Neuro Review

I. Cerebral metabolism
   a. Average adult brain is 1500 g
   b. CMRO$_2$ = 50 ml/min or 3.5 ml/100g/min
      i. 60% electrical activity
      ii. 40% cell integrity
   c. Brain lacks O$_2$ reserve
      i. Loss of consciousness in 10 secs
      ii. Hypoxic injury in 3 – 8 mins
         1. Hypocampus and cerebellum most sensitive

II. Cerebral blood flow
   a. Parallels metabolic activity
      i. Ranges between 10 – 300 ml/100g/min
      ii. Average 50 ml/100g/min
      iii. About 20% of cardiac output
      iv. Flows below 10 ml/100g/min associated with hypoxic injury
   b. Extrinsic control of CBF
      i. PaCO$_2$ linear correlation with CBF between 20 – 80
      ii. PaCO$_2$ < 20 associated with ischemia
      iii. PaO$_2$
         1. Hyperoxia causes little change
         2. Hypoxia acutely raises CBF
   iv. Temperature
      1. 6 - 7% change / °C
   v. Autonomic control of CBF
      1. Vessels receive sympathetic and parasympathetic innervation
      2. Physiologic function remains unclear
         a. Roll may only be in pathologic states
      3. Pharmacologic control through the ANS very limited
   vi. Hypertension causes a left shift of autoregulation curve
vii. Extrinsic control summary

III. Cerebral perfusion pressure
   a. CPP = MAP – ICP (or CVP if greater)
      i. Normally 80 – 100
      ii. CPP < 40 = flat EEG
      iii. CPP < 25 = brain damage – worse with hyperglycemia

IV. Cerebrospinal Fluid
   a. Found in ventricles, cisterns and subarachnoid space
   b. Formed in choroid plexus
   c. Absorbed by arachnoid villi
   d. Adults make 400 – 500 mL/day
      i. CSF production decreased by steroids, acetazolamide, furosemide, isoflurane spironolactone and vasoconstrictors
   e. CSF volume is about 150 mL
   f. CSF flow
      i. Lateral ventricle to foramina of Monroe to 3rd ventricle to cerebral aqueduct to 4th ventricle to foramen of Magendie to cysterna magna to subarachnoid space
   g. CSF chemistry
      i. Isotonic with plasma
      ii. Lower K⁺, HCO₃⁻, glucose and protein
      iii. Specific gravity = 1.003 – 1.009

V. Sitting Craniotomy
   a. Usually done for lesions in posterior fossa
   b. Increases likelihood of pneumocephalus and excessive CSF loss
   c. Venous air embolism
      i. 20 – 40% incidence (highest of all surgeries)
      ii. Paradoxical embolism can occur with probe-patent foramen ovale (10 – 25%)
      iii. Venous air trapped in pulmonary vascular tree
         1. Increased PA pressures
         2. Decreases ETCO₂
         3. Hemodynamic manifestations
4. Aspiration via CVP – multiorifed catheter should be placed in upper RA
5. Treatment
   a. Notify surgeon – flood surgical field, pack bone
   b. DC nitrous oxide
   c. Aspirate CVP
   d. Increase CVP with volume, PEEP
   e. Bilateral jugular vein compression
   f. Hemodynamic support
   g. Head down if necessary

VI. Cerebral aneurysms
   a. Aneurysms and AVMs are most common causes of nontraumatic intracranial hemorrhage
   b. Usually occur at arterial bifurcations
   c. 10 – 30% have multiple aneurysms
   d. 5% of population have aneurysms
   e. M&M very high from rupture (50%)
   f. > 7mm warrants intervention
   g. Vasospasm can occur after rupture (30%)
   h. Vasospasm treated with “triple H” therapy
      i. Hypervolemia, hemodilution, hypertension
   i. Unruptured aneurysms associated with headache, 3rd nerve palsy
   j. Patients usually 40 – 60 years of age
   k. Intraop management
      i. Tightly managed hemodynamics
         1. Both hyper and hypotension can cause rupture – caution with intubation
         2. Avoid rapid decrease in ICP prior to opening of dura – this may precipitate rupture
         3. “Brain relaxation” or “slack brain” facilitates surgery – mannitol, steroids, hypocapnia, thiopental(?)

VII. Seizure disorder
   a. Grand Mal (Tonic-Clonic) seizures
      i. Usually idiopathic
      ii. Seizures usually benign, secondary injury common
      iii. Airway reflexes preserved during seizure
      iv. Patients tolerant to opioids, NMBs
      v. Sudden intraop hemodynamic changes may indicate ongoing seizure
   b. Petit Mal
      i. Patients appear to be day-dreaming
      ii. May be resistant to NMB’s depending on medication

VIII. CVA
   a. This is a major perioperative risk
      i. Age > 50 = 0.4%
      ii. Age > 80 = 2.4%
iii. Vascular reconstructions = 1%
iv. CABG = 1 – 5%
v. CEA = 3%

b. CEA
   i. Maintain BP in preop range
   ii. Cerebral monitoring – awake patient is best, next is EEG
   iii. Bradyarrhythmias can occur with carotid sinus manipulation
   iv. Postop hemodynamic instability common

IX. Intracranial hypertension and hydrocephalus
   a. Intracranial hypertension
      i. Cranial vault has a fixed volume
         1. Brain – 85%
         2. CSF – 10%
         3. Blood – 5%
         4. ICP > 15 mmHg = intracranial hypertension
         5. Cushing’s Triad – hypertension, bradycardia, irregular ventilation
      ii. Hydrocephalus
         1. Congenital – aqueductal stenosis, Arnold-Chiari malformation, Dandy-Walker syndrome
         2. Posttraumatic
         3. Neoplastic
         4. Post-inflammatory

b. Methods of reducing ICP
   i. Hyperventilation – most efficient method, but temporary
   ii. Head elevation
   iii. Avoidance of hypoxia
   iv. Osmotic diuretic therapy – mannitol, not urea
   v. Corticosteroids
   vi. Thiobarbiturates
   vii. CSF drainage

c. Cerebral protection
   i. Doesn’t work – outcome studies report no change

d. Anesthetic management of patients with increased ICP
   i. Avoid premeds – depress ventilation
   ii. Hyperventilation prior to induction
iii. Thiopental, etomidate, propofol, lidocaine all decrease ICP
iv. Nitrous, volatile agents, ketamine all are cerebral vasodilators
v. Osmotic diuretics

e. Parkinson’s Disease
i. Degenerative extrapyramidal disease
ii. Dopaminergic failure with cholinergic excess in basal ganglia
iii. Bradykinesia, tremor, postural instability
iv. Dementia in up to 50%
v. Treatment
1. L-dopa
2. Bromocryptine, lergotrile
3. Amantadine
4. selegiline
5. CNS anticholinergics
6. Sterotactic surgery
vi. Anesthetic management
1. Avoid droperidol, phenothiazines
2. Treat nausea with anticholinergics
3. May have reduced responsiveness to indirect acting pressors
4. Selegiline a monamine oxidase inhibitor – no ephedrine
5. May have contracted intravascular volume
6. Postop delirium common

f. Multiple Sclerosis
i. Demyelinating disease of CNS
ii. May have autonomic dysfunction
iii. Symptoms aggravated by hyperthermia
iv. Patients have often received steroid therapy
v. Anesthetic management
1. Avoid hyperthermia
2. Spinal anesthetic associated with exacerbation

g. Alzheimer’s disease
i. Affects 6% over 65, 18% over 75, 50% over 85
ii. Disease of cholinergic neurons in CNS
iii. Extensive cerebral atrophy – especially hippocampus
iv. Treatment with CNS anticholinesterases

h. Autonomic dysreflexia
i. Seen with spinal cord lesions above T7
ii. CNS inhibition of SNS lost
iii. Develops 2 – 3 weeks after injury
iv. Treatment
1. Stop inciting event
2. Nifedipine prophylaxis
3. Spinal anesthetic
4. Centrally acting antihypertensives not effective
v. With spinal cord trauma initial pathophysiology is lower-motor neuron, then upper-motor neuron
   1. After 48 hours avoid succinylcholine
   2. May use succinylcholine after spasticity ensues

Coma

- Pathophysiology
  Coma implies diffuse cerebral pathology or dysfunction
  Many causes including: hyperosmolar coma, shock, head trauma, poisoning, infection, uremia, electrolyte imbalance

- Glasgow coma scale
  \[ \begin{array}{c|c}
  \text{Eye Opening} & \text{Score} \\
  \hline
  \text{Spontaneous} & 4 \\
  \text{To speech} & 3 \\
  \text{To pain} & 2 \\
  \text{None} & 1 \\
  \end{array} \]

  \[ \begin{array}{c|c}
  \text{Motor Response} & \text{Score} \\
  \hline
  \text{Obeys} & 6 \\
  \text{Localizes} & 5 \\
  \text{Withdraws} & 4 \\
  \text{Abnormal flexion} & 3 \\
  \text{Extensor response} & 2 \\
  \text{None} & 1 \\
  \end{array} \]

  \[ \begin{array}{c|c}
  \text{Verbal Response} & \text{Score} \\
  \hline
  \text{Oriented} & 5 \\
  \text{Confused} & 4 \\
  \text{Inappropriate words} & 3 \\
  \text{Incomprehensible} & 2 \\
  \text{None} & 1 \\
  \end{array} \]