ICU Management after Reperfusion Therapy

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Disclosures / Objectives

Disclosures:
- No financial disclosures

Objectives
- Review ICU management of AIS
- Discuss treatment options
Acute Stroke: Optimum Scenario

- Symptoms rapidly identified
- Early presentation to stroke center
- Head CT is negative
- ‘Clot-buster’ drug given
- Resolution of symptoms
- Short stay in ICU

- Unfortunately that is not the typical scenario!
Critical Care Issues

- Blood Pressure Control
  - Procedure related events

- General Measures – Aim for Normal
  - Temperature
  - Electrolytes (sodium, glucose)
  - Volume status
  - Respiratory Management

- Mass Effect / Intracranial Hypertension

- Medical Decision Making

- Preventative ICU Measures & Recovery
Hyperacute BP Management in AIS

- No tPA: generally < 220 / 120
  - Exceptions
    - aortic dissection; acute MI; heart failure; acute renal failure; hypertensive encephalopathy
- Prior / After tPA: < 185 / 110 prior; < 180 / 105 after
- Post Thrombectomy: SBP < 140 – 160

- Consider BP Augmentation
  - Fluctuating symptoms: MAP ↑ by 20 – 25%
  - Large vessel occlusion
  - Sedation
BP Control Agents

Optimal agents
- Short-acting continuous infusions
- Reliable dose-response relationship
- Favorable safety profile

Acute Ischemic Stroke (no tPA)
- Fluctuating symptoms / inducing HTN: fluids, phenylephrine, norepinephrine
Blood Pressure Agents

- **Nicardipine**
  - Minimal cerebral vasodilation
  - Titratable – 5 to 15 mg/hr; adjust every 5 – 15 minutes
  - Can result in pulmonary shunting and hypoxia

- **Clevidipine**
  - Similar to nicardipine but costs more
  - Rapid titration – 2 to 32 mg/hr; adjust every 1-2 minutes
  - Lipid load

- **Labetolol**
  - Bolus 10 – 20 mg
  - Longer half life

- **Enalapril; Esmolol**
BP Control Agent ‘Whys’

- No Nipride
  - Dilates cerebral vasculature
  - Raises ICP, lowers CPP
  - Impairs autoregulation
  - Lacks smooth dose-response curve
    - Excessive hypotension in elderly or hypovolemic patients
    - Rebound hypertension during withdrawal
  - Cyanide, thiocyanate toxicity
CATIS – antihypertensives vs none

4071 patients
SBP 140 - 220
Randomized w/in 48 hrs

He et al, CATIS Trial. JAMA. 2014;311(5):479-489
Procedure Related Events

- Autonomic dysfunction can occur post carotid procedures
- Bradycardia & Hypotension
  - Atropine at bedside
  - Augment blood pressure
- Duration is usually 24 hours
Temperature Control

- Fever definition: $T \geq 101.5^\circ F$ or $\geq 38.5^\circ C$.
- "central fevers" is a diagnosis of exclusion

<table>
<thead>
<tr>
<th>Causes of Fever in NSICU</th>
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<tbody>
<tr>
<td><strong>Infectious</strong></td>
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<tr>
<td>Urinary tract infections</td>
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<tr>
<td>Pneumonia</td>
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<tr>
<td>Line infections</td>
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<tr>
<td>Septicemia</td>
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<tr>
<td>Meningitis / ventriculitis</td>
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<tr>
<td>Wound infection</td>
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</table>

Fever definition: $T \geq 101.5^\circ F$ or $\geq 38.5^\circ C$. “central fevers” is a diagnosis of exclusion.
Fever in the NSICU

Diagnostic work up

- Blood cultures x 2 sets.
  - CVL, arterial line, or peripheral site.
- Urine for urinalysis ONLY; change Foley catheter
- Chest X-ray
- Bronch guided BAL / PAL if intubated; NO sputum
- CSF if a ventriculostomy or lumbar drain present.
- Swab from any site with evidence of purulent discharge
- Consider LP

No more cultures for 48 hours

- Repeat cultures are not necessary within 48 hours after initiation or modification of antibiotics.
Empiric Antibiotics

- No benefit to prophylactic antibiotics
- Triggers to start (combination of 3):
  - Leukocytosis
  - Fever
  - Abnormal culture / radiographic findings
  - Clinical findings (hemodynamic instability suggestive of sepsis, hypoxia, secretions, wound drainage, etc.)
- Use empiric agents that match ICU biogram
- Culture results
  - If negative at 72 hours, stop antibiotics
  - If positive, narrow antibiotics based on results. Do not treat a colony count < 10k, hesitate on 10 – 50k.
  - Positive urine cx: change foley 24 hrs after antibx started
Temperature Control

- Goal temperature
  - No benefit of hypothermia

- Method
  - Multiple options

- Shivering
  - Have a protocol

Zoll

Artic Sun
Volume Status

- Maintain normal volume status
  - No good measurement – options include daily weights, bedside US

- Isotonic solutions
  - Aggressively treat hyponatremia
  - Sodium 135 – 145

- Enteral fluids whenever possible
  - Shortage of IVFs
Normoglycemia

- Hyperglycemia (> 180 mg/dL) has been associated with increased mortality & morbidity
- Effects in injured brain:
  - Increased acidosis, release of excitatory amino acids, increases edema formation, disrupts blood-brain barrier, increased risk of hemorrhage
- Systemic effects:
  - Increased risk of infection, impaired wound healing
- Early, tight glucose control has been shown to improve clinical outcomes after MI & surgery
- Treat hypoglycemia (< 60 mg/dL; Class I, LOE C)
NICU considerations

- Goal: maintain glucose levels 140 – 180 mg/dL
- HgbA1c
  - Measure in all patients with high daily insulin needs unless known diabetic
- Management guided by expected LOS in NSICU
  - If > 3 days, use an insulin drip
  - If < 3 days, start a BBC
- Scheduled insulin issues
  - If taking po: accucheks q ac & hs; may use lantus and novolog insulin
  - If on tube feeds: accucheks q 6 hours; use NPH and regular insulin only
Respiratory Management

- Normoxia
  - Supplemental oxygen is not recommended

- Normocarbia

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**Roffe et al, JAMA 2017**
Risk Factors for Malignant MCA Stroke

- Younger age
- >50% MCA territory infarct with BG involvement
- High NIHSS (>15 nondominant, >20 dominant)
- Rapid progression of hypodensity on CT
ICP control in CVA

- Predominately cytotoxic
  - Symptoms usually develop 24 – 96 hrs post acute ischemia

- General principles
  - Steroids NOT effective
  - Facilitate venous drainage
  - Penumbra at risk with traditional ICP therapies
  - HV is a temporizing measure
Malignant Edema

- Earliest signs – drowsiness and pupil asymmetry
- ICP elevation not reliable

Mass effect is local

Neurologic deterioration usually occurs within 48 hours

Qureshi et al. Crit Care Med 2003
Frank JL, Neurol 1995
Ropper et al, Arch Neurol 1984
Signs of Herniation

- May initially see tachycardia with hypertension
- Deteriorating level of consciousness (GCS)
- Pupil asymmetry
- Motor asymmetry
- Cushing’s triad**

**Cushing’s triad**
- Respiratory irregularity
- Bradycardia
- Hypertension*
Acute Herniation Treatment

- Secure Airway
- Hyperventilation
- Hyperosmotic bolus therapy
- Consider acute treatment of:
  - Pain, anxiety, seizures, fever, outflow obstruction

- Only AFTER you save their life do you send the patient off the unit
Current cerebral edema therapies: treating symptoms

Osmotherapy

Decompressive Craniectomy
Hyperosmolar therapy

- Mannitol:
  - 1 g/kg Q6H; can use lower doses
  - Hold subsequent dose if osmolar gap > 10
  - Avoid if impaired GFR
  - A diuretic, give normal saline to maintain normovolemia

- Hypertonic saline bolus:
  - 30 cc’s of 23.4% over 10 mins via central line
  - 250 cc’s of 3%

- Hypertonic saline continuous infusion:
  - Often favored to “drive up the sodium”
  - Little data to support beyond targeting normonatremia
Who should undergo decompression?

- **HAMLET/DESTINY/DECIMAL** pooled analysis
  - 93 patients age 18 to 60
  - MCA infarct: >50% territory or >145 cc’s
  - Decrease in LOC
  - Randomized to medical therapy vs. decompression
  - Decompression within 48 hours (3 hours from randomization)
  - Surgical technique – duraplasty & large bone flap
  - Primary outcome measure: dichotomized mRS at 1 year between favorable (0–4) and unfavorable (5 and death)

*Vahedi et al., Lancet Neurology, 2007*
Improved Outcomes after Decompression

Number needed to treat
- 2 patients to achieve mRS ≤ 4
- 4 patients to achieve mRS ≤ 3

Vahedi et al., Lancet Neurology, 2007
Steroids in Stroke

NO BENEFIT!!!
Emerging therapies: Blocking the development of edema

Stokum et al. JCBFM. 2015
How good can outcomes be?

A Life Worth Living: Seven Years after Craniectomy

David R. Larach · Daniel B. Larach · Marilyn Green Larach

- 49 year-old anesthesiologist with large left MCA stroke
- Underwent DHC
- 6 months → virtually independent ADL’s
- After years of therapy
  - Walks with a cane, reads, speaks full sentences
How good can outcomes be?

**fMRI during language comprehension, 7 years after stroke**

*A Life Worth Living: Seven Years after Craniectomy*

David R. Larach · Daniel B. Larach · Marilyn Green Larach
Shared Decision Making

- Minimize nihilism
- Patient / surrogate involvement early
- Focus should be on:
  - Quality of life
  - The patient’s values, beliefs and preferences
- Be aware of resources available
Atrial Fibrillation

📍 Most common arrhythmia in general population

📍 Causes
  ☢ Structural heart disease, CAD, HTN, pulmonary disease, thyrotoxicosis, post cardiac surgery

📍 Management
  ☢ Rate Control ≤ 100 bpm
  ☢ If unstable & duration < 48 hrs: Cardioversion

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dosing</th>
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<tr>
<td>Diltiazem</td>
<td>0.25 mg/kg over 2 min; then infuse at 5 – 15 mg/hr x 24 hrs</td>
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<tr>
<td>Esmolol</td>
<td>500 mcg/kg over 1 min; then 50 mcg/kg/min</td>
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<tr>
<td>Metoprolol</td>
<td>2.5 – 5.0 mg IV</td>
</tr>
<tr>
<td>Amiodarone</td>
<td>300 mg over 15 min; then 1 mg/kg/hr x 6 hours followed by 0.5 mg/kg/hr x 18 hrs</td>
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Preventing ICU Badness & Focusing on Recovery
Reversal of Anticoagulation

- Discontinue warfarin; Target INR < 1.5
  - It may be difficult to achieve with FFP & vit K
  - FFP 15 – 20 mL / kg
  - Vitamin K, 10 mg IV. Usually only need 2-3 doses
  - Prothrombin Complex Concentrate
  - Recombinant Factor VIIa (selected patients?)

- If PTT > 50
  - Protamine 50 mg IV

- Platelet dysfunction
  - Thrombelastography testing
TEG

- Thrombelastography technology analyzes functional activities of blood
  - Coagulation & fibrinolytic factors, activators, inhibitors
  - TEG®; Haemonetics Corp

- Components
  - R value = time until first evidence of a clot
  - K value = time from the end of R until the clot reaches 20mm (speed of clot formation)
  - Angle = tangent of curve made as the K is reached and offers similar information to K
  - MA (maximum amplitude) = reflection of clot strength
TEG

<table>
<thead>
<tr>
<th>Value</th>
<th>Normal Range</th>
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<tbody>
<tr>
<td>R</td>
<td>4 – 8 min</td>
</tr>
<tr>
<td>k</td>
<td>0 – 4 min</td>
</tr>
<tr>
<td>angle</td>
<td>47 – 74 deg</td>
</tr>
<tr>
<td>MA</td>
<td>54 – 72 mm</td>
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Seizure Prevention

- Less common in AIS
- Consider in patients with hemorrhagic conversion with fluctuating exam findings
- May be non-convulsive events
  - Consider 24 hour continuous EEG
- If decision is made to start treatment, avoid sedating medications
Other Management Issues

- **Nutrition**
  - Start tube feeds early

- **DVT Prophylaxis**
  - Start mechanical prophylaxis immediately
  - Start pharmacological prophylaxis 24 hr after injury unless known hemorrhagic lesions or post-op. If so, start when CT stable.

- **GI Bleeding Prophylaxis**
  - Low incidence
  - Indications: mechanical ventilation, steroids
  - Stop once on full nutrition

- **Aspiration precautions / oral care**
ICU Delirium

- Acute, reversible disorder of attention & cognition,
  - Disrupted sleep / wake cycle; Usually transient
- Three forms:
  - Hyperactive and agitated
  - Lethargic or hypoactive
  - Combination of hyperactive and hypoactive
- Risk Factors
  - The acute illness
  - Age, prior cerebral damage, and chronic health conditions
  - Pharmacologic agents
  - Iatrogenic: sleep wake cycle disturbance, noise, neuro checks, etc.
  - Underlying cognitive impairment
  - Underlying anxiety and psychiatric illness
ICU Delirium: Why do we care?

- Under recognized
  - Incidence: 15-87%; most studies are 30-50%
  - Male, ventilated, older, LOS++, SICU
  - Lower numbers when excluding
    - Neurological deficits (stroke)
    - Pre-existing dementia
    - Pre-existing psychotic depression/schizophrenia

- Higher morbidity and mortality
  - Lines, ET tubes, catheters, aspiration, etc.

- Prolonged Length of Stay (LOS)
- Higher nursing attention demand
- Higher incidence of Post Traumatic Stress Disorder
Potentially Harmful Agents

- Neurological Exams
- Benzodiazepines
- Dopamine antagonists
- Neuromuscular blockade
- Anticholinergics
- H2 receptor antagonists: cimetidine, ranitidine
- Antihypertensives: clonidine, prazosin
- Anticonvulsants: phenytoin, phenobarbital
Management & Pharmacology

- Sleep Holidays
- Analgesics: scheduled medications rather than prn
  - Tylenol issues
- Antipsychotics
  - Dopamine antagonists
    - Treat aggression by causing sedation
  - Very good immediate intervention for safety issues
    - Use lowest dose for shortest time
  - Lowers seizure threshold, may increase agitation
  - Traditional ones have adverse effects on motor recovery
  - Suggestion: Quetiapine fumarate (Seroquel)
    - Dosage: typical dose 25 - 100 mg qhs / bid
    - Allows for REM sleep
Transition to Rehabilitation

- Early consultation of rehabilitation specialties
  - PM & R involvement shortly after admission
  - Multidisciplinary rounds
  - PT, OT, Speech
  - Mobilization of patient

- Address Alertness
  - Consider psychostimulants

- Surgical interventions
  - Tracheostomy, PEG tube, IVC filter

- Facilitation of transfer to rehabilitation setting
  - Role of LTAC