Objectives

- Review Neurological Assessment
- Discuss the basic neuro anatomy and physiology
- Describe the pathophysiology, management and nursing interventions of:
  - Hydrocephalus
  - Cerebrovascular disease
  - Meningitis
  - Seizures/status epilepticus
  - Head/Spinal Cord Injury
  - Neuromuscular Disorders

Basic Neurologic Exam

- Level of consciousness
- GCS
- Orientation and speech fluency
- Cranial Nerves
- Strength, drift
- Sensation
- Ataxia, cerebellar signs
- DTRs and “extras”

Level of Consciousness
Glasgow Coma Scale (GCS)

- Consists of three categories:
  - Eye opening
  - Best verbal
  - Best motor

- Scores range from 3 to 15.

- The lower the score, the worse the patient and prognosis.

Orientation and Speech Fluency

- Person, place, time, situation
- Speech:
  - Sound, vocality
  - Clarity
  - Ability to find words and receive words
- Broca’s and Wernicke’s

Muscle strength grading scale

- 0/5: no contraction
- 1/5: muscle flicker, but no movement
- 2/5: movement possible, but not against gravity
- 3/5: movement possible against gravity
- 4/5: movement against some resistance by the examiner
- 5/5: normal strength
Sensation

- “Neglect” more common in RMCA ischemic strokes
  - Can vary in degrees from mild sensory loss to hemibody neglect
- Tested with eyes closed
- Sharp versus Dull

Cerebellar exam

- Ataxia
  - Uncoordinated muscle movements to complete a task
- Dysdiadokinesia
- Gait

DTRs

- Different disease can manifest as hyporeflexic or hyperreflexic
- Hyperreflexia usually means “upper motor neuron lesion”
- Hyporeflexia problem with reflex arc

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<tr>
<th>Grade</th>
<th>Description</th>
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<tr>
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<td>1+</td>
<td>Diminished</td>
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<tr>
<td>2+</td>
<td>“Normal”</td>
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<tr>
<td>3+</td>
<td>Hyperactive without clonus</td>
</tr>
<tr>
<td>4+</td>
<td>Hyperactive with clonus</td>
</tr>
</tbody>
</table>

Posturing
Respirations

• Cheyne-Stokes
• Central neurogenic
• Apneustic
• Ataxic

ICP

• Blood, Brain, Cerebral Spinal Fluid
• Skull is incompressible.
• Monroe-Kellie doctrine:
  – If one dynamic changes inside the skull, the other 2 must change to accommodate and maintain a normal intracranial pressure
  – There is “end point”

Elevated ICP

• Normal ICP 5-15 mmHg
• ICP >20 mmHg has been associated with worse outcome and is usually treated.

Elevated ICP

• Alias: “intracranial hypertension”
• Why is elevated ICP bad?
  – Reduces cerebral perfusion pressure (CPP)
  – Causes ischemia
  – Herniation Syndromes
  – Death and Destruction
Cerebral Perfusion Pressure

**MAP – ICP = CPP**

**Keep CPP >60-70**

- Body detects decreased CPP
- Raises ICP
- Raises SBP
- Dilates cerebral b.vessels
- Increase cerebral blood volume

Cerebral Perfusion Pressure

- Cerebral Perfusion Pressure (CPP) = MAP – ICP
- MAP = Diastolic Pressure – 1/3 Pulse Pressure

**Example:**

- HR = 78
- B/P = 120/60
- MAP = 80
- ICP = 10
- CPP = 70

Elevated ICP

- Focal examination findings
- Headache
- Nausea and vomiting
- Depressed level of consciousness
- Ocular palsies
- Papilloedema
- Hyperventilation or Cheyne-Stokes respirations
- Cushing’s Triad

Elevated ICP

Cushing’s Triad

- Raised systolic blood pressure
- Widened pulse pressure
- Bradycardia
Elevated ICP: Treatment

- Treat the cause!
  - Optimize jugular venous return
  - Reduce other systemic ICP contributors (high PEEP, intra-abdominal pressure) and protect CPP
  - Hyperventilation (short term fix)
  - Mannitol and Hypertonic Saline
  - Reduce brain’s metabolic/oxygen demands (sedation/paralysis)
  - Open the box?

External Ventriculostomy Drains

- Monitor plus treatment
- Must be level with tragus of ear

Intraparenchymal Bolt

- Zeroed once with insertion
- Only offers ICP monitoring

ICP Waveform

- ICP waveform has three peaks:
  - P1—the percussion wave (arterial)
  - P2—the tidal wave (rebound)
  - P3—the dicrotic wave (venous)
ICP Waveform

- Normal waveforms simulate arterial waveform pattern
- P1 should be higher than P2 under normal conditions
- Pathologic waveforms:
  - P2 higher than P1
  - Lundberg waves

ICP Waveform

- Lundberg waves followed over minutes
- A and B wave patterns are problematic
- A waves (plateau) are the sudden increases in ICP, last up to 20 minutes.
- B waves shorter duration ICP spikes

Things to Avoid

- Acidosis
- Hypotonic Solutions
- Hyperextension or flexion of neck
- Low Protein Intake
- Wrist Restraints

Herniation Syndromes

- Subfalcine
- Transcalvarial
- Transtentorial
- Uncal
- Tonsillar
Traumatic Brain Injury

- External noncongenital injury
- Multitude of mechanisms
- Graded by severity (Glasgow Coma Scale)
- GCS 3-8 = SEVERE
- 9-12 = MODERATE
- 13-15 = MILD

Types of Injuries

- Concussion
- Contusion
- Coup-Countercoup Injury
- Diffuse Axonal Injury
- Hemorrhagic Injury
- Penetrating Injury

TBI: Types of Injuries

- Concussion- immediate temporary loss of consciousness from mechanical force to the brain
- Contusion- bruising of cerebral cortex, injury ranges from mod-severe, have LOC and confusion
- Coup injury occurs under the site of impact with an object
- Contrecoup injury occurs on the side opposite the area that was impacted
- Diffuse Axonal shearing of white matter tracts, is one of the major causes of unconsciousness and persistent vegetative state after head trauma

TBI: Types of Injuries

- Penetrating-missile injuries, gun shots, nail guns.
  - Location, path and depth of injury affect symptoms and severity
  - high risk for infection from hair, bone fragments, skin entering brain
- Stab wounds-knife, ice pick, scissors
  - neurologic injury depending on the location
TBI: Types of Injuries

- Epidural Hematoma
  - Between skull and dura mater
  - Usually from arterial bleeding source
    - Rapidly expanding & Life threatening
    - Treatment: emergency surgical evacuation

- Subdural Hematoma
  - Between dura mater and arachnoid/pia layers
  - Often venous bleeding source
    - May be acute or chronic
    - Can be life threatening
- ICH
- SAH

Severe TBI: Guidelines

- [www.braintrauma.org](http://www.braintrauma.org)
- Avoid hypotension (SBP <90mmHg)
- Avoid hypoxemia (PaO2 <60mmHg or O2 saturation <90%)
- Use hyperosmolar therapy when indicated, not prophylactically
- Prophylactic hypothermia may help
- Periprocedural antibiotics preintubation reduces PNA risk

Meninges

Severe TBI: Guidelines

- VTE prophylaxis
- ICP monitoring in all severe TBI patients (GCS <8) with abnormal CT scan (EVD is best)
- Treat ICP >20mmHg
- Avoid CPP <50. Avoid aggressive fluid resuscitation to keep CPP >70
  - Keep CPP 50-70, closer to 70 if intact autoregulation
Severe TBI: Guidelines

- Brain tissue oxygen monitoring:
  - Avoid Jugular venous O2 sat <50% or brain tissue O2 <15mmHg
- Use barbituates or propofol* (not high dose) in refractory ICP
- Don’t give prophylactic steroids or anticonvulsants
- Feed your patients early and fully

Skull Fractures

- Linear
- Depressed
- Diastatic
- Basilar

Basilar Skull Fractures

Raccoons Eyes
Battle Sign
Ottonrhea
Rhonnorrhea
Lose Cranial Nerve I

Skull Fracture

- Linear-Bed rest and observation
- Basal-Bed rest, prophylactic antibiotics
- Depressed-Surgery to elevate the bone and debridement
  - craniectomy
  - cranioplasty
### Stroke
- Ischemic Stroke
- Intraparenchymal Hemorrhage
- Subarachnoid Hemorrhage

### Ischemic Stroke
- Most common causes:
  1. Cardioembolism
  2. Small artery occlusion
  3. Large artery atherosclerosis
- Acute onset neurological symptoms, vary according to location
- tPA is still the only FDA approved therapy for the treatment of ischemic stroke

### Acute Stroke Management
- Early stroke imaging
- Ruling out stroke mimickers
- Early intervention
- FDA approved IV tPA to 3-4.5 hours
- tPA activates plasminogen to plasmin in order to lyse clots

### tPA administration
- Dose 0.9mg/kg
- Maximum 90mg administered
- 10% bolus, followed by rest given over 1 hour
- Have foley, arterial line, and IVs inserted prior to tPA start. Don’t delay tPA for these procedures.
- VS, neuro exam monitoring.
- Keep SBP <185 and DBP <105
- Side effects monitoring
Acute Ischemic Stroke Management

• Endovascular Stroke Intervention
  – Intraarterial tPA
  – Mechanical Embolectomy and thrombolysis

Post-Stroke Complications
  – Cerebral Edema and herniation
  – Seizure
  – Aspiration, VTEs, infections
  – Falls
  – Recurrent stroke

Intraparenchymal Hemorrhage

• Alias Intracerebral Hemorrhage (ICH)
• Most common cause = uncontrolled hypertension
• Other causes, some include:
  – Amyloid Angiopathy
  – Vascular lesions
  – Brain Tumor, infections

ICH key points

• Acute neurologic symptoms
• Goals in early management:
  – Prevention of rebleeding/hematoma expansion
    • Blood pressure, blood glucose control
    • Anticoagulant reversal
  – Diagnosis of bleeding cause
  – Treatment of potential complications
    • Intraventricular blood and hydrocephalus
    • Edema, intracranial hypertension
    • Seizure

Subarachnoid Hemorrhage

• Most common cause is TRAUMA
• Nontraumatic cases 80% due to cerebral aneurysm
• Hallmark symptom is WORST HEADACHE OF LIFE
• Other symptoms can include
  – Neck/back pain
  – Focal neurologic symptoms
  – Symptoms of increased ICP
  – Seizure
Subarachnoid Hemorrhage

- Hunt-Hess Grading Scale
  - Clinical exam scale
  - Corresponds to mortality/morbidity scoring
- Modified Fisher Grading Scale
  - CT grading scale (amount and location of blood on CT)
  - mFS scores 3 and 4 highest risk for cerebral vasospasm
- WFNS grading scale

Subarachnoid Hemorrhage: 5 key points

- Rebleeding
  - Early diagnosis and treatment of aneurysm
  - Platelet and clotting normalization, when applicable
  - Blood pressure management
- Cerebral edema and Hydrocephalus (HCP)
  - Early: obstructive HCP
  - Later: communicating HCP
- Cerebral vasospasm
- Cerebral Salt Wasting
- Seizure

Hydrocephalus

- Progressive dilation of ventricular system

- Potential causes
  - Less CSF is absorbed than is produced
  - More CSF is produced than absorbed (very rare)
  - Blockage in normal CSF flow pathways

Hydrocephalus Signs and Symptoms

- Mental status changes
  - Forgetfulness
  - Change in cognitive function
  - Decreased LOC
- Gait disturbance
  - Slowed pace
  - Wide base
  - Zig-zag steps
  - Unsteady
  - Loss of ambulation
**Hydrocephalus Treatment**
- Treatment of the ICP
  - Preventing intracranial hypertension
  - Ventriculostomy Drain/Shunt
  - Osmotic Diuretics (ex. Mannitol)
  - Hemi-craniectomy
- Eliminating/treating cause

**Brain Tumor Basics**
- Most common malignant brain tumors in brain are metastatic cancers
  - Lung, breast, renal cell, melanoma
- Primary brain tumors may be malignant or benign

**Brain Tumor Basics**
- Symptoms vary according to location
- Benign tumor typical behavior: slow growing, rarely spread.
  - Can be life threatening if in vital location
- Malignant tumor typical behavior: fast growing, indistinct borders, spread throughout CNS

**Brain Tumor Basics**
- Average 5 year prognosis survival from brain CA ~ 31%
- Surgery gives primary brain CA patients best survival hope
- Post-op considerations:
  - General
  - Edema
  - Seizures
  - Endocrine
Seizure

- Abnormal firing of neuron from cerebral cortex
  - Partial
    - Simple (consciousness preserved)
    - Complex (consciousness impaired)
  - Generalized (consciousness lost)

Seizure

- Causes: multifold!
  - Any kind of cortical lesion
  - Drugs/alcohol
  - Fever
- Typical seizure lasts few seconds to few minutes (depending on kind)

Interventions

- Maintain ABC’s and keep patient safe
- Time the seizure
- Treat the seizure
  - Not every seizure has to be treated
  - First treatment choices are LORAZEPAM OR DIAZEPAM
    - DIAZEPAM has rectal suppository route if you don’t have IV access
    - Buccal or intranasal midazolam options
- Eliciting the cause
- Preventing further seizures

Status Epilepticus

- Defined either as a seizure lasting >30 minutes or multiple seizures without return to baseline between
- If you have seizure >5 minutes, YOU MUST SUSPECT AND BEGIN TREATING
- Can have subtypes of status (generalized, partial, nonconvulsive)
- Status is a neurological emergency!
**Status Epilepticus: Treatment**

- Benzodiazepines
  - Diazepam 0.15mg/kg or lorazepam 0.1mg/kg
  - Often escalating, high doses
  - Midazolam infusion if single doses not enough
- Airway support if escalating BZDs are required
- Antiepileptics
- Anesthetics
  - Propofol sometimes used
  - Pentobarbital usually for refractory status
- EEG
- Cause investigation
  - Easy things to think about in the ED: hypoglycemia (Dextrose IV) or drug overdose (naloxone)

**Meningitis**

- Irritation of the brain’s coverings
- Can be infectious or noninfectious
- Symptoms:
  - Headache
  - Nuchal rigidity
  - Photophobia
  - Focal symptoms

**Meningitis: Treatment**

- Early identification
  - Lumbar Puncture**
  - Rapid CT imaging for anyone who is suspected to have elevated ICP
- Early treatment
  - Antimicrobials (bacteria/HSV/fungus)
  - Neisseria coverage for anyone at risk
  - Listeria coverage for persons at risk
  - Steroids

**Brudzinski’s and Kernig’s signs**

- Headache
- Nuchal rigidity
- Photophobia
- Focal symptoms

Brudzinski’s and Kernig’s signs are physical signs that may indicate meningitis or other neurological conditions. They involve the patient’s response to certain movements and can be indicative of increased intracranial pressure (ICP).
### Meningitis

<table>
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<th>Bacterial</th>
<th>vs</th>
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<tbody>
<tr>
<td>Staph Aureus</td>
<td></td>
<td></td>
<td>Enterovirus or Herpes Virus</td>
</tr>
<tr>
<td>Very Elevated Protein</td>
<td>Elevated Protein</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leukocytes</td>
<td></td>
<td></td>
<td>Lymphocytes</td>
</tr>
<tr>
<td>Low Glucose</td>
<td></td>
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<td>Normal Glucose</td>
</tr>
<tr>
<td>Purulent</td>
<td></td>
<td></td>
<td>Clear</td>
</tr>
</tbody>
</table>

Headache, Nuchal Rigidity, Kernig's Sign and Brudinski's

### Encephalitis

- Inflammatory process of the brain with clinical evidence of neurologic dysfunction
- Virus (HSV) is most common
- Careful H&P, assessment of any encephalitis “risk factors” is key
- Diagnosis usually involves cultures, CSF cultures, sometimes brain biopsy

### Guillain Barré

- Aggressive, inflammatory disease affecting the peripheral nerves

### Pathophysiology

- Inflammatory response triggered by a viral or bacterial infection 1-3 weeks prior
  - Campylobacter jejuni, cytomegalovirus, Ebstein-Barr, Mycoplasma Pneumonia
- Suggested link to vaccinations
- Damage to nerves of the PNS by antimyelin antibody
Characteristics

• Motor weakness
  – Symmetric
  – Begins in legs, progresses to trunk and arms
  – Respiratory failure possible

• Cranial nerve involvement
  – CN 7 (facial nerve)
  – CN 9 (glossopharyngeal), CN 10 (vagus), CN 11 (spinal accessory), CN 12 (hypoglossal)

Characteristics

• Sensory changes
  – Paresthesias: pins and needles, hypersensitivity

  – PAIN: cramping progressing to frank pain in the arms, legs, back, and buttock

Characteristics

• Sympathetic and parasympathetic dysfunction
  – Orthostatic hypotension/hypertension
  – Bradycardia
  – Bowel and bladder problems
  – Diaphoresis

Phases

• Acute: 1-3 weeks
• Plateau: few days to few weeks
• Recovery: up to 2 years with residual symptoms
Diagnosis

- Progressive weakness of 2 or more limbs due to neuropathy
- Areflexia
- Disease course <4 weeks
- Other causes ruled out

Treatment

- IVlg
- Plasmapheresis
- Cardiac monitoring
- Respiratory monitoring
  - Vital capacity=12-15 ml/kg
  - 160 lb patient=1000-1200 ml

Diagnosis

- Recent viral infection
- Elevated CSF protein level with NML cell count
- Abnormal EMG
- Slow nerve conduction

Symptom Management

- Autonomic dysfunction
  - Watch for:
    - cardiac arrhythmias
    - paralytic ileus
    - Urinary retention
    - Fluid and electrolyte imbalance
    - Sleep dysfunction
Symptom Management

- **PAIN**
  - “severe charley horse”
  - Worse at night
  - Not relieved by NSAIDS or non-narcotic agents
  - Narcotics via slow drip/subcutaneous

Myasthenia Gravis-MG

- Defined: acquired autoimmune disease consisting of weakness of skeletal muscles and fatigue that worsens with exercise and improves with rest
- Block or loss of acetylcholine receptors at the NMJ
- Treatment: monitor respiratory function, myasthenic crisis vs. cholinergic crisis, IVIG, plasma exchange, corticosteroids

Myasthenia Gravis-MG

- Myasthenic crisis:
  - Result of undermedication or lack of response
  - Sudden worsening of symptoms
  - Intubation
  - Usually a result of infection, stress, medications
- Cholinergic crisis:
  - Result of overmedication
  - Patient managed similar to myasthenic crisis
  - DC previous medication regimen and begin new protocol
  - Avoid neuromuscular blocking agents

Tensilon Test

- Edrophonium chloride (Tensilon) is a drug that temporarily blocks the action of acetylcholinesterase
- administered intravenously (into a vein) and muscle response is evaluated
- Side effects of the test include temporary abnormal heart rhythms such as rapid heart rate (atrial fibrillation) and slow heart rate (bradycardia)
MG: Diagnosis

- Bloodwork for antibody testing
- Clinical Exam
- EMG

MG: Treatment

- Anticholesterase drugs
  - Pyridostigmine (Mestinon)
  - Atropine is the reversal agent
- Thymectomy
- Steroids
- Plasmapheresis
- IVIG

**STRICT ADHERENCE TO MEDS**

Anticholesterase Interactions

- Depolarizing neuromuscular blocking agents
- Antibiotics
  - Amino glycosides
  - Quinolones
- Beta Blockers

Spine

- 33 bones
  - 7 cervical
  - 12 thoracic
  - 5 lumbar
  - Sacrum: 4 fused sacral vertebrae fused to form a single bone
  - Coccyx: 4 fused coccygeal vertebrae
Dermatomes

- Skin areas supplied by sensory fibers of a given spinal nerve
- Evaluate level of injury

Superficial reflexes - spinal nerve innervation

<table>
<thead>
<tr>
<th>Upper abdominal</th>
<th>T8-T10</th>
<th>Stroke upper abdomen</th>
<th>Abdominal wall contraction causes umbilicus to move toward stimulus</th>
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<td>T10-T12</td>
<td>Stroke lower abdomen</td>
<td>Abdominal wall contraction causes umbilicus to move toward stimulus</td>
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<td>Cremasteric</td>
<td>L1, L2</td>
<td>Stroke medial thigh</td>
<td>Testicular elevation</td>
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<td>Bulbocavernous</td>
<td>S3</td>
<td>Apply pressure to the glans penis</td>
<td>Contraction of the anus</td>
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<tr>
<td>Perianal</td>
<td>S3-S5</td>
<td>Stroke perianal area</td>
<td>Contraction of the external anal sphincter</td>
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Spinal Cord Injuries

- Brown-Séquard syndrome
- Central Cord Syndrome