
    1. Diagram and describe in detail the carotid and vertebral arteries and their branches:
      - a. extracranial carotid branches
      - b. extracranial vertebral artery branches
      - c. meningeal arteries
      - d. PICA
      - e. AICA



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- f. SCA
  - g. intraosseus intracavernous carotid artery
  - h. ophthalmic artery
  - i. intracranial carotid artery
  - j. MCA
  - k. ACA
  - l. PCA
2. Discuss in detail the arterial blood supply to the spinal cord. Include in the discussion the anterior spinal and radicular arteries and the concept of watershed ischemia.
3. Identify and review the venous drainage of the central nervous system.
- a. Deep and intraventricular veins
  - b. Superficial supratentorial veins
  - c. Veins of the pineal region
  - d. Veins of the posterior fossa
- D. Osseus Anatomy
- 1. List and identify the bones of the skull. Note their anatomic relationship to one another.
  - 2. Describe each of the sutures of the skull.
  - 3. Identify each named foramen of the skull and list its contents.
- E. Extracerebral anatomy
- 1. Describe the anatomy of the meninges including the:
    - a. dura mater
    - b. arachnoid mater
    - c. pia mater
  - 2. Describe the anatomy of the dura including the falx cerebri and tentorium.
  - 3. Review the layers of the scalp and discuss its innervation.
  - 4. Discuss the major arachnoid cisterns.
  - 5. Review the anatomy of the arachnoid villi.
  - 6. Discuss the anatomic correlates pertinent to the production, flow, and
  - 7. reabsorption of cerebrospinal fluid.
- F. Diagram the cerebral ventricles.
- 1. Floor of the fourth ventricle
  - 2. Lateral ventricles
  - 3. Third ventricle
- G. Spinal anatomy
- 1. Identify and describe the gross anatomy of the spine including:
    - a. atlas
    - b. axis
    - c. subaxial cervical vertebrae
    - d. thoracic vertebrae



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- e. lumbar vertebrae
  - f. sacrum
  - g. coccyx
  - h. intervertebral disc complex
    - i. supporting ligaments of the spine
  - 2. List the muscles related to the skull and spine.
    - a. suboccipital muscles
    - b. anterior cervical muscles
    - c. posterior spinal muscle
  - 3. Describe the gross anatomy of the neck.
    - a. carotid artery
    - b. jugular vein
    - c. lower cranial nerves
    - d. superior laryngeal nerve
    - e. recurrent laryngeal nerve
- II. Central Nervous System
- A. Describe the gross anatomy (external features) of the brain, brain stem, cerebellum, cranial nerves, and spinal cord in detail.
    - 1. Describe the exit of the cranial nerves.
    - 2. Note the gyral pattern(?) of the cerebral cortex.
    - 3. Describe the anatomy of the cerebral cortex in detail including:
      - a. cortical layers
      - b. sensory layers
      - c. motor areas
      - d. prefrontal cortex
      - e. calcarine cortex
    - 4. Identify the major sulci and gyri of the brain
  - B. Describe the anatomy of the olfactory pathways, hippocampal formation and amygdala in detail including:
    - a. rhinencephalon
    - b. olfactory pathways
    - c. anterior commissure
    - d. hippocampal formation (including cytoarchitecture)
    - e. amygdala
    - f. limbic system
  - C. Describe the anatomy of the basal ganglia in detail including:
    - a. striatum
    - b. globus pallidus
    - c. claustrum
    - d. subthalamic region
    - e. striatal afferent and efferent connections
    - f. pallidal afferent and efferent connections
    - g. pallidofugal fiber systems
    - h. diagram the circuits relevant to functional surgery
  - D. Describe the anatomy of the hypothalamus and pituitary in detail including:
    - a. afferent and efferent connections of the hypothalamus



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. supraoptic nuclei and tracts
- c. hypophysial portal system
- d. anatomy of pituitary stalk
- e. anterior and posterior pituitary
- f. cellular organization of the anterior pituitary
- g. hormonally active cells of the hypothalamus and pituitary
- E. Describe the anatomy of the diencephalon in detail including:
  - a. midbrain-diencephalon junction
  - b. caudal diencephalon
  - c. epithalamus
  - d. thalamus (including nuclei)
  - e. thalamic radiations
  - f. internal capsule
  - g. visual pathways
- F. Describe the anatomy of the cerebellum in detail including:
  - a. cerebellar cortex including organization of incoming and outgoing fibers
  - b. deep cerebellar nuclei
  - c. cerebellar connections
  - d. cerebellar peduncles
- G. Describe the anatomy of the mesencephalon in detail including:
  - a. superior colliculus
  - b. inferior colliculus
  - c. pretectal region
  - d. posterior commissure
  - e. mesencephalic nuclei
  - f. oculomotor nerve
  - g. tegmentum
  - h. mesencephalic reticular formation
  - i. substantia nigra
  - j. crus cerebri
  - k. ascending and descending tracts
- H. Describe the anatomy of the pons in detail including:
  - a. vestibulocochlear nerve
  - b. facial nerve
  - c. abducens nerve
  - d. trigeminal nerve
  - e. ascending and descending tracts
- I. Describe the anatomy of the medulla in detail including:
  - a. olivary nucleus
  - b. medullary reticular formation
  - c. cranial nerves of the medulla
  - d. ascending and descending tracts
- J. Review the location and connection of each cranial nerve nuclei. Trace the course of each cranial nerve from nucleus to end organ termination.
- K. Describe the external topography and landmarks of the fourth ventricle.
- L. Describe the anatomy of the spinal cord in detail including:



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- a. nuclei and cell groups
- b. cytoarchitectural lamination (Rexed laminae)
- c. somatic and visceral efferent neurons
- d. posterior horn neurons
- e. descending tracts
- f. ascending tracts
- g. upper and lower motor neurons

**III. Autonomic Nervous System**

1. Describe the sympathetic nervous system.
2. Distinguish pre- and post-ganglionic neurons.
3. Describe the parasympathetic nervous system.
4. Review the visceral afferent fibers.
5. Describe the structure of the autonomic ganglia.
6. Discuss the central autonomic pathways.

**IV. Peripheral Nervous System**

1. Differentiate between segmental and peripheral innervation.
2. Diagram the anatomy of the spinal nerve root.
3. Diagram and discuss the major plexi:
  - a. Cervical
  - b. Brachial
  - c. Lumbosacral
4. Outline the anatomy of the major peripheral nerves of the upper and lower extremity including:
  - a. axillary
  - b. suprascapular
  - c. median
  - d. ulnar
  - e. radial
  - f. long thoracic
  - g. musculocutaneous
  - h. lateral femoral cutaneous
  - i. femoral
  - j. obturator
  - k. sciatic
  - l. saphenous
  - m. peroneal
  - n. tibial
5. Describe the neuroanatomy of the peripheral nerves in detail.
6. Explain the difference between myelinated and unmyelinated nerves.
7. Review the anatomy of the Schwann cell.
8. List the peripheral afferent receptors and describe the anatomy of each.
9. Segregate peripheral neurons by size and explain the rationale for such a classification scheme.

**V. Muscle**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

1. Explain the concept of the motor unit.
2. Describe the anatomy of the motor end plate.
3. Describe the microscopic anatomy of striated and smooth muscle.
4. Discuss the subcellular components of muscle.

**Middle Level:** During the PGY-4 year the resident should review the anatomy outlined above and link the anatomy with clinical syndromes encountered.

1. Discuss the clinical presentation in anatomical terms of syndromes resulting from extracerebral cranial injuries
  - a. epidural hematoma
  - b. acute subdural hematoma
  - c. chronic subdural hematoma
  - d. subgaleal hematoma
  - e. injury to innervation of the scalp
2. Discuss the syndromes produced by extracranial mass lesions affecting the cranial nerves including:
  - a. suprasellar lesions
  - b. lesion of jugular foramen
  - c. lesion of internal auditory canal
  - d. lesions or distortion at the incisura
  - e. lesions within the cerebellar pontine angle
3. Review the expected effects of occlusion of the named arteries supplying the brainstem
4. List the expected effects of destructive lesions in the basal ganglia and cerebellum.
5. Discuss the expected effect of destructive lesions of specific regions of the cerebral cortex.
6. Review the clinical presentation of strokes in the distribution of the supratentorial cerebral blood vessels.
7. Diagram the structures comprising the boundaries of the spinal neural foramina.
8. Anatomy of the described and (?) named syndrome that follow spinal cord injury.
9. Discuss the clinical manifestation of injury for each of the major peripheral nerves.
10. Describe the anatomy and presentation of common entrapment syndromes of peripheral nerves including:
  - a. thoracic outlet syndrome
  - b. carpal tunnel syndrome
  - c. ulnar nerve entrapment syndrome at wrist and elbow
  - d. anterior interosseous syndrome
  - e. posterior interosseous syndrome
  - f. meralgia paresthetica
  - g. peroneal nerve palsy
  - h. tarsal tunnel syndrome



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

11. Describe the surgical exposure for the decompression of common peripheral nerve entrapments including:
  - a. carpal tunnel
  - b. ulnar nerve at elbow
  - c. ulnar nerve at wrist
  - d. lateral femoral cutaneous nerve
  - e. peroneal nerve
  - f. posterior tibial nerve
  
12. Discuss the clinical presentation and neurological deficits associated with common lesions of and injuries to the spinal cord and nerve roots.

**Competency-based Performance Objectives:  
*Middle Level:***

1. Identify at the time of surgery:
  - a. occipital artery
  - b. superficial temporal artery
  - c. frontalis muscle
  - d. pterion
  - e.inion
  - f. asterion
  - g. coronal suture
  - h. sagittal suture
  - i. middle meningeal artery
  - j. sagittal sinus
  - k. transverse sinus
  - l. foramen rotundum
  - m. foramen ovale
  - n. foramen spinosum
  - o. superior orbital fissure
  - p. jugular foramen
  - q. internal auditory canal
  - r. superior sagittal sinus
  - s. sigmoid sinus
  - t. incisura
  - u. each cranial nerve
  - v. each named cerebral artery and vein
  - w. components of the brain stem
  - x. named structures on the floor of the fourth ventricle
  - y. Foramina of Magendie and Luschka
  - z. cerebral peduncles
  - aa. components of the cerebellum
  - ab. cerebellar tonsils
  - ac. brachium cerebelli
  - ad. vermis
  - ae. major supratentorial gyri
  - af. supratentorial lobes
  - ag. sylvian fissure
  - ah. central sulcus
  
2. Identify at time of surgery structures visible in the lateral ventricles including:



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- a. Foramen of Monro
  - b. fornix
  - c. caudate
  - d. thalamus
  - e. choroidal fissure
  - f. named veins
  - g. glomus of the choroid plexus
  - h. hippocampus
  - i.
3. Identify the parts of the vertebral column, spinal cord, and nerve roots at the time of surgery including:
- a. spinous process
  - b. lamina
  - c. superior facet
  - d. inferior facet
  - e. pedicle
  - f. pars interarticularis
  - g. uncovertebral joint
  - h. neural foramen and nerve root
  - i. nerve root ganglion
  - j. disc space
  - k. vertebral artery
  - l. dorsal column and lateral column of spinal cord
  - m. intradural afferent and efferent rootlets



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

## **NEUROPHYSIOLOGY**

### **UNIT OBJECTIVES**

Demonstrate knowledge of physiology that is pertinent to the understanding of neurological disease.

### **COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

#### ***Junior Resident R2 year:***

1. Review the basic biology of the nerves including:
  - a. synthesis and movement of proteins in the nerve
  - b. membrane potential and membrane properties
  - c. ion channels
  - d. generation and conduction of an action potential
2. Discuss synaptic transmission including:
  - a. types of synaptic transmission
  - b. transmitter release
  - c. nerve-muscle transmission
  - d. chemical messengers
  - e. direct gated receptors
  - f. second messenger linked receptors
3. Describe the physiology of the sensory systems including:
  - a. sensory receptor physiology
  - b. anatomy of somatic sensory system
  - c. coding of modality specific sensory information
  - d. pain and analgesia
  - e. cortical integration of sensory perception
  - f. visual system
    1. processing of information in the retina
    2. processing of vision in the central visual pathways
    3. columnar units of visual cortex



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

4. processing in the geniculate nucleus
5. visual perception of motion and form.
- g. auditory system. Within this description review the processing of hearing in the cochlea and the central auditory pathways.
- h. olfaction and taste

***R3 Year Level***

4. Discuss the physiology of the motor system including:
  - a. mechanisms of muscle contraction
  - b. muscle receptors, spinal reflexes
  - c. spinal reflexes concerned with position
  - d. brain stem reflexes controlling motion
  - e. vestibular nuclei control of movement and posture
  - f. red nucleus control of movement
  - g. cortical control of movement
  - h. cerebellar control of movement
    1. regional and cellular organization of the cerebellum
    2. functional divisions of the cerebellum
    3. the role of the cerebellum in planning movement
  - i. basal ganglia
    1. the anatomy of basal ganglia pathways
    2. neural transmitters in the circuits within the basal ganglia
  - j. thalamus
    1. location of all nuclei
    2. pathways and connections
    3. reticular nucleus of thalamas
5. Describe the attributes of the autonomic nervous system including both the sympathetic and parasympathetic systems.
  - a. Preganglionic location and pathways
  - b. Postganglionic location and pathways



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- c. Functional effects of stimulation and blockade
6. Review the physiological basis of arousal and emotion. Include within this review the:
  - a. noradrenergic systems
  - b. limbic system. Include within this review the physiologic basis for emotion and memory
    1. memory types: working, declarative
    2. hippocampus and short-term memory
    3. disorders of memory
  - c. sleeping and sleep states
    1. EEG patterns of four stages of sleep
    2. Disorders of sleep and EEG patterns
  - d. reticular activating system
    1. Descending systems and spinal cord connections
    2. effect of lesion and stimulation of different RAS nuclei
7. Describe the higher cortical functions including:
  - a. anatomy of language
    1. expressive aphasia
    2. receptive aphasia
    3. transcortical aphasia
  - b. function of association cortex
    1. SMA (supplementary motor area) and lesions
    2. visual association areas and effect of lesions
8. Describe the physiological basis for cerebrospinal fluid production and reabsorption.
9. Review the physiological control of the cerebral vasculature.
  - a. normal control and autoregulation
  - b. pathological changes and loss of autoregulation
10. Discuss, in detail, the physiology of the hypothalamus and pituitary, particularly as related to endocrinology.
  - c. pituitary hormones and respective precursors
  - d. pituitary hormones and feedback control



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

**NEUROPATHOLOGY**

**UNIT OBJECTIVES**

Demonstrate knowledge of neuropathology that is pertinent to the diagnosis of diseases of the nervous system and practice of neurological surgery.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Middle Level:***

General Neuropathology

1. Describe the techniques available for examination of surgical specimens from central nervous system, peripheral nervous system, skeletal muscle, pineal and pituitary.
2. Review the use of standard chromatic, histochemical and selected immunohistochemical stains employed in the evaluation of surgical specimens from the central nervous system, peripheral nervous system, skeletal muscle, pineal and pituitary.
3. List the techniques available for morphological examination of cerebrospinal fluid and the abnormalities observed in cerebrospinal fluid from patients with meningeal carcinomatosis, meningeal lymphomatosis, pyogenic meningitis and aseptic meningitis.

Central Nervous System

1. Describe the gross and histopathological features, prognosis, and, when applicable, the genetic basis of the following congenital and perinatal disorders:
  - a. encephaloceles and cranial meningoceles
  - b. myelomeningocele and meningocele
  - c. hydromyelia
  - d. diastatomyelia and diplomyelia
  - e. syringomyelia and syringobulbia
  - f. Chiari I malformation
  - g. Chiari II malformation
  - h. Dandy-Walker malformation
  - i. arachnoid cysts
  - j. porencephaly
  - k. aqueductal stenosis
  - l. subependymal germinal matrix hemorrhages
  - m. posthemorrhagic hydrocephalus
  - n. periventricular leukomalacia (white matter infarcts)



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

2. Describe the gross and histopathological features, prognosis, and characteristics of the causative agents of the following infectious diseases:
  - a. cranial and spinal epidural abscesses
  - b. cranial and spinal subdural abscesses
  - c. pyogenic bacterial meningitis and ventriculitis
  - d. brain abscesses
  - e. tuberculous meningitis and tuberculomas
  - f. central nervous system sarcoidosis
  - g. central nervous system cryptococcosis
  - h. central nervous system mucormycosis
  - i. central nervous system toxoplasmosis
  - j. central nervous system cysticercosis
  - k. Herpes simplex encephalitis
  - l. central nervous system HIV infections
  - m. central nervous system cytomegalovirus infection
  
3. Describe the gross and histopathological features, and prognosis, of the following vascular lesions:
  - a. acute, subacute, and remote infarcts
  - b. border zone and watershed infarcts
  - c. manifestations of embolic infarcts including those secondary to atheromatous embolization and embolization from extracorporeal pumps
  - d. vasculitis including temporal arteritis, primary central nervous system vasculitis, granulomatous angiitis, and Wegener's granulomatosis
  - e. moyamoya
  - f. hypertensive intracerebral hemorrhages
  - g. lobar intracerebral hemorrhages
  - h. amyloid angiopathy
  - i. malformations including arteriovenous malformations, cavernous angiomas, venous angioma and capillary telangiectases
  - j. Vein of Galen "aneurysms"
  - k. saccular aneurysms



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- l. infectious ("mycotic") aneurysms
        - m. giant aneurysms
        - n. traumatic and dissecting aneurysms
        - o. venous and dural sinus occlusive disease
        - p. vascular malformations of the spinal cord
        - q. spinal cord infarcts
4. Describe the gross and histopathological features and prognosis of the following traumatic lesions:
  - a. skull fractures
  - b. entrance and exit gunshot wounds of the skull
  - c. gunshot wounds of the brain including internal ricochet
  - d. epidural hematomas
  - e. acute subdural hematomas
  - f. chronic subdural hematomas
  - g. recent and remote cerebral contusions
  - h. traumatic intraparenchymal hemorrhages
  - i. diffuse axonal injury
  - j. traumatic cranial nerve injuries
  - k. spinal cord injuries
  - l. cerebral herniation syndromes
  - m. fat embolization
  - n. central nervous system trauma in infancy
  - o. central nervous system radiation injuries
  - p. manifestations of prior surgical intervention
5. Describe the gross and histopathological features and prognosis, and, when applicable, the metabolic basis for the following intoxications and deficiency states:
  - a. hypoxic-anoxic encephalopathy
  - b. carbon monoxide intoxication
  - c. ethanol intoxication



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- d. alcoholic cerebellar degeneration
  - e. central pontine myelinolysis
  - f. CNS complications of diagnostic agents including contrast material
  - g. CNS complications of antimicrobial therapy
  - h. CNS complications of antineoplastic therapy
  - i. CNS complications of "street drugs"
  - j. Wernicke's encephalopathy and thiamine deficiency
  - k. Subacute combined degeneration and B12 deficiency
6. Describe the gross and histopathological features and prognosis, of the following demyelinating diseases:
- a. multiple sclerosis
  - b. progressive multifocal leukoencephalopathy
  - c. HIV vacuolar myelopathy
  - d. postinfectious encephalomyelitis
7. Describe the gross and histopathological features and prognosis, and the metabolic basis for the following leukodystrophies:
- a. adrenoleukodystrophy and adrenomyeloneuropathy
  - b. Krabbe's disease
  - c. metachromatic leukodystrophy
8. Describe the gross and histopathological features and prognosis, and, when applicable, the genetic basis for the following dementias and degenerations:
- a. Alzheimer's disease including familial forms
  - b. vascular dementia including Binswanger's disease and cerebral autosomal dominant arteriopathy (CADASIL)
  - c. Pick's disease
  - d. other fronto-temporal dementias
  - e. Creutzfeldt-Jacob disease and other prion diseases
  - f. Parkinson's disease
  - g. diffuse Lewy body disease
  - h. Huntington's disease



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- i. amyotrophic lateral sclerosis
  - j. paraneoplastic degenerative diseases
9. Describe the gross and histopathological features and prognosis, and, when applicable, the biochemical and genetic basis for the following metabolic diseases:
- a. Wilson's disease
  - b. Tay Sachs disease and other GM-2 gangliosidoses
  - c. neuronal ceroid-lipofuscinoses
  - d. hepatic encephalopathy
  - e. Reye's syndrome
10. Describe the gross and histopathological features and prognosis, and, when applicable, the grading criteria and known genetic basis for the following central nervous system neoplasms:
- a. diffuse fibrillary astrocytomas
  - b. gemistocytic astrocytomas
  - c. anaplastic astrocytomas
  - d. glioblastoma multiforme including giant cell glioblastoma and gliosarcomas
  - e. pilocytic astrocytomas including cerebellar, diencephalic, dorsal exophytic pontine, and cerebral pilocytic astrocytomas
  - f. subependymal giant cell astrocytomas
  - g. pleomorphic xanthoastrocytoma
  - h. oligodendrogliomas including anaplastic oligodendrogliomas and mixed oligoastrocytomas
  - i. ependymomas including myxopapillary ependymomas
  - j. subependymomas
  - k. choroid plexus tumors
  - l. colloid cysts
  - m. gliomatosis cerebri
  - n. gangliocytomas and gangliogliomas
  - o. dysembryoplastic neuroepithelial neoplasms
  - p. central neurocytomas
  - q. medulloblastomas



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- r. atypical teratoid/rhabdoid tumors
  - s. primitive neuroectodermal tumors and cerebral neuroblastomas
  - t. olfactory neuroblastoma
  - u. spinal paragangliomas
  - v. meningiomas including meningotheial (syncytial) fibrous, transitional, psammomatous, angiomatous, and papillary meningiomas
  - w. anaplastic and malignant meningiomas
  - x. meningeal hemangiopericytomas
  - y. other meningeal mesenchymal tumors
  - z. meningeal melanomatosis and melanomas
  - aa. hemangioblastomas
  - bb. lipomas
  - cc. primary central nervous system lymphomas
  - dd. metastatic carcinomas including leptomeningeal carcinomatosis
  - ee. teratomas
  - ff. dermoids and epidermoids
  - gg. schwannomas including acoustic neurinomas or vestibular schwannomas, schwannomas of other cranial nerves, and spinal root schwannomas
11. Describe the gross and histopathological features and prognosis, and the genetic basis for the following tumor syndromes:
- a. Neurofibromatosis type 1
  - b. Neurofibromatosis type 2
  - c. von Hippel-Lindau syndrome
  - d. Tuberous sclerosis
  - e. Cowden syndrome
  - f. Turcot syndrome

**Peripheral Nervous System**

- 1. Describe the gross and histopathological features and prognosis, and, when applicable, the genetic and biochemical basis for the following disorders of peripheral nerves:
  - a. compressive and traumatic neuropathies



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. leprosy
  - c. diabetic and uremic neuropathy
  - d. Charcot-Marie-Tooth disease
  - e. Guillain-Barre syndrome
  - f. sympathetic dystrophy
2. Describe the gross and histopathological features and prognosis of the following neoplastic and tumorous disorders of peripheral nerves:
- a. peripheral schwannoma
  - b. neurofibromas
  - c. malignant peripheral nerve sheath tumors
  - d. spinal root and peripheral nerve root cysts

**Pituitary and Pineal**

1. Describe the gross and histopathological features and prognosis of the following pituitary conditions:
  - a. pituitary adenomas including null cell adenomas, growth hormone secreting adenomas, prolactin secreting adenomas, ACTH secreting adenomas, and oncocytomas
  - b. craniopharyngiomas including adamantinomatous and squamopapillary craniopharyngiomas
  - c. Rathke pouch (cleft) cysts
  - d. pituitary involvement by metastatic neoplasms
  - e. lymphocytic hypophysitis
  - f. pituitary infarcts including pituitary "apoplexy"
  - g. pituitary lesions resulting from closed head trauma
  - h. empty sella syndromes
2. Describe the gross and histopathological features and prognosis of the following lesions of the pineal:
  - a. germinomas
  - b. teratomas and embryonal carcinomas
  - c. pineoblastomas and pineocytomas
  - d. metastatic carcinoma

**Skull and Spine (including intervertebral discs)**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

1. Describe the gross and histopathological features and prognosis of the following disorders of the skull:
  - a. dermoids and epidermoids
  - b. hemangiomas
  - c. osteomas
  - d. chordomas
  - e. solitary and multifocal eosinophilic granuloma
  - f. Paget's disease including secondary osteosarcoma
  - g. metastatic carcinomas
  - h. plasmacytoma including myeloma
  
2. Describe the gross and histopathological features and prognosis of the following disorders of the spine and intervertebral discs:
  - a. herniated intervertebral discs
  - b. pyrophosphate disease including involvement of ligamentum flavum
  - c. tumoral calcinosis
  - d. hemangiomas
  - e. chordomas
  - f. eosinophilic granulomas
  - g. metastatic carcinomas including epidural metastases
  - h. plasmacytoma including myeloma
  - i. lymphomas
  - j. primary bone tumors
  - k. spinal osteomyelitis including tuberculous and fungal spinal osteomyelitis

**Eye and Orbit**

1. Describe the gross and histopathological features and prognosis of the following ocular lesions:
  - a. retinoblastomas
  - b. ocular melanomas
  
2. Describe the gross and histopathological features and prognosis of the following orbital lesions:
  - a. optic nerve gliomas



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. optic nerve meningiomas
- c. orbital lymphomas and pseudotumors
- d. orbital metastases

Miscellaneous

1. List the gross and histopathological features found in temporal lobectomy and cerebral hemispherectomy specimens removed during epilepsy surgery.
2. Review the gross, histopathological, and cytopathological features that can be observed in shunt revision specimens.
3. Describe the gross, histopathological, and cytopathological features that can be observed with indwelling pump and intrathecal catheter specimens.
4. Cite the techniques for examination of foreign objects removed from the nervous system and the need for documentation of chain of custody when of potential legal significance.
5. Describe the histopathological features of myotonic dystrophy and central core myopathy and list the potential implications of these diseases with regard to adverse anesthetic reactions including development of malignant hyperthermia.
6. Discuss the role of MGMT methylation and 1p 19q chromosomal deletions in the selection and efficacy of therapy for glial tumors.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

## **NEUROLOGY**

### **UNIT OBJECTIVES**

Demonstrate an understanding of the neurologic examination, diagnostic neurologic testing, neurologic diseases and their treatment.

### **COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

*Junior and Middle Levels:*

#### **Neurophysiologic Studies:**

1. Discuss electroencephalography. Recognize normal and abnormal EEG patterns. Identify specific epileptic conditions by EEG findings.
2. Describe the principles of sensory evoked potential testing (SEPs). Discuss how SEPs may be useful diagnostically.
3. List the indications for using intraoperative SEP monitoring and describe in detail how the procedure may be performed.
4. Describe the principles of visual evoked potential testing (VEPs). Discuss how VEPs may be useful diagnostically.
5. Describe the principles of motor evoked potential testing (MEPs). Discuss how MEPs may be useful diagnostically.
6. List the indications for using intraoperative MEP monitoring and describe in detail how the procedure may be performed.
7. Discuss electromyographic (EMG) testing in detail. Describe how the testing is performed and review the diagnostic capabilities of EMG testing. Describe the EMG changes associated with neuromuscular pathology.
8. List the indications for using intraoperative EMG testing and describe in detail how the procedure may be performed.
9. Discuss nerve conduction velocity (NCV) testing in detail. Describe how the testing is performed and review its diagnostic capabilities. List the transmission velocities of the major nerves. Describe NCV changes observed in neuropathy.
10. Discuss the principles and utilization of brainstem evoked responses (BAER).

#### **Altered mentation, confusional states and level of consciousness:**

11. Define delirium and dementia. List the differential diagnoses for each.
12. Discuss alterations in memory.
13. Define and discuss coma and altered states of consciousness.
14. Describe the evaluation of a patient with syncope.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

15. Discuss the management of hyperosmolar hyperglycemic nonketotic diabetic coma.
16. Describe autism.

**Cerebrovascular disease:**

17. Describe the etiology and pathogenesis of cerebrovascular disease.
18. Review the clinical presentation and discuss the radiographic evaluation, clinical evaluation, and management of the following:
  - a. transient ischemic attacks
  - b. cerebral infarction
  - c. cerebral and cerebellar hemorrhage
  - d. subarachnoid hemorrhage
  - e. venous infarction
19. Describe the medical and surgical management of carotid artery stenosis.
20. Identify the primary causes of stroke in the pediatric population.
21. Comprehensively discuss the etiology, clinical presentation, diagnostic evaluation, and management of cerebral vasculitis.
22. Differentiate between basal occlusive disease with and without telangiectasia. Review the prognosis and treatment options for each.
23. Describe the acute and chronic effects of ionizing radiation on the central nervous system.

**Headache:**

24. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of migraine and non-migrainous headaches.
25. Discuss the diagnosis and management of non-migrainous headache syndromes, including cluster, tension, temporal-mandibular joint disease, trigeminal neuralgia, occipital neuralgia, glossopharyngeal neuralgia, postherpetic neuralgia, Ramsay-Hunt, temporal arteritis, pseudotumor cerebri, hypertensive, and muscle spasm-related.

**Epilepsy:**

26. Review the pathophysiology and clinical presentation of the common epileptic disorders in detail.
27. Describe the indications and role of various methods for diagnosing seizure foci, including clinical presentation, neuroimaging (CT, MRI, PET, SPECT), video-EEG monitoring, and intracranial electrodes (single, strip, panel).
28. Review medical and surgical treatments of common epileptic disorders.
29. Define status epilepticus and discuss the medical treatment of same.

**Alteration of CSF, Intracranial pressure**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

30. Review the diagnosis and management of pseudotumor cerebri.
31. Discuss the diagnosis and management of normal pressure hydrocephalus.

**Endocrine Disorders:**

32. Diabetes mellitus- describe classification, pathophysiology, and neurologic manifestations.
33. Paraneoplastic syndromes and multiple endocrinopathies.

**Congenital Disorders:**

34. Review normal neurodevelopment.
35. Review the general topic of chromosomal abnormalities as they may relate to the central nervous system including etiology, inheritance patterns, penetrance, and laboratory diagnosis.
36. Review the general topics of abnormalities in gastrulation, primary neurulation, secondary neurulation, dysjunction, post-neurulation defects and neuronal migration, organization, and myelination.
37. List the major syndromes characterized by obesity and hypogonadism, including Prader-Willi syndrome.
38. Discuss agenesis of the corpus callosum.
39. Discuss anencephaly, microencephaly, and megaencephaly.

**Metabolic and storage disorders:**

40. List the major disorders of amino acid and purine metabolism, including phenylketonuria, homocysteinuria, and maple syrup urine disease. Discuss the neurological manifestations of each.
41. Review each of the major lysosomal storage diseases including:
  - a. GM<sub>1</sub>-Gangliosidoses
  - b. GM<sub>2</sub>-Gangliosidoses
  - c. Fabry disease
  - d. Gaucher disease
  - e. Niemann-Pick disease
  - f. Farber disease
  - g. Wolman disease
  - h. Refsum disease
  - i. Cerebrotendinous Xanthomatosis
  - j. Neuronal ceroid lipofuscinoses



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- k. Tay-Sachs disease
  - l. Sandhoff's disease
42. Review each of the major leukodystrophies including:
- a. Krabbe leukodystrophy
  - b. Metachromatic leukodystrophy
  - c. Adrenoleukodystrophy
  - d. Pelizaeus-Merzbacher disease
  - e. Canavan's disease
  - f. Alexander's disease
  - g. Sudanophyllic leukodystrophy
43. Review each of the major mucopolysaccharidoses including:
- a. Hurler syndrome (MPS IH)
  - b. Scheie's syndrome (MPS 1S)
  - c. Hunter syndrome (MPS II)
  - d. Sanfilippo syndrome (MPS III)
  - e. Morquio syndrome (MPS IV)
  - f. Maroteaux-Lamy syndrome (MPS VI)
44. Review the disorders of carbohydrate metabolism including:
- a. glycogen storage diseases
  - b. Lafora disease and other polyglucosyl storage diseases
45. Discuss hyperammonemia as it relates to neurological dysfunction.
46. Discuss adrenoleukodystrophy as it relates to neurological dysfunction including Reye's syndrome.
47. Review the major syndromes of dysfunctional copper metabolism including:
- a. hepatolenticular degeneration (Wilson disease)
  - b. trichopoliodystrophy (Menkes' syndrome)
48. Review the pathogenesis, clinical presentation, diagnosis, and treatment of acute intermittent porphyria. List drugs to avoid in patients with porphyria (i.e., sulfa drugs, etc.).
49. Review the pathogenesis, clinical presentation, diagnosis, and treatment of abetalipoproteinemia.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

**Demyelinating Diseases:**

50. Review the epidemiology, pathophysiology, clinical presentation, diagnosis, subtypes, treatment, and prognosis of multiple sclerosis.
51. Define Marchiafava-Bignami disease.
52. Review etiologies of central pontine myelinolysis in detail.
53. Discuss multiple system atrophy.
54. Review metabolic, toxic, immune-mediated, infectious, ischemic, and iatrogenic causes of demyelination disease.

**Degenerative Disorders:**

55. Describe pathophysiology and management of Alzheimer's disease, Pick's disease, Huntington's disease, Parkinson's disease, Wilson's disease, Fahr's disease, progressive supranuclear palsy, striatonigral degeneration, diffuse lewy body disease, and Friedreich's ataxia.
56. Disorders associated with xeroderma pigmentosum.
57. List the major cerebral degenerative disorders of childhood including:
  - a. progressive sclerosing poliodystrophy
  - b. spongy degeneration
  - c. infantile neuraxonal dystrophy
  - d. Hallervorden-Spatz disease
  - e. Pelizaeus-Merzbacher disease
  - f. Alexander disease
  - g. Cockayne syndrome
  - h. peroxisomal diseases
  - i. Leigh disease

**Neurocutaneous Disorders:**

58. Review in detail the major neurocutaneous disorders including:
  - a. neurofibromatosis, Type 1 and Type 2
  - b. encephalotrigeminal angiomas
  - c. incontinentia pigmenti
  - d. tuberous sclerosis
  - e. von Hippel Lindau syndrome



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- f. Sturge-Weber disease
- g. Rendu-Osler-Weber syndrome
- h. Wyburn-Mason syndrome
- i. Ataxia-telangiectasia

**Cranial Nerve Disorders:**

- 59. Discuss Leber Hereditary Optic Atrophy.
- 60. Review the salient features of progressive external ophthalmoplegia.
- 61. Discuss differential diagnosis of vertigo, tinnitus and/or hearing loss.

**Peripheral Neuropathies:**

- 62. Review anatomy, physiology, and evaluation of the peripheral nervous system.
- 63. Define peripheral neuropathy, polyneuropathy, mononeuropathy, mononeuropathy multiplex, and neuritis.
- 64. Review the major inherited neuropathies including:
  - a. peroneal muscle atrophy
  - b. Dejerine-Sottas disease
  - c. Refsum disease
  - d. hereditary sensory neuropathy
  - e. porphyric neuropathy
- 65. Discuss the etiology, clinical presentation, diagnosis, treatment, and prognosis of Guillain-Barre syndrome.
- 66. List the major acquired neuropathies other than Guillain-Barre syndrome including:
  - a. chronic demyelinating polyneuritis
  - b. acute and chronic idiopathic sensory neuropathy
  - c. acute pandysautonomia
  - d. tick paralysis
  - e. brachial neuropathy (neuralgic amyotrophy)
  - f. radiation neuropathy
  - g. cold neuropathy
  - h. cryoglobulin neuropathy



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- i. diabetic neuropathy
- j. hypothyroid neuropathy
- k. acromegalic neuropathy
- l. vasculitic neuropathy
- m. uremic neuropathy
- n. hepatic neuropathy
- o. infectious neuropathies
  - i. leprosy
  - ii. acquired immunodeficiency virus
  - iii. Lyme
  - iv. herpes zoster
- p. sarcoid neuropathy
- q. paraneoplastic neuropathy
- r. amyloid neuropathy
- s. polyneuropathy associated with plasma cell dyscrasia
- t. polyneuropathy associated with dietary deficiencies
- u. neuropathy induced by metals
  - i. arsenic
  - ii. lead
  - iii. mercury
  - iv. thallium
- v. drug-induced neuropathy
- w. neuropathy produced by aliphatic chemicals

**Movement Disorders**

67. Discuss the major hereditary ataxias including:
- a. Friedreich ataxia
  - b. Levy-Roussy syndrome
  - c. hereditary cerebellar ataxia
68. Review the major noninherited forms of cerebellar ataxia including:
- a. acute cerebellar ataxia in children
  - b. ataxia telangiectasia
  - c. Marinesco-Sjögren syndrome
  - d. Ramsay-Hunt syndrome
  - e. Joseph disease



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

69. Discuss the pathophysiology, clinical presentation, treatment, and prognosis of Alzheimer's disease, Pick disease, and diffuse Lewy body disease.
70. Define hemichorea and hemiballismus.
71. Review the pathophysiology, clinical presentation, treatment, and prognosis of Sydenham chorea, Huntington's disease, and senile chorea.
72. Define myoclonus.
73. Review Tourette's syndrome.
74. Review the major general and focal dystonic conditions.
75. Define benign essential tremor.
76. Discuss the pathophysiology, clinical presentation, diagnosis, treatments and prognosis of Parkinsonism in detail.
77. Define progressive supranuclear palsy.
78. Review the pathophysiology, clinical presentation, diagnosis, and treatment of tardive dyskinesia.

**Spinal Cord Disorders:**

79. Discuss spinal inflammatory diseases such as acute transverse myelitis.
80. Discuss hereditary spastic paraplegia.
81. List the major generalized and focal forms of spinal muscular atrophy including:
  - a. Wernig-Hoffmann disease
  - b. Kugelberg-Welander syndrome
  - c. benign focal amyotrophy
82. Describe the pathophysiology and neurological manifestations of poliomyelitis.
83. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of amyotrophic lateral sclerosis.
84. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of subacute combined degeneration of the spinal cord.
85. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of juvenile and adult myasthenia gravis.
86. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of botulism.

**Muscular Disorders:**

87. Review the common muscular dystrophies including:
  - a. Duchenne muscular dystrophy



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. fascioscapulohumeral muscular dystrophy
  - c. myotonic muscular dystrophy
  - d. myotonia congenita
  - e. congenital muscular dystrophy
88. Review the major periodic paralysis syndromes including:
- a. familial periodic paralysis
  - b. hypokalemic periodic paralysis
  - c. hyperkalemic periodic paralysis
  - d. paramyotonia congenita
89. Discuss polymyositis.

**Behavioral:**

- 90. Review relevant anatomic structures, neural systems, and neurotransmitters involved in basic emotions of fear, anxiety, depression, aggression.
- 91. Review etiologies (metabolic, iatrogenic, infectious, toxic, degenerative) of alterations in these basic emotions.

**Neuro-ophthalmology:**

- 92. Review in detail anatomy, physiology and examination of the visual system.
- 93. Review clinical presentation, diagnosis, and treatment of common neuro-ophthalmologic disorders.

**Other:**

- 94. Review the neurological manifestations of altitude sickness.
- 95. List the neurological manifestations of decompression sickness.
- 96. Describe the neurological implications of the common collagen-vascular diseases.
- 97. Describe the neurological implications of alcoholism.
- 98. Discuss the neurological aspects of pregnancy.
- 99. Review malignant hyperthermia.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

**NEURORADIOLOGY**

**UNIT OBJECTIVES**

Demonstrate an understanding of neuroradiological imaging and interventions as they specifically relate to neurosurgical patients.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

*Junior Level:*

1. Describe the precautions which should be taken when performing radiologic examinations, particularly in ICU patients (with ventricular drains or monitoring)
2. Identify the normal anatomical structures of the skull on antero-posterior, lateral, Towne, and submental vertex radiographs.
3. List the indications for carotid and cerebral angiography.
4. Review the potential complications to intravenous contrast agents and discuss the management of same.
5. Identify the major arteries and veins of the neck and brain on angiograms.
6. Describe the concepts of computerized tomographic (CT) scanning.
7. Identify the normal anatomical structures of the scalp, skull, dura, brain, and cranial vasculature on CT scans.
8. Describe the concepts of magnetic resonance (MR) scanning. Review the various imaging sequences which may be obtained.
9. Identify the normal anatomical structures of the scalp, skull, dura, brain, and cranial vasculature on MR scans.
10. Recognize common traumatic injuries which may be detected by skull radiographs including:
  - a. linear skull fractures
  - b. depressed skull fractures
  - c. pneumocephalus
  - d. foreign bodies
11. Recognize common pathologic conditions which may be detected by skull radiographs including:
  - a. neoplasms
  - b. fibrous dysplasia
  - c. congenital bone diseases
  - d. metabolic bone disorders



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- e. infections
12. Recognize common traumatic injuries which may be detected by head CT including:
- a. skull fractures
  - b. pneumocephalus
  - c. intracranial hematomas
    - i. epidural
    - ii. acute subdural
    - iii. chronic subdural
    - iv. intraparenchymal
    - v. intraventricular
  - d. cerebral contusions
  - e. subarachnoid hemorrhage
  - f. diffuse axonal injury
  - g. foreign bodies
13. Recognize common pathologic conditions which may be detected by head CT including:
- a. ischemic infarction
  - b. venous infarction, deep venous sinus occlusion (empty delta)
  - c. hydrocephalus
  - d. cysts (arachnoid, pencephalic)
  - e. tumors
  - f. cerebral edema
  - g. infections
  - h. congenital abnormalities (i.e. craniostenoses)
  - i. infections
14. Recognize common traumatic injuries which may be detected by head MR scans including:
- a. pneumocephalus
  - b. intracranial hematomas
    - i. epidural



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- ii. acute subdural
  - iii. chronic subdural
  - iv. intraparenchymal
  - v. intraventricular
- c. cerebral contusions
  - d. diffuse axonal injury
15. Recognize common pathologic conditions which may be detected by head MR scans including:
- a. ischemic infarction
  - b. venous infarction
  - c. hydrocephalus
  - d. cysts
  - e. tumors
  - f. cerebral edema
  - g. vascular occlusions
  - h. infections
  - i. congenital abnormalities (Chiari I and II malformations, neurofibromatosis, Dandy Walker spectrum)
  - j. intracranial hypotension
16. Identify the normal anatomical structures of the craniovertebral junction on plain radiographs.
17. Review the radiographic diagnoses of platybasia and cranial settling.
18. Describe the plain radiographic findings of common traumatic injuries to the craniovertebral junction including:
- a. occipital condyle fractures (Type I, II, and III)
  - b. atlanto-occipital dislocation
  - c. Jefferson fractures
  - d. posterior atlas fractures
  - e. dens fractures (Type I, II, and III)
  - f. axis body fractures
  - g. hangman's fracture



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- h. atlas and axis facet fractures
  - i. atlanto-axial rotatory dislocation
19. Distinguish between orthotropic and dystropic os odontoideum.
20. Describe the common congenital abnormalities of the craniovertebral junction.
21. Recognize common spinal congenital abnormalities on plain radiographs.
22. Recognize common spinal traumatic injuries which may be detected by plain radiographs including:
- a. vertebral body fractures
  - b. facet fractures and dislocations
  - c. posterior element fractures
  - d. transverse process fractures
  - e. vertebral subluxation/dislocation
23. Recognize common spinal degenerative conditions which may be detected by plain radiographs.
24. Discuss the indications for CT and MR scanning of the spine in the setting of trauma.
25. Describe the CT scan appearance of each of the traumatic spinal lesions previously listed.
26. Describe the MR scan appearance of:
- a. spinal ligament injury
  - b. traumatic disc herniation
  - c. spinal cord contusion
  - d. spinal epidural hematoma
27. Recognize common spinal degenerative conditions which may be detected by MR including:
- a. disc degeneration
  - b. disc herniation
  - c. degenerative spinal stenosis
  - d. facet hypertrophy
  - e. osteophyte formation
  - f. foraminal stenosis
  - g. degenerative spondylolisthesis
  - h. degenerative scoliosis



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- i. ossification of the posterior longitudinal ligament
  - j. spina bifida (tethered cord)
  - k. syringomyelia
28. Identify spinal and spinal cord tumors on CT and MR scans (differentiate between intramedullary, extramedullary, and extradural).
29. Discuss the indications for spinal myelography.
30. Review the indications for spinal angiography and classification of AV fistulas.
31. Discuss the use of both the radiographic contrast and radionuclide shuntogram in evaluating neurosurgical patients.

***Middle Level:***

1. Identify the common carotid and vertebral circulation and congenital variants on angiograms.
2. Recognize intracranial aneurysms on angiograms and CT angiograms
3. Identify and characterize intracranial vascular malformations on angiograms. Recognize:
  - a. arteriovenous malformations
  - b. venous angiomas
  - c. arteriovenous fistula
  - d. feeding vessels
  - e. draining veins
  - f. associated aneurysms
  - g. degree of shunting
4. Discuss the angiographic evaluation of carotid and vertebral disease.
5. Review the role of MR angiography and venography in the evaluation of cerebrovascular disease, neoplasms, and trauma.
6. Describe the radiological evaluation of CNS vasculitis.
7. Describe the radiological evaluation of spinal vascular malformations.
8. Discuss the role of myelography in the evaluation of neurosurgical patients.
9. Discuss the radiological evaluation of suspected CNS and spinal infection.
10. Review MR neurography.
11. Describe the appearance of peripheral nerve tumors on MR scans.
12. Review the role of radionuclide scans in the evaluation of patients with suspected cranial and spinal disease.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

13. Discuss the use of intraoperative radiographs and fluoroscopy for localization and placing instrumentation.
14. List the indications for CT- and MR-guided biopsies.
15. Describe the concepts of ultrasonography for intraoperative use.
16. Review the findings of normal and abnormal neonatal cranial ultrasound.
17. Review the findings of normal and abnormal carotid ultrasounds.
18. Discuss the use of transcranial doppler ultrasonography in the management of patients with subarachnoid hemorrhage, trauma, and occlusive vascular disease.

***Senior Level:***

1. Review the indications for interventional endovascular therapies for:
  - a. aneurysms
  - b. vasospasm
  - c. cranial vascular malformations
  - d. spinal vascular malformations
  - e. tumor embolization
  - f. carotid and vertebral stenosis
  - g. carotid and vertebral dissection
2. Describe the indications and techniques of endovascular trial occlusions.
3. Review the role of quantitative cerebral blood flow studies in the management of neurosurgical patients.
4. Describe the concepts of positron emission tomography. Review the indications for obtaining such scans.
5. Describe the concepts of functional MR imaging. Review the indications for obtaining such scans.
6. Describe the concepts of MR spectroscopy. Review the indications for obtaining such evaluations in neurosurgical patients.
7. Discuss the indications and technique of discography. Describe the procedure.
8. Discuss the indications for percutaneous vertebroplasty or kyphoplasty. Describe the procedure.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior Level:***

1. Order appropriate radiological evaluations in a timely fashion.
2. Complete radiological requisitions properly.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

3. Demonstrate the ability to accurately interpret the radiographic studies of trauma patients.

***Middle Level:***

1. Demonstrate the ability to accurately interpret carotid and vertebral angiograms.
2. Demonstrate the ability to accurately interpret spinal angiograms.
3. Demonstrate the ability to accurately interpret spinal myelograms and post-myelogram CT scans.
4. Demonstrate the ability to accurately interpret cranial and spinal CT and MR scans of nontraumatic lesions.

***Senior Level:***

1. Demonstrate the ability to accurately interpret radiological examinations of neurosurgical patients.
2. Demonstrate the ability to use intraoperative ultrasonography.



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

**GENERAL CLINICAL TOPICS**

**FLUIDS, ELECTROLYTES, AND NUTRITION**

**UNIT OBJECTIVES**

Demonstrate an understanding of normal and pathologic fluid and electrolyte homeostasis. Demonstrate an ability to maintain normal electrolyte balance. Demonstrate an understanding of the basics of nutritional management in neurosurgical patients.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior Resident R2 Year:***

1. Discuss the normal distribution of intracellular and extracellular fluid and electrolytes including:
  - a. sodium and water distribution and metabolism
  - b. clinical assessment of water and sodium balance and the concept of osmolality
  - c. normal maintenance requirements
  - d. management of pathologic conditions such as diabetes insipidus and the syndrome of inappropriate antidiuretic hormone secretion
  - e. cerebral salt wasting
2. Review the potential implications of diuresis and fluid restriction on water and electrolyte balance.
3. Briefly review the potential clinical implications of sodium, calcium, potassium, phosphorous, and magnesium excesses and deficiencies and the treatment of same.
4. Review the criteria for nutritional assessment including:
  - a. history of significant weight loss
  - b. hypoalbuminemia
  - c. impaired immune response including diminished total lymphocyte count and anergy
  - d. physical signs of malnutrition
5. Describe daily requirements and normal metabolism of carbohydrates, lipids, and proteins.
6. Describe the essential vitamins, metabolism, symptoms and management of vitamin deficiencies.
7. Describe most common essential trace elements, metabolism, symptoms and management of deficiencies.
8. Briefly describe the metabolic responses to starvation and stress.
9. Describe and contrast the indications, contraindications, complications, and benefits of enteral and parenteral nutrition.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

10. Analyze the implications of specific nutritional deficiencies as they relate to neurological and neurosurgical diseases.
11. Briefly review swallowing disorders.

**Junior Resident R3 Year:**

1. Demonstrate an ability to manage the fluid and electrolyte requirements of neonatal, pediatric, and adult neurosurgical patients including familiarity with:
  - a. Hyper and hypotonic saline infusions
  - b. Desmopressin
2. Demonstrate the ability to place central venous catheters.
3. Demonstrate the ability to place enteral feeding tubes.
4. Demonstrate an ability to prescribe appropriate parenteral and enteral nutrition.
5. Recognize and treat the complications of parenteral and enteral feeding including:
  - a. line sepsis
  - b. glucose intolerance
  - c. diarrhea
  - d. dehydration
6. Recognize swallowing disorders and manage same.
7. Describe the common changes of metabolism and nutritional requirements of trauma patients and their evaluation.



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

**GENERAL CRITICAL CARE**

**UNIT OBJECTIVES**

- 1) Demonstrate the ability to evaluate and triage neurosurgical patients to and from a critical care setting.
- 2) Demonstrate a knowledge of critical care medicine and competency in the management of neurosurgical patients in the critical care setting.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior Level:***

1. Identify patients (adult and pediatric) that would be best served in a critical care setting; include both medical and neurosurgical issues within the context of this discussion.
2. Review general medical issues pertinent to the management of neurosurgical patients in a critical care setting including:
  - a. prophylaxis of gastrointestinal hemorrhage
  - b. prophylaxis of pulmonary morbidity
  - c. prophylaxis, diagnosis, and treatment of deep venous thrombosis and pulmonary embolism
  - d. skin care
  - e. eye care
  - f. physical therapy to maintain strength and joint range of motion
  - g. universal precautions
  - h. workup of fever and treatment of sepsis
3. Describe the indications and pharmacokinetics for medications commonly used in the management of critically ill neurosurgical patients including:
  - a. vasoactive drugs
  - b. inotropic drugs
  - c. bronchodilators
  - d. diuretics
  - e. antiarrhythmics
  - f. antihypertensives
  - g. antimicrobials
  - h. anticonvulsants



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

4. Describe the clinical presentation, evaluation, and treatment of infections that commonly occur in critical care neurosurgical patients.
5. Review the indications for intubation including:
  - a. loss of patient airway
  - b. respiratory insufficiency
  - c. inability to protect airway
6. Discuss commonly used pulmonary values including:
  - a. measured pulmonary functions
    - i. rate
    - ii. minute ventilation
    - iii. spontaneous tidal volume
    - iv. forced vital capacity (FVC)
    - v. functional residual capacity (FRC)
    - vi. maximum ventilatory volume (MVV)
  - b. ventilator modes and settings
    - i. pressure versus volume ventilation
    - ii. continuous positive airway pressure (CPAP)
    - iii. intermittent positive airway pressure (IPAP)
    - iv. pressure support
    - v. assist control
    - vi. intermittent mandatory ventilation (IMV)
    - vii. positive end expiratory pressure (PEEP)
    - viii. rate
    - ix. tidal volume
7. Review the indications for weaning patients from ventilatory support. Describe the methods by which this is accomplished and the general pulmonary parameters a patient must demonstrate prior to extubation.
8. Discuss the medications used to improve pulmonary function.
9. Briefly review the following cardiac function parameters:
  - a. preload



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. afterload
  - c. contractility
10. Review the indications for implementing the following monitoring devices. Briefly describe how the information obtained is utilized to optimize patient management:
- a. arterial catheters
  - b. central venous catheters
  - c. Swan-Ganz catheters
  - d. pulse oximetry
  - e. electrocardiographic monitoring
  - f. end-tidal CO<sub>2</sub> monitors
11. List the signs of acute myocardial ischemia and briefly discuss the emergent treatment of this condition after interpreting the Troponins.
12. Review the impact of renal insufficiency as it pertains to the management of neurosurgical patients.
13. Briefly discuss the diagnosis and management of acute renal insufficiency.
14. Describe the diagnosis and management of an ileus. List the differential diagnosis for an ileus.
15. Review the diagnosis and management principles of the following endocrine disorders:
- a. hypo/hyperthyroidism
  - b. hypo/hyperparathyroidism
  - c. adrenal cortical excess and deficiency
  - d. diabetes mellitus
16. Review the diagnosis and management of common electrolyte disorders :
- a. diabetes insipidus
  - b. syndrome of inappropriate antidiuretic hormone secretion (SIADH)
  - c. cerebral salt-wasting
17. Review the medical and legal definitions of brain death.
18. Discuss moral and ethical issues pertaining to critically ill neurosurgical patients including:
- a. patient or family requests to withhold or withdraw treatment
  - b. organ donation.
19. Discuss the acute treatment of status epilepticus



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

20. Summarize and discuss acid-base physiology
  - a. Discuss mechanisms of hydrogen ion production and excretion
  - b. Briefly discuss acute and chronic buffering systems.
  - c. Discuss metabolic acidosis and alkalosis
  - d. Discuss respiratory acidosis and alkalosis.
  - e. Review the effects of acid-base disturbances on the CNS function and ICP
21. Discuss in detail the physiology of intracranial pressure
  - a. Discuss the physiology of normal ICP
  - b. Discuss of normal physiology of CSF production and turnover
  - c. Discuss the pathophysiology of increased ICP
  - d. Discuss the indications for ICP monitoring and the methods to monitor ICP
  - e. Discuss in detail the treatment of elevated ICP
22. Discuss the strategies to preserve CPP (cerebral perfusion pressure) and lower ICP
  - a. Mannitol
  - b. Hypertonic saline
  - c. Hyperventilation
  - d. Hypothermia
  - e. Barbituate coma
  - f. Decompressive surgery (i.e. craniectomy)
23. Perform the following procedures (with supervision)
  - a. Ventriculostomy and other types of ICP monitoring
  - b. Licox monitor for brain tissue oxygen monitoring
  - c. Lumbar puncture
  - d. Insertion of lumbar drain
  - e. Shunt tap
  - f. Arterial catheterization
  - g. Swan-Ganz catheterization
  - h. Bladder catheterization



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- i. Orotracheal intubation
- j. Nasogastric intubation

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior and Middle Levels:***

1. Obtain ACLS and ATLS certification.
2. Demonstrate the ability to perform an initial evaluation and management of critically ill neurosurgical patients.
3. Perform the following procedures (independently):
  - a. ventriculostomy and other forms of ICP monitoring
  - b. orotracheal intubation
  - c. nasogastric intubation
  - d. bladder intubation
  - e. arterial catheterization
  - f. Swan-Ganz catheterization
4. Serve on a trauma team.
5. Demonstrate competency in the management critically-ill neurosurgical patients
6. Diagnose and treat acid-base abnormalities in neurosurgical patients.
7. Diagnose and treat electrolyte disorders in neurosurgical patients.
8. Demonstrate an understanding of the management of complex acid-base disturbances in the critical care setting.

***Senior Level:***

1. Oversee and direct the junior and middle level resident management of critically ill neurosurgical patients.



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

## **INFECTION**

### **UNIT OBJECTIVES**

Demonstrate an understanding of the factors related to the acquisition, diagnosis, and treatment of infections as they pertain to neurosurgical patients. Describe the typical presentation and treatment of common neurosurgical infections. Review the methods used to minimize infectious complications in neurosurgical patients. Demonstrate an understanding of the techniques to minimize the risk of spread of viral infections, including hepatitis and human immunodeficiency virus (HIV).

### **COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

#### ***Junior and Middle Levels:***

1. List the common organisms responsible for bacterial meningitis. **Describe the most common organisms encountered in various age groups (neonatal, pediatric, adult).**
2. List the common CNS infections and describe the populations most at risk for each.
  - a. Bacterial meningitis
  - b. Pyogenic brain abscess
  - c. Cranial epidural abscess**
  - d. Subdural empyema**
  - e. Pyogenic vertebral osteomyelitis
  - f. Tuberculous osteomyelitis
  - g. Spinal epidural abscess
3. List the common opportunistic CNS infections and the populations at risk for each.
  - a. Fungal meningitis
  - b. Fungal brain abscess
  - c. Parasitic infections**
  - d. HIV infection of the CNS
4. Describe in detail the clinical and pathological symptoms and findings associated with CNS infections.
5. Discuss the radiological evaluation of patients with suspected and known CNS infections.
  - a. Describe the evolution of brain abscess demonstrated by both CT and MRI
  - b. Describe the typical MRI findings of spinal osteomyelitis and epidural abscess



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- c. Describe of role of radionuclide imaging in the diagnosis of spinal and intracranial infection
6. Review the indications for alerting individuals at risk for infections based on exposure to a patient with a known CNS infectious process.
7. Review the major classes of antimicrobial drugs:
  - a. describe the potential of resistance to each drug
  - b. list the potential complications of each agent
  - c. review the serological monitoring of each antimicrobial agent including the need for monitoring renal, hepatic, and hemopoietic function
  - d. indicate which drugs will traverse the blood-brain barrier and which will not
  - e. demonstrate a knowledge of the pharmacokinetics of each antimicrobial agent
  - f. describe the potential complications of each antimicrobial drug and explain how to monitor for and detect same
  - g. review the rationale for monitoring drug levels and list the therapeutic levels of antimicrobials commonly used to treat neurosurgical infections
8. Discuss the advantages and disadvantages of treatment of CNS infections with corticosteroids.
9. Review the role of anticonvulsant therapy in the management of CNS infections.
10. List the universal precautions for prevention of infection as they pertain to health care workers in general and neurosurgeons in particular.
11. Discuss the role of hand washing as the most important method of preventing infection.
12. Describe the role of the clinical epidemiologist in tracking infectious disease incidence and potential sources of infection within the hospital and community setting.
13. Review the mode of transmission, diagnosis, and treatment of non-CNS infections which may commonly arise in neurosurgical patients such as:
  - a. respiratory infections
  - b. urinary tract infections
  - c. wound infections
14. Review the prevention, diagnosis and management of sepsis.
15. List the common sources of a postoperative fever.
16. Describe the workup for a febrile patient.
17. Discuss the use of prophylactic antibiotics
  - a. **For procedures with a Class I (clean) surgical wound**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. For procedures with a clean, contaminated surgical approach**
  - c. For procedures involving permanent implants such as shunts, drug delivery devices, stimulators, etc.**
  - d. For patients with basilar skull fractures with associated CSF leak**
18. Review the symptoms, clinical evaluation and management of patients with shunt infections.
19. Discuss prion disease and precautions to be taken when it is suspected.
20. Discuss viral infections of the CNS as they relate to neurosurgical practice
- a. Herpes simplex encephalitis
21. Demonstrate competency in sterile technique

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior and Middle Levels:***

- 1. Demonstrate the ability to use universal precautions.
- 2. Demonstrate the ability to use sterile technique.
- 3. Appropriately diagnose and treat non-CNS infections in neurosurgical patients.
- 4. Appropriately diagnose and treat CNS infections in neurosurgical patients.

***Senior Level:***

- 1. Discuss the indications for open (craniotomy and excision) vs. stereotactic treatment of brain abscess
- 2. Discuss the indications for surgical vs. non-operative management of spinal osteomyelitis and/or spinal epidural abscess
  - a. Discuss indications for anterior vs. posterior surgical approaches
  - b. Discuss the pros and cons of spinal instrumentation in patients with spinal infection
- 3. Perform the following procedures:
  - a. Stereotactic aspiration of brain abscess
  - b. Craniotomy with excision of brain abscess
  - c. Laminectomy for drainage of spinal epidural abscess
  - d. Anterior decompression for spinal osteomyelitis and epidural abscess

**Guidelines for Evidence-based Medicine**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

All residents should be aware of the deficiencies in the different types of clinical studies. The junior resident should also have some familiarity with statistical analysis employed in clinical research. These skills should be honed during the PGY-4 year.

- I. Understand the pitfalls of the following sources of medical knowledge.
  1. Expert opinion
  2. Case report
  3. Retrospectively reviewed case series
  4. Prospective uncontrolled case series
  5. Case controlled series
  6. Randomized prospective trial
  
- II. The resident should understand the following terms in the context of medical statistics.
  - a. Accuracy
  - b. Bias
  - c. Sensitivity
  - d. Specificity
  - e. Positive predictive value
  - f. Negative predictive value
  - g. Kappa value
  - h. Standard deviation
  - i. Prevalence
  - j. Confidence limits
  - k. P value
  - l. Type one ERROR
  - m. Type two ERROR
  - n. Power of the study
  - o. Relative risk reduction
  - p. Absolute risk reduction
  - q. Stratification
  - r. Odds ratio null hypothesis
  
- III. Statistical analysis
  1. Fisher's test
  2. Kaplan-Meier or "Actual" survival curves
  3. Log rank test for comparison of survival curves
  4. Linear regression models
  5. T-test
  6. Wilcoxon test
  7. Regression models (Cox, Liang-Zeger, etc.)

## **Competency-based knowledge objectives**

### **Junior level**

2. Residents should be able to distinguish different study designs
3. Residents should understand the significance of simple statistical terms such as sensitivity, specificity, confidence limits, p value



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

**Middle level**

1. Residents should be able to apply to assess the power of a journal article using the rules of evidence-based medicine
2. Residents should be able to apply simple statistical analysis to their research



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

**PRACTICE MANAGEMENT, LEGAL AND SOCIOECONOMIC ISSUES**

**UNIT OBJECTIVES**

Demonstrate an understanding of the principles of practice management and the business aspects associated with the delivery of health care.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior and Middle Levels:***

1. Demonstrate an ability to interact effectively, professionally, and respectfully with:
  - a. patients and their families
  - b. fellow residents
  - c. allied health care personnel
  - d. hospital staff
  - e. medical students
  - f. faculty physicians
  - g. referring physicians
2. Demonstrate the ability to maintain accurate and current medical records.
3. Discuss neurosurgical career options with:
  - a. faculty
  - b. peers
  - c. family
  - d. non-faculty neurosurgeons and other mentors
4. Accumulate information about post-residency career options.
5. Create and keep current a resume/curriculum vitae.
6. Record CPT codes for office visits and procedures performed on service.
7. Accurately document H&P and consultations according to the AMA-CPT E&M documentation guidelines.

***Senior Level:***

1. Demonstrate the ability to properly code neurosurgical activities.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

2. Accurately assign and justify medical impairment ratings for neurosurgical patients.
3. Outline a post-residency career track.
4. Apply for post-residency fellowship if appropriate.
5. Obtain information about specific practice, research, or administrative career opportunities as appropriate.
6. Compose a list of questions to ask and things to see when interviewing for a neurosurgical position.
7. Read and interpret a financial report.
8. Design a structure for an office practice including a listing of the generic office processes and how to arrange staffing.
9. Prepare lists of neurosurgical instruments/equipment needed for specific operative procedures.
10. Select a proper practice, research, or administrative opportunity if appropriate.
11. Complete license and registration requirements for your chosen location.
12. Complete applications for hospital staff membership and clinical privileges.
13. Complete resident case data sheet for the American Board of Neurological Surgery and have same signed by Program Chair.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior and Middle Levels:***

1. Discuss the ethical and moral factors associated with the practice of neurosurgery.
2. Explain the neurosurgeon's responsibilities in terms of health care cost containment.
3. Review the features and relationships of the healthcare system including:
  - a. treatment facilities
  - b. third party payment systems
    1. Medicare
    2. Medicaid
    3. employer-provided insurance
    4. private insurance
  - c. physician practice organizations
  - d. medical equipment manufacturers



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- e. pharmaceutical companies
4. Recite the rules and regulations of the training hospital(s) as they pertain to the practice of neurosurgery in which the residency is performed.
5. Name the institutional and social service agencies in your community and review their role in the overall management of neurosurgical patients.
6. Discuss the concept of informed consent.
7. Discuss mandatory reporting laws.
8. Discuss issues pertinent to the topic of the impaired physician.
9. Discuss the importance of tracking morbidity, mortality, and patient outcomes.
10. Review the career options available at the completion of neurosurgical residency in detail including:
  - a. private practice
  - b. academic practice
  - c. subspecialty fellowship
  - d. research
  - e. administration
  - f. military
11. Describe the types and characteristics of surgical practice organizations including:
  - a. solo practice
  - b. group practice
    1. partnership
    2. professional association
    3. corporation
  - c. academic practice
  - d. Health Maintenance Organizations (HMO)
    1. Preferred Provider Organizations (PPO)
    2. Individual Practice Associations(IPA)
    3. staff model (Kaiser-Permanente type)
  - e. Federal
    1. Department of Veterans Affairs



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

2. Military
3. Public Health Service
12. Discuss the role and influence of national quality oversight and review organizations for hospitals and health plans (JCAHO, NCQA).
13. Discuss the history, changes, eligibility, funding, and problems associated with the Medicare program.
14. Describe the Medicare program features, such as eligibility, funding, administration, federal-state relationship, benefits, and payment methods.
15. Discuss federal funding of graduate medical education and how current federal budget allocations and proposals for changes in funding affect or will affect neurosurgical training programs.
16. Discuss the significance of the following issues as they relate to the practice of neurosurgery:
  - a. legislative/regulatory requirements
    1. Americans with Disabilities Act
    2. Clinical Laboratory Improvement Amendments (CLIA)
  - b. Federal/professional regulatory institutions
    1. Health Care Financing Administration (HFCA)
    2. Joint Commission on Accreditation of Healthcare Organizations (JCAHO)
    3. Occupational Safety and Health Administration (OSHA)
  - c. miscellaneous
    1. affirmative action
    2. equal opportunity
    3. sexual harassment
17. Discuss the common causes of malpractice actions and effective measures to reduce the risk of malpractice complaints.
18. Outline the requirements for certification by the American Board of Neurological Surgery.
19. Formulate a strategy to evaluate personal and professional considerations in making a career choice.
20. Appraise the importance of family involvement in making career choices, including geographic location.

**Senior Level:**

1. Review the requirements to obtain certification from The American Board of Neurological Surgery.
2. Discuss the available opportunities to obtain continuing medical education credits.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

3. Describe the political, economic, and social factors which impact on the practice of medicine generally and neurosurgery specifically.
4. Demonstrate a working knowledge of the International Classification of Diseases (ICD) and the Current Procedural Terminology (CPT) coding and analysis.
5. Discuss the concept of relative values units (RVUs).
6. Summarize the process of impairment determination as it relates to the neurosurgical patient population.
7. Review the availability, requirements, and application procedures for post-residency fellowship if appropriate.
8. Discuss the following issues as they relate to planned neurosurgical practice:
  - a. healthcare delivery systems, including managed care
  - b. health care economics
  - c. political and legislative processes in healthcare
9. Obtain a demographic profile of potential practice locations to include population and medical demographics.
10. Outline the essential business characteristics of neurosurgical practice including:
  - a. content and interpretation of financial reports
  - b. management of human resources
  - c. facility design and maintenance
  - d. billing and collection processes
11. Discuss the key elements of a provider professional services agreement, such as a PPO or HMO contract, and identify provisions that require particular attention.
12. Describe the typical provisions and considerations in a physician employment contract including what to look for and what to avoid.
13. Describe, compare, and contrast partnership versus corporate practice structures, including the tax and liability advantages and disadvantages of each.
14. Describe the advantages and disadvantages of solo, single specialty group, and multispecialty group practice.
15. Review the financial issues associated with the neurosurgical career options under consideration.
16. Describe the administrative structures and processes required for managing an office practice including:
  - a. billing and collection for medical services
  - b. financial accounting and reporting



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- c. scheduling
  - d. transcription
  - e. medical record management
  - f. appointment scheduling
  - g. information system
  - h. facility selection and maintenance
  - i. secretarial services
17. Describe the content, interpretation, and utilization of the following financial documents:
- a. balance sheet
  - b. income and expense statement
  - c. accounts payable and receivable
  - d. collection analysis
18. Discuss the insurance requirements associated with neurosurgical practice including:
- a. personal and professional liability
  - b. personal health and disability
  - c. casualty, fire, and theft
  - d. personal life
19. Discuss the issues of quality assurance as related to neurosurgical practice including:
1. maintenance of the clinical record
  2. review and documentation of morbidity and mortality
  3. risk management
20. Discuss the theory and organization of CPT coding, along with examples of complex procedural coding.
21. Describe the considerations in Evaluation and Management (E & M) coding, including documentation requirements.
22. Describe the work, practice expense, and malpractice expense components of Medicare's Resource-based Relative Value Scale (RBRVS) and how they are derived.
23. Explain how Medicare and commercial payer conversion factors are derived and used to create a fee schedule from the RBRVS.
24. Describe commonly used methods of physician risk contracting, such as capitation payment, and explain the considerations in negotiating such a contract.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

25. Describe the practice information necessary to safely and profitably manage a neurosurgical risk contract.
26. Review the features, similarities, and differences in various third party payment systems including:
  - . Medicare
  - a. Medicaid
  - b. commercial insurance
  - c. worker's compensation
27. Contrast HMO and PPO health plans.
28. Describe the meaning of "managed care" and its typical components including:
  - a. contractual discounts
  - b. provider risk arrangements
  - c. utilization management
  - d. provider report cards
  - e. practice guidelines
  - f. restricted access models
    - i. primary gatekeeper
    - ii. point of service
    - iii. open access
29. List and discuss the ethical issues and conflicts of interest involved in managed care treatment decisions such as:
  - a. capitation reimbursement
  - b. risk pools
  - c. cost saving incentive bonuses
30. Discuss antitrust considerations faced by physicians in payer contract negotiations including the concepts of collective bargaining, price fixing, and group boycott.
31. Describe types of retirement plans and funding considerations and limitations.
32. Explain the differences between occurrence and claims-made professional liability insurance and considerations made in selecting insurer and coverage levels.



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

**NEUROSURGICAL CLINICAL TOPICS**

**CEREBROVASCULAR SURGERY**

**UNIT OBJECTIVES**

Demonstrate an understanding of the anatomy, physiology, pathophysiology and presentation of cerebrovascular diseases, including ischemic and hemorrhagic stroke, and other diseases and malformations of intracranial, extracranial, and spinal vasculature. Demonstrate the ability to formulate and implement a diagnostic and treatment plan for cerebrovascular diseases, including medical and surgical management.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

Junior Level:

**Anatomy:**

1. Describe the detailed anatomy of the extracranial and intracranial arteries (ICA, MCA, ACA, vertebral, basilar, PICA, AICA, SCA, PCA,ECA) and spinal arteries.
2. Review the anatomy of the venous circulation as it pertains to the central nervous system including the major sinuses (superior sagittal, inferior sagittal, vein of Galen, straight sinus, transverse sinus, sigmoid, cavernous sinus, circular sinus, etc.).

**Pathophysiology:**

1. Explain the concepts of
  - a. cerebral blood flow
  - b. cerebral autoregulation (hemodynamic and metabolic)
  - c. intracranial pressure
  - d. cerebral perfusion pressure.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

2. Describe the impact of intracranial hypertension on cerebral blood flow.
3. Recognize the common causes of intracranial and intraspinal hemorrhage including:
  - aneurysmal disease
  - AVMs
  - cavernous malformations
  - hypertension
  - vasculopathies
  - Amyloid angiopathy
  - hemorrhagic arterial infarction
  - venous infarction.
4. List the appropriate diagnostic neuro-imaging studies utilized to evaluate hemorrhagic stroke.
5. Describe the fundamentals of CT scanning, including the typical appearance of acute, subacute, and chronic blood, and mass effect.
6. Explain the fundamentals of MR imaging. Distinguish between normal and abnormal findings within the realm of cerebrovascular disease. Recognize the classic MR appearance of:
  - arteriovenous malformations
  - cavernous malformations
  - aneurysms
7. Relate typical imaging (CT and MRI) characteristics of central nervous system hemorrhagic lesions to probable causes.
8. List the indications for non-invasive vascular imaging, including ultrasound, magnetic resonance angiography (MRA), and CT angiography. Recite the limitations of non-invasive studies. Describe the practical application of commonly employed non-invasive studies, such as transcranial Doppler, in the setting of cerebral vasospasm.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

9. List the indications for catheter angiography in hemorrhagic cerebrovascular conditions.
  
10. Identify the key angiographic anatomy of the anterior and posterior circulation and venous system.
  
11. Be able to identify angiographic characteristics of
  - arteriovenous malformations
  - cavernous malformations
  - aneurysms
  - Deep venous anomalies
  
12. Define the natural history of common hemorrhagic cerebrovascular disorders including
  - a. Aneurysms
  - b. AVMs
  - c. Cavernous Malformations
  
13. Recognize the typical clinical course of patients with hemorrhagic stroke, including peak risk intervals for edema, vasospasm, re-bleeding, etc.
  
14. Explain the principles of augmentation of cerebral blood flow during cerebral vasospasm. (Why is it necessary, what is triple H therapy)
  
15. Describe the epidemiology, physiology, and underlying pathophysiology of ischemic brain injury, including concepts of critical therapeutic window.
  
16. Recognize the common causes of brain ischemic states including:
  - cardiac embolism
  - embolism from proximal vasculature
  - large vessel occlusion



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

intracranial conducting vessel occlusion

small vessel disease

17. Identify the classic syndromes of vessel occlusion of the following:

internal carotid artery

middle cerebral artery

anterior cerebral artery

recurrent artery of Heubner

anterior choroidal artery

vertebral artery

posterior inferior cerebellar artery (PICA)

lower and upper basilar trunk

18. Describe the location of key perforating arteries involving the anterior and posterior circulation, their target distribution, and the consequence of occlusion or injury.

19. Identify the classic brain stem ischemic syndromes (e.g. Weber, Wallenberg)

20. List the appropriate diagnostic neuro-imaging studies utilized to evaluate ischemic stroke.

21. Associate computed tomography (CT) and magnetic resonance (MR) evidence of ischemic injury with likely anatomic substrate.

22. Describe the typical CT appearance of an ischemic stroke. Provide a detailed explanation for the typical delay between the onset of stroke and appearance of confirmatory CT findings.

23. Describe the typical MRI appearance of an ischemic stroke. Provide a detailed explanation for the difference of findings with different sequences.

24. Discuss Indications and treatment options of asymptomatic carotid stenosis

25. Discuss Indications and treatment options of symptomatic carotid stenosis

26. Discuss Indications and treatment options of posterior circulation cerebrovascular occlusive disease.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

27. Discuss venous infarctions
  - a. Causes
  - b. Management
28. Recognize the need for laboratory evaluation for systemic illness in a stroke patient (e.g. ESR, ACE, Rh factor).
29. Recognize the typical clinical course of patients with ischemic stroke, including peak risk intervals for edema, hemorrhagic conversion etc.
30. Identify the periods of high vulnerability to systemic complications of cerebrovascular illness, including deep venous thrombosis, pulmonary embolism, bacterial pneumonia, aspiration, congestive heart failure, etc.
31. Explain the principles of fluid and electrolyte resuscitation and maintenance, respiratory physiology, cardiac physiology, and nutritional physiology, as applied to the neurological patient following ischemic or hemorrhagic stroke. Integrate this knowledge with the specific issues of the perioperative period.

**Cerebrovascular Surgery:**

1. Discuss the principles and indications for surgical treatment of;
  - a. Aneurysms
  - b. AVMs
  - c. Cavernous Malformations
  - d. Dural Fistula`s (spinal and cranial)
  - e. Supra and infra tentorial paranchymal hemorrhages.
2. Relate the principles of timing to the surgical intervention in these same disease states.
3. Describe the principles of a pterional craniotomy, including scalp and bony anatomy, as well as the anatomy of the sphenoid ridge.
4. Discuss different skull base approaches that may be used to treat these conditions in detail.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

5. Discuss the use of adjuvants in surgery in treating these conditions such as motor mapping, intra operative angiography etc.
6. Discuss indications for cerebral bypasses in a modern practice and discuss different types of bypass procedures and different graft options.
7. Describe the surgical anatomy and the principles of exposure of the cervical carotid artery.

**Endovascular Surgery:**

1. Discuss the principles and indications for the endovascular treatment of;
  - a. Aneurysms
  - b. AVMs
  - c. Carotid stenosis
  - d. Posterior circulation occlusive disease states
  - e. Intra cranial stenosis
  - f. Dural Fistula`s (spinal and cranial)
2. Relate the principles of timing to the endovascular intervention in these same disease states.
3. Understand the concept of dome to neck ratio, aspect ratio etc as it relates to the endovascular treatment of cerebral aneurysms.
4. Understand indications to use different embolic agents in the endovascular treatment of AVMs, and dural fistula`s eg, glue, onyx ect.
5. Discuss the principles of stents, including self expanding and balloon expanding and discuss the differences.

**Middle Level:**

1. Review the principles of guideline development and outcome assessment related to the basic knowledge objectives achieved during junior residency.
2. Recognize controversies regarding the knowledge concepts mastered during junior residency.

**Senior Level:**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

1. Review the principles of guideline development and outcome assessment related to the basic knowledge objectives achieved during junior residency.
2. Review the controversies regarding the knowledge concepts mastered during junior residency.
3. Demonstrate a sophisticated understanding of current literature related to the knowledge objectives acquired as a junior and middle resident.
4. Demonstrate a mature fundamental knowledge in clinical and teaching conferences, specialty conferences, and in publications and scientific presentations.
5. Teach the junior and midlevel residents.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

Neurosurgical Oncology Competency-Based Knowledge Objectives

Junior Level

1. Discuss the basic tenants of tumor biology and genetics, including the basic principals of oncogenes, tumor suppressor genes, cell signaling, and immune responses to tumors.
2. Discuss the mechanism of action of drugs commonly used to treat benign and malignant intracranial neoplasms.
3. For the areas of the head listed below, provide a thorough differential diagnosis of possible lesions and radiographic findings that may differentiate those lesions, diagnostic approaches to the definitive diagnosis or management of those lesions, their approximate incidence, a description of their histology, their clinical presentation, and appropriate treatment options, including adjuvant therapy for newly diagnosed or recurrent masses:
  - a. calvarium
  - b. dura
  - c. nasal sinuses
  - d. supratentorial intraparenchymal compartment (superficial and deep lesions)
  - e. interventricular masses
  - f. intraparenchymal posterior fossa masses
  - g. cerebellar pontine angle masses
  - h. sellar and parasellar masses
  - i. cavernous sinus masses
  - j. pituitary masses
4. Describe the intracranial course and function of the cranial nerves of the posterior fossa, especially those within the internal auditory canal and cavernous sinus, with special attention to the relevant surgical anatomy.
5. Discuss the principals of stereotaxy and demonstrate proficiency in using intraoperative stereotactic devices, both frameless and frame-based.
6. Discuss the options, rationale, benefits, and risks of various approaches to intracranial tumors as follows:
  - a. pterional
  - b. frontal sinus approaches
  - c. transtemporal approaches
  - d. approaches to the ventricles
7. Discuss the performance and information obtained from the following preoperative evaluations: WADA test, balloon test occlusion of carotid artery, functional MRI, and embolization.
8. Discuss the performance of and the information obtained through the use of various intraoperative adjuncts including: ultrasound, cortical mapping, cortical monitoring, and evoked potential monitoring. This would include being able to interpret the results of these tests.
9. Discuss the techniques for performance of and the rationale for radiosurgical approaches to benign and malignant tumors. Provide a rationale why certain tumors should be treated with radiosurgery and others should not. Be familiar with the literature, especially Phase 3 trials that discuss the advantages and disadvantages of radiosurgery and be able to communicate the



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

options, rationale, benefits, and risks of radiosurgery to patients. Be familiar with commonly used dose ranges and dose planning strategies for radiosurgery.

*Senior Level:*

1. Discuss the options, rationale, benefits, and risks and indications for various skull-based approaches, including those to the anterior, middle, and posterior fossa. Specific attention should be given to the indications, advantages and risks of facial nerve transposition. Special attention should be given to the approaches to the clivus, the endonasal approach, the transcondylar approach, the combined petrosal approach, and transbasil approach.
2. Discuss the options for surgical approaches to acoustic neuromas and the rationale and risks for each approach and the preoperative considerations for each approach.
3. Be familiar with the literature, especially Phase 3 trials, that discuss the efficacy and toxicity of commonly used approaches to treat malignant and low grade gliomas including surgery, radiation, chemotherapy, immunotherapy and convection-enhanced delivery.



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

**NEUROSURGICAL Critical Care Competency-Based Knowledge Objectives**

***Junior Level:***

1. Define the adult and pediatric patient which would be best served in a critical care setting; include both medical and neurosurgical issues within the context of this discussion.
2. Review general medical issues pertinent to the management of neurosurgical patients in a critical care setting including:
  - a. prophylaxis of gastrointestinal hemorrhage
  - b. prophylaxis against aspiration pneumonia
  - c. prophylaxis, diagnosis, and treatment of venous thrombosis and pulmonary embolism
  - d. prophylaxis against and management of decubiti
  - e. prophylaxis against corneal abrasions for patients with facial nerve palsies
  - f. physical therapy to maintain strength and joint range of motion
  - g. universal precautions (MRSA precautions)
  - h. workup of fever and treatment of sepsis
3. Describe the indications and pharmacokinetics for medications commonly used in the management of critically ill neurosurgical patients including:
  - a. vasoactive drugs
  - b. ionotropic drugs
  - c. bronchodilators
  - d. diuretics
  - e. antiarrhythmics
  - f. antihypertensives
  - g. antimicrobials
  - h. anticonvulsants
4. Describe the clinical presentation, evaluation, and treatment of infections which commonly occur in critical care neurosurgical patients.
5. Review the indications for intubation including:
  - a. loss of patient airway
  - b. respiratory insufficiency



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- c. inability to protect airway
6. Discuss commonly used pulmonary values including:
  - a. measured pulmonary functions
    - i. rate
    - ii. minute ventilation
    - iii. spontaneous tidal volume
    - iv. forced vital capacity (FVC)
    - v. functional residual capacity (FRC)
    - vi. maximum ventilatory volume (MVV)
  - b. ventilator modes and settings
    - i. pressure versus volume ventilation
    - ii. continuous positive airway pressure (CPAP)
    - iii. intermittent positive airway pressure (IPAP)
    - iv. pressure support
    - v. assist control
    - vi. intermittent mandatory ventilation (IMV)
    - vii. positive end expiratory pressure (PEEP)
    - viii. rate
    - ix. tidal volume
7. Review the indications for weaning patients from ventilatory support. Describe the methods by which this is accomplished and the general pulmonary parameters a patient must demonstrate prior to extubation.
8. Discuss the medications used to improve pulmonary function.
9. Briefly review the following cardiac function parameters:
  - a. preload
  - b. afterload
  - c. contractility
10. Review the indications for implementing the following monitoring devices. Briefly describe how the information obtained is utilized to optimize patient management:
  - a. arterial catheters



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. central venous catheters
  - c. Swan-Ganz catheters
  - d. pulse oximetry
  - e. electrocardiographic monitoring
  - f. end-tidal CO<sub>2</sub> monitors
11. Review the medical and legal definitions of brain death.
  12. Discuss moral and ethical issues pertaining to critically ill neurosurgical patients including:
    - a. patient or family requests to withhold or withdraw treatment
    - b. organ donation.
  13. Summarize the physiology of hydrogen ion production and excretion.
  14. Briefly discuss acute and chronic buffering systems.
  15. Discuss metabolic acidosis and alkalosis.
  16. Discuss respiratory acidosis and alkalosis.
  17. Review the effects of acid-base disturbances on the central nervous system and intracranial pressure.
  18. Perform the following procedures:
    - a. orotracheal intubation
    - b. nasogastric intubation
  19. Obtain ACLS and ATLS certification. List the signs of acute symptoms of myocardial ischemia and diagnostic criteria using Troponin and briefly discuss the emergent treatment of this condition.
  20. Review the impact of renal insufficiency as it pertains to the management of neurosurgical patients.
  21. Briefly discuss the diagnosis and management of acute renal insufficiency.
  22. Describe the diagnosis and management of an ileus. List the differential diagnosis for an ileus.
  23. Review the diagnosis and management principles of the following endocrine disorders:
    - a. hypo/hyperthyroidism
    - b. hypo/hyperparathyroidism
    - c. adrenal cortical excess and deficiency
    - d. diabetes mellitus



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

e. diabetes insipidus

***Senior Level:***

1. Oversee and direct the junior and middle level resident management of critically ill neurosurgical patients.



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

## PAIN MANAGEMENT

### UNIT OBJECTIVES

Demonstrate an understanding of the anatomical and physiological substrates of pain and pain disorders. Demonstrate an ability to formulate and execute diagnostic and therapeutic plans for management of pain and disorders giving rise to pain.

### COMPETENCY-BASED KNOWLEDGE OBJECTIVES:

#### *Junior Level:*

1. Describe the anatomy and physiology of nociception (**pain signal transduction, pain transmission, pain perception, pain modulation**) within the peripheral and central nervous system.
  - a. Describe the normal neuroanatomy and neurophysiology of the ascending pain transmission system from the periphery to the central nervous system.
    1. Describe the **normal physiological function of the peripheral pain receptors (nociceptors) involved in nociception**
    2. **Describe the types of nerve fibers that are involved in pain processing**
    3. Describe the structure of the spinal cord including the organization of the dorsal horn according to Rexed's laminae
    4. **Describe the afferent pathways involving in pain transmission and pain processing including the spinothalamic pathway for the body and the trigeminothalamic pathway for the head and face**
  - b. Describe the descending anatomical pathways involved in pain modulation **including the endogenous opiate system**
    1. **Describe the various brainstem sites that are involved in pain modulation (periaqueductal gray, locus ceruleus, raphe nuclei)**
  - c. Describe the anatomy of the primary sensory cortex (S1), Rolandic fissure, and the relationship of S1 to the primary motor cortex.
  - d. **Describe the functional anatomy (afferent and efferent connection, somatotopic organization) of the following thalamic nuclei: ventral caudal nucleus (Vc) (includes VPL and VPM), ventral caudal parvocellular nucleus, medial thalamic nuclei, and the centromedian-parafascicular complex. Discuss the role of these nuclei as they relate to the pain processing system.**
2. **Define the following terms: hypalgesia, hyperalgesia, hyperpathia, hyperesthesia, allodynia.**
3. **Discuss the pathophysiological mechanisms underlying hyperalgesia and allodynia.**
4. **Discuss the pathophysiology of central sensitization and the phenomenon of wind-up.**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

5. **Differentiate between the neospinothalamic system and the paleospinothalamic system. Discuss the interaction between the pain transmission and processing system and the limbic pathways.**
6. **Describe the pathophysiology of the following conditions:**
7. List the common mechanisms of peripheral nerve injury and describe the changes which occur in an injured nerve at both the microscopic and macroscopic level. Explain the theories of pain generation in peripheral nerve injury.
8. Describe the anatomy of the major peripheral nerves, brachial plexus, and lumbosacral plexus.
9. Describe the anatomy of the sympathetic nervous system and explain its role in pain.
10. Diagram the anatomy of the following: trigeminal nerve divisions (ophthalmic, maxillary and mandibular nerves), foramen ovale, Meckel's cave, trigeminal (gasserian) ganglion, cistern of Meckel's cave, retrogasserian root, descending tract and nuclei, nervus intermedius, glossopharyngeal nerve
11. Differentiate between the following types of pain, particularly as related to the philosophy of management
  - a. acute pain vs. chronic pain
  - b. cancer-related pain
  - c. postoperative pain
12. Explain the differences between nociceptive pain and neuropathic pain.
13. Discuss the concept of Complex Regional Pain Syndrome
  - a. **List the diagnostics criteria established by the International Association for the Study of Pain for CRPS and explain the primary differentiation between CRPS type I (aka RSD) and CRPS type II (aka caualgia)**
14. Describe the methods for pain assessment in both adult and pediatric patients
  - a. **Describe of various pain assessment scales**
    1. **Visual analog pain scale**
    2. **Faces pain scale**
    3. **McGill Pain Questionnaire**
    4. **Oregon Health Sciences Univ. Facial Pain Questionnaire (at [www.ohsu.edu/neurosurgery](http://www.ohsu.edu/neurosurgery))**
    5. **Brief Pain Inventory**
    6. **Pain Disability Questionnair**
15. **Become familiar with some of the more commonly utilized outcome scale**
  - a. **SF-36**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

**b. Oswestry Low Back Disability Questionnaire**

16. Explain the concept of chronic pain as a biopsychosocial disorder.
17. Discuss the role of rehabilitation in chronic pain management.
18. Describe methods for assessing pain in pediatric patients.
19. Discuss ethical standards in pain management and research.
20. Discuss the classification of facial pain as proposed by Burchiel
21. Describe the typical history of a patient with trigeminal neuralgia, trigeminal neuropathic pain, and atypical facial pain.
  - a. Illustrate the appropriate medical management of patients with trigeminal neuralgia, trigeminal neuropathic pain, and atypical facial pain.
  - b. Discuss the various surgical procedures available for the treatment of trigeminal neuralgia and the relative advantages and disadvantages of each
    1. Discuss the concept of neurovascular compression and the role of microvascular decompression for trigeminal neuralgia.
      - **discuss the role of high resolution imaging of the trigeminal nerve in decision making for patients with trigeminal neuralgia**
    2. Discuss the role of, advantages/disadvantages of the percutaneous procedures (radiofrequency rhizotomy, glycerol rhizolysis, balloon compression), and their potential complications. **Discuss the technique(s) for cannulating the foramen ovale. Discuss the differences in long-term success rates, recurrence rates, incidence of facial numbness, incidence of deafferentation pain (anesthesia dolorosa), and the incidence of corneal anesthesia for each of the ablative procedures**
    3. Discuss the role of stereotactic radiosurgery for trigeminal neuralgia.
22. Identify the primary clinical indications for spinal cord stimulation, peripheral nerve stimulation, and intraspinal (epidural, intrathecal) drug infusion therapy.
  - a. Diagram the spinal anatomy pertinent to SCS and intraspinal drug administration, including the spinous process/interspinous ligament/spinous process complex, ligamentum flavum and dorsal epidural space. Review the different degrees of angulation of the spinous processes at various spine levels in the cervical and thoracic area.
  - b. Describe and recognize complications arising from implantation of epidural electrodes, pulse generators/receivers, and intraspinal infusion devices.
23. **Discuss the basic electrophysiology of spinal cord stimulation**
24. **Discuss the current drugs that can be utilized for intrathecal analgesia. Outline the most common drug-related adverse side effects. Discuss the clinical syndromes associated with overdose and withdrawal of intrathecal opiates and intrathecal baclofen. Discuss the treatment of these entities.**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

25. Diagram the spinal cord anatomy pertinent to spinal ablative procedures for pain management (cordotomy, DREZ, midline myelotomy).
26. Describe the pharmacology of local anesthetic agents (e.g., lidocaine, procaine, tetracaine, bupivacaine) and the use of epinephrine with local anesthetic agents. **Discuss the maximum doses of the various local anesthetic agents and describe the toxicity associated with these agents.**
27. Discuss the indications for peripheral neural blockade. Explain the principles of blocking procedures including the techniques and expected outcomes. Cite the complications of peripheral neural blockade (including anaphylaxis, neural injury, intravascular or intrathecal administration). List the alternatives to temporary blockade including neurolytic blocks, ablative neurosurgical procedures, augmentative neurosurgical procedures, alternative traditional pain management procedures, and alternative medicine approaches.
28. Describe the benefits limitations, sensitivity, specificity, and accuracy of various blocks when used for diagnostic and/or prognostic purposes.
29. Review the indications for radiofrequency facet rhizolysis.
30. Discuss the anatomy and biomechanics of the facet complex with emphasis on bone, cartilage, fibrous capsule, synovial fluid, and innervation of this structure.

***Middle Level:***

1. Name and differentiate the major classes of medications that are used commonly for pain treatment (opioids, non-steroidals and acetaminophen, antidepressants, anticonvulsants).
2. Review the psychosocial issues that may influence a pain disorder and describe the role of behavioral interventions in pain management.
3. Explain the rationale for multidisciplinary management of pain disorders.
4. Contrast impairment and disability.
5. Discuss spinal cord stimulation (SCS)
  - a. Describe the various mechanisms by which SCS is believed to produce analgesia
  - b. types of electrodes (percutaneous vs. plates electrodes) and the relative advantages and disadvantages of each
  - c. types of power sources and the advantages and disadvantages of each (internal pulse generator vs. radiofrequency receiver)
  - d. described the basic techniques of insertion of percutaneous and plate electrodes
  - e. discuss the rationale and goals of intraoperative SCS screening (paresthesia coverage of painful area, avoidance of undesirable stimulation)
  - f. discuss the correlation between electrode location and paresthesia location
  - g. discuss the various sites for implantation of SCS pulse generator/receiver and the advantages/disadvantages of each.





**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

10. Discuss the role of central neuroablative procedures in the management of chronic non-malignant and cancer-related pain
  - a. Discuss the primary clinical indications for the following procedures:
    1. dorsal root entry zone ablation
    2. nucleus caudalis DREZ
    3. anterolateral cordotomy (percutaneous and open)
    4. midline myelotomy
    5. midbrain tractotomy
    6. medial thalamotomy
    7. cingulotomy
    8. pituitary ablation
  - b. Describe the relative correlative anatomy for the procedures listed above
  - c. Describe the potential complications associated with central neuroablative procedures including production of deafferentation pain.
11. Discuss the role of peripheral ablative procedures in the management of chronic pain
  - a. Discuss the role of peripheral neurectomy vs. neurolysis for the treatment of pain following peripheral nerve injury; compare to alternative techniques of pain control including SCS, PNS, intraspinal drug infusion, etc.
  - b. Discuss the primary indications for the following procedures:
    1. peripheral neurectomy, excision of painful neuromas
    2. dorsal root ganglionectomy; describe the anatomy of the dorsal root ganglion, the bony anatomy of the nerve root foramen and the location of the ganglion within that foramen. Discuss indications for ganglionectomy and describe long-term outcome from ganglionectomy with emphasis on pain recurrence and deafferentation.
    3. sympathectomy
12. Discuss basic principles of ablative neurolytic procedures in terms of technique, expected outcomes, and complications including neural injury, injury to surrounding soft tissue, inadvertent intravascular or intrathecal administration. Describe the alternatives to neurolysis, including temporary anesthetic blocks, ablative neurosurgical procedures, augmentative procedures, alternative traditional pain management procedures, and alternative medicine approaches.
13. Describe indications for ablative peripheral neurolysis.
  - a. Review the differences between the following techniques:
    1. radiofrequency lesioning including pulsed radiofrequency



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

2. chemical neurolysis (review the pharmacology and histopathologic effects of neurolytic agents (e.g., phenol, glycerine/glycerol, chlorcreosol, absolute alcohol, ammonium chloride/sulfate).
  3. cryoablation
14. Describe the basic principles of radiofrequency lesioning. Include in the discussion the following topics:
- a. probe
  - b. thermocouple and thermistor
  - c. time
  - d. intensity of heat
  - e. isotherm fields
15. Discuss basic principles of radiofrequency facet rhizolysis and list the equipment utilized, technique employed, expected outcomes, and complications (including damage to other nerve root branches, potential for spinal instability, inadvertent damage to radicular artery, CSF leak, and spinal cord injury).
16. Compare the alternatives to radiofrequency lesioning:
- a. local anesthetic facet blocks
  - b. epidural injections
  - c. neurolytic facet blocks
  - d. ablative neurosurgical procedures
  - e. augmentative neurosurgical procedures
  - f. alternative traditional pain management procedures
  - g. alternative medicine approaches
  - h. surgical intervention such as instrumentation and fusion
17. Explain the basis of chemical, balloon compression, and radiofrequency neurolysis in the treatment of trigeminal neuralgia.

**Senior Level:**

1. Distinguish the indications for surgical and non-surgical treatment of pain.
2. Management of trigeminal neuralgia
  - a. Construct a management strategy relating to application of percutaneous trigeminal neurolytic procedures, retrogasserian rhizotomy, **stereotactic radiosurgery**, and microvascular decompression in the care of patients with trigeminal neuralgia.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. Describe and contrast the approaches to the cerebellopontine angle for microvascular decompression or rhizotomy of the trigeminal and glossopharyngeal nerves.
3. Spinal cord stimulation
  - a. Identify the various target spine levels for spinal cord stimulation according to the pain topography (simple and complex).
4. Intraspinal drug administration
  - a. Compare the different methods of intraspinal drug administration (epidural, intrathecal, tunneled catheter, implanted infusion system).
  - b. Describe the techniques for trialing intraspinal drugs.
  - c. Compare the pharmacodynamics of different drugs delivered intrathecally (e.g., hydrophilic vs. lipophilic).
  - d. Describe the common drug side effects associated with intraspinal analgesic administration.
5. Describe the possible complications of spinal cord stimulation electrode or spinal catheter insertion and their evaluation and treatment:
  - a. paralysis
  - b. nerve root damage
  - c. electrode or catheter migration
  - d. electrode or catheter breakage
  - e. epidural hematoma
  - f. cerebrospinal fluid leak
6. Describe the correct placement of lesions for DREZ, cordotomy, and myelotomy, including lesion depth and structures affected.
  - a. Discuss the possible neurological sequelae of spinal ablative procedures with both correct and incorrect lesion placement, with anatomical correlates.
  - b. Describe the role of DREZ lesioning in the overall management of the patient with deafferentation pain.
7. Describe the techniques for exposure of the major peripheral nerves.
8. Demonstrate knowledge of basic principles of nerve grafting, including regeneration, graft length considerations, and use of allograft donor nerves.
9. Describe the role and outcomes of ganglionectomy in the management of various pain syndromes, contrasting it with augmentative techniques.
  - a. Discuss in detail the surgical technique of ganglionectomy.
  - b. Describe percutaneous methods of gangliolysis.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

10. Explain the effects of blocking agents at the membrane and synaptic cleft, and the biochemistry and histology of neurotoxicity.
11. Explain the histologic effects of neurolytic agents at the membrane level and display a comprehensive level of understanding with regard to toxicity.
12. Describe the histologic effects of radiofrequency lesioning.
13. Discuss in detail the evaluation and management of a patient selected for radiofrequency lesioning of the facets.
  - a. Discuss the alternatives to radiofrequency lesioning, with particular emphasis on the potential surgical remedies including decompression, instrumentation, and fusion.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior Level:***

1. Diagnosis and Management
  - a. Obtain a pertinent history and perform an appropriate physical examination for a patient with a primary complaint of pain.
  - b. Formulate and implement treatment plans for simple pain syndromes (e.g., acute postoperative pain, acute low back pain).
  - c. Evaluate and diagnose a patient with trigeminal neuralgia, trigeminal neuropathic pain, and atypical facial pain.
  - d. Illustrate appropriate patient selection for spinal ablative or augmentative procedures for pain management.
  - e. Evaluate electrodiagnostic studies pertaining to peripheral nerve injury.
  - f. Recognize and treat the potential complications of peripheral nerve repair, neurectomy, and neurolysis including hematoma formation, infection, and local wound problems.
  - g. Assess patients for appropriateness of local anesthetic block(s).
    1. of block over a specified time interval
    2. assess need for repeat blocks
2. Surgical Techniques and Procedures
  - a. Assist with radiofrequency, glycerol or balloon compression neurolysis of the trigeminal nerve in patients with trigeminal neuralgia.
  - b. Assist with surgical exploration of the trigeminal nerve, nervus intermedius, or glossopharyngeal nerve for MVD or rhizotomy.
  - c. Locate the spinal epidural space and place a percutaneous spinal cord stimulation electrode with supervision.
  - d. Assist with implantation of a plate electrode for spinal cord stimulation.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- e. Insert with supervision a spinal catheter for drug administration.
- f. Insert with supervision a percutaneous electrode for peripheral field stimulation (occipital, supraorbital, infraorbital, auriculotemporal, lumbar)
- g. Implant with supervision a spinal cord stimulation system pulse generator/receiver and extension wire.
- h. Implant with supervision an intraspinal drug infusion pump.
- i. Assist with spinal ablative procedure for pain management (cordotomy, myelotomy, DREZ).
- j. For peripheral nerve repair, neurectomy, and neurolysis perform, record, and report complete patient evaluation and assessment, including comprehensive neuromuscular examination of affected nerve distribution.
- k. Assist in surgical treatment of peripheral nerves.
- l. Assist with implantation of a peripheral nerve stimulation system.
- m. Assist in foraminotomy and exposure of dorsal root ganglion. Recognize and treat the potential complications of dorsal root ganglionectomy including cerebrospinal fluid leak, infection, and local wound problems.
- n. Perform simple superficial blocks with supervision and assist in complicated procedures. Following such procedures:
  - 1. assess outcome of nerve block
  - 2. recognize and treat complications
  - 3. record and monitor effects
- o. Assess patient for appropriateness of ablative neurolysis. Perform simple superficial neurolysis with supervision and assist in complicated procedures. Following ablative neurolysis:
  - 1. assess outcome of procedure
  - 2. recognize and treat complications
  - 3. record and monitor effects of neurolysis over a specified time interval
  - 4. assess need for repeat procedures

***Middle Level:***

- 1. Diagnosis and Management
  - a. Formulate and implement an appropriate treatment program for complicated pain syndromes (e.g., chronic back pain, "failed back surgery syndrome").
  - b. Assess the need for multidisciplinary management of pain disorders.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- c. Demonstrate appropriate management of psychosocial factors complicating a pain disorder.
  - d. Diagnose and formulate appropriate treatment plans for sympathetically-maintained pain.
  - e. Diagnose and formulate an appropriate treatment plan for a patient with occipital neuralgia.
2. Surgical Techniques and Procedures
- a. Employ the Hartel technique to perform radiofrequency, glycerol or balloon compression neurolysis of the trigeminal nerve in patients with trigeminal neuralgia.
  - b. Implant a plate electrode.
  - c. Demonstrate appropriate methods for trialing spinal cord stimulation and intraspinal drug administration systems.
  - d. Implant a peripheral nerve stimulation system.
  - e. **Perform exposure with minimal assistance for placement of surgical leads in the high cervical region and lower to mid-thoracic region.**
  - f. **Perform with assistance, exposure for microvascular decompression up to and including dural opening.**
  - g. Assess patient for appropriateness of radiofrequency facet blocks. Perform radiofrequency facet blocks with supervision. Following the performance of such procedures:
    1. assess outcome of facet blocks
    2. recognize and treat complications
    3. record and monitor effects of facet blocks over a specified time interval
    4. assess need for repeat facet blocks

**Senior Level:**

1. Diagnosis and Management
  - a. Recognize and execute intelligent treatment choices for different pain syndromes including nociceptive, neuropathic, and cancer pain.
  - b. Demonstrate appropriate use of each of the major classes of medications in common use for treating pain.
  - c. Demonstrate appropriate selection of patients for surgical treatment of pain disorders.
  - d. Formulate and implement an appropriate treatment plan for management of pain using spinal ablative and augmentative techniques according to pain etiology, pain topography, and status of spinal column (e.g. previous surgery at implant level, scoliosis, stenosis, etc.).



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- e. Demonstrate proficiency with maintenance and programming of spinal drug administration systems and spinal cord stimulation systems.
  - f. Recognize and evaluate malfunctions of SCS and intraspinal drug administration systems.
  - g. Display appropriate patient selection for ablative peripheral neurolysis.
2. Surgical Techniques and Procedures
- a. Perform microvascular decompression and rhizotomy of the trigeminal nerve and glossopharyngeal nerves.
  - b. Assist a junior resident in performing a percutaneous ablative procedure for trigeminal neuralgia.
  - c. Select and implant an appropriate SCS system, recognizing how to modify electrode insertion technique and location based upon intraoperative responses.
  - d. Implant a plate electrode in a patient with previous spinal surgery at the same level.
  - e. Perform surgical revision of SCS and intraspinal drug administration systems.
  - f. Perform dorsal root entry zone lesioning
  - g. Demonstrate proficiency in performing myelotomy and cordotomy.
  - h. Plan and execute surgical approaches to injuries of the major peripheral nerves.
    - 1. Expose major peripheral nerves and perform closure of extremity incision for peripheral neurectomy/neurolysis.
    - 2. Demonstrate proficiency in neurolysis and nerve grafting techniques.
    - 3. Plan a peripheral nerve reconstruction including exposure, preparation of donor site, and nerve graft.
  - i. Demonstrate proficiency in technique of ganglion resection.
    - 1. Incorporate ganglionectomy as one part of an integrated approach to the patient with intractable pain.
  - j. Perform simple superficial blocks with minimal supervision. Relative to these blocks perform the following:
    - 1. assess outcome of block
    - 2. recognize and treat complications
    - 3. maintain detailed records of effects of block and follow-up
    - 4. assess need for repeat blocks
  - k. Perform complicated nerve block procedures with direct supervision. Recognize and treat the complications of these procedures.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- I. Perform simple neurolytic procedures with minimal supervision. Relative to these procedures perform the following:
  1. assess outcome of the procedure
  2. recognize and treat complications
  3. maintain detailed records of effects of neurolysis and follow-up
  4. assess need for repeat neurolysis
  5. Provide information regarding alternatives for failed neurolysis.
- m. Perform complicated neurolytic procedures with direct supervision.
- n. Display appropriate patient selection for radiofrequency facet rhizolysis.
- o. Perform simple facet blocks with minimal supervision. Relative to these procedures perform the following:
  1. assess outcome of the procedure
  2. recognize and treat complications
  3. maintain detailed records of effects of facet blocks and follow-up
  4. assess need for repeat facet blocks
- p. Perform complicated facet blocks with direct supervision.
- q. Perform sympathectomy



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

**PEDIATRIC NEUROSURGERY**

**UNIT OBJECTIVES**

Demonstrate an understanding of the anatomy, physiology, pathophysiology, and presentation of diseases in children which a neurosurgeon may be called upon to diagnose and treat. Demonstrate the ability to formulate and implement a diagnostic and treatment plan for these diseases.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

*Junior Level:*

Myelomeningocele and its Variants, Meningocele, Encephalocele, Chiari Malformations, Occult Spinal Dysraphism, Split Cord Anomalies, Segmentation Anomalies, Craniofacial Syndromes and Phakomatosis

1. Review the embryology of the central nervous system (CNS) and its supporting structures.
2. List the abnormalities a neurosurgeon may treat which are congenital/developmental in nature and classify them with respect to their embryology defect.
3. Describe the incidence, epidemiology and inheritance patterns.
4. State other disorders associated with this set of diseases.
5. Describe the anatomic and pathophysiologic parameters which distinguish amongst these diseases.
6. Develop a diagnostic treatment plan along with prognostication of outcome with optimal management.
7. List disorders which may be referred for neurosurgical care but do not require surgery.
8. Display current knowledge of the molecular basis for these diseases where known.
9. Describe the expected outcome if treatment is not undertaken.

**Hydrocephalus and Other Disorders of CSF Circulation**

1. Describe the normal physiology of CSF.
2. Delineate the different etiologies of hydrocephalus and their relative incidence.
3. Explain how to differentiate between CSF collections which require treatment and those which do not.
4. Indicate the various treatment options for the management of hydrocephalus.
5. Distinguish between treatment options for hydrocephalus with normal CSF and contaminated (e.g. infection, blood) CSF.
6. List the complications associated with each treatment option for hydrocephalus and the diagnosis and treatment of same.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

7. Differentiate between low-pressure and high-pressure hydrocephalus.
8. Describe the presentation and diagnostic approach to a patient with suspected shunt malfunction.
9. Define how the diagnosis of hydrocephalus is made.
10. List nonsurgical diseases which may be mistaken for hydrocephalus but require treatment different than surgery.
11. Review the causes of cerebral atrophy.

**Neoplasia**

1. Delineate the differences between pediatric and adult tumors.
2. List the common tumor types occurring in children and their typical location.
3. Describe the changing tumor type and location based upon age.
4. Identify lesions which require biopsy as part of the treatment/diagnostic plan.
5. Describe the typical presentations of tumors.
6. Describe appropriate evaluation for patients suspected of having a tumor.
7. Classify tumor types as to degree of malignancy, role of surgical vs. nonsurgical therapy, and outcomes of optimal treatment.
8. Discuss the possible complications associated with specific tumor types.
9. Describe the pertinent anatomy for surgical treatment of midline or hemispheric cerebellar tumors and hemispheric cerebral tumors.
10. Discuss appropriate preoperative management of patients with tumors.
11. Compare the role of biopsy, subtotal resection and total resection in the management of tumors.
12. List possible complications of the treatment options, their diagnostic evaluation and treatment.

**Infection**

1. Describe the presentations of a shunt infection.
2. List the indications for ventricular lumbar and subarachnoid CSF sampling.
3. List the common organisms seen in shunt infections.
4. Describe treatment plans for shunt infection.
5. List risk factors and risks of shunt infection and the proper diagnostic protocol to establish the presence of a shunt infection.
6. Describe common presentations of intracranial and intraspinal suppuration.
7. List host risk factors which are associated with CNS infections.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

8. Describe appropriate diagnostic protocol to establish the presence of CNS infection.
9. Discuss the timeliness and utility of surgical therapy for the treatment of CNS infection both shunt-related and non-shunt-related.

**Other**

1. Delineate the various types of spasticity and movement disorders seen in children.
2. List seizure types.
3. Describe surgical lesions which may be related to seizures.
4. Describe surgical and non-surgical treatment options regarding the alleviation of spasticity in children.
5. Discuss the pathophysiology of craniosynostosis.

**Cerebrovascular**

1. Delineate the possible causes of an atraumatic intracerebral or subarachnoid hemorrhage.
2. Delineate the possible causes of cerebral infarction/ischemia.
3. Discuss the common locations of arteriovenous shunts and their presentation, evaluation, and treatment (includes dural AVM).
4. Discuss the embryology of the cerebral and spinal vasculature and its possible role in vascular anomalies in children.
5. Describe the common locations and types of aneurysms seen in children and how they differ from those seen in adults.
6. List the possible presentations of Vein of Galen aneurysms, their diagnosis and management.
7. List the possible causes of aneurysms in children which are not congenital in nature.
8. Describe the pathophysiology, treatment, and outcome of intraventricular hemorrhage in the neonate.

**Trauma**

1. List the appropriate diagnostic tests to evaluate a children who has sustained multisystem trauma.
2. Describe the Glasgow Coma Scale and its use.
3. List the salient historical and exam features which lead one to the diagnosis of non-accidental trauma.
4. Discuss the management of the cervical spine in a child who is comatose.
5. Describe the anatomy of the child's spine which causes the epidemiology of spinal cord injury to differ from adults.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

6. Describe the common injuries seen as a result of birth trauma and discuss their diagnosis and management.
7. Describe the use of antibiotics and anticonvulsants in CNS trauma.
8. Review the evaluation and management of a child who has sustained a head injury with loss of consciousness but is now awake.
9. Discuss the management of depressed skull fractures, both open and closed.
10. Describe the diagnosis and management of spinal column injury.
11. Discuss the diagnosis and management of spinal cord injury without radiologic abnormality (SCIWORA).
12. Describe the intracranial pressure (ICP) compliance curve and discuss its utility in the management of head injury.
13. List the parameters needed to decide on letting an athlete who has sustained a CNS injury return to activity.
14. Discuss the concept of "brain death", its diagnosis and role in organ donation.
15. Discuss the importance and interplay between ICP and cerebral perfusion pressure (CPP) in the management of head and spinal cord injury.
16. Define the concept of "secondary injury".
17. Discuss the role of invasive monitoring in all its forms in closed head injury (CHI).

***Middle Level:***

Myelomeningocele and its Variants, Meningocele, Encephalocele, Chiari Malformations, Occult Spinal Dysraphism, Split Cord Anomalies, Segmentation Anomalies, Craniofacial Syndromes and Phakomatosis

1. Enumerate the indications for surgery, surgical options and expected outcomes for each disease entity.
2. Explain the indications for and utility of intraoperative monitoring.
3. Describe appropriate timing of intervention and its rationale.
4. Describe the pathophysiology and presentation of the tethered cord syndrome.

Hydrocephalus and Other Disorders of CSF Circulation

1. Describe normal ICP dynamics and their relation to establishing a differential diagnosis of CSF flow disturbance.
2. Define "slit ventricle system" and how it is diagnosed and treated.
3. Define "brain compliance" and relate how that can affect ventricular size.
4. List indications for and describe technique of accessing a shunt for CSF samples.
5. List disease states which are commonly associated with hydrocephalus.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

Neoplasia

1. Discuss the differential diagnosis and evaluation of tumors located in the following areas:
  - a. suprasellar
  - b. pineal region
  - c. intraventricular
2. Discuss the treatment/diagnostic options for tumors in each location listed in #1 including surgical approaches.
3. Describe the appropriate evaluation and treatment of patients with neoplastic processes associated with:
  - a. neurofibromatosis
  - b. tuberous sclerosis
  - c. von Hippel Lindau
4. Discuss the appropriate use of skull base approaches for specific tumor locations.
5. List tumors which will require adjunctive therapy and describe those therapies and potential complications thereof.
6. Discuss the global management of tumoral hydrocephalus.
7. Cite the long-term outcome and complications for treatment of the common cerebellar and supratentorial hemispheric tumors.

Infection

1. Compare the differing patterns of infection as seen in immune-compromised patients to those with a functioning immune system.
2. Discuss the sequelae of CNS infection, both shunt-related and non-shunt-related.
3. List all acceptable treatment options for CNS infection with the pros and cons of each plan.
4. Demonstrate an understanding of the different etiologies for subdural and epidural empyema and brain abscess and differing treatments thereof.
5. Provide a complete differential diagnosis in regard to infectious disease for ring enhancing brain lesions.
6. Discuss the role of osteomyelitis in CNS infection.
7. Differentiate radiographically between infection and tumor of bone.

Other

1. Discuss variance in the surgical management of tumoral vs non-tumoral seizure foci.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

2. Discuss surgical options, indications and outcome for non-lesional approaches (e.g., callosotomy).
3. Discuss various surgical options for the management of spasticity.
4. Discuss preoperative evaluation and planning for seizure treatment.
5. Discuss preoperative evaluation and planning for treatment of spasticity and postoperative management.

**Cerebrovascular**

1. Describe the nomenclature for congenital vascular anomalies and what, if any, role inheritance plays.
2. Describe the pathology, risk factors, diagnosis and treatment of moyamoya in children.
3. List the phakomatoses which have vascular anomalies associated with them and their treatment.

**Trauma**

1. Discuss the role of apoptosis in brain and spinal cord injury.
2. Compare the utility of epidural, subdural, parenchymal, and intraventricular ICP monitoring.
3. Differentiate between retinal hemorrhages and Terson's syndrome.
4. Describe the role of electrophysiological monitoring in the management and prognostication of the CNS injured patient.
5. Discuss the evidence for and role of steroid therapy in CNS injury.
6. Discuss the prognosis and management of penetrating injuries to the brain and spine.
7. Discuss the management of CSF leaks after head injury.
8. Describe the diagnosis and treatment of a traumatic leptomeningeal cyst.

**Senior Level:**

Myelomeningocele and its Variants, Meningocele, Encephalocele, Chiari Malformations, Occult Spinal Dysraphism, Split Cord Anomalies, Segmentation Anomalies, Craniofacial Syndromes and Phakomatosis

1. Differentiate between the use of rigid and non-rigid skeletal fixation in the appropriate surgical setting for this group of disorders.
2. Explain the rationale for surgical treatment of a symptomatic disease.

**Hydrocephalus and Other Disorders of CSF Circulation**

1. Discuss the utility of expansion craniotomy in the treatment of hydrocephalus.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

2. Differentiate between ventriculomegaly, compensated hydrocephalus, and pseudotumor cerebri.
3. Describe the pertinent anatomy of the ventricular system and prepontine cisterns.
4. Describe the role of venous outflow obstruction in hydrocephalus.

**Neoplasia**

1. Describe the pertinent surgical anatomy for approaches to tumors in the following locations:
  - a. suprasellar
  - b. pineal region
  - c. intraventricular
2. Discuss the role of endoscopic third ventriculostomy in management of tumoral hydrocephalus.
3. Cite the long-term outcome and complications of all treatment options for tumors arising in the following locations:
  - a. suprasellar
  - b. pineal region
  - c. intraventricular
4. Discuss the utility of preoperative embolization and/or chemotherapy in the surgical management of specific tumors.
5. Discuss the role of stereotactic radiosurgery in the management of selected tumors.
6. Describe the presentations of hypothalamic hamartomas and the role of surgery in management.
7. Describe options for CNS monitoring during surgical therapy and their efficacy.
8. Discuss options for treatment and expected outcomes for recurrent tumors.

**Infection**

1. Describe in detail the differential diagnosis, evolution and treatment options of an immune-compromised patient with a ring enhancing brain lesion.
2. List the important aspects of the patient's history which may lead one to entertain the diagnosis of CNS infection, both shunt-related and non-shunt-related.
3. List diagnostic tools, other than CSF culture, which are utilized to diagnose a shunt infection.

**Cerebrovascular**

1. List the locations for traumatic vascular lesions and their risk factors, diagnosis, and treatment.
2. Discuss management options and controversies in the treatment of vascular disease in children.

**Trauma**



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

1. Discuss the potential complications and evaluation of comatose patients with skull base fractures.
2. Discuss the utility of lumbar drains and expansion craniectomy and the removal of frontal or temporal lobe in the management of refractory elevated ICP.
3. Describe the approaches to the management of traumatic ICH and its supporting data, both surgical and non-surgical.
4. List the vascular and endocrine complications seen after head injury.
5. Discuss the long-term management of a child who has sustained CNS trauma including rehabilitation and neuro-cognitive issues.
6. Discuss the management of peripheral nerve injuries in a child.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior Level:***

1. Perform complete history, physical examination and assessment on newborns, infants, and children.
2. Interpret results of the physical examination, laboratory and radiological studies to arrive at a differential diagnosis.
3. Perform subdural, intraventricular and lumbar punctures in children.
4. Perform a shunt tap.
5. Perform a twist drill or burr hole for subdural, parenchymal, or ventricular access or as part of a craniotomy.
6. Perform a craniotomy or craniectomy for evacuation of subdural or epidural lesion.
7. Perform a craniectomy as part of skull biopsy.
8. Perform craniotomy for elevation of depressed skull fracture.
9. Place a ventriculoperitoneal, jugular, or pleural shunt.
10. Revise a ventriculoperitoneal, jugular, or pleural shunt.
11. Perform a cranioplasty with artificial material or homologous material.
12. Perform a laminectomy in a patient with normal spinal anatomy.
13. Position a patient for intracranial or intraspinal surgery.
14. Demonstrate an ability to open and close cranial and spinal wounds to include dural opening and repair.
15. Complete a sagittal synostectomy.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

***Middle Level:***

1. Close an open spinal or cranial neural tube defect.
2. Repair an intracranial encephalocele.
3. Perform the opening for a complex craniofacial repair.
4. Perform the exposure for supratentorial and infratentorial lesions (excluding pineal, suprasellar and intraventricular locations).
5. Perform the exposure for spinal exploration in a patient with abnormal spinal anatomy or reoperation.
6. Evacuate an intraparenchymal hematoma.
7. Accomplish endoscopic third ventriculostomy in uncomplicated settings.
8. Apply and utilize frameless or framed stereotactic modalities for lesion location and shunt placement.
9. Accomplish repair of a Chiari malformation.
10. Accomplish an uncomplicated detethering procedure.
11. Perform a cranial vault expansion.
12. Perform placement of baclofen type pumps.
13. Perform spinal fusion without instrumentation.
14. Apply a vagal nerve stimulator.

***Senior Level:***

1. Perform exposure for suprasellar, pineal and intraventricular lesion (including orbito-frontal, transcallosal and supracerebellar).
2. Remove uncomplicated posterior fossa and supratentorial lesions.
3. Repair complex tethered cords (e.g. lipomyelomeningocele, retethering, and diastematomyelia).
4. Accomplish exposure for intradural spinal neoplasms.
5. Utilize an endoscope to communicate trapped CSF spaces.
6. Remove intracranial vascular malformation less than 3 cm in size and in non-eloquent brain.
7. Perform placement of grids for seizure monitoring.
8. Perform rhizotomy for spasticity.
9. Perform temporal lobectomy in an uncomplicated patient.
10. Perform stereotactic biopsy of supratentorial lesion.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

11. Perform spinal fusion utilizing instrumentation.
12. Accomplish endoscopic third ventriculostomy in uncomplicated settings.
13. Assist with complex craniofacial surgery.
14. Assist with a vascular procedure for moyamoya disease.



RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER

**Guidelines for Surgery of the Peripheral Nervous System**

**Unit Objectives** – Demonstrate an understanding of the anatomy, physiology, pathophysiology, and presentation of peripheral nerve diseases. Demonstrate the ability to formulate and implement a diagnostic and treatment plan for diseases of the peripheral nerves that are amenable to surgical intervention.

**Competency-based Knowledge Objectives:**

***Junior Level:***

1. Define the peripheral nervous system versus the central nervous system.
2. Discuss the major structural elements of a peripheral nerve:
  - a. epineurium
  - b. perineurium
  - c. endoneurium
  - d. axon
  - e. fascicle
  - f. Schwann cell
  - g. connective tissues
  - h. motor end plate
  - i. sensory receptor
3. Discuss the blood supply of the peripheral nerves.
4. Discuss the blood-nerve barrier.
5. Define axonal transport and differentiate fast from slow transport.
6. Describe the propagation of an action potential including the concomitant flow of ions.
7. Describe the various nerve fibers in terms of size.
8. Discuss the significance of fiber size in terms of function (e.g., c-fiber – nociceptive).
9. Discuss the various forms of action potential propagation.
10. Discuss the pathophysiological response to various injuries by a nerve:
  - a. compression
  - b. ischemia
  - c. metabolic
  - d. insult
  - e. stretch
11. Define and discuss apoptosis.
12. Define Wallerian degeneration.
13. Discuss nerve regeneration:
  - a. sprouting



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. nerve growth factors
  - c. rate of growth
  - d. remyelination
14. Define traumatic neuroma:
- a. mechano-sensitivity
  - b. neuroma-in-continuity
15. Define and discuss the pathophysiology and clinical significance of Tinel's sign.
16. Describe the symptoms and signs of typical nerve injuries:
- a. entrapment syndromes
  - b. stretch injuries
  - c. laceration injuries
  - d. concussive injuries
  - e. injection injuries
17. Distinguish upper versus lower motor neuron symptoms and signs in nerve injury:
- a. anatomical definition
  - b. degree of atrophy
  - c. distribution of weakness
  - d. reflex changes
  - e. potential for recovery
18. Describe the classification of nerve injury:
- a. Seddon classification
  - b. Sunderland classification
19. List the major peripheral nerves of the body. Describe the motor and sensory innervation of each.
20. Draw the major components of the brachial plexus.
21. Describe the rating scale that you use for motor power.
22. Describe the various sensory modalities and how to examine each.
23. Describe the symptoms and signs of common nerve entrapments:
- a. carpal tunnel
  - b. ulnar entrapment at elbow
  - c. lateral femoral cutaneous nerve
  - d. peroneal at fibular head
24. Define EMG and NCV and describe their clinical usefulness.
25. Describe the changes in EMG and NCV in nerve entrapment.
26. Describe the nonoperative and operative treatment of entrapment syndromes.
27. Define:
- a. coaptation
  - b. neurorrhaphy
  - c. neurotization
  - d. nerve transfer



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

***Middle Level:***

1. Define the autonomic nervous system:
  - a. differentiate sympathetic and parasympathetic
  - b. discuss the basic anatomy of the sympathetic and parasympathetic systems.
  - c. identify the various neurotransmitters present at each synapses
  - d. discuss Horner's syndrome
  
2. Compare and contrast a peripheral nerve to a cranial nerve:
  - a. histology
  - b. response to injury
  - c. root entry zone
  
3. Describe nerve regeneration in terms of:
  - a. specificity
  - b. pruning of sprouts
  - c. end to side sprouting
  
4. Draw the complete brachial plexus.
  
5. Discuss the lumbar plexus.
  
6. Discuss stretch injury, missile injury and avulsion injury:
  - a. definition
  - b. typical etiology
  - c. physical findings
  - d. electrical findings
  - e. nonoperative management
  - f. indications for surgery
  - g. intraoperative findings
  - h. potential for recovery
  
7. Describe the local anatomy around the common peripheral nerve entrapment sites. List the various bands and arcades that produce entrapment.
  
8. Provide a differential diagnosis for common entrapment syndromes:
  - a. differentiate radiculopathies from entrapments
  - b. discuss repetitive strain disorder
  
9. Discuss uncommon entrapment neuropathies:
  - a. Guyon's canal
  - b. suprascapular entrapment
  - c. radial tunnel/PIN
  - d. median nerve in forearm/AIN
  - e. tarsal tunnel (anterior and posterior)
  - f. piriformis syndrome
  
10. Explain the use of EMG/NCV in the management of peripheral nerve disorders:
  - a. physiology
  - b. typical findings in neuropathy
  - c. typical findings in nerve injury
  - d. typical findings in nerve regeneration



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

11. Discuss the common metabolic/inherited neuropathies
12. Discuss burn and electrical injury effects on nerves.
13. Classify peripheral nerve tumors.
14. Discuss the pathophysiology of NF1 and NF2.
15. Discuss the timing of peripheral nerve surgery:
  - a. laceration injury
  - b. blunt injury
  - c. missile injury
  - d. iatrogenic injury
  - e. surgical injury
  - f. injection injury
16. Discuss the outcome priorities in brachial plexus surgery:
  - a. motor versus sensory
  - b. most important(?) muscle functions to restore
17. Discuss tension at the nerve repair site.
18. Discuss nerve repair techniques:
  - a. direct coaptation
  - b. nerve graft
  - c. nerve transfer
  - d. donor (graft) nerves
  - e. epineurial repair
  - f. fascicular repair
19. Describe intra-operative nerve evaluation:
  - a. visual
  - b. palpation
  - c. internal neurolysis
  - d. electrical nerve conduction
  - e. biopsy

**Senior Level:**

1. Discuss with the aid of diagrams the anatomy of the peripheral nervous system:
  - a. common sites of entrapments
  - b. the brachial and lumbar plexus
  - c. innervation of the bladder
2. Discuss the use of nerve grafting:
  - a. types of fixation (suture/glue)
  - b. types of grafts (nerve, vein, artificial)
  - c. end to side
3. Discuss entrapment syndromes:
  - a. thoracic outlet\



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

- b. double crush syndrome
  - c. repetitive strain
4. Discuss ulnar nerve decompression:
- a. in situ decompression
  - b. transposition (subcutaneous/intramuscular/submuscular)
  - c. medial epicondylectomy
5. Differentiate brachial plexus from brachial plexitis.
6. Formulate a management plan for:
- a. birth brachial plexus injury
  - b. acute nerve injury (stretch/decompression/laceration/injection)
  - c. chronic nerve injury
  - d. failed nerve decompression
  - e. painful nerve/neuroma
7. Describe the management of nerve tumors:
- a. imaging techniques, including MR neurography
  - b. indications for surgery in patients suffering from NF1
  - c. operative and adjuvant treatment for malignant peripheral nerve sheath tumors
  - d. use of monitoring during nerve tumor surgery
  - e. interfascicular dissection
8. Describe adjuvant therapies in nerve injury:
- a. muscle and tendon transfers
  - b. prosthesis
  - c. joint fusion

**Competency-based Performance Objectives:**

***Junior Level:***

1. Obtain a history in a patient with a peripheral nerve injury and perform a motor and sensory examination of the peripheral nervous system.
2. Based on data obtained by history and physical, anatomically localize the lesion.
3. Plan a diagnostic strategy incorporating appropriate ancillary tests:
  - a. EMG/NCV
  - b. metabolic screens
  - c. imaging studies
4. Formulate a differential diagnosis for common entrapments.
5. Position and prep an extremity for common entrapment releases.
6. Perform a diagnostic nerve and muscle biopsy.
7. Obtain sural nerve for grafting.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

***Middle Level:***

1. Perform pre- and post-operative care of the patient with a peripheral nerve injury.
2. Evaluate a child with birth palsy.
3. Position a patient for nerve surgery:
  - a. all entrapment sites
  - b. brachial plexus surgery
4. Perform a neurolysis/decompression.
5. Expose the brachial plexus.
6. Manage the pain associated with nerve injury:
  - a. use of medications
  - b. use of rehabilitation
  - c. use of stimulation

***Senior Level:***

1. Perform a consultation evaluating a potential nerve injury.
2. Discuss the risks versus benefits of a surgical repair of a given nerve injury.
3. Determine the parameters confirming anticipated nerve regeneration.
  - a. anticipated using Tinel's sign
  - b. order of muscle re-innervation
4. Perform a nerve decompression for:
  - a. carpal tunnel
  - b. ulnar nerve compression at elbow
  - c. peroneal nerve compression
5. Perform a nerve repair:
  - a. neurolysis
  - b. internal neurolysis
  - c. intraoperative nerve conduction
  - d. placement and suture of nerve graft
6. Actively participate in the excision of a nerve sheath tumor.
7. Actively participate in exposure of a brachial plexus injury:
  - a. determine possible repairs including nerve transfers
  - b. expose the spinal accessory nerve
  - c. expose the intercostal nerves



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

## **SPINAL SURGERY**

### **UNIT OBJECTIVES**

Demonstrate an understanding of the anatomy, physiology, pathophysiology, and presentation of disorders of the spine, its connecting ligaments, the spinal cord, the cauda equina, and the spinal roots.

Demonstrate the ability to formulate and implement a diagnostic and treatment plan for diseases of the spine, its connecting ligaments, the spinal cord, the cauda equina, and the spinal roots that are amenable to surgical intervention.

### **COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

#### ***Junior Level:***

1. Review the anatomy of the craniocervical junction, cervical, thoracic, and lumbar spine, sacrum, and pelvis.
2. Interpret plain and dynamic radiographs, bone scans, myelograms, computerized tomographic (CT) scans, and magnetic resonance (MR) scans of patients with spinal disorders.
3. Review the signs, symptoms, and pathophysiology of common syndromes of degenerative spinal disorders: radiculopathy, myelopathy, instability, and neurogenic claudication.
4. Identify the common syndromes of spinal cord injury, including complete transverse injury, anterior cord injury, Brown-Sequard injury, central cord injury, cruciate paralysis, syringomyelia, conus syndrome, and sacral sparing. Describe the pathophysiology of spinal cord injury.
5. Describe the cauda equina syndrome.
6. Recite the differential diagnosis of cervical, thoracic, and lumbar axial pain.
7. Discuss the indications for cervical, thoracic, and lumbar discectomy.
8. Identify non-surgical spinal cord syndromes including amyotrophic lateral sclerosis, demyelinating conditions, and combined systems disease.
9. Review the initial management of spine and spinal cord injured patients including immobilization, traction, reduction, appropriate radiographic studies, and medical management.
10. Classify fractures, dislocations, and ligament injuries of the craniocervical region, subaxial cervical spine, thoracic, thoracolumbar junction, lumbar, and sacral spine. Describe the mechanism of injury and classify the injuries as stable or unstable. Review the indications for surgical management.
11. Discuss briefly the concept of grading schemes for spinal cord injury and myelopathy.

#### ***Middle Level:***

1. Review the biomechanics of the craniocervical junction, cervical spine, and thoracolumbar and lumbar spine.
2. Review the biomechanics of common available internal spinal fixation systems.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

3. Review the definition of spinal instability based upon the principles of Punjabi and White and other authors, including differences between acute (subluxation) and chronic (spondylolisthesis) instability.
4. Recognize the radiographic signs of degenerative, neoplastic, traumatic, and congenital spinal instability.
5. Review the indications for, and uses, and relative effectiveness of common spinal external orthoses. Discuss the degree of segmental and regional immobilization these orthoses provide.
6. Review the indications for, and physiology of, intraoperative spinal cord monitoring. Describe the technical aspects of intraoperative spinal cord monitoring.
7. Compare and contrast indications for anterior and posterior approaches to the cervical spine for the treatment of herniated cervical discs, spondylosis, and instability.
8. Discuss the role of corpectomy versus discectomy in the management of cervical disorders.
9. Discuss the indications and techniques for available anterior and posterior cervical spinal internal spine fixation systems..
10. Explain the biology of bone healing and options for bone grafting in spinal surgery.
11. Review the diagnosis and management of primary spinal tumors, spinal cord tumors, and spinal metastatic disease including indications for dorsal decompression, ventral decompression, and radiotherapy.
12. Discuss the management principles for gunshot and other penetrating wounds to the spine.
13. Review the signs, symptoms, and management options in the treatment of the adult Chiari malformations, tethered cord syndrome and syringomyelia.
14. Review management principles for spontaneous and postoperative spinal infections.
15. Review the management principles for intraoperative and postoperative cerebrospinal fluid leaks.
16. Discuss the surgical management of intradural, congenital, neoplastic, and vascular lesions
17. Discuss internal fixation options for the thoracolumbar spine.
18. Compare and contrast as well as discuss the indications for open versus minimally invasive spinal decompression and fixation techniques.
19. Compare interbody fusion to posterior intertransverse fusion. .

**Senior Level:**

1. Describe indications for the use of angiography and endovascular procedures in the management of spinal disorders.
2. Discuss the management of cervical degenerative disease secondary to rheumatoid arthritis. Describe factors which make it different from the management of non-rheumatoid disease.
3. Compare and contrast the treatment options for cervical spondylotic myelopathy and ossification of the posterior longitudinal ligament, including multilevel anterior cervical corpectomy and fusion, laminectomy, laminectomy and fusion, laminoplasty, and nonoperative therapies.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

4. Discuss the indications for posterior cervical spinal internal fixation systems.
5. Compare and contrast the transthoracic, transpedicular, costotransverse, and lateral extracavitary approaches to a herniated thoracic disc, thoracic tumor, or thoracic spinal injury.
6. Discuss the indications for lumbar fusion for congenital disorders, iatrogenic disease, and degenerative disease, ranking indications from least to most controversial.
7. Compare and contrast the indications for anterior or posterior lumbar interbody fusion and intertransverse fusion for lumbar disease.
8. Summarize the most common types of spinal tumors in the following categories:
  - a. intradural/intramedullary
  - b. intradural/extramedullary
  - c. extradural/extramedullary.
9. Discuss nonoperative and operative treatment options for fractures and dislocations affecting the atlas and axis.
10. Compare and contrast the indications for nonoperative treatment, anterior approaches, and posterior operative approaches for the treatment of fractures and dislocations of the subaxial cervical spine.
11. Describe the indications for anterior, posterior, and posterolateral procedures in the management of thoracolumbar tumor, trauma, or infection.
12. Compare and contrast the indications for anterior and posterior spinal fixation systems in the management of thoracolumbar tumor, trauma, or infection.
13. Discuss reconstruction options for vertebral body defects after corpectomy for tumor, trauma, or infection.
14. Discuss pelvic reconstruction options and indications.
15. Discuss the options and indications for spinal osteotomies.
16. Discuss the surgical aspects of intervention in scoliotic and kyphotic patients, including levels for instrumentation and failure management/avoidance.

**COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

***Junior Level:***

1. Perform a complete history and physical examination on patients with spinal disorders.
2. Interpret plain x-rays, dynamic x-rays, myelograms, CT scans and MR scans of patients with spinal disorders.
3. Prepare patients for spinal surgery, including proper positioning, protection to pressure points, and placement of indicated arterial and central venous catheters, indwelling urinary catheters and anti-embolism devices.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

4. Perform lumbar punctures and placement of lumbar drains.
5. Demonstrate the ability to place and manage cranial traction devices for reduction and immobilization of the unstable cervical spine.
6. Demonstrate the ability to place and manage a halo vest, including indications for placement and criteria for removal.
7. Demonstrate the ability to properly place the Mayfield head holder and other headrests.
8. Demonstrate the ability to harvest autologous bone graft from the anterior or posterior iliac crest.
9. Perform dorsal exposure of the spinous processes, laminae, and facets of the cervical, thoracic, and lumbar spine.
10. Demonstrate the ability to close dorsal, ventral, and lateral spinal incisions.
11. Demonstrate proper postoperative wound care.
12. Demonstrate appropriate postoperative management of patients who have undergone spinal procedures.
13. Demonstrate the ability to perform, with supervision, a lumbar decompressive laminectomy for spinal stenosis.
14. Demonstrate the ability to excise, with supervision, a herniated lumbar disc, using open and minimally invasive techniques.
15. Demonstrate the ability to prepare a posterolateral fusion bed.
16. Demonstrate the appropriate use of the operating microscope.

***Middle Level:***

1. Demonstrate the ability to prepare structural allografts for use in spinal surgery.
2. Determine the need for postoperative inpatient or outpatient rehabilitation in patients with spinal disorders.
3. Demonstrate the ability to perform a ventral exposure of the cervical spine followed by anterior cervical decompression.
4. Demonstrate the ability to perform an anterior cervical arthrodesis.
5. Demonstrate the ability to place anterior cervical instrumentation.
6. Demonstrate the ability to perform posterior cervical decompressive laminectomy with and without arthrodesis.
7. Demonstrate the ability to perform posterior cervical foraminotomy with or without discectomy.
8. Demonstrate the ability to perform medial and lateral approaches to a far lateral lumbar disc herniation.
9. Demonstrate appropriate surgical technique in the management of recurrent lumbar disc herniations and recurrent lumbar stenosis, using open and minimally invasive techniques.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

10. Demonstrate the ability to perform posterior lumbar arthrodesis with or without the use of interbody instrumentation.
11. Demonstrate exposure of the cervical lateral masses, thoracic and lumbar transverse processes, and the sacral ala.
12. Demonstrate the ability to perform posterior/intertransverse arthrodesis in the cervical, thoracic and lumbar regions.
13. Demonstrate the ability to perform posterior interbody arthrodesis in the lumbar spine.
14. Demonstrate the ability to perform a laminectomy with or without transpedicular decompression for tumor, infection, or trauma.
15. Demonstrate the proper placement of open transpedicular screws in the thoracic and lumbar spine.
16. Demonstrate techniques for percutaneous pedicle screw fixation in the thoracic and lumbar spine.
17. Demonstrate the ability to manage postoperative complications of spinal surgery including:
  - a. hematoma
  - b. infection
  - c. spinal fluid leak
  - d. new neurologic deficit
18. Demonstrate the ability to perform a tethered cord release and chiari decompression.
19. Demonstrate the ability to perform methylmethacrylate vertebroplasty and kyphoplasty

**Senior Level:**

1. Demonstrate the ability to function independently in all phases of management of patients with spinal disorders.
2. Demonstrate the ability to perform occipital-cervical arthrodesis.
3. Demonstrate the ability to perform sacroiliac arthrodesis.
4. Demonstrate the ability to properly place sublaminar wires, lateral mass screws, lower cervical/upper thoracic pedicle screws, C2 pars interarticularis / pedicle screws, C1 lateral mass screws, odontoid screws, and C1-2 transarticular screws for the management of cervical spine disorders.
5. Demonstrate the ability to perform, with assistance if necessary, transoral odontoidectomy.
6. Demonstrate common techniques for performing C1-2 arthrodesis.
7. Demonstrate the ability to perform, with assistance if necessary, transthoracic, thoracoabdominal, retroperitoneal, and transabdominal approaches to the thoracic and lumbar spine.
8. Demonstrate the ability to perform, with assistance, thoracoscopic approaches to the spine for sympathectomy, discectomy, corpectomy, and instrumentation.



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

9. Demonstrate the ability to perform costotransverse and lateral extracavitary approaches to the thoracolumbar spine.
10. Demonstrate the ability to excise a herniated thoracic disc by use of the above-mentioned approaches.
11. Demonstrate the perform multilevel minimally invasive fusion and fixation techniques.
12. Demonstrate the ability to perform vertebral corpectomy of the thoracolumbar spine for tumor, infection, or trauma, utilizing the above-mentioned approaches.
13. Demonstrate the ability to perform anterior arthrodesis and reconstruction of the thoracolumbar spine, both using open and minimally invasive techniques
14. Demonstrate the ability to resect intradural spinal neoplasms.
15. Demonstrate techniques of open reduction of fractures and dislocations of the cervical, thoracic, and lumbar spine.
16. Demonstrate the ability to surgically manage arachnoid cysts and spinal cord syrinx.
17. Demonstrate the ability to perform intradural procedures for congenital, neoplastic, and vascular lesions.

## **STEREOTACTIC AND FUNCTIONAL NEUROSURGERY**

### **UNIT OBJECTIVES**

Define neurosurgical stereotactic procedures and recognize their proper application. Describe the appropriate anatomy, physiology, and presentation of patients that are candidates for stereotactic procedures.

### **COMPETENCY-BASED KNOWLEDGE OBJECTIVES:**

#### ***Junior Level:***

1. Discuss the considerations of stereotactic frame placement **and frameless stereotactic fiducial placement** in regard to target localization and purpose of procedure (biopsy, craniotomy, functional, radiosurgery).
2. Describe the direct and indirect basal ganglion-thalamocortical motor pathways.
3. Define and distinguish each of the following entities:
  - a. tremor
  - b. rigidity
  - c. dystonia
  - d. chorea
  - e. athetosis



**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

4. Describe the pathophysiology of Parkinson's disease and cerebellar tremor.
5. Explain the primary symptoms treated by deep brain stimulation and lesions of thalamus, globus pallidus and subthalamic nucleus, for disorders including Parkinson's disease, essential tremor and dystonia.
6. Discuss the advantages and disadvantages of stereotactic **frame-based and frameless** biopsy compared to open biopsy procedures.
7. Discuss the differential diagnosis of a newly discovered ring-enhancing intracranial mass.
8. Discuss the differential diagnosis of a newly discovered non-enhancing intracranial mass.
9. Define different seizure types (partial, partial-complex, generalized, etc).
10. Define medically intractable epilepsy.
11. Describe the anatomy of the mesial temporal lobe.
12. Define brachytherapy.
13. Describe the anatomy of the trigeminal nuclei, root, ganglion and divisions.
14. Define typical trigeminal neuralgia, atypical trigeminal neuralgia, and trigeminal neuropathy.
15. Explain the potential causes for trigeminal neuralgia.
16. Define stereotactic radiosurgery.
17. Explain the differences between **stereotactic** radiosurgery and radiation therapy.
18. List the potential indications for radiosurgery.
19. List the reported complications of radiosurgery.
20. Compare advantages and disadvantages of frame-based or frameless stereotactic craniotomies to non-stereotactic craniotomies.

*Middle Level:*

1. Describe factors guiding the choice of neuroimaging (CT, MRI, angiography) for stereotactic **localization**.
2. Explain the rationale for various MRI sequences used for tumor localization and functional procedures, **in terms of visualization and accuracy**.
3. Discuss the benefits and limitations of frame-based stereotactic procedures.
4. Discuss patient selection for thalamic, pallidal and subthalamic stimulation and lesion procedures.
5. Discuss the advantages and disadvantages of ablative procedures versus deep brain stimulation techniques.
6. List the potential complications of VL thalamotomy, pallidotomy, and bilateral thalamotomies or pallidotomies.





**RESIDENT CURRICULUM  
DIVISION OF NEUROSURGERY  
DUKE UNIVERSITY MEDICAL CENTER**

1. Place stereotactic frame, obtain coordinates and set up room for stereotactic biopsy procedures.

***Middle Level:***

1. *Be able to perform stereotactic biopsy for tumor or other lesions.*
2. *Perform simple radiosurgery dose-planning.*
3. **Set up stereotactic frame and planning for functional neurosurgery procedures.**

***Senior Level:***

1. Perform complex radiosurgery dose-planning.  
Perform stereotactic craniotomies.