Penn State Hershey Medical Center Neurosurgery Residency Core Curriculum
CORE COMPETENCIES

The Penn State Neurosurgery residency program requires its residents to obtain competencies in the 6 areas below to the level expected of a new neurosurgical practitioner. We will define the specific knowledge, skills, and attitudes required and provide educational experiences as needed in order for our residents to demonstrate:

**Patient Care** that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health

**Medical Knowledge** about established and evolving biomedical, clinical, and cognate (e.g. epidemiological and social-behavioral) sciences and the application of this knowledge to patient care

**Practice-Based Learning and Improvement** that involves investigation and evaluation of their own patient care, appraisal and assimilation of scientific evidence, and improvements in patient care

**Interpersonal and Communication Skills** that result in effective information exchange and teaming with patients, their families, and other health professionals

**Professionalism**, as manifested through a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population

**Systems-Based Practice**, as manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value

PATIENT CARE AND MEDICAL KNOWLEDGE

PGY1 – NS4 OFF SERVICE ROTATIONS

NEUROLOGY

UNIT OBJECTIVES

Residents are expected to develop an increasing understanding of neurology over the course of their residency. This will occur during clinical rotations with didactic and practical teaching from the neurosurgery and neurology faculty. Neurosurgery residents must take at least a three month Neurology rotation. A minimum of three months of training in neurology is a requirement of the American Board of Neurological Surgery for board certification. This training is usually done during the PGY1 year but clinical neurology is also one of the options for the three month off service elective time in the NS4 year of residency training. Graduating neurosurgery residents are
expected to demonstrate an understanding of the neurological examination, diagnostic neurological testing, neurological diseases and their treatment as outlined below.

A. Competency-Based Knowledge Objectives:
1. Discuss electroencephalography (EEG). 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. Define delirium and dementia. List the differential diagnoses for each.
11. Define and discuss coma and altered states of consciousness.
12. Describe the evaluation of a patient with syncope.
13. Describe the etiology and pathogenesis of cerebrovascular disease.
14. 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
15. Identify the primary causes of stroke in the pediatric population.
16. Comprehensively discuss the etiology, clinical presentation, diagnostic evaluation, and management of cerebral vasculitis.
17. Differentiate between basal occlusive disease with and without telangiectasia. Review the prognosis and treatment options for each.
18. Describe the acute and chronic effects of ionizing radiation on the central nervous system.
19. Review the diagnosis and management of pseudotumor cerebri.
20. Discuss the diagnosis and management of normal pressure hydrocephalus.
21. Discuss the management of hyperosmolar hyperglycemic nonketotic diabetic coma.
22. Review the neurological manifestations of altitude sickness.
23. List the neurological manifestations of decompression sickness.
25. Review the general topic of chromosomal abnormalities as they may relate to the central nervous system including etiology, inheritance patterns, penetrance, and laboratory diagnosis.
26. List the major syndromes characterized by obesity and hypogonadism, including Prader-Willi syndrome.
27. Discuss agenesis of the corpus callosum.
28. Discuss anencephaly, microencephaly, and megalencephaly.
29. List the major disorders of amino acid and purine metabolism. Discuss the neurological manifestations of each.
30. Review each of the major storage diseases including:
   a. GM1-Gangliosidoses
   b. GM2-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
31. Review each of the major leukodystrophies including:
   a. Krabbe leukodystrophy
   b. Metachromatic leukodystrophy
   c. X-linked leukodystrophies with and without adrenal involvement.
32. Review each of the major mucopolysaccharidoses including:
   a. Hurler syndrome (MPS IH)
   b. Hunter syndrome (MPS II)
   c. Sanfilippo syndrome (MPS III)
   d. Morquio syndrome (WS IV)
   e. Maroteaux-Lamy syndrome (MPS VI)
33. Review the disorders of carbohydrate metabolism including:
   a. Glycogen storage diseases
   b. Lafora disease and other polyglucosan storage diseases
34. Discuss hyperammonemia as it relates to neurological dysfunction.
35. Discuss adrenoleukodystrophy as it relates to neurological dysfunction including Reye's syndrome.
36. Review the major syndromes of dysfunctional copper metabolism including:
   a. Hepatolenticular degeneration (Wilson disease)
   b. Trichopoliodystrophy (Menkes' syndrome)
37. 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.).

38. Review the pathogenesis, clinical presentation, diagnosis, and treatment of abetalipoproteinemia.

39. List the neurological disorders associated with xeroderma pigmentosum.

40. 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

41. Review in detail the major neurocutaneous disorders including:
   a. neurofibromatosis, Type 1 and Type 2
   b. encephalotrigeminal angiomatosis
   c. incontinentia pigmenti
   d. tuberous sclerosis

42. Discuss Leber Hereditary Optic Atrophy.

43. Review the salient features of progressive external ophthalmoplegia.

44. Define peripheral neuropathy, polyneuropathy, mononeuropathy, mononeuropathy multiplex, and neuritis.

45. Review the major inherited neuropathies including:
   a. peroneal muscle atrophy
   b. Dejerine-Sottas disease
   c. Refsum disease
   d. hereditary sensory neuropathy
   e. porphyric neuropathy

46. Discuss the etiology, clinical presentation, diagnosis, treatment, and prognosis of Guillain-Barre syndrome.

47. 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
   i. diabetic neuropathy
   j. hypothyroid neuropathy
   k. acromegalic neuropathy
1. 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

48. Discuss the major hereditary ataxias including:
   a. Friedreich ataxia
   b. Levy-Roussy syndrome
c. hereditary cerebellar ataxia

49. Review the major non-inherited forms of cerebellar ataxia including
   a. acute cerebellar ataxia in children
   b. ataxia telangiectasia
c. Marinesco-Sjogren syndrome
d. Ramsay-Hunt syndrome
e. Joseph disease

50. Discuss the pathophysiology, clinical presentation, treatment, and prognosis of Alzheimer's disease, Pick disease, and diffuse Lewy body disease.

51. Define hemichorea and hemiballismus.

52. Review the pathophysiology, clinical presentation, treatment, and prognosis of Sydenham chorea, Huntington's disease, and senile chorea.

53. Define myoclonus.

54. Review Tourette's syndrome.

55. Review the major general and focal dystonic conditions.

56. Define benign essential tremor.

57. Discuss the pathophysiology, clinical presentation, diagnosis, treatments and prognosis of Parkinsonism in detail.

58. Define progressive supranuclear palsy.

59. Review the pathophysiology, clinical presentation, diagnosis, and treatment of tardive dyskinesia.

60. Discuss hereditary spastic paraplegia.
61. List the major generalized and focal forms of spinal muscular atrophy including:
   a. Wernig-Hoffmann disease
   b. Kugelberg-Welander syndrome
   c. benign focal amyotrophy

62. Describe the pathophysiology and neurological manifestations of poliomyelitis.

63. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of amyotrophic lateral sclerosis.

64. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of subacute combined degeneration of the spinal cord.

65. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of juvenile and adult myasthenia gravis.

66. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of botulism.

67. Review the common muscular dystrophies including:
   a. Duchenne muscular dystrophy
   b. fascioscapulohumeral muscular dystrophy
   c. myotonic muscular dystrophy
   d. myotonia congenita
   e. congenital muscular dystrophy

68. Review the major periodic paralysis syndromes including:
   a. familial periodic paralysis
   b. hypokalemic periodic paralysis
   c. hyperkalemic periodic paralysis
   d. paramyotonia congenita

69. Discuss polymyositis.

70. Review the epidemiology, pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of multiple sclerosis.

71. Define Marchiafava-Bignami disease.

72. Review central pontine myelinolysis in detail.

73. Discuss multiple system atrophy.

74. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of migraine headaches.

75. Discuss the diagnosis and management of non-migrainous headache syndromes.

76. Review the pathophysiology, clinical presentation, diagnosis, treatment, and prognosis of the common epileptic disorders in detail.

77. Define status epilepticus and discuss the medical treatment of same.

78. Describe the neurological implications of the common collagen-vascular diseases.

79. Describe the neurological implications of alcoholism.

80. Discuss the neurological aspects of pregnancy.

81. Review malignant hyperthermia.
NEUROANATOMY

UNIT OBJECTIVE

Residents are expected to develop an increasing understanding of the anatomy pertinent to neurosurgical practice over the course of their residency. This will occur during clinical rotations with didactic and practical teaching from the neurosurgical faculty. A three month off service rotation in Neuroanatomy is also offered in the NS1 year. Graduating residents will be expected to demonstrate knowledge of anatomy that is pertinent to the diagnosis of diseases of the nervous system and the practice of neurological surgery as outlined below.

A. Competency-Based Knowledge Objectives:
   General:
   1. Review the embryological development of the brain, cerebellum, brain stem, glial elements, spinal cord, conus medullaris, cauda equina, sympathetic and parasympathetic systems and the peripheral nervous system.
   2. Review the embryologic development of the skull, craniovertebral junction, and spine.
   3. Describe and differentiate types of neurons.
   4. Discuss the microanatomy of the neuron including the:
      a. cell body
      b. dendritic process
      c. axonal process
   5. Diagram and describe the microanatomy of the synapse.
   6. List the microglial elements and review their microanatomy:
      a. astrocytes
      b. oligodendrocytes
      c. microglia
      d. ependyma
      e. choroid epithelium
   7. Diagram and describe in detail the carotid and vertebral arteries and their branches which provide blood supply to the face, scalp, skull, meninges, brain, brain stem, cerebellum, and rostral spinal cord.
   8. Discuss the arterial blood supply to the spinal cord. Include in the discussion the spinal and radicular arteries.
   9. Identify and review the venous drainage of the central nervous system.
   10. List and identify the bones of the skull.
   11. Describe the sutures of the skull.
   12. Identify the foramen of the skull and their contents.
   13. Describe the anatomy of the meninges including the:
      a. dura mater
      b. arachnoid mater
      c. pia mater
   14. Describe the anatomy of the dura including the falx cerebri and tentorium.
   15. Review the layers of the scalp and discuss its innervation.
   16. Diagram the cerebral ventricles.
17. Discuss the major arachnoid cisterns.

18. Review the anatomy of the arachnoid villi.

19. Discuss the anatomic correlates pertinent to the production, flow, and reabsorption of cerebrospinal fluid.

20. Identify and describe the gross anatomy of the spine including:
   a. atlas
   b. axis
   c. subaxial cervical vertebrae
   d. thoracic vertebrae
   e. lumbar vertebrae
   f. sacrum
   g. coccyx
   h. intervertebral disc complex
   i. supporting ligaments of the spine

21. List the muscles related to the skull and spine.

22. Describe the gross anatomy of the neck.

23. Discuss the anatomical basis for the blood-brain barrier in detail.

24. Discuss the clinical presentation in anatomical terms of syndromes of the brain and its coverings including:
   a. epidural hematoma
   b. acute subdural hematoma
   c. chronic subdural hematoma
   d. subgaleal hematoma
   e. injury to innervation of the scalp

25. Discuss the syndromes produced by 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

26. List the expected effects of destructive lesions in the basal ganglia and cerebellum.

27. Discuss the relationship of the spinal nerves to the vertebral level of exit.

28. Diagram the structures comprising the boundaries of the spinal neural foramina.

29. Describe the anatomy of common entrapment syndromes of 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

Central Nervous System
1. Describe the gross anatomy of the brain, brain stem, cerebellum, cranial nerves, and spinal cord.

2. Describe the anatomy of the cerebral cortex including:
   a. cortical layers
   b. sensory areas
   c. motor areas
   d. prefrontal cortex
   e. fiber tracts
   f. calcarine cortex

3. Describe the anatomy of the olfactory pathways, hippocampal formation and amygdala including:
   a. rhinencephalon
   b. olfactory pathways
   c. anterior commissure
   d. hippocampal formation (including cytoarchitecture)
   e. amygdala
   f. limbic system

4. Describe the anatomy of the corpus striatum 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

5. Describe the anatomy of the hypothalamus and pituitary including:
   a. cytoarchitecture of the hypothalamus
   b. afferent and efferent connections of the hypothalamus
   c. supraoptic nuclei and tracts
   d. hypophysial portal system
   e. anatomy of the pituitary stalk
   f. anterior and posterior pituitary
   g. cellular organization of the anterior pituitary
   h. hormonally active cells of the hypothalamus and pituitary

6. Describe the anatomy of the diencephalon including:
   a. midbrain-diencephalon junction
   b. caudal diencephalon
   c. epithalamus
   d. thalamus (including nuclei)
   e. thalamic radiations
   f. internal capsule
   g. visual pathways

7. Describe the anatomy of the cerebellum including:
   a. cerebellar cortex including organization
   b. deep cerebellar nuclei
   c. cerebellar connections
d. cerebellar peduncles

8. Describe the anatomy of the mesencephalon 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

9. Describe the anatomy of the pons including:
   a. vestibulocochlear nerve
   b. facial nerve
   c. abducens nerve
   d. trigeminal nerve
   e. ascending and descending tracts

10. Describe the anatomy of the medulla including:
    a. olivary nucleus
    b. medullary reticular formation
    c. cranial nerves of the medulla
    d. ascending and descending tracts

11. Review the location and connections of each cranial nerve nuclei. Trace the course of each cranial nerve from nucleus to end organ termination.

12. Describe the external topography and landmarks of the fourth ventricle.

13. Describe the anatomy of the spinal cord including:
    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
    h. somatotopic organization

**Autonomic Nervous System**

1. Distinguish pre- and postganglionic neurons.
2. Describe the sympathetic nervous system.
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.

**Peripheral Nervous System**
1. Differentiate between segmental and peripheral innervation.
2. Diagram the anatomy of the spinal nerve root.
3. Diagram and discuss the cervical, brachial, and lumbosacral plexi.

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 microanatomy of peripheral nerves.
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.

**Muscle**

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.

**B. Competency-Based Performance Objectives:**

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
bb. cerebellar tonsils
cc. brachium cerebelli
dd. vermis
ee. major supratentorial gyri
ff. supratentorial lobes
gg. sylvian fissure
hh. central sulcus

2. Identify at the time of surgery structures visible in the lateral ventricles including:
   a. Foramen of Monro
   b. fornix
c. caudate
d. thalamus
e. choroidal fissure
f. named veins
g. glomus of the choroid plexus
h. hippocampus

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. ligamentous structures of the spinal column including:
      i. intraspinous ligament
      ii. ligament
      iii. post-longitudinal ligament annulus
      iv. anterior longitudinal ligament
NEURORADIOLOGY

UNIT OBJECTIVES

Residents are expected to develop an increasing understanding of the radiology pertinent to neurosurgical practice over the course of their residency. This will occur during clinical rotations with didactic and practical teaching from the neurosurgical and neuroradiology faculty. A three month off service rotation in Neuroradiology is also offered in the NS2 year. Graduating residents will be expected to demonstrate knowledge of radiology that is pertinent to the diagnosis of diseases of the nervous system and the practice of neurological surgery as outlined below.

A. Competency-Based Knowledge Objectives:
1. Describe precautions to be taken when performing radiation examinations.
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. fractures: linear, elevated, depressed, diastatic, ping pong
   b. pneumocephalus
   c. 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
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
      vi. intraparenchymal
      v. intraventricular
   d. cerebral contusions
   e. subarachnoid hemorrhage
   f. foreign bodies

13. Recognize common pathologic conditions which may be detected by head CT including:
   a. ischemic infarction
   b. venous infarction
   c. hydrocephalus
   d. cysts
   e. tumors
   f. cerebral edema
   g. infections
   h. congenital abnormalities
   i. infections

14. Recognize common traumatic injuries which may be detected by head MR scans including:
   a. pneumocephalus
   b. intracranial hematomas
      i. epidural
      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

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
   b. atlanto-occipital dislocation
c. Jefferson fractures
d. posterior atlas fractures
e. dens fractures
f. axis body fractures
g. hangman's fracture
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  
i. ossification of the posterior longitudinal ligament  

28. Identify spinal and spinal cord tumors on CT and MR scans.  
29. Discuss the indications for spinal myelography.  
30. Review the indications for spinal angiography.  
31. Discuss the use of both the radiographic contrast and radionuclide shuntogram in evaluating neurosurgical patients.  
32. Identify the common carotid and vertebral circulation congenital variants on angiograms.  
33. Recognize intracranial aneurysms on angiograms.  
34. 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  
35. Discuss the angiographic evaluation of carotid and vertebral disease.  
36. Review the role of MR angiography and venography in the evaluation of cerebrovascular disease, neoplasms, and trauma.  
37. Describe the radiological evaluation of CNS vasculitis.  
38. Describe the radiological evaluation of spinal vascular malformations.  
39. Discuss the role of myelography in the evaluation of neurosurgical patients.  
40. Discuss the radiological evaluation of suspected CNS and spinal infection.  
41. Review MR neurography.  
42. Describe the appearance of peripheral nerve tumors on MR scans.  
43. Review the role of radionuclide scans in the evaluation of patients with suspected cranial and spinal disease.  
44. Discuss the use of intraoperative radiographs and fluoroscopy.  
45. List the indications for CT- and MR-guided biopsies.  
46. Describe the concepts of ultrasonography.  
47. Review the findings of normal and abnormal neonatal cranial ultrasound.  
48. Review the findings of normal and abnormal carotid ultrasounds.  
49. Discuss the use of transcranial doppler ultrasonography in the management of patients with subarachnoid hemorrhage, trauma, and occlusive vascular disease.  
50. 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

51. Describe the indications and techniques of endovascular trial occlusions.
52. Review the role of quantitative cerebral blood flow studies in the management of neurosurgical patients.
53. Describe the concepts of positron emission tomography. Review the indications for obtaining such scans.
54. Describe the concepts of functional MR imaging. Review the indications for obtaining such scans.
55. Describe the concepts of MR spectroscopy. Review the indications for obtaining such evaluations in neurosurgical patients.
56. Discuss the indications and technique of discography. Describe the procedure.
57. Discuss the indications for percutaneous vertebroplasty. Describe the procedure.

B. Competency-Based Performance Objectives:
1. Order appropriate radiological evaluations in a timely fashion.
2. Demonstrate the ability to accurately interpret the radiographic studies of trauma patients.
3. Demonstrate the ability to accurately interpret carotid and vertebral angiograms.
4. Demonstrate the ability to accurately interpret spinal angiograms.
5. Demonstrate the ability to accurately interpret spinal myelograms and post-myelogram CT scans.
6. Demonstrate the ability to accurately interpret cranial and spinal CT and MR scans of nontraumatic lesions.
7. Demonstrate the ability to accurately interpret radiological examinations of neurosurgical patients.
8. Demonstrate the ability to use intraoperative ultrasonography.

NEUROPATHOLOGY

UNIT OBJECTIVES

Residents are expected to develop an increasing understanding of the pathology pertinent to neurosurgical practice over the course of their residency. This will occur during clinical rotations with didactic and practical teaching from the neurosurgical and neuropathology faculty. A three month off service rotation in Neuropathology is also offered in the NS3 year. Graduating residents will be expected to demonstrate knowledge of pathology that is pertinent to the diagnosis of diseases of the nervous system and the practice of neurological surgery as outlined below.
A. **Competency-Based Knowledge Objectives:**

**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 and, when applicable, the genetic basis of the following congenital and perinatal disorders:
   a. encephaloceles and cranial meningoceles
   b. myelomeningoceles and meningoceles
   c. hydromyelia
   d. diastematomyelia 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
   1. subependymal germinal matrix hemorrhages
   m. posthemorrhagic hydrocephalus
   n. periventricular leukomalacia (white matter infarcts)

2. Describe the gross and histopathological features 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 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
   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 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, when applicable, the metabolic basis for the following intoxications and deficiency states:
   a. hypoxic-anoxic encephalopathy
   b. carbon monoxide intoxication
c. ethanol intoxication
d. alcoholic cerebellar degeneration
e. central pontine myelinolysis
f. CNS complications of antimicrobial therapy
g. CNS complications of antineoplastic therapy
h. CNS complications of "street drugs"
i. Wernicke's encephalopathy and thiamine deficiency
j. Subacute combined degeneration and B12 deficiency

6. Describe the gross and histopathological features 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 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, 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
i. amyotrophic lateral sclerosis
j. paraneoplastic degenerative diseases

9. Describe the gross and histopathological features 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, when applicable, the grading criteria 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
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 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, when applicable, the genetic and biochemical basis for the following disorders of peripheral nerves:
   a. compressive and traumatic neuropathies
   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 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 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 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)
1. Describe the gross and histopathological features 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 of the following disorders of the spine and intervertebral discs:  
a. herniated inter-vertebral 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 of the following ocular lesions:  
a. retinoblastomas  
b. ocular melanomas

2. Describe the gross and histopathological features of the following orbital lesions:  
a. optic nerve gliomas  
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.
NEUROPHARMACOLOGY

UNIT OBJECTIVES

Residents are expected to develop an increasing understanding of the pharmacology pertinent to neurosurgical practice over the course of their residency. This will occur during clinical rotations with didactic and practical teaching from the neurosurgical faculty. A three month off service elective rotation is also offered in the NS4 year. Neuropharmacology is an option for this elective time. Graduating residents will be expected to demonstrate knowledge of pharmacology that is pertinent to the diagnosis of diseases of the nervous system and the practice of neurological surgery as outlined below.

A. Competency-Based Knowledge Objectives:

1. Review basic cellular neurotransmission. In the course of this review discuss:
   a. the synapse
   b. membrane potentials
   c. ion pumps
   d. ion channels
   e. transmitter secretion
   f. transmitter identification

2. Define and discuss receptors and receptor pharmacodynamics including:
   a. receptor classification
   b. receptor identification
   c. dose response curves
   d. agonists and antagonists
   e. receptor modulation

3. Discuss the neurotransmitter acetylcholine in detail. Include within the context of the discussion:
   a. cholinergic receptor classification
   b. functional aspects of cholinergic receptors
   c. synthesis, storage, and release of acetylcholine

4. Discuss the catecholamine neurotransmitters (norepinephrine and dopamine) in detail. Include within the context of the discussion:
   a. biosynthesis of catecholamines
   b. storage and release of catecholamines
   c. anatomy of catecholamine receptors
   d. and adrenergic receptors
   e. dopaminergic receptors

5. Discuss the neurotransmitter serotonin in detail. Include within the context of the discussion:
   a. anatomy of serotonin receptors
b. biosynthesis, storage and release of serotonin
c. sub-types of serotonin receptors

6. Discuss the neurotransmitter glutamate in detail. Include within the context of the discussion:
   a. biosynthesis, storage and release of glutamate
   b. inotropic glutamate receptors
   c. NMDA receptors and subunits
   d. non-NMDA receptors and subunits
   e. metabotropic glutamate receptors
      i. Group I metabotropic receptors and subunits
      ii. Group II metabotropic receptors and subunits
      iii. Group III metabotropic receptors and subunits
   f. role in neurological disorders

7. Discuss the neurotransmitters GABA and glycine in detail. Include within the context of the discussion:
   a. synthesis, uptake, and release
   b. physiology and pharmacology
   c. clinically relevant agonists and antagonists of GABA and glycine receptors

8. Discuss the peptide neurotransmitters.

9. Describe pharmacology of each of the drugs used to treat neurological disorders.

NEUROPHYSIOLOGY

UNIT OBJECTIVES

Residents are expected to develop an increasing understanding of the physiology pertinent to neurosurgical practice over the course of their residency. This will occur during clinical rotations with didactic and practical teaching from the neurosurgical faculty. A three month off service elective rotation is also offered in the NS4 year. Clinical Neurophysiology is one option for this elective time. Graduating residents will be expected to demonstrate knowledge of physiology that is pertinent to the diagnosis of diseases of the nervous system and the practice of neurological surgery as outlined below.

A. Competency-Based Knowledge Objectives:

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:
1. 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
      i. processing of information in the retina
      ii. processing of vision in the central visual pathways
      iii. columnar units of visual cortex
      iv. processing in the geniculate nucleus
      v. 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

2. 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
      i. regional and cellular organization of the cerebellum
      ii. functional divisions of the cerebellum
      iii. the role of the cerebellum in planning movement
      iv. basal ganglia
      v. the anatomy of basal ganglia pathways
      vi. neural transmitters in the circuits within the basal ganglia
   j. thalamus

5. Describe the attributes of the autonomic nervous system including both the sympathetic and parasympathetic systems.

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
   c. sleeping and sleep states
   d. reticular activating system
7. Describe the higher cortical functions including:
   a. anatomy of language
   b. function of association cortex

8. Describe the physiological basis for cerebrospinal fluid production and reabsorption.

9. Review the physiological control of the cerebral vasculature.

10. Discuss, in detail, the physiology of the hypothalamus and pituitary, particularly as related to endocrinology

PATIENT CARE AND MEDICAL KNOWLEDGE

NS1 – NS3 CLINICAL ROTATIONS

Neurosurgery residents are expected to develop an increasing understanding of the subspecialties of neurosurgical practice over the course of their residency. This will occur during clinical rotations on the various subspecialty services and via didactic and experiential teaching from the neurosurgical faculty. Each of the first four years of the neurosurgery residency the resident will spend three months on the Red Service (emphasis on cerebrovascular, endovascular and tumor surgery), three months on the Blue Service (emphasis on spine, peripheral nerve and stereotactic and functional neurosurgery) and three months on the pediatric neurosurgery service. Neurotrauma, critical care and pain management are part of each of these clinical rotations. A three month off service rotation also occurs each year. As residents progress through the program they will be expected to demonstrate knowledge and skills pertinent to the neurosurgical subspecialties as outlined below.

1. Cerebrovascular Surgery

A. Competency-Based Knowledge Objectives:
   1. Describe the location of key perforating arteries involving the anterior and posterior circulation, their target distribution, and the consequence of occlusion or injury.
   2. Identify the classic syndromes of vessel occlusion of the
      a. including internal carotid artery
      b. middle cerebral artery
      c. anterior cerebral artery
      d. recurrent artery of Heubner
      e. anterior choroidal artery
      f. vertebral artery
      g. posterior inferior cerebellar artery (PICA)
      h. lower and upper basilar trunk
   3. Identify the classic brainstem ischemic syndromes.
   4. Explain the concepts of cerebral blood flow, cerebral autoregulation (hemodynamic and metabolic), ischemic thresholds, intracranial pressure,
cerebral perfusion pressure. Describe the impact of intracranial hypertension with and without mass lesion on cerebral blood flow.

5. Recognize the common causes of brain ischemic states including:
   a. cardiac embolism
   b. embolism from proximal vasculature
   c. large vessel occlusion
   d. intracranial conducting vessel occlusion
   e. small vessel disease

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

7. Describe the epidemiology, physiology, and underlying pathophysiology of ischemic brain injury, including concepts of critical therapeutic window.

8. Recognize the common causes of intracranial and intraspinal hemorrhage including:
   a. aneurysmal disease
   b. vascular malformations
   c. hypertension
   d. vasculopathies
   e. degenerative diseases
   f. hemorrhagic arterial infarction
   g. venous infarction.

9. Categorize common causes of intracranial hemorrhage, subarachnoid hemorrhage, and ischemic stroke.

10. 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.

11. Recognize the typical clinical course of patients with ischemic and hemorrhagic stroke, including peak risk intervals for edema, vasospasm, re-bleeding, etc.

12. 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.

13. Explain the principles of augmentation of cerebral blood flow during cerebral vasospasm.

14. Describe the practical application of commonly employed non-invasive studies, such as transcranial Doppler, in the setting of cerebral vasospasm should be developed.

15. List the indications for catheter angiography. Interpret the findings of angiography in ischemic and hemorrhagic cerebrovascular conditions. Identify the key segments of the internal carotid artery including the upper cervical, petrous, cavernous, and supraclinoid components.

16. Recite the principles of localizing focal intracranial, and spinal vascular pathology by the use of traditional topographic measurements and the application of stereotactic guidance.
17. Describe the surgical anatomy and the principles of exposure of the cervical carotid artery.
18. Describe the principles of pterional craniotomy, including scalp and bony anatomy, as well as the anatomy of the sphenoid ridge.
19. Explain the principles of cerebrovascular surgery detailed in the previous objectives to medical students and allied health personnel during conferences.

B. Competency-Based Performance Objectives:
1. Adapt comprehensive evaluation to specific pertinent positives and negatives with regard to ischemic and hemorrhagic stroke.
2. Demonstrate an understanding of urgency and the ability to prioritize during emergent aspects of hemorrhagic and ischemic disease states.
3. Demonstrate the ability to manage cardiac and pulmonary complications following cerebrovascular illness and therapy, and review the need for specialty and subspecialty consultations.
4. Apply the principles of perioperative care following common endovascular and surgical procedures directed at cerebrovascular disease.
5. Demonstrate the ability to be vigilant in the clinical detection of subtle neurological change during the acute and subacute phases of illness.
6. Define the proper placement of a craniotomy flap in the planned surgical evacuation of hematoma. This should be performed using both topographical as well as stereotactic-assisted navigation techniques.
8. Assist during pterional craniotomy for vascular disease.

2. Neuro-Oncology

A. Competency-Based Knowledge Objectives:
1. List a differential diagnoses of lesions requiring biopsy and describe their pathophysiology.
2. List the various types of bone tumors involving the calvarium.
3. Describe and differentiate:
   a. astrocytomas, including the accepted World Health Organization grading scheme.
   b. gliomas other than astrocytomas.
   c. metastatic tumors, including location and common origins.
   d. infectious, granulomatous, and cystic lesions that may present in a tumor-like manner.
4. Define the cell or origin of meningioma, its common intracranial locations, and the expected presentation for each location.
5. Define the embryological origin of arachnoid cysts and their natural history; list the etiologies of other cystic lesions of the brain, including tumoral and infectious.

6. Describe the anatomic location, cell of origin, clinical presentation, age at presentation, and natural history of common intrinsic posterior fossa neoplasms, including cerebellar astrocytoma, medulloblastoma, and ependymoma.

7. Describe the various tumors that may arise in the cerebelao-pontine angle (CPA).

8. Describe the management of a patient with a brain abscess, including the role of stereotactic drainage or open drainage.

9. Explain the medical work up of a patient with a diagnosed brain abscess.

10. Specify the follow up and evaluation of the patient with a brain abscess following surgical treatment.

11. Describe the embryological origin of craniopharyngioma. List the common locations of the tumor.

12. Describe the common presentations of pituitary tumors, the cell of origin, and endocrinopathies associated with:
   a. null cell adenomas
   b. somatotrophic adenomas
   c. prolactinomas
   d. corticotrophic secreting adenomas
   e. thyrotrophic-secreting adenoma
   Define the medical management of the secreting pituitary tumors. Explain the role of surgery in each of the tumors above.

13. Describe the etiology of fibrous dysplasia, its presentation and general management. List the indications for surgery for benign tumors of bone at the base of the skull, and potential adjuvant therapy.

14. List the tumors that may be routinely approached through a transtemporal route.

15. Describe the indications for use of lumbar spinal drainage in skull base surgery, and its implementation. List all complications associated with continuous lumbar spinal drainage.

16. Illustrate the general principles of stereotaxis and the underlying localization techniques used in the presently used frame-based and frameless systems.

B. Competency-Based Performance Objectives:
1. Understand the positioning of patients for craniotomy and craniectomy.
2. Assist in the opening and closing of craniotomies and craniectomies for neoplasms.
3. Place lumbar drains.
4. Demonstrate the ability to open and close scalp incisions.
5. Perform ventriculostomies.

3. Pain
A. **Competency-Based Knowledge Objectives:**
1. Differentiate the basic categories of pain syndromes:
   a. acute
   b. chronic
   c. nociceptive
   d. neuropathic (including complex regional pain syndromes)
   e. myofascial
   f. cancer-related
   g. post-operative
2. Explain the concept of pain as a biopsychosocial disorder.
3. Discuss the role of rehabilitation in pain management.
5. Discuss methods of assessing outcomes of pain treatment and describe common assessment tools.
6. Describe a typical history and medical management of a patient with trigeminal neuralgia, trigeminal neuropathic pain, and atypical facial pain.
7. Discuss the potential complications of percutaneous procedures for trigeminal neuralgia.
8. Identify the primary indications for spinal cord stimulation, peripheral nerve, stimulation, and intraspinal (epidural, intrathecal) drug infusion therapy.
10. 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.
11. Describe the pharmacology of local anesthetic agents (e.g., lidocaine, procaine, tetracaine, bupivacaine) and the use of epinephrine with local anesthetic agents.
12. 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.
13. Review the indications for radiofrequency facet rhizolysis.
14. Discuss the anatomy and biomechanics of the facet complex with emphasis on bone, cartilage, fibrous capsule, synovial fluid, and innervation of this structure.

B. **Competency-Based Performance Objectives:**
1. Formulate and implement treatment plans for simple pain syndromes (e.g., acute post-operative pain, acute low back pain).
2. Evaluate and diagnose a patient with trigeminal neuralgia, trigeminal neuropathic pain, and atypical facial pain.
3. Assist with radiofrequency, glycerol or balloon compression neurolysis of the trigeminal nerve in patients with trigeminal neuralgia.
4. Assist with surgical exploration of the trigeminal nerve, nervus intermedius, or glossopharyngeal nerve for MVD or rhizotomy.
5. Illustrate appropriate patient selection for spinal ablative or augmentative procedures for pain management.
6. Locate the spinal epidural space and place a percutaneous spinal cord stimulation electrode with supervision.
7. Assist with implantation of a plate electrode for spinal cord stimulation.
8. Insert with supervision a spinal catheter for drug administration.
9. Implant with supervision a spinal cord stimulation system pulse generator/receiver and extension wire.
10. Implant with supervision an intraspinal drug infusion pump.
11. Assist with spinal ablative procedure for pain management (cordotomy, myelotomy, DREZ).
12. For peripheral nerve repair, neurectomy, and neurolysis perform, record, and report complete patient evaluation and assessment, including comprehensive neuromuscular examination of affected nerve distribution.
13. Evaluate electrodiagnostic studies pertaining to peripheral nerve injury.
14. Assist in surgical treatment of peripheral nerves.
15. Assist with implantation of a peripheral nerve stimulation system.
17. Recognize and treat the potential complications of dorsal root ganglionectomy including cerebrospinal fluid leak, infection, and local wound problems.
19. Assess patients for appropriateness of local anesthetic block(s).
20. Perform simple superficial blocks with supervision and assist in complicated procedures. Following such procedures:
   a. assess outcome of nerve block
   b. recognize and treat complications
   c. record and monitor effects of block over a specified time interval
   d. assess need for repeat blocks
21. Assess patient for appropriateness of ablative neurolysis. Perform simple superficial neurolysis with supervision and assist in complicated procedures. Following ablative neurolysis:
   a. assess outcome of procedure
   b. recognize and treat complications
   c. record and monitor effects of neurolysis over a specified time interval
   d. assess need for repeat procedures

4. Pediatrics
A. COMPETENCY-BASED KNOWLEDGE OBJECTIVES:
Myelomeningocele and its variants, meningocele, encephalocele, Chiari malformations, occult spinal dysraphism, split cord anomalies, segmentation anomalies, craniofacial syndromes and phakomatosis
1. List the abnormalities a neurosurgeon may treat which are congenital/developmental in nature and classify them with respect to their embryology defect.
2. Describe the incidence, epidemiology and inheritance patterns.
3. State other disorders associated with this set of diseases.
4. Describe the anatomic and pathophysiologic parameters which distinguishes amongst these diseases.
5. Develop a diagnostic treatment plan along with prognostication of outcome with optimal treatment.
6. List disorders which may be referred for neurosurgical care but do not require surgery.
7. Display current knowledge of the molecular basis for these diseases where known.
8. Describe the expected outcome if treatment is not undertaken.

Hydrocephalus and Other Disorders of CSF Circulation
1. Delineate the different etiologies of hydrocephalus and their relative incidence.
2. Explain how to differentiate between CSF collections which require treatment and those which do not.
3. Indicate the various treatment options for the management of hydrocephalus.
4. Distinguish between treatment options for hydrocephalus with normal CSF and contaminated (e.g. infection, blood) CSF.
5. List the complications associated with each treatment option for hydrocephalus and the diagnosis and treatment of same.
6. Differentiate between low-pressure and high-pressure hydrocephalus.
7. Describe the presentations and diagnostic approach to a patient with suspected shunt malfunction.
8. Define how the diagnosis of hydrocephalus is made.
9. List nonsurgical diseases which may be mistaken for hydrocephalus but require treatment different than surgery.

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 optional 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.
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.

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.
**Trauma**

1. List the appropriate diagnostic tests to evaluate a child who has sustained multisystem trauma.
2. Describe the Glasgow Coma Scale and its use.
3. List the salient historical and exam feature 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.
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. List 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 importance and interplay between ICP and cerebral perfusion pressure (CPP) in the management of head and spinal cord injury.
15. Define the concept of "secondary injury".
16. Discuss the role of invasive monitoring in all its forms in closed head injury (CHI).

**B. Competency-Based Performance Objectives:**

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.
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.
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.

5. Peripheral Nerve

A. Competency-Based Knowledge Objectives:
1. Discuss the patho-physiological response to various injuries by a nerve
   a. compression
   b. ischemia
   c. metabolic
   d. concussive
   e. stretch
2. Define and discuss apoptosis.
3. Discuss nerve regeneration
   a. sprouting
   b. nerve growth factors
   c. rate of growth
   d. re-myelination
4. Define Neuroma
   a. axonal-sensitivity
   b. mechan-sensitivity
   c. neuroma-in-continuity
5. Define the pathophysiology and clinical significance of the Tinel sign.
6. Describe the symptoms and signs of typical nerve injuries.
   a. entrapment syndromes
   b. stretch injuries
   c. laceration injuries
   d. concussive injuries
   e. injection injuries
7. 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
8. Describe the classification of nerve injury
   a. Seddon classification
   b. Sunderland classification
9. Describe the rating scales for motor power
10. Describe the symptoms and signs of common nerve entrapments
    a. carpal tunnel
    b. ulnar entrapment at the elbow
c. lateral femoral cutaneous nerve
d. peroneal at fibular head

11. Describe the changes in EMG and NCV in nerve entrapment.
12. Define
   a. coaptation
   b. neurorrhaphy
   c. neurotization
   d. nerve transfer

B. Competency-Based Performance Objectives:
1. Based on history and physical anatomically localize the lesion
2. Obtain appropriate ancillary tests
   a. EMG/NCV
   b. metabolic screens
   c. imaging studies
3. Formulate a differential diagnosis for common entrapments
4. Position and prep for common entrapment releases.
5. Perform a diagnostic nerve and muscle biopsy.
6. Obtain sural nerve for grafting.

6. Spine

A. Competency-Based Knowledge Objectives:
   1. Review the signs, symptoms, and pathophysiology of common syndromes of degenerative spinal disorders: radiculopathy, myelopathy, and neurogenic claudication.
   2. 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.
   3. Describe the cauda equina syndrome.
   4. Recite the differential diagnosis of cervical, thoracic, and lumbar pain.
   5. Discuss the indications for cervical, thoracic, and lumbar discectomy.
   6. Identify non-surgical spinal cord syndromes including amyotrophic lateral sclerosis, demyelinating conditions, and combined systems disease.
   7. Review the initial management of spine and spinal cord injured patients including immobilization, traction, reduction, appropriate radiographic studies, and medical management.
   8. Classify fractures and dislocations 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.

B. Competency-Based Knowledge Objectives:
1. 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.
2. Perform lumbar punctures and placement of lumbar drains.
3. Demonstrate the ability to place and manage a halo vest, including indications for placement and criteria removal.
4. Demonstrate the ability to properly place the Mayfield head holder and other headrests.
5. Demonstrate the ability to harvest autologous bone graft from the calvarium, rib, fibula, and anterior or posterior iliac crest.
6. Perform dorsal exposure of the spinous processes, lamina, and facets of the cervical, thoracic, and lumbar spine.
7. Demonstrate the ability to close dorsal, ventral and lateral spinal incisions.
8. Demonstrate the ability to perform, with supervision, a lumbar decompressive laminectomy for spinal stenosis.
9. Demonstrate the ability to excise, with supervision, a herniated lumbar disc.

7. Stereotactic/Functional

A. Competency-Based Knowledge Objectives:
   1. Discuss the considerations of stereotactic frame placement in regard to target localization, purpose of procedure (biopsy, craniotomy, functional, radiosurgery).
   2. Define and distinguish each of the following entities:
      a. tremor
      b. rigidity
      c. dystonia
      d. chorea
      e. athetosis.
   3. Describe the pathophysiology of Parkinson's disease, cerebellar tremor.
   4. Explain the primary symptoms treated by ventro-lateral (VL) thalamotomy pallidotomy.
   5. Discuss the advantages, disadvantages of stereotactic biopsy compared to open biopsy procedures.
   6. Discuss the differential diagnosis of a newly discovered ring-enhancing intracranial mass.
   7. Discuss the differential diagnosis of a newly discovered non-enhancing intracranial mass.
   8. Define different seizure types (partial, partial-complex, generalized, etc).
  10. Describe the anatomy of the mesial temporal lobe.
  11. Define brachytherapy.
  12. Review the limitations of conventional care for patients with high-grade gliomas.
14. Explain the differences between radiosurgery and radiation therapy.
15. List the potential indications for radiosurgery.
16. List the reported complications of radiosurgery.
17. Compare advantages, disadvantages of frame-based or frameless stereotactic craniotomies to non-stereotactic craniotomies.

B. Competency-Based Performance Objectives

8. Trauma/Critical Care

A. Competency-Based Knowledge Objectives:
1. Describe the systematic assessment of polytrauma patients.
2. Rank management priorities in polytrauma patients appropriately.
3. Discuss principles of resuscitation of polytrauma patients.
4. Name an initial choice for intravenous fluids for a newly admitted ICU patient and explain changes in that choice based upon specific changes in the patient's electrolyte or volume status.
5. Propose appropriate initial ventilator settings for patients with different types of common neurosurgical conditions and explain changes in that choice based upon specific changes in the patient's metabolic or pulmonary status.
6. List the mechanisms of action and potential complications of commonly used pressors and hypotensive agents.
7. Discuss indications, pharmacologic mechanism, duration of action, and effect on the neurologic examination for sedative and analgesic agents commonly used in the ICU.
8. Explain the indications, advantages, and risks for various hemodynamic monitoring tools (e.g., pulmonary artery catheters, indwelling arterial lines) used in critically ill patients.
9. Discuss the pathophysiology and management of coagulopathy after head injury.
10. Describe basic principles of nutritional management in neurosurgical critical care.
11. Explain the treatment of posttraumatic seizures.
12. Outline basic principles of ICU management of patients with spinal cord injury.
13. Discuss the evaluation, treatment, and prognosis of subarachnoid hemorrhage, both traumatic and spontaneous.
14. Explain the evaluation and management of birth-related intracranial hemorrhage, spinal cord injury, and brachial plexus injury.
15. List principles of rehabilitation of different types of neurosurgical patients.
16. Define brain death and discuss methods of making such a diagnosis.

B. Competency-Based Performance Objectives:
1. Insert intravascular monitoring devices for use in the hemodynamic management of critically ill patients, including central venous lines, pulmonary artery catheters, and arterial catheters.
2. Insert intracranial pressure monitoring devices, including ventriculostomy catheters and electronic (fiberoptic or miniaturized strain gauge) devices.
3. Perform twist-drill or burr-hole drainage of subdural fluid collections.
4. Decide appropriately which patients require emergency craniotomy and other procedures.
5. Position patients appropriately for procedures/surgery and begin emergency procedures if more experienced neurosurgeons have not yet arrived.
6. Assist with closure of craniotomies.
7. Perform elective tracheostomies and be able to perform emergency tracheostomies.
8. Be able to intubate patients in both emergency and elective situations.

PATIENT CARE AND MEDICAL KNOWLEDGE

NS4 RESIDENT CLINICAL ROTATION

Neurosurgery residents are expected to develop an increasing understanding of the subspecialties of neurosurgical practice over the course of their residency. This will occur during clinical rotations on the various subspecialty services and via didactic and experiential teaching from the neurosurgical faculty. Each of the first four years of the neurosurgery residency the resident will spend three months on the Red Service (emphasis on cerebrovascular, endovascular and tumor surgery), three months on the Blue Service (emphasis on spine, peripheral nerve and stereotactic and functional neurosurgery) and three months on the pediatric neurosurgery service. Neurotrauma, critical care and pain management are part of each of these clinical rotations. By the time residents have completed their NS 4 year they are expected to demonstrate competencies in each of the neurosurgical subspecialties, as listed below, that would allow them to assume the role of Chief Resident.

1. Cerebrovascular

A. Competency-Based Knowledge Objectives:
   1. Explain the principles of ischemic neuronal protection and salvage.

B. Competency-Based Performance Objectives:
   1. Perform pterional craniotomy for vascular disease
   2. Demonstrate the ability to make independent management decisions regarding ischemic and hemorrhagic stroke states.
   3. Demonstrate efficient prioritization skills for clinical assessment of multiple simultaneous problems in the same or different patients. Display a clear
sense of prioritization regarding timing and urgency of medical and surgical intervention for ischemic and hemorrhagic stroke states. Recognize the impact of systemic conditions on prioritization and timing issues
4. Correctly interpret and respond to changes in patient status related to systemic and neurological parameters.
5. Implement patient-care protocols regarding perioperative management.
6. Display skills in prioritization of diagnostic interventions, including the choice and sequence of studies in the setting of ischemic and hemorrhagic states.
7. Perform frameless navigation procedures.
8. Perform routine and complicated twist drill or burr-hole procedures for the drainage of the ventricular system or intracranial hematomas.
9. Perform exposure of the cervical carotid artery for endarterectomy or proximal arterial control.
11. Demonstrate an understanding of the planning and performance of pterional craniotomy for intracranial vascular pathology. Perform pterional craniotomy with initiation of microsurgical clinical skills. Observe the microsurgical dissection of the Sylvian fissure and basal cisterns for vascular pathology.
12. Perform the surgical approach to vascular structures via a craniotomy other than pterional.
13. Supervise and assist Junior Residents in burr-hole and twist-drill procedures for ventricular access or intracranial pressure monitoring.

2. Neuro-Oncology

A. Competency-Based Knowledge Objectives:

1. Describe appropriate postoperative management with drainage of brain abscess or cyst.
2. Describe the appropriate surgical management and postoperative treatment of bony skull lesions.
3. Describe the role of surgery in arachnoid cysts, infectious cysts, and in tumor-related cystic lesions. Describe the adjuvant treatment of parasitic cysts.
4. Explain the rationale and indications for various skull base approaches to the anterior, middle and posterior cranial fossae. Identify the important anatomical landmarks for each approach. Illustrate the general principles used in prophylaxis of CSF leaks employed in skull base surgery.
5. Describe their neurosurgical management for the following tumors involving the anterior cranial fossa:
   a. meningioma
b. fibrous dysplasia  
c. esthesioneuroblastoma  
d. osteoma of the frontal sinus  
e. chondroma, chordoma  
f. mucocele  
g. bony metastases.

6. Explain the use of the balloon occlusion test of the carotid artery, its indication for use in skull base tumor surgery, how it is performed, and how the information gained influences surgical management.

7. Explain the surgical advantage of transposing the facial nerve during a transtemporal skull base approach.

8. Describe the transcondylar approach, the relationship of the lower cranial nerves, and the exposure gained over a routine suboccipital craniectomy.

9. Illustrate the transpetrosal approach, and the relationship of the transverse and sigmoid sinus with skull bony landmarks such as the asterion, mastoid and inion. Describe the intradural course of the trochlear nerve, trigeminal nerve through Meckel's cave and the abducens nerve and Dorello's canal.

10. Describe the surgical management of the frontal sinus which has been exposed during craniotomy for anterior skull base surgery. Illustrate the development and use of a frontal vascularized pericranial flap and explain its indication. Similarly, illustrate the use of a myocutaneous flap of the temporalis muscle and list the locations for application.

11. Describe the general methods employed for embolization of tumors of the head and neck, and the indications for such procedures.

12. Compare and contrast the methods for stereotactic radiation, including particle beam, gamma ray or linear accelerator, and the indications for each technique.

B. Competency-Based Performance Objectives:

1. Independently determine a differential diagnosis based on the patient's history, physical examination, and radiographic studies.

2. Perform the opening and closing of craniotomies and craniectomies under supervision.

3. Assist in the resection of intracranial neoplasms.

4. Resect skull lesions.

5. Operatively treat supra- and infratentorial brain abscesses.

6. Demonstrate the ability to manage post operative complications including but not limited to:
   a. brain edema
   b. meningitis
   c. cranial flap infection
   d. postoperative seizures

7. Assess the need for appropriate pre, intra, and postoperative monitoring.
3. Pain

A. Competency-Based Knowledge Objectives:
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.
5. Explain the basis of chemical, balloon compression, and radiofrequency neurolysis as applicable to the trigeminal nerve.
6. Relate subcortical and brain stem sites that appear to be involved in the modulation of nociception to targets for deep brain stimulation (DBS) for pain control.
7. Explain how central neurostimulation (cortical, subcortical) is thought to produce analgesia.
8. Explain the role of ablative brain and brain stem procedures, e.g., cingulotomy, mesencephalic tractotomy, trigeminal tractotomy, in the management of chronic benign pain and cancer pain.
9. Discuss the possible complications of subcortical and brain stem ablative procedures for deafferentation pain.
10. List the primary indications for the following spinal ablative lesions: dorsal root entry zone lesion, open and percutaneous anterolateral cordotomy, myelotomy.
11. Discuss spinal cord stimulation (SCS), including types of stimulation systems and electrodes available, basic techniques of insertion of percutaneous and plate electrodes, the rationale and goals of intraoperative SCS testing (paresthesiae coverage of painful area, avoidance of undesirable stimulation), the rationale and techniques for trialing SCS, and advantages and disadvantages of different sites of implantation of SCS pulse generator/receiver.
12. Explain the key aspects of intraspinal drug administration, including the pharmacology of intraspinal drugs, the various types of infusion systems available, the rationale for trialing intraspinal drug infusions, basic techniques for insertion of intrathecal and epidural catheters, and the proper location for infusion pump implantation.
13. Discuss the role of neurectomy and neurolysis for pain control in nerve injury and compare alternative techniques for pain control.
14. 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.
15. Describe the indications for peripheral nerve stimulation and contrast to spinal cord stimulation.
16. Describe indications for ablative peripheral neurolysis. Review the pharmacology and histopathologic effects of neurolytic agents (e.g., phenol, glycerine/glycerol, chlorcreosol, absolute alcohol, ammonium chloride/sulfate).

17. Discuss basic principles of ablative neurolytic procedures in terms of technique, expected outcomes, 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.

18. Describe the principles of radiofrequency lesioning probe, thermocouple or thermistor, time, duration, and intensity of heat, and isotherm fields.

19. 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).

20. 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

B. Competency-Based Performance Objectives:
1. Formulate and implement an appropriate treatment program for complicated pain syndromes (e.g., chronic back pain, "failed back surgery syndrome").
2. Assess the need for multidisciplinary management of pain disorders.
3. Demonstrate appropriate management of psychosocial factors complicating a pain disorder.
4. Employ the Hartel technique to perform radiofrequency, glycerol or balloon compression neurolysis of the trigeminal nerve in patients with trigeminal neuralgia.
5. Implant a plate electrode.
6. Demonstrate appropriate methods for trialing spinal cord stimulation and intraspinal drug administration systems.
7. Implant a peripheral nerve stimulation system.
8. Assess patient for appropriateness of radiofrequency facet blocks. Perform radiofrequency facet blocks with supervision. Following the performance of such procedures:
   a. assess outcome of facet blocks
b. recognize and treat complications  
c. record and monitor effects of facet blocks over a specified time interval  
d. assess need for repeat facet blocks  
9. Diagnose and formulate appropriate treatment plans for sympathetically-maintained pain.  
10. Diagnose and formulate an appropriate treatment plan for a patient with occipital neuralgia.

4. Pediatrics

A. Competency-Based Knowledge Objectives:
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 its use in the 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.

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 neoplastic processes associated with:  
   a. neurofibromatosis  
   b. tuberous sclerosis  
   c. von Hippel Lindau Describe the appropriate evaluation and treatment of patients with these entities.  
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 as regards 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.
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.

B. Competency-Based Performance Objectives:
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.
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.

5. Peripheral Nerve

A. Competency-Based Knowledge Objectives:
1. Define the autonomic system a. discuss Homer'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. Discuss Stretch injury, Missile injury and Avulsion injury
   a. definition
   b. typical etiology
   c. physical findings
d. electrical findings
e. non-operative management
f. indications for surgery
g. intra-operative findings
h. potential for recovery
5. Describe the anatomical location of the common entrapment sites
   a. describe the various bands and arcades that the nerves are entrapped by
6. Provide a differential diagnosis for common entrapment syndromes.
   a. differentiate radiculopathies from entrapments
   b. discuss repetitive strain disorder
7. 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. pyriformis syndrome
8. Discuss bum and electrical injuries affects on nerve
9. Classify peripheral nerve tumors
10. Discuss the pathophysiology of NF 1 and NF2
11. Discuss the timing of peripheral nerve surgery
    a. laceration injury
    b. blunt injury
    c. missile injury
    d. iatrogenic injury
    e. surgical injection
12. Discuss outcome priorities in brachial plexus surgery
    a. motor versus sensory
    b. functional outcome _elbow flexion, shoulder abduction, etc.
13. Discuss tension at the nerve repair site
14. Discuss nerve repair techniques
    a. direct coaptation
    b. nerve graft
    c. nerve transfer
    d. donor (graft) nerves
    e. epineurial repair
    f. fascicular repair
15. Describe intra-operative nerve evaluation
    a. visual
    b. palpation
    c. internal neurolysis
    d. nerve conduction
    e. biopsy

B. Competency-Based Performance Objectives:
1. Perform pre and post operative care of the patient with a missile injury to peripheral nerve.
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

6. Spine

A. Competency-Based Knowledge Objectives:
1. Review the biomechanics of the cranio-cervical junction, cervical spine, and thoracolumbar and lumbar spine.
2. Review the biomechanics of common internal spinal fixators.
3. Review the definition of spinal instability based upon the principles of Punjabi, White, and other authors.
4. Review the indications for, and relative effectiveness of common spinal orthoses. Discuss the degree of segmental and regional immobilization these orthoses provide.
5. Compare and contrast indications for anterior and posterior approaches to the cervical spine for the treatment of herniated cervical discs, spondylosis, and instability.
6. Discuss the role of corpectomy in the management of cervical disorders.
7. Compare and contrast the indications for anterior cervical discectomy with and without anterior interbody fusion.
8. Discuss the indications and techniques for anterior and posterior cervical spinal internal fixators.
10. 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.
11. Discuss the management principles for gunshot and other penetrating wounds to the spine.
12. Review the signs, symptoms, and management options in the treatment of the adult tethered cord syndrome and syringomyelia.
13. Review the management principles for spontaneous and postoperative spinal infections.
14. Review the management principles for intraoperative and postoperative cerebrospinal fluid leaks.
15. Discuss the surgical management of intradural congenital, neoplastic, and vascular lesions.

B. Competency-Based Performance Objectives:
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 discectomy.
4. Demonstrate the ability to perform an anterior cervical interbody arthrodesis.
5. Demonstrate the ability to place anterior cervical instrumentation.
6. Demonstrate the ability to perform posterior cervical decompressive laminectomy.
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.
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 a laminectomy with or without transpedicular decompression for tumor, infection, or trauma.
14. Demonstrate techniques for spinous process arthrodesis of the subaxial cervical spine for fracture or dislocation.
15. Demonstrate the ability to manage postoperative complications of spinal surgery including:
   a. hematoma
   b. infection
   c. spinal fluid leak
   d. new neurologic deficit
16. Demonstrate the ability to perform a tethered cord release.

7. Stereotactic/Functional

A. Competency-Based Knowledge Objectives:
1. Discuss the benefits and limitations of frame-based stereotactic procedures.
2. Discuss patient selection for VL thalamotomy, pallidotomy.
3. Discuss the advantages and disadvantages of ablative procedures.
4. List the potential complications of VL thalamotomy, pallidotomy; bilateral thalamotomies or pallidotomies.
5. Discuss technical considerations to minimize the potential for an intracranial hemorrhage after a stereotactic biopsy.
6. Discuss technical considerations to minimize the potential for a non-diagnostic stereotactic biopsy.
7. Describe the appropriate trajectories to biopsy a lesion in the pineal region, midbrain, pons, and medulla.
8. Compare the advantages, disadvantages of radiosurgery and surgical resection for tumors, vascular malformations.

B. Competency-Based Performance Objectives:
1. Perform simple dose-planning.

8. Trauma/Critical Care

A. Competency-Based Knowledge Objectives:
1. Describe the pathophysiology of intracranial hypertension and explain a plan for its management, including arguments for and against various treatments.

B. Competency-Based Performance Objectives:
1. Perform the following surgical procedures in uncomplicated cases:
a. Craniotomy for subdural and/or epidural hematoma
b. Craniotomy for penetrating head injury
c. Craniotomy for intracerebral hematoma or contusion
d. Craniotomy for depressed skull fracture
e. Decompressive craniectomy
f. Repair/cranialization of frontal sinus fracture
g. Posterior fossa epidural, subdural, or intracerebral hematoma
h. Simple cranioplasty
2. Manage traumatic skull base fractures with CSF leak.
3. Manage infections associated with open CNS injuries.

PATIENT CARE AND MEDICAL KNOWLEDGE

CHIEF RESIDENT CLINICAL ROTATION

Neurosurgery residents are expected to develop an increasing understanding of the subspecialties of neurosurgical practice over the course of their residency. This will occur during clinical rotations on the various subspecialty services and via didactic and experiential teaching from the neurosurgical faculty. Each of the first four years of the neurosurgery residency the resident will spend three months on the Red Service (emphasis on cerebrovascular, endovascular and tumor surgery), three months on the Blue Service (emphasis on spine, peripheral nerve and stereotactic and functional neurosurgery) and three months on the pediatric neurosurgery service. Neurotrauma,
critical care and pain management are part of each of these clinical rotations. By the time residents have completed their NS 4 year they are expected to demonstrate competencies in each of the neurosurgical subspecialties that would allow them to assume the role of Chief Resident. During the Chief Resident year the resident develops the additional competencies that will allow him or her to enter practice as a new neurosurgical practitioner.

1. Cerebrovascular

A. Competency-Based Knowledge Objectives:
   1. Demonstrate an understanding of current literature related to basic neuroscience knowledge objectives acquired as a Junior and Middle Resident. Define scientific hypotheses in relationship to controversies and evolving knowledge regarding these same objectives and demonstrate the ability to interpret and adapt new knowledge to evolving patient-care paradigms.

B. Competency-Based Performance Objectives:
   1. Review fundamental concepts of cerebrovascular disease during conferences and clinical rounds with the house staff and medical student.
   2. Demonstrate clinical judgment related to the spectrum of problems encountered in hemorrhagic and ischemic stroke states.
   3. Formulate independent plans for patient assessment and management, including prioritization in cerebrovascular disease while maintaining a clear reporting relationship with faculty.
   4. Identify the indications and controversies of endovascular catheter procedures, perioperative management, and follow-up. Implement and supervise patient care protocols related to these procedures.
   5. Display a detailed understanding of indications, principles, and interpretation of the full spectrum of neurodiagnostic armamentarium. Formulate independent management plans based on sophisticated interpretation of diagnostic studies for concise presentation to faculty.
   6. Demonstrate an understanding of surgical strategies and approaches to common and unusual vascular disease.
   7. Apply the principles of intraoperative anesthetic management, proximal and distal control, temporary arterial occlusion, brain protective strategies, and intraoperative localization as applied to vascular disease.
   8. Complete the planning, positioning, and execution of pterional craniotomy for common vascular disease under supervision.
   9. Perform microsurgical dissection of the Sylvian fissure and exposure of the basal cisterns for vascular disease.
   11. Complete the planning, positioning, and execution of non-pterional craniotomy for intracranial vascular disease.
   12. Assist in the microsurgical management of highly complex cerebrovascular disease.
13. Plan and execute the craniotomy for the evacuation of intracranial hematomas.

2. Neuro-Oncology

A. Competency-Based Knowledge Objectives:
   1. Describe the indications for transcranial orbitotomy and pathology approached.
   2. Discuss the surgical management and postoperative treatment of astrocytomas, gliomas other than astrocytomas, metastatic brain tumors, infectious granulomas, and cystic lesions presenting in a tumor-like manner. Review the role of radiotherapy, chemotherapy, and other adjunctive treatments of these neoplasms.
   3. Describe the role of surgery for intracranial meningioma, and the relation between the surgical option and location or tumor. Discuss optional adjuvant treatments of meningioma and their efficacy.
   4. Discuss the surgical treatment of common intrinsic posterior fossa neoplasms, including cerebellar astrocytoma, medulloblastoma, and ependymoma including the role of ventricular drainage, and surveillance imaging. Present adjuvant treatment options and outcomes for the various posterior fossa intrinsic tumors.
   5. Address the surgical goals of treatment, complications of surgical treatment, and adjuvant therapy for posterior fossa meningioma.
   6. List and illustrate the various approaches for removal of a vestibular schwannoma, and the rationale and indication for each approach.
      a. middle cranial fossa
      b. trans labyrinth
      c. retro sigmoid
   7. Describe the role of stereotactic radiosurgery and microsurgery in the management of vestibular schwannoma and other tumors.
   8. List the various approaches to the midline clivus, including the cervical-medullary junction the indications for each approach. Outline the surgical and medical management of tumors of the clivus and midline skull base.
   9. Explain the management goal for a patient with craniopharyngioma, and the risks of surgical treatment and conservative treatment. Describe the various surgical approaches used to resect craniopharyngiomas and the options for adjuvant treatment, including radiotherapy, chemotherapy (systemic and local).
   10. Illustrate the transnasal-transsphenoidal approach and its indications. Define the options for treatment of recurrent pituitary tumors of all types (including medical management). Describe the risks of the approach and the management of the complication of CSF leak.
   11. Illustrate the various skull base approaches to the anterior, middle and posterior cranial fossa in detail, explaining the key anatomical landmarks.
and strict indications for the approach. List the complications relevant to each approach, and the management of each complication.

12. List a differential diagnosis of orbital tumors, their usual location within the orbit, medical and surgical management of the tumor and the approach used to remove the tumor if indicated.

13. List the various tumors and their location in which an orbitocranial approach may be indicated for their removal.

14. Compare and contrast the exposure offered by the pre- and postauricular infratemporal approach, and the indications for each approach.

15. Illustrate transposition of the facial nerve during a transtemporal skull base approach.

16. Describe the location of meningiomas intracranially which are amenable to preoperative embolization.

**B. Competency-Based Performance Objectives:**

1. Demonstrate the capability to function independently in all phases of management of patients with intracranial neoplasms.

2. Perform resection of supra and infratentorial intra-axial and extra axial neoplasms.

3. Perform resection of pituitary lesions.

4. Perform under supervision or serve as first assistant for the skull base procedures listed.

**3. Pain**

**A. Competency-Based Knowledge Objectives:**

1. Distinguish the indications for surgical and non-surgical treatment of pain.

2. Construct a management strategy relating to application of percutaneous trigeminal neurolytic procedures, retrogasserian rhizotomy and microvascular decompression in the care of patients with trigeminal neuralgia.

3. Describe and contrast the approaches to the cerebellopontine angle for microvascular decompression or rhizotomy of the trigeminal and glossopharyngeal nerves.

4. Identify the various target spine levels for spinal cord stimulation according to the pain topography (simple and complex).

5. Identify the various intraspinal structures based on their responses to mechanical and electrical stimulation (dura mater, lateral canal wall, dorsal columns, dorsal roots, ventral roots, motoneurons).

6. Compare the different methods of intraspinal drug administration (epidural, intrathecal, tunneled catheter, implanted infusion system).

7. Describe the techniques for trialing intraspinal drugs.

8. Compare the pharmacodynamics of different drugs delivered intrathecally (e.g., hydrophilic vs. lipophilic).
9. Describe the possible complications of spinal cord stimulation electrode or spinal catheter insertion, 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
10. Describe the common drug side effects associated with intraspinal analgesic administration.
11. Describe the correct placement of lesions for DREZ, cordotomy, and myelotomy, including lesion depth and structures affected.
12. Discuss the possible neurological sequelae of spinal ablative procedures with both correct and incorrect lesion placement, with anatomical correlates.
13. Describe the role of DREZ lesioning in the overall management of the patient with deafferentation pain.
14. Describe the role and outcomes of ganglionectomy in the management of various pain syndromes, contrasting it with augmentative techniques.
15. Discuss in detail the surgical technique of ganglionectomy.
17. Explain the effects of blocking agents at the membrane and synaptic cleft, and the biochemistry and histology of neurotoxicity.
18. Explain the histologic effects of neurolytic agents at the membrane level and display a comprehensive level of understanding with regard to toxicity.
19. Describe the histologic effects of radiofrequency lesioning.
20. Discuss in detail the evaluation and management of a patient selected for radiofrequency lesioning of the facets.
21. Discuss the alternatives to radiofrequency lesioning, with particular emphasis on the potential surgical remedies including decompression, instrumentation, and fusion.

B. Competency-Based Performance Objectives:
1. Demonstrate appropriate use of each of the major classes of medications in common use for treating pain disorders.
2. Demonstrate appropriate selection of patients for surgical treatment of pain disorders.
3. Perform microvascular decompression, and rhizotomy on the trigeminal nerve, and glossopharyngeal nerves.
4. Assist a junior resident in performing a percutaneous ablative procedure for trigeminal neuralgia.
5. 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.).
6. Select and implant an appropriate SCS system, recognizing how to modify electrode insertion technique and location based upon intraoperative responses.
7. Implant a plate electrode in a patient with previous spinal surgery at the same level.
8. Demonstrate proficiency with maintenance and programming of spinal drug administration systems and spinal cord stimulation systems.
9. Recognize and evaluate malfunctions of SCS and intraspinal drug administration systems.
10. Perform surgical revision of SCS and intraspinal drug administration systems.
11. Demonstrate proficiency in identification and lesioning of the dorsal root entry zone, even in cases of nerve root avulsion.
12. Demonstrate proficiency in performing myelotomy and cordotomy.
13. Demonstrate proficiency in technique of ganglion resection.
14. Incorporate ganglionectomy as one part of an integrated approach to the patient with intractable pain.
15. Display appropriate patient selection for local anesthetic blocks.
16. Perform simple superficial blocks with minimal supervision. Relative to these blocks perform the following:
   a. assess outcome of block
   b. recognize and treat complications
   c. maintain detailed records of effects of block and follow-up
   d. assess need for repeat blocks
17. Provide information regarding alternatives for failed nerve block.
18. Perform complicated procedures with direct supervision. Recognize and treat the complications of these procedures.
19. Display appropriate patient selection for ablative peripheral neurolysis.
20. Perform simple neurolytic procedures with minimal supervision. Relative to these procedures perform the following:
   a. assess outcome of the procedure
   b. recognize and treat complications
   c. maintain detailed records of effects of neurolysis and follow-up
   d. assess need for repeat neurolysis
22. Perform complicated neurolytic procedures with direct supervision.
23. Display appropriate patient selection or radiofrequency facet rhizolysis.
24. Perform simple facet blocks with minimal supervision. Relative to these procedures perform the following:
   a. assess outcome of the procedure
   b. recognize and treat complications
   c. maintain detailed records of effects of facet blocks and follow-up
   d. assess need for repeat facet blocks
25. Provide information regarding alternatives for failed facet blocks.
26. Perform complicated facet blocks with direct supervision.
27. Perform sympathectomy.
4. Pediatrics

A. Competency-Based Knowledge Objectives:
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.
2. Differentiate between ventriculomegaly, compensated hydrocephalus, and pseudotumor cerebri.
3. 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 nonshunt-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.

**Trauma**
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.

**B. Competency-Based Performance Objectives:**
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
7. Perform placement of grids for seizure monitoring.
8. Perform rhizotomy for spasticity.
10. Perform stereotactic biopsy of supratentorial lesion.
11. Perform spinal fusion utilizing instrumentation.

**5. Peripheral Nerve**

**A. Competency-Based Knowledge Objectives:**
1. Discuss the use of nerve grafting
   a. types of fixation (suture/glue)
b. types of grafts (nerve, vein, artificial)
c. end to side
2. Discuss entrapment syndromes
   a. thoracic outlet
   b. double crush syndrome
   c. repetitive strain
3. Discuss ulnar nerve decompression
   a. in situ decompression
   b. transposition (subcutaneous/intramuscular/submuscular)
   c. medial epicondylectomy
4. Differentiate brachial plexus injury from brachial plexitis
5. Formulate a management plan for
   a. birth brachial plexus injury
   b. acute nerve injury (stretch/compression/laceration/injection)
   c. chronic nerve injury
   d. failed nerve decompression
   e. painful nerve/neuroma
6. Describe the management of nerve tumors
   a. indications for surgery in NF1
   b. operative and adjuvant treatment for malignant peripheral nerve sheath tumors
   c. use of monitoring during tumor surgery
   d. fascicular dissection
7. Describe adjuvant therapies in nerve injury
   a. muscle and tendon transfers
   b. prosthesis
   c. joint fusion

B. Competency-Based Performance Objectives:
   1. Determine the parameters confirming anticipated nerve regeneration:
      a. anticipated advancing Tinel sign
      b. order of muscle re-innervation
   2. Perform a nerve decompression:
   3. Excise a nerve sheath tumor
   4. Expose a brachial plexus injury
      a. determine possible repairs including nerve transfers
      b. expose the spinal accessory nerve
      c. expose the intercostal nerves

6. Spine

A. Competency-Based Knowledge Objectives:
   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.

4. Discuss the indications for posterior cervical spinal internal fixators.

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 in degenerative lumbar disease.

8. Discuss internal fixation options for posterior lumbar interbody fusion and intertransverse fusion.

9. Summarize the most common types of spinal tumors in the following categories:
   a. intradural/intramedullary
   b. intradural/extramedullary
   c. extradural/extramedullary.

10. Discuss nonoperative and operative treatment options for fractures and dislocations affecting the atlas and axis.

11. 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.

12. Describe the indications for anterior, posterior, and posterolateral procedures in the management of thoracolumbar tumor, trauma, or infection.

13. Compare and contrast the indications for anterior and posterior spinal fixators in the management of thoracolumbar tumor, trauma, or infection.

14. Discuss reconstruction options for vertebral body defects after corpectomy for tumor, trauma, or infection.

B. Competency-Based Performance Objectives:

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 properly place sublaminar wires, lateral mass screws, lower cervical/upper thoracic pedicle screws, C2 pars interarticularis screws, and C1-2 transarticular screws for the management of cervical spine disorders.

4. Demonstrate the ability to perform, with assistance if necessary, transoral odontoidectomy.
5. Demonstrate common techniques for performing intraspinous C1-2 arthrodesis.
6. Demonstrate the ability to perform anterior cervical corpectomy followed by 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 costotransverse and lateral extracavitary approaches to the thoracolumbar spine.
9. Demonstrate the ability to excise a herniated thoracic disc by use of the above mentioned approaches.
10. Demonstrate the ability to perform vertebral corpectomy of the thoracolumbar spine for tumor, infection, or trauma, utilizing the above mentioned approaches.
11. Demonstrate the ability to perform anterior arthrodesis of the thoracolumbar spine.
12. Demonstrate the proper placement of transpedicular screws in the thoracic and lumbar spine.
13. Demonstrate the proper placement of laminar, transverse process, and pedicle hooks in the thoracic and lumbar spine.
14. Demonstrate the ability to resect intradural spinal neoplasms.
15. Demonstrate the ability to perform methylmethacrylate vertebroplasty.
16. Demonstrate techniques of open reduction of fractures and dislocations of the cervical, thoracic, and lumbar spine.
17. Demonstrate the ability to surgically manage arachnoid cysts and spinal cord syrinx.
18. Demonstrate the ability to perform intradural procedures for congenital, neoplastic, and vascular lesions.

7. Stereotactic/Functional

A. Competency-Based Knowledge Objectives:
1. Identify the microelectrode recordings of the thalamus, globus pallidus.
2. Identify the primary indications for medial thalamotomy, cingulotomy.
3. Describe the evaluation of a patient with medically intractable epilepsy.
4. Discuss the indications for placement of depth electrodes.
5. Describe the surgical treatment of epilepsy in detail.
6. Discuss the theoretical advantages of brachytherapy over external beam radiation therapy.
7. Describe the most common complications of brachytherapy and their treatment.
8. Explain the effect of patient selection on the reported results of brachytherapy for high-grade gliomas.
9. Describe the methods used to localize and percutaneously penetrate the foramen ovale.
10. Discuss the dose-volume relationships for radiation-related complications after radiosurgery.
11. Discuss potential sources of inaccuracy for stereotactic procedures.
12. Discuss advantages, disadvantages of deep brain stimulation compared to ablative techniques.

B. Competency-Based Performance Objectives:
1. Perform complex dose-planning.
2. Perform stereotactic craniotomies

8. Trauma/Critical Care

A. Competency-Based Knowledge Objectives:
1. Discuss management priorities in polytrauma patients with severe neurological and systemic trauma.

B. Competency-Based Performance Objectives:
1. Perform the above procedures (listed under #1 for "Middle Level") in complicated cases.
2. Reconstruct complex cranial defects, with assistance from other specialties as indicated.
3. Reconstruct traumatic skull base defects, with assistance from other specialties as indicated.
4. Lead the critical care team in the treatment of patients with neurological injuries, either in isolation or in polytrauma patients.

PRACTICE BASED LEARNING AND IMPROVEMENT

Independent Study

Twelve months are devoted to independent study time for the resident during the NS5 year. Each resident is required to meet with the Program Director to discuss his/her intentions and plans for focused basic and/or clinical neuroscience research a minimum of 6 months prior to the start of this rotation. The resident may engage in basic science research under the mentorship of one of the faculty in the College of Medicine, under the Vice Chair for Neurosurgical Research (Dr. Connor), the Director of Clinical Research (Dr. Farace) or under another scientist if approved by the Program Director. Both clinical and basic science research require the resident to generate and evaluate data, locate and analyze scientific literature, apply knowledge of study design and communicate their findings to students and other health care professionals.

A resident may choose to use this time for enfoded fellowship training in one of the neurosurgical subspecialties such as spine, pediatrics, endovascular, neuro-oncology or peripheral nerve.
However, if a resident chooses to spend his/her time in a fellowship, he/she must engage in basic and/or clinical research activities as part of that program. The resident is expected to learn the fundamental skills in research design, interpretation of data, statistical methods and scientific writing during this year. As such, the resident is expected to produce a minimum of 1 scientific paper for publication in a national peer reviewed journal for time spent on this rotation.

**Basic & Clinical Biostatistics**

During their independent study year residents are expected to study statistics applied to medicine under the direction of Drs. Robert Harbaugh, Kevin Cockroft or Elana Farace or another faculty mentor approved by the Program Director. The objective of this course of study is to prepare residents to understand and apply biostatistical techniques used in the design and analysis of biomedical experiments and investigations as listed below.

1. Measures Of Central Tendency  
   a. Mean  
   b. Median  
   c. Mode  
2. Measures Of Dispersion  
   a. Variance  
   b. Standard Deviation  
   c. Coefficient Of Variation  
3. Normal Distribution  
   a. Symmetry and Kurtosis  
   b. Distribution Of means  
   c. Introduction to Hypothesis Testing  
4. One Sample Hypothesis  
   a. One Tail Hypothesis concerning Mean  
   b. Two tail Hypothesis concerning mean  
   c. Power & Sample size in Test concerning the means  
5. Two Sample Hypothesis  
   a. Testing for Difference between two variances  
   b. Paired t-test  
   c. Unpaired t -test  
6. Multisample Hypothesis  
   a. Single factor analysis of Variance  
   b. Homogeneity of Variance  
7. Multiple Comparison  
   a. The Tukey Test  
   b. Scheffe's Multiple Comparison  
8. Two Factor Analysis Of Variance  
   a. Two factor ANOVA with equal replication  
   b. Two factor ANOVA with unequal replication  
   c. Two factor ANOVA without replication  
   c. Randomized Block Design
9. Data Transformation
   a. The Logarithmic Transformation
   b. The Square Root Transformation
   c. The Arcsine Transformation

10. Simple Linear Regression
    a. Regression vs. Correlation
    b. Linear Regression Equation
    c. Testing The significance of Regression
    d. Power and sample size in Regression
    e. Data Transformation in Regression
    f. Comparing Simple Linear Regression Equations
    g. Comparing Two Slopes
    h. Comparing Two Elevations

11. Multiple regression and Correlation
    a. Multiple regression Equation
    b. Selection of Independent Variables
    c. Analysis Of Variance of Multiple Regression
    d. Dummy Variables

12. Testing for Goodness of Fit
    a. Chi-Square goodness of fit
    b. Chi-Square goodness of fit for more than two Categories
    c. Chi-Square Correction for Continuity

13. Contingency Tables
    a. Chi-Square Analysis of Contingency Table
    b. 2 X 2 Contingency Table

INTERPERSONAL AND COMMUNICATION SKILLS
SYSTEMS BASED PRACTICE

UNIT OBJECTIVES

The neurosurgery resident will develop interpersonal and communication skills that result in effective information exchange and team building with patients, their families, and other health professionals. They must also demonstrate an understanding of systems-based practice, as manifested by actions that demonstrate an awareness of and responsiveness to the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value. Neurosurgery residents will be expected to develop skills in evaluating their patient care practices to demonstrate an understanding of the principles of practice management and the socio-economic aspects associated with the delivery of health care.
A. COMPETENCY-BASED KNOWLEDGE OBJECTIVES:

1. Review the role of the neurosurgical leadership in the community and hospital setting.

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
      i. Medicare
      ii. Medicaid
      iii. employer-provided insurance
      iv. private insurance
   c. physician practice organizations
   d. medical equipment manufacturers
   e. pharmaceutical companies

4. Review 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. Demonstrate a knowledge of the rules and regulations of your State Medical Board.

7. Discuss mandatory reporting laws.

8. Discuss issues pertinent to the topic of the impaired physician.

9. Name and describe the local, regional, and national neurosurgical organizations including their purposes, roles, activities, and interactions.

10. Discuss the importance of tracking morbidity, mortality, and patient outcomes.

11. 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

12. Discuss post-residency fellowship training program availability, application process, and career usefulness.

13. Describe the types and characteristics of surgical practice organizations including:
   a. solo practice
   b. group practice
      i. partnership
      ii. professional association
      iii. corporation
   c. academic practice
   d. Health Maintenance Organizations (HMO)
i. Preferred Provider Organizations (PPO)
ii. Individual Practice Associations(IPA)
iii. staff model (Kaiser-Permanente type)

e. Federal
   i. Department of Veterans Affairs
   ii. Military
   iii. Public Health Service

14. Discuss hospital payment systems (e.g., DRGs, per diem rates) and describe their incentives and how they affect hospital profitability.
15. Discuss the role and influence of national quality oversight and review organizations for hospitals and health plans (JCAHO, NCQA).
16. Discuss the history, changes, eligibility, funding, and problems associated with the Medicare program.
17. Describe the Medicare program features, such as eligibility, funding, administration, federal-state relationship, benefits, and payment methods.
18. 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.
19. Discuss the significance of the following issues as they relate to the practice of neurosurgery:
   a. legislative/regulatory requirements
      i. Americans with Disabilities Act
      ii. Clinical Laboratory Improvement Amendments (CLIA)
   b. Federal/professional regulatory institutions
      i. Health Care Financing Administration (HFCA)
      ii. Joint Commission on Accreditation of Healthcare Organizations (JCAHO)
      iii. Occupational Safety and Health Administration (OSHA)
   c. miscellaneous
      i. affirmative action
      ii. equal opportunity
      iii. sexual harassment

20. Describe the ways, means, and reasons physicians influence the political process at the national, state, and local level.
21. Discuss the demographics of neurosurgeon distribution, numbers, workload studies, and workforce needs.
22. Outline the requirements for certification by the American Board of Neurological Surgery.
23. Formulate a strategy to evaluate personal and professional considerations in making a career choice.
24. Appraise the importance of family involvement in making career choices, including geographic location.
25. Discuss the available opportunities to obtain continuing medical education credits. Describe the political, economic, and social factors which impact on the practice of medicine generally and neurosurgery specifically.

27. Discuss the concept of relative values units (RVUs).

28. Summarize the process of impairment determination as it relates to the neurosurgical patient population.

29. Review the availability, requirements, and application procedures for post-residency fellowship if appropriate.

30. Discuss the following issues as they relate to planned neurosurgical practice:
   a. healthcare delivery systems, including managed care
   b. healthcare economics
   c. political and legislative processes in healthcare

31. Obtain a demographic profile of potential practice locations to include population and medical demographics.

32. 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

33. Discuss the key elements of a provider professional services agreement, such as a PPO or HMO contract, and identify provisions that require particular attention.

34. Describe the typical provisions and considerations in a physician employment contract including what to look for and what to avoid.

35. Describe, compare, and contrast partnership versus corporate practice structures, including the tax and liability advantages and disadvantages of each.

36. Describe the advantages and disadvantages of solo, single specialty group, and multispecialty group practice.

37. Review the financial issues associated with the neurosurgical career options under consideration.

38. 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
   c. scheduling
   d. transcription
   e. medical record management
   f. appointment scheduling
   g. information system
   h. facility selection and maintenance
   i. secretarial services

39. 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
40. 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
41. Discuss the issues of quality assurance as related to neurosurgical practice including:
a. maintenance of the clinical record
b. review and documentation of morbidity and mortality
42. Describe the considerations in Evaluation and Management (E & M) coding, including documentation requirements.
43. Describe the work, practice expense, and malpractice expense components of Medicare's Resource-based Relative Value Scale (RBRVS) and how they are derived.
44. Explain how Medicare and commercial payer conversion factors are derived and used to create a fee schedule from the RBRVS.
45. Describe commonly used methods of physician risk contracting, such as capitation payment, and explain the considerations in negotiating such a contract.
46. Describe the practice information necessary to safely and profitably manage a neurosurgical risk contract.
47. Review the features, similarities, and differences in various third party payment systems including:
a. Medicare
b. Medicaid .
c. commercial insurance
d. worker's compensation
48. Contrast HMO and PPO health plans.
49. 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
50. 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

51. Discuss antitrust considerations faced by physicians in payer contract negotiations including the concepts of collective bargaining, price fixing, and group boycott.

52. Describe types of retirement plans and funding considerations and limitations.

53. Explain the differences between occurrence and claims-made professional liability insurance and considerations made in selecting insurer and coverage levels.

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

PROFESSIONALISM

SYSTEMS BASED PRACTICE

Ethics

Unit Objectives

I  Understand the Major Theories of Biomedical Ethics

II Define the Primary Principles of Biomedical Ethics
   A. Beneficence
   B. Nonmaleficence
   C. Autonomy
   D. Justice

III Informed Consent
   A. Briefly outline the historical development of informed consent
   B. Discuss what it means to be "informed" and the role of disclosure in making choices
   C. Describe the difference between the professional practice standard and the reasonable person standard of disclosure
   D. Discuss "consent" and the role of competence and the context of decision-making
   E. Discuss the three areas of exception to the duty of informed consent
   F. Understand some of the future trends in informed consent
      1. Governmental regulations
      2. Multi-center trials
      3. Outcomes measures
      4. Case law
   G. Describe informed refusal

IV Advanced Directives and Substituted Judgement
   A. Understand the key underlying ethical principle
   B. Describe some different types of advanced directives
      1. Living Will
      2. Durable Power of Attorney
      3. Values Statement

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C. Describe durable Power of Attorney
D. Discuss some of the problems with advanced directives

V Critical Care and End of Life Issues
A. Pain Management
   1. Discuss the ethical principle of “double effect”
B. Futile Care
C. Define futility
D. Physiological futility
   1. Imminent demise futility
   2. Quality of life futility
   3. Poor probability of efficacy
E. Discuss a new approach to the issues of futility
   1. "Triage planning framework" communities
F. Define palliative care
G. Persistent vegetative state
   1. Discuss the difference between vegetative state and persistent vegetative state
   2. Discuss the legal conclusions in the Nancy Cruzan case
H. Brain Death
   1. Define brain death
   2. Define "higher brain" or "cerebral" death
I. Physician Assisted Death
   1. Forgoing life sustaining treatment
   2. Withdrawal vs. withholding of treatment
   3. Euthanasia
   4. Physician-assisted suicide
   5. Physician-assisted death

VI Ethical Issues in Transplantation
1. Discuss the ethical issues in fetal tissue transplantation

VII Ethical Issues of Gene Therapy
1. Germ-line gene therapy
2. Human cloning

VIII The Physician-Societal Relationship
A. Describe the physician-patient relationship
B. Describe the physician-societal relationship
C. Discuss the impact of managed care on these relationships
D. Identify the ethical principles that underlie the physician-patient and the physician societal relationship
   1. Beneficence
   2. Nonmaleficence
   3. Justice
E. Identify some ethical duties that result from these principles
1. Duty to maintain the health of the individual and the group
2. Duty to increase the resources available for medical care
3. Duty to continue to improve the quality of care
4. Duty to lower cost while maintaining quality of care

F. Discuss how to resolve when duties conflict

IX  Ethical Issues in Human Experimentation

X  Ethics Committees
A. Describe the role of ethics committees
B. Discuss the process of decision making
C. Discuss who should be a member
D. Define an ethics faculty

XI  Organizational Ethics
A. Define organizational ethics
B. Define the characteristics of an ethics infrastructure
C. Discuss the position of the Joint Council on Accreditation of Health Care Organizations and organizational ethics
D. Discuss the role of neurosurgeons in organizational ethics

Medico-Legal

UNIT OBJECTIVES

Demonstration and understanding of the principles of medico legal practice and the delivery of health care in Neurosurgery.

A. Competency-based knowledge objectives.
   1. Review the concepts of Fraud and Abuse legislation pertinent to the practice of Neurosurgery
      a. Understand the limitation of interaction as a provider with another provider in the delivery of healthcare to Medicare, Medicaid, and other Federal supported programs.
      b. Understand the penalties and liabilities associated with the intentional or erroneous infraction of one of these relationships.
      c. Understand the need to set-up a compliance program to prevent infractions of the federally supported programs.
   2. Review the concepts of Anti Kick-Back legislature.
      a. Understand the types of kick-backs which can trigger an investigation
      b. Understand the nature of the severity of the violations.
      c. Understand the nature of intent requirement vs. error.
      d. Understand the parties involved, and their possible interactions.
   3. Review the principles of compliance with State Licensing laws.
a. Understand the legal requirements for a medical license.
b. Understand the legal implications of practicing medicine without a license.

4. Understand the liabilities for those practicing medicine in a state without a license.
   a. Understand the cross-over or reciprocity provisions for medical licensing in different states.
   b. Understand the implications of the practice of medicine by paramedical personnel under the supervision of a physician.
   c. Understand the legality of the prescription of controlled substances under a medical license;
      i. By the practitioner.
      ii. By paramedical personnel under supervision.

5. Review the principles of compliance with hospital regulations and bylaws.
   a. Understand the legal implication of having hospital bylaws.
   b. Understand the legal implications of not complying with hospital bylaws.
   c. Understand the legal meaning and implications of altering hospital bylaws.
   d. Understand the limitations of hospital bylaws and their applicability to controversial situations.

6. Demonstrate knowledge of State mandatory reporting laws.
   a. Demonstrate knowledge of state mandatory reporting laws regarding child abuse.
   b. Demonstrate knowledge of state mandatory reporting laws regarding fraud and abuse pertinent to Medicaid programs.

7. Demonstrate knowledge of the issues pertaining to Impaired Physician legislature.
   a. Understand what the significance of the impaired physician legislation is, and how it applies to neurosurgeons.
   b. Understand the implications of practicing Neurosurgery while impaired.
   c. Understand the liability and sanctions existing regarding the practice of Neurosurgery while impaired.
   d. Understand the legal responsibilities for identification, and notification regarding the practice of Neurosurgery while impaired.

8. Demonstrate understanding of the principles of Americans with Disabilities Act legislation, and their application in the practice of Neurosurgery.
   a. Understand the legal obligations applicable to the physician practicing medicine regarding hiring and firing of Americans with disabilities.
   b. Understand the legal obligations in the practice of medicine regarding interaction with patients with disabilities.
   c. Understand the legal requirements regarding accessibility to office resources applicable to patients and employees with disabilities.

a. Understand the legal implications of sexual abuse legislation applicable to the practice of medicine, and dealing with patients.
b. Understand the legal issues of sexual abuse legislation in the workplace.
c. Understand the legal necessity of having in place sexual abuse policies, applicable to employees and patients, and the need to enforce those policies.

10. Demonstrate understanding of EMTALA legislation.
   a. Understand the principles of Anti-dumping laws.
   b. Understand limitations of concept of patient stability prior to transfer.
   c. Understand requirements of neurosurgical availability to emergency rooms.
   d. Understand liability for internal transfers within hospital.
   e. Understand liability for transferring unstable patients.

11. Demonstrate understanding of Medical Malpractice litigation.
   a. Understand the concept of medical negligence.
   b. Understand the difference between negligence and maloccurrence.
   c. Understand the concept of medical necessity.
   d. Understand the concept of informed consent.
   e. Understand the concept of Reasonable Medical Certainty.
   f. Understand the concept of Standard of Care.
   g. Understand the concept of Tort Legislation.
   h. Understand the concept of Tort Reform.
   i. Understand the requirements for legal testimony as a medical expert, and as a treating physician.
   j. Understand the concept of the National Physician Data Bank, and its functions.

12. Demonstrate an understanding of basic medico legal procedures.
   a. Understand what a subpoena is and its implications.
   b. Understand what a discovery deposition is.
   c. Understand what is required for trial testimony.
   d. Understand when to produce a medical summary or report as a treating physician, and as a medical expert.
   e. Understand when it is acceptable to charge fees for medical review, and testimony.
   f. Understand the purpose of a trier of fact: The Judge, or the Jury.
   g. Understand the difference between civil and criminal liability as applied to medical practice.
   h. Understand the extent of penalties applicable to civil and criminal liabilities.
   i. Understand the need to have independent counsel.
RECOMMENDED TEXTS

**JUNIOR LEVEL: PRELIMINARY/NS1**

**NEUROANATOMY**


**NEUROPHARMACOLOGY**


**NEUROPHYSIOLOGY**


**MEDIUM LEVEL: NS2-NS3**

**NEURORADIOLOGY**


**NEUROPATHOLOGY**


**NEUROLOGY**
CLINICAL: ALL LEVELS

CEREBROVASCULAR


NEURO-ONCOLOGY


GENERAL NEUROSURGERY

PAIN


PEDIATRICS

**PERIPHERAL NERVE**


**SPINE**


**STEREOTACTIC/FUNCTIONAL**


**TRAUMA/Critical Care**