Neuro Assessment (P)

- Always compare left side to right side
  - Asymmetry is abnormal
  - Start at the top and work down
  - Have a system-do your exam the same way every time

- Components
  - LOC and language
  - Motor and sensory function
  - Cranial nerves
  - Cerebellar function
Anatomy Review (P)

- **Bones**
  - Fontanelles close 18-24 mos

- **Meninges**
  - Dura, arachnoid, pia

- **Ventricles**
  - CSF, choroid plexus, arachnoid villi

- **Basal ganglia**
  - Fine motor control
A Little Anatomy...

Frontal Lobe
- Primary motor cortex
- Judgment, reasoning, intellect, personality, abstract thinking
- Long term memory
- Broca’s area

Parietal Lobe
- Interpretation and discrimination of sensory input
- Define shape, size, texture, consistency
- Touch, pressure, position
- Awareness of body parts, spatial orientation
A Little Anatomy...

Occipital Lobe
- Interpretation and discrimination of visual input
- Primary visual cortex receives direct signals from macula
- Secondary visual cortex interprets vision and meaning of written words

Temporal Lobe
- Hearing and discrimination of auditory input
- Primary auditory area detects loudness, tones
- Secondary auditory area interprets meaning of spoken word and music
- Wernicke’s area
Anatomy Review

- **Cerebellum**
  - Coordinates voluntary muscle control, equilibrium
  - *Chiari malformation*

- **Cerebral Circulation**
  - Arteries and areas supplied
  - Venous system

- **Blood-brain Barrier**
  - Restricts certain molecules and cells from passing

- **Spine and Spinal Cord**
Cerebral Arterial Circulation

- Anterior cerebral
- Anterior communicating
- Internal carotids
- Middle cerebral
- Posterior cerebral
- Posterior communicating
- Basilar
Arterial Supply
Anatomy Review

- **Thalamus**
  - Initial processing of sensory input

- **Hypothalamus**
  - Temperature, appetite, thirst, emotional expression, sleep-wake cycles

- **Pituitary Gland (Hypophysis)**
  - Hormones

- **Brainstem**
  - Midbrain, pons, medulla
Level of Consciousness

Most sensitive indicator of problems

Studying the brain without studying consciousness would be like studying the stomach without studying digestion...

John R. Searle, Philosopher
Definitions of LOC

- **Full consciousness**
  - Awake, alert and oriented

- **Confused**
  - Disorientation to one or more spheres,
  - ↓ attention span and memory, difficulty following commands

- **Lethargic**
  - May or may not be fully oriented, follows commands but mental and motor activities slow

- **Obtunded**
  - Arouse to tactile stimuli, responds with 1-2 words, may not follow commands
Definitions of LOC

- **Stuporus**
  - Shows little spontaneous movement, moans
  - Responds purposefully to noxious stimuli

- **Comatose**
  - Total absence of awareness
  - No response to verbal stimuli
  - May be purposeful to totally unresponsive
  - GCS <8
Aphasia

- **Broca’s Aphasia**
  - Motor, expressive
  - Cannot convert thoughts to words
  - Automatic speech may be preserved

- **Wernicke’s Aphasia**
  - Sensory, receptive
  - Speech lacks content and meaning
  - Cannot understand written and/or spoken words

- **Global Aphasia**
  - Motor and sensory
  - Expressive and receptive

- **Dysarthria**
  - Loss of articulation, phonation due to motor deficits or loss of breath control
## Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Points</th>
<th>Adult/Child</th>
<th>Infant/Preverbal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Eye Opening</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Spontaneous</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>3</td>
<td>To speech</td>
<td>To speech</td>
</tr>
<tr>
<td>2</td>
<td>To pain</td>
<td>To pain</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Verbal Response</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Oriented</td>
<td>Coos, babbles</td>
</tr>
<tr>
<td>4</td>
<td>Confused</td>
<td>Irritable cry</td>
</tr>
<tr>
<td>3</td>
<td>Inappropriate words</td>
<td>Cries to pain</td>
</tr>
<tr>
<td>2</td>
<td>Sounds</td>
<td>Moans to pain</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>Motor Response</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Obeyes</td>
<td>Normal, spontaneous</td>
</tr>
<tr>
<td>5</td>
<td>Localizes pain</td>
<td>Withdraws to touch</td>
</tr>
<tr>
<td>4</td>
<td>Withdraws to pain</td>
<td>Withdraws to pain</td>
</tr>
<tr>
<td>3</td>
<td>Abnormal flexion</td>
<td>Abnormal flexion</td>
</tr>
<tr>
<td>2</td>
<td>Abnormal extension</td>
<td>Abnormal extension</td>
</tr>
<tr>
<td>1</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Components of the Neurological Assessment

- **Verbal response**
  - Orientation
  - Memory
  - Fund of Knowledge

- **Motor Response**
  - Obey
  - Localize
  - Withdraw
  - Abnormal Flexion
  - Extension

- **Eye Opening**
  - Spontaneous
  - To speech
  - To pain
  - None
Pupillary Assessment

- Size
- Shape
- Reaction to light
  - Direct and consensual
EOM and OCR
Decorticate Posturing: Abnormal Flexion
Decerebrate Posturing: Extension
Pathological Reflexes

Babinski
- Present or absent
- Presence in adults is abnormal

Occulocephalectic Reflex
- Absent (negative) if eyes don’t move
Cranial Nerves

- **CN 1** Smell
- **CN 2** See
- **CN 3, 4, 6** Move eyes, 3 constricts, lid up
- **CN 5** Chew and feel front of face
- **CN 7** Moves face, tastes, salivates, cries, lid down
- **CN 8** Hears, regulates balance
- **CN 9** Taste, salivate, swallow, monitors carotid body and sinus
- **CN 10** Tastes, swallow, lift palate, communicates with viscera
- **CN 11** Turns head and lifts shoulders
- **CN 12** Moves tongue
Anatomy Review

- **Peripheral Nervous System**
  - Dorsal root is sensory, ventral is motor

- **Cranial Nerves**
  - Names and functions

- **Autonomic Nervous System**
  - Sympathetic and Parasympathetic

- **Reflexes**
  - Babinski’s
Intracranial Contents and ICP

- Blood 10%
- Brain 80%
- CSF 10%

- Normal ICP 0-15mmHg
  - Constantly changing phenomenon
  - Intracranial hypertension ICP >20mmHg
Increased Intracranial Pressure

- Munro-Kellie Hypothesis
  - Contents of cranial vault (brain, blood, CSF) are in a state of dynamic equilibrium
  - Increase in one component requires a reciprocal decrease in one or both of the others
  - Normal ICP 0-15mmHg
  - CPP = MAP - ICP
Normal ICP Waveform

Normal ICP waveform (ICP = 8 mm Hg)

P1  P2  P3

Abnormal ICP Waveform

Abnormal ICP waveform (ICP = 18 mm Hg)

A Waves

A Waveform - Plateau Waves: Pressure Peaks 50 – 100 mm Hg
B Waves

B Waveform: Pressure peaks 20 – 50 mm Hg
C Waves

C Waveform: Rhythmic waves occurring with changes in ventilation and blood pressure
Conditions that Increase ICP

- **Increased Brain Volume**
  - Space occupying lesions
  - Hematoma or intracerebral hemorrhage
  - Cerebral edema

- **Increased CSF Volume**
  - Increased production (rare)
  - Decreased absorption
    - Hydrocephalus-communicating and noncommunicating

- **Increased Blood Volume**
  - Acidosis
  - Hypercapnia
  - Obstructed venous flow
  - Seizures
  - Hyperthermia
  - Increased intrathoracic pressure
  - Position
Clinical Signs of Increased ICP

- **Early**
  - Deterioration in LOC
  - Deterioration in motor function-contralateral
  - Pupillary dysfunction-ipsilateral
  - Possible headache

- **Late Signs**
  - Coma
  - Pupils fixed and dilated-bilateral
  - Profound change in motor exam-bilateral
  - Cushing’s Triad-
    - ↑systolic pressure, widening pulse pressure, bradycardia
  - Alterations in respirations and temperature
Medical Interventions to Control ICP

- Analgesia and sedation
- Hyperventilation for rapid reduction
- Oxygenation and BP control
- Maintain CPP: CSF drainage
- Mannitol
- Hypertonic saline

- Neuromuscular blockade
- Fluid management
- Temperature control-hypothermia
- Seizure prophylaxis
- High-dose barbiturate coma
- Surgery
Nursing Management

- **Positioning**
  - HOB elevation-reverse Trendelenburg
  - No lateral neck flexion or rotation

- **Suctioning**
  - Hyperventilate and limit to 10 seconds

- **Avoid clustering of activities**

- **Control extraneous activities**
  - Noise, visitation, light
Aneurysm (P)

- Saccular outpouching
- Occur at arterial bifurcations in Circle of Willis
- Incidence increases with age, may be familial
- More common in women
- Classified by size or by size and shape
Aneurysm

- **Berry** - most common, has a neck or stem
- **Fusiform** - no stem
- **Traumatic** - any aneurysm that results from trauma
- **Mycotic** - septic emboli lead to formation
- **Charcot-Bouchard** - microscopic, associated with hypertension, involves basal ganglion and brainstem
- **Dissecting** - related to atherosclerosis, inflammation or trauma; separation of intimal and medial layers of artery
Aneurysm

Location
- Carotid system: 85-95%
- Anterior Communicating Artery: 30%
- ACA: more common in men
- Posterior Communicating Artery: 25%
- Posterior circulation: 5-15%
- 20%-30% of patients who suffer an aneurysm have more than one
Aneurysm: Unruptured

- Asymptomatic until aneurysm bleeds
  - Warning signs (prodromal)
    - Dilated pupil
    - Abnormal EOMs
    - Ptosis
    - Pain above or behind the eye
    - Localized headache
    - Nuchal rigidity
    - Photophobia
Management

- Assess risk for rupture
- No definitive recommendations
- Risk factor reduction:
  - Hypertension
  - Cigarette smoking
  - Use of oral contraceptives
  - Alcohol consumption
- Surgery if technically possible
Aneurysm: Ruptured

- Most frequent presentation is subarachnoid hemorrhage (SAH)
  - At time of rupture, blood forced into subarachnoid space
  - Patient experiences sudden explosive headache; c/o “worst headache of my life”
  - Decreased or immediate loss of consciousness
  - Mortality 25% and most die within first 24 hours
  - 50% of patients who survive aneurysmal rupture left with severe disabilities
Aneurysm: Ruptured

- Other signs and symptoms
  - Cranial nerve deficits-3,4,and 6
  - Meningeal irritation: nausea and vomiting, neck and back pain, nuchal rigidity, blurred vision, photophobia, mild temperature elevation
  - Stroke syndrome: paresis or plegia, aphasia, cognitive deficits
  - Cerebral edema and increased ICP: seizures, HTN, Cushing’s
  - Pituitary dysfunction: diabetes insipidus, hyponatremia
## Hunt-Hess Classification of SAH

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Assymptomatic or mild headache, slight nuchal rigidity</td>
</tr>
<tr>
<td>II</td>
<td>CN palsy, moderate to severe headache, nuchal rigidity</td>
</tr>
<tr>
<td>III</td>
<td>Mild focal deficit, lethargy or confusion</td>
</tr>
<tr>
<td>IV</td>
<td>Stupor, moderate to severe hemiparesis, early decerebrate rigidity</td>
</tr>
<tr>
<td>V</td>
<td>Deep coma, decerebrate, moribund appearance</td>
</tr>
</tbody>
</table>
Diagnosis of Aneurysm

- Neurological exam
- CT without and with contrast
- LP if CT negative
- CTA
- MRI/MRA
  - Not sensitive within first 24-48 hours, best after 4-7 days
- Cerebral Angiography – “Gold Standard”
Management of Ruptured Aneurysm

- Primary goal of therapy is to minimize rebleeding while maintaining cerebral blood flow
  - Increase CPP
  - Maintain euvoolemia
  - Maintain normal ICP
  - Neuroprotection
Management of Ruptured Aneurysm

- Fluid management
  - NS, albumin

- BP control
  - Unsecured: SBP 120-150mmHg
    - Labetalol, Nipride, Nicardipine

- Pulmonary artery catheter for Hunt-Hess $\geq 3$, SIADH or hemodynamically unstable

- Intubation if comatose or need airway protection

- ICP monitoring in patients who are developing hydrocephalus and Hunt-Hess grade $\geq 3$
Nursing Responsibilities

- VS and neuro exam every hour
- Pulse oximetry
- Bedrest with HOB elevation 30 degrees
- Minimize external stimulation
- Strict I&O
- DVT prophylaxis-SCD, TED hose, etc..
- Indwelling urinary catheter as needed
Aneurysm Treatment

- **Surgical**
  - Clipping
  - Wrapping

- **Endovascular**
  - Coiling
  - Stent-assisted coiling
    - For wide-necked aneurysms and fusiform aneurysms
Cerebral Vasospasm

- Major cause of mortality and morbidity in patients who survive initial rupture of aneurysm
- Causes reduced blood flow which may lead to delayed ischemic deficit and infarction
- Occurs in approximately 30% of patients
  - Clinically evident in 30% of these patients, 70% are found only through transcranial doppler or angio
Signs and Symptoms of Vasospasm

- Gradual neurological deterioration
- Confusion
- Decreased LOC
- Paresis/plegia
- Cranial nerve deficits
- Aphasia
Treatment of Vasospasm: Triple H Therapy

- **Hypervolemia:**
  - CVP 8-10 mmHg, PCOP 14-18 mmHg
    - NS, colloids

- **Hypertension**
  - Unsecured: 120-150 mmHg for the duration of spasm
  - Secured: 160-170 mmHg for the duration of spasm
    - Phenylephrine, Levophed, Dopamine, Dobutamine

- **Hemodilution**
  - Target Hct ≤ 33%, transfuse for Hct < 25%
Latest Recommendations for Treatment of Vasospasm

- Oral Nimodipine
  - Hypotensive adverse effects

- Hemodynamic Augmentation
  - Induced hypertension, maintain euvolemic status
  - Monitor BP to avoid sudden drops in CPP, prevent hypertension (BP >160mmHg)

- Intravenous magnesium

- Statins
Brain Death

- Defined as irreversible cessation of all functions of the entire brain including the brainstem. Three key characteristics:

1. Coma or unresponsiveness
   - must rule out all confounding factors such as hypothermia, drug intoxication, metabolic or endocrine imbalance
   - Some recommend neuroimaging to confirm catastrophic neurological event
2. Absence of brainstem reflexes

- Pupillary reaction
- Corneal reflex
- Gag reflex
- Oculovestibular reflexes
  - OCR and calorics
- Loss of spontaneous respirations and vasomotor control
3. Apnea

- Apnea test to confirm absence of respiratory drive
- Testing can result in severe hypotension or cardiac arrhythmias. Recommended pre-requisites include:
  - Core temperature $\geq 36^\circ C$ (97 $^\circ F$)
  - SBP $\geq 90$mmHg
  - Positive fluid balance in past 6 hours
  - Arterial PCO$_2$ between 35 and 45 mmHg
  - Arterial PO$_2$ 200mmHg or higher
Arteriovenous Malformation (AVM) (P)

- Tangling of the high pressure arterial flow with low pressure venous flow without intervening capillary network
- Creates a shunt that leads to ischemia and atrophy of adjacent tissue
- Leads to venous engorgement and rupture
AVM

- Congential
- Most common cause of spontaneous hemorrhage in children
- Mortality 20%-60%
- 80% symptomatic AVM patients between ages of 20 and 40 years
AVM: Clinical Presentation

- Hemorrhage
  - ICH most common presenting symptom
    - Sudden headache
    - Nausea and vomiting
    - Paresis or plegia
    - Decreased LOC
  - Seizures
  - Headache
  - Progressive focal deficits
AVM

- Diagnostic Studies
  - CT
  - MRI/MRA
  - Angiography
Management of AVM

- **Symptom Control**
  - Airway management
  - BP management
    - HTN: labetalol, hydralazine
    - Hypotension: phenylephrine
  - Seizure management
    - Phenytoin, fosphenytoin
Treatment of AVM

- Following recovery from hemorrhage
  - Surgery
    - Complete removal
    - May be embolized prior to resection
  - Radiotherapy
    - Induces inflammatory process results in thrombosis and obliteration of AVM
  - Endovascular treatment
    - Embolization to permanently occlusion of AVM
    - Indicated when lesion not accessible by surgery
Encephalopathy (P)

- General category used to designate diffuse cerebral dysfunction
- Manifested by alterations in cortical function and disturbances of consciousness ranging from mild confusion to coma
- Caused by systemic disorder that has a diffuse effect on the brain-
  - Infections, hypoxia, alcohol, liver failure, renal failure, metabolic disease, brain tumors, toxic chemicals, intracranial hypertension, malnourishment
Presentation, Diagnosis and Treatment

- **Symptoms**
  - Mild confusion to dementia, seizure, coma
  - Lethargy, tremors, twitching, apraxia

- **Diagnosis**
  - Blood tests to diagnose systemic disorder
  - CT, MRI, EEG

- **Treatment**
  - Correct underlying cause
Head Trauma

Background:

- External forces that impact with the body resulting in structural and/or physiological injuries
- Leading cause of trauma related deaths in people <45, predominantly male
- 1.5 -2 million/year, 50K deaths, 80-100K significant disability, 300,000 sports related
Etiology

- **Blunt Trauma:**
  - MVC, pedestrian vs. car, bicycle accidents, falls, sports related, assaults
  - Caused by contact, acceleration-deceleration, and rotational forces

- **Penetrating trauma**
  - GSW, knives, sharp objects
  - Penetration of the skull producing focal damage
Primary and Secondary Injuries

- Primary injury results from direct trauma to the brain

- Secondary injuries follow the primary
  - Immediate and delayed
  - Due to hypoxia, cerebral edema, alterations in cerebral blood flow, hypercapnia, increased ICP
Secondary Injury

- Cascade of ischemia and cellular changes that lead to neuronal injury and cell death
  - Ischemia
  - Cerebral edema (vasogenic, cytotoxic, interstitial)
  - Rapid increase in release of excitatory neurotransmitters
Types of Injuries

- **Scalp Lacerations**
  - Often associated with skull fracture
  - May bleed profusely!

- **Scalp Abrasions**
  - Top layers scraped away, may have small mount of bleeding

- **Scalp Contusions**
  - Bruise with blood accumulation in SQ layer
Types of Injury

- Skull Fractures
  - Extent of injury depends on thickness of skull, point of impact and the mechanism of injury
  - Stress waves radiate throughout entire skull
Types of Skull Fractures

- Linear - single fracture line
- Comminuted - bone splintered and fractures into pieces
- Depressed - bone embedded in brain tissue, dura may be torn (watch for underlying intracranial hemorrhage)
- Compound - open depressed - greater risk for infection
- Basilar skull fracture - linear fracture at base of skull, associated with dural tear, high risk of infection
Basilar Skull Fracture

Watch for

- CSF leak
- Racoon eyes
- Battle sign
- Signs & symptoms of meningitis, encephalitis, EDH
Brain Injuries

- Concussion
  - Brief loss of consciousness, headache, dizziness, possible nausea and vomiting
  - Altered LOC and focal deficits usually resolve in 6-12 hrs
  - Post-concussion syndrome common
    - STM deficits, headaches, cognitive and visual disturbances, poor coordination, lethargy
Brain Injuries

- Contusions
  - Bleeding of small vessels, necrotic brain tissue
  - Acceleration-deceleration
  - Change in LOC, cranial nerve dysfunction, hemiparesis or hemiplegia, seizures, increased ICP
  - Clinical findings depend on size and location
Brain Injuries

- Diffuse Axonal Injury
  - Acceleration-deceleration
  - Shearing at white-gray matter junction, corpus callosum, brainstem and sometimes cerebellum
  - Diffuse tearing of axons and small blood vessels
Diffuse Axonal Injury

- **Mild**
  - Coma duration 6-24 hours, death uncommon, often have cognitive and neurological deficits

- **Moderate**
  - Coma duration >24 hours, no prominent brainstem signs, incomplete neurological recovery

- **Severe**
  - Prolonged coma, prominent brainstem signs, results in death or severe disability
Epidural Hematoma (P)

- 85% arterial
- Most often injury to middle meningeal artery
- Classic “talk and die”
  - Brief loss of consciousness followed by lucid interval then rapid deterioration
Epidural Hematoma

- Presentation
  - Alteration in LOC
  - Headache
  - Nausea and vomiting
  - Seizures
  - Ipsilateral occulomotor paralysis
  - Contralateral motor paresis/plegia
  - Increased ICP (know these signs & symptoms)
Epidural Hematoma

- **Diagnosis**
  - Skull x-ray
  - CT without contrast
  - LP contraindicated due to increased ICP

- **Treatment**
  - ICP management
  - Surgical evacuation
Subdural Hematoma (P)

- Bleeding from injury to veins that bridge the dura and arachnoid space
- May occur with minimal trauma especially in patients on anticoagulants
- Majority in elderly patients with atrophy or alcoholism
- May be acute or chronic or both
Subdural Hematoma

- Presentation
  - Acute
    - Gradual or rapid deterioration in LOC
    - Pupillary changes
    - Hemiparesis/hemiplegia
  - Chronic
    - Headache, cognitively impaired, confusion, slow pupillary response, seizures
    - Symptoms develop gradually
Subdural Hematoma

- **Diagnosis**
  - Skull films
  - CT without contrast
  - MRI

- **Treatment**
  - Acute: surgery or burr hole to remove clot
  - Chronic or small acute: observation, serial CT, allow clot to liquefy
Intracerebral Hemorrhage (P)

- Trauma-penetrating or acceleration-deceleration
- Also due to tumors, bleeding disorders, anticoagulant or hypertension
Intracerebral Hemorrhage

- **Clinical Presentation**
  - Depends on location, size and rate of blood accumulation
  - Headache, decreased LOC progressing to coma, hemiplegia/hemiparesis progressing to bilateral weakness/paralysis, dilated pupil, increased ICP
Intracerebral Hemorrhage

- **Diagnosis**
  - Skull films
  - CT and MRI

- **Treatment**
  - Supportive including management of ICP
  - Surgery if accessible, rarely improves outcome
Hydrocephalus

- Abnormal accumulation of CSF in cranial vault; brain tissue squeezed against skull
- Caused by tumors, ICH, intraventricular blood, malabsorption by arachnoid villi
- Surgical correction with VP shunt
Neurological Infections

- **Meningitis**
  - Inflammation of meninges and CSF within subarachnoid space caused by bacteria, virus or fungus
  - Blood-brain barrier interrupted
  - With bacterial meningitis, purulent exudate obstructs CSF flow
  - Viral meningitis (acute aseptic meningitis)
Signs and Symptoms

- Headache and fever
- Meningeal irritation
  - Nuchal rigidity
  - Kernig’s Sign: 90 degree hip flexion and attempt to extend knee, + with pain and spasm of hamstring
  - Brudzinski Sign: + when hip and knee flex with lifting the head and neck
- Altered LOC
- Photophobia

Meningococcal – rapid development of delirium and stupor, petechial rash on legs
# CSF Findings in Meningitis

<table>
<thead>
<tr>
<th>CSF Characteristics</th>
<th>Normal</th>
<th>Acute Bacterial Meningitis</th>
<th>Acute Viral Meningitis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Clear</td>
<td>Turbid, cloudy</td>
<td>Clear</td>
</tr>
<tr>
<td>WBC</td>
<td>0-5 cells/mm$^3$</td>
<td>1000-2000 cells/mm$^3$</td>
<td>300 cells/mm$^3$</td>
</tr>
<tr>
<td>Protein</td>
<td>15-50 mg/dL</td>
<td>100-500mg/dL</td>
<td>Normal</td>
</tr>
<tr>
<td>Glucose</td>
<td>40-80 mg/dL $\approx$ 66% of blood value</td>
<td>$&lt;40$mg/dL $\approx$40% of blood value</td>
<td>Normal</td>
</tr>
<tr>
<td>Culture</td>
<td>Bacteria on gram stain</td>
<td>Virus using special techniques</td>
<td></td>
</tr>
<tr>
<td>Pressure</td>
<td>80-100mmH$\text{}_2$O, 8-14mmHg</td>
<td>Elevated; $&gt;180$mmH$\text{}_2$O</td>
<td>Variable</td>
</tr>
</tbody>
</table>
Neuromuscular Disorders

- Guillain-Barre Syndrome
  - Inflammation of nervous system, flu-like illness
  - Probably autoimmune triggered by infection, leads to demyelination of axons
  - Acute onset of lower extremity weakness, ascends rapidly and progresses to respiratory failure
  - Treatment:
    - Supportive
    - IV Ig or plasmaphoresis
Neuromuscular Disorders

Muscular Dystrophy
- Group of inherited diseases in which the muscles voluntary muscles progressively weaken. In some forms of this disease, the heart and other organs are also affected.
- 9 Types….
  - Oculopharyngeal: Affects men and women in later in life. Progresses slowly with weakness in the eye and face muscles. Difficulty swallowing and recurrent pneumonia.
Neuromuscular Disorders

- Myesthenia Gravis
  - Autoimmune disease of neuromuscular junction, destruction of acetylcholine receptor sites
  - Characterized by abnormal muscle fatigue brought on by activity and improving with rest
  - May be autoimmune
  - Thymectomy may improve symptoms
Myesthenia Gravis

- **Diagnosis**
  - Tensilon Test
    - Administration of edrophonium, an anticholinesterase, produces rapid improvement in symptoms

- **Treatment**
  - Mestinon (pyridostigmine)
  - Immunosuppression
  - Plasmaphoresis and IV Ig
Myesthenic Crisis

- Sudden relapse of symptoms
- Rapidly develop respiratory and swallowing difficulties
- May require intubation
- Anticholinesterase drugs ineffective during crisis
- Management is supportive until crisis resolves
Cholinergic Crisis

- Issue of overmedication!
  - Abdominal cramping and diarrhea
  - Generalized weakness, excessive pulmonary secretions, impaired respiratory function

- Tensilon test used to differentiate
  - Improvement with drugs suggests myesthenic crisis
  - No improvement or deterioration suggests cholinergic crisis
Neurosurgery

- **Craniotomy**
  - Surgical opening to allow access to brain
  - Supratentorial for access to frontal, parietal, temporal and occipital lobes
  - Infratentorial to access posterior fossa (midbrain, pons, medulla and cerebellum)
  - Transsphenoidal approach to remove pituitary tumors
Neurosurgery

- **Craniectomy**
  - Excision of portion of skull without replacement, used for decompression or removal of bone fragments from skull fracture

- **Cranioplasty**
  - Repair of the skull using synthetic material
  - Burr holes are small holes drilled on the skull to access underlying structures
    - Drainage of epidural or subdural hematomas, insertion of EVD or ICP monitors
Neurosurgery

- Complications
  - Intracranial hypertension
  - Ischemia or infarction
  - CSF leaks
  - CNS infection
  - Seizures
  - Fluid & electrolyte imbalances-DI following pituitary resection, CSW
Seizure Disorders (P)

- Sudden uncontrolled discharge of electrical activity
- Frequently a symptom of underlying pathology
- Etiology
  - CNS infections, AVM, genetic metabolic disorders, TBI, stroke, following cranial surgery
Clinical Presentation

- Aura
  - Auditory, visual, gustatory, visceral
- Ictal phase-seizure activity
- Post-ictal phase-period following the seizure
  - Sleepy, confused, amnesic
- Generalized seizures originate in all regions of the cortex, partial seizures originate in a specific area
Generalized Seizures

- Absence-childhood, last 5-10 sec, eye blinking, lip smacking
- Atypical absence-associated with mental retardation, same as absence with muscle spasm
- Myoclonic-sudden brief muscle contractions (arms>legs), usually little change in LOC
Generalized Seizures

- Clonic-rhythmic, repetitive clonic movements of extremities (arms > legs), neck and face
- Tonic-clonic-"grand mal", most common, last 2-3 minutes, risk for injuries, tongue biting, head injury
- Atonic-sudden loss of muscle control, fall to the floor, increased risk of injury
Partial Seizures

Clinical manifestations depend on region of brain involved

- Simple partial—may have motor, sensory, autonomic or cognitive manifestations but no loss of consciousness
- Complex partial—most common epileptic seizures in adults, similar to simple but there is loss of consciousness and awareness
Status Epilpticus

- Continuous seizures lasting >5 minutes or two or more seizures with incomplete recovery of consciousness between
- Most common cause is abrupt discontinuation of AEDs
- Characterized by tonic, clonic, or tonic-clonic movements, may be subclinical
Status Epilpticus

- Medical emergency
  - Accompanied by respiratory distress
  - Morbidity and mortality 20%
  - Increased cerebral metabolism leads to hypoglycemia, HTN, increased cardiac output, increased CVP, increased HR, fever, excessive salivation, vomiting, incontinence
    - Elevated catecholamines and lactic acidosis promote cardiac dysrhythmias and autonomic dysfunction
    - Develop electrolyte disturbances and dehydration
Status Epilpticus

- Lack oxygen and glucose stimulates production and release of glutamine, changes in electrical balance eventually leads to instability and injury of neurons.
- If unable to control seizures with AEDs, use general anesthetics until seizure activity on EEG activity stops.
"Brain Attack"

- 3rd leading cause of death and leading cause of disability in the US
- Sudden development of focal neurological deficits caused by interruption of blood flow to brain tissue
  - Brain dependant on constant supply of oxygen and glucose, insufficiency leads to cellular injury
  - Severity proportional to reduced blood flow
  - Infarction core surrounded by ischemic zone
Signs & Symptoms

- **FAST Acronym**
  - **F**acial asymmetry, droop, usually unilateral
  - **A**rm and/or leg weakness and/or numbness, usually unilateral
  - **S**peech abnormal, slurred or unable to speak
  - **T**ime-TPA window 3 hours

- **Headache, visual disturbances, confusion**
Transient Ischemic Attack (P)

- Stroke symptoms lasting <24 hours
- Last several minutes to few hours
- Warning sign for stroke
- 5% risk for stroke within 48 hours
- 10% risk of stroke within 3 months
- 2% death within 3 months
Ischemic Stroke (P)

- Due to thrombus or embolus
- Risk factors:
  - Atrial fibrillation
  - CAD
  - Bacterial endocarditis
  - Valvular heart disease
  - DVT
  - Air and fat embolism
Treatment of Acute Ischemic Stroke

Eligibility for thrombolytic therapy (rtPA)
- Age 18 or older
- Clinical diagnosis of ischemic stroke causing a measurable neurological deficit.
- Time of symptom onset well established to be less than 180 minutes (3 hours) before treatment would begin.
Ischemic Stroke: BP Management

- Patient otherwise eligible for acute reperfusion therapy except that BP is >185/110 mm Hg:
  - Labetalol 10–20 mg IV over 1–2 minutes, may repeat 1 time; or
  - Nicardipine 5 mg/h IV, titrate up by 2.5 mg/h every 5–15 minutes, maximum 15 mg/h; when desired BP reached, adjust to maintain proper BP limits; or other agents (hydralazine, enalaprilat, etc) may be considered when appropriate

- If BP is not maintained at or below 185/110 mm Hg, do not administer rtPA
Ischemic Stroke: BP Management

- Management of BP during and after rtPA or other acute reperfusion therapy to maintain BP at or below 180/105 mm Hg:
  - Monitor BP every 15 minutes for 2 hours from the start of rtPA therapy, then every 30 minutes for 6 hours, and then every hour for 16 hours

- If systolic BP >180–230 mm Hg or diastolic BP >105–120 mm Hg:
  - Labetalol 10 mg IV followed by continuous IV infusion 2–8 mg/min; or
  - Nicardipine 5 mg/h IV, titrate up to desired effect by 2.5 mg/h every 5–15 minutes, maximum 15 mg/h

- If BP not controlled or diastolic BP >140 mm Hg, consider IV sodium nitroprusside
2 peripheral IVs

Complete all invasive procedures

Dose:

- 0.9mg/kg up to max of 90 mg
- 10% of dose as bolus over 1-2 minutes with remaining 90% over 60 minutes
- Hold all antithrombotics for 24 hours to prevent re-bleeding
Hemorrhagic Stroke (P)

- Rupture of cerebral vessel, blood leaks into the brain tissue
  - Major risk factor is long-standing, poorly controlled hypertension
- Most common sites
  - Basal ganglia (50%)
  - Thalamus (30%)
  - Cerebellum (10%)
  - Pons (10%)
Hemorrhagic Stroke: BP Management

- Focus is to prevent rebleeding
  - Between time of bleed and aneurysm obliteration, BP controlled to balance risk of stroke, HTN related rebleeding and maintenance of CPP.
    - Magnitude of BP control not established - decrease in systolic BP to <160mmHg is reasonable.
  - Once aneurysm is secure, increased BP permitted to increase CBF.
    - Goal is to maintain cerebral perfusion and prevent ischemia.
Left Brain Stroke

- Paralysis or weakness on right side
- Impaired speech
- Impaired right/left discrimination
- Slow performance, cautious
- Impaired comprehension related to language and computation
- Aware of deficits - depression, anxiety
Right Brain Stroke

- Paralysis or weakness of left side
- Left-sided neglect
- Spatial-perceptual deficits
- Denies or minimizes problems
- Impulsive
- Rapid performance, short attention span
- Impaired judgement
- Impaired concept of time
Cerebellar Stroke

- Nausea and vomiting
- Dysphagia and dysarthria
- Nystagmus
- Ipsilateral Horner’s Syndrome
- Ataxia and vertigo
- Loss of pain and temperature sensation on opposite side
Safety

- Fall prevention
  - Weakness, visual deficits, neglect/denial, impulsiveness, memory deficits, overestimating abilities and underestimating deficits

- DVT
  - Compression stockings

- Aspiration
  - Swallow screening

- Seizures
Motor Deficits

- Mobility
- Respiratory function
- Swallowing and speech
- Gag reflex
- Self-care
Affect

- Difficulty controlling emotions
  - Exaggerated or unpredictable
  - Depression
  - Frustration
Intellectual Function

- Impaired memory and judgment
  - Left
    - Memory problems related to language
    - Extremely cautious
  - Right
    - Impulsive
    - Moves quickly
    - Underestimates limitations
Spatial-Perceptual Alterations

- Can occur with both but more common in right-sided stroke
  - Altered perception of self and limitations
  - Deny illness or body parts
  - Neglect input from affected side
  - Erroneous perception of self related to space
  - Worsened by homonymous hemianopsia, agnosia and/or apraxia
Urinary Elimination

- Present initially but usually resolves over time
- Prognosis for normal bladder function best if stroke affects only one side
  - Intact sensation of bladder filling
  - Voluntary urination present
- UTI most likely due to presence of indwelling catheter
Bowel Elimination

- Motor control usually intact
- Problems associated with constipation
  - Immobility
  - Weak abdominal muscles
  - Dehydration
  - Diminished response to defecation reflex
  - Inability to express needs
  - Difficulty managing clothing
Airway Management

- Optimal positioning to maintain a clear airway and maximize intrathoracic pressure during cough
  - Deep breaths, several huffs against open glottis and lean forward to expectorate secretions
  - Incentive spirometry
Mobility

- Active and/or passive ROM
- Positioning
  - Prevent dependant edema
  - Preserve function
  - Careful positioning and moving to avoid injury and pain
    - Trochanter roll
    - Hand cones
    - Arm supports and slings
    - Do not pull up by arms
- Rest periods after to exercise
Neglect

- Teach patient to scan the environment
- At first, approach from unaffected side, later approach patient from affected side
- Place objects in field of vision
- Provide physical and verbal cues
- Teach patient & family to stimulated affected limbs to promote reintegration with whole body
- Remind patient to survey whole body for position, cleanliness and appropriate dress
Nutrition

- NPO until swallow screening completed and oral intake approved by SLP or physician
- Out of bed for meals if possible, HOB as close to 90° as possible
  - Maintain sitting position for 30 min after meal
- Teach patient to take small bites, place in unaffected side of mouth
- Check oral cavity for pocketing
- Consult OT for assistive devices
Urinary Incontinence

- Avoid indwelling catheter, remove ASAP
- Establish toileting schedule based on voiding patterns
Self-Esteem

- Establish achievable goals
- Involve patient in planning
- Praise every success
- Encourage independence
- Identify stressors and situations that trigger emotional response

What matters most is how you see yourself.
Body Image

- Monitor patient’s ability to look at affected body part
- Help patient to determine extent of actual changes
  - Prevent misinterpretation of function