ICU Management of Acute Ischemic Stroke

Lori A. Shutter, MD
lori.shutter@uc.edu
Director, NSICU/Neurocritical Program
Assoc. Professor, Clinical Neurosurgery & Neurology
University of Cincinnati Medical Center
http://www.ucneurocriticalcare.com/physicians
Disclosures / Objectives

- Disclosures: Grants / Research
  - NIH, DoD, UCB Pharma

- 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!
Case Presentation

- 45 yo F presented with acute onset of left sided weakness
  - NIHSS = 22
    - Arousalable w/ stimulation, dysarthria, forced right gaze, left hemiparesis, sensory loss, neglect
  - OSH CT read a dense R MCA sign, not confirmed but subtle changes suggestive of hemispheric edema noted
- To angio suite (Day 0)
Case Presentation

- Day 1: lethargic, oriented x 1, following commands with right side. Had emesis x 2 so taken to CT

- Increase mass effect so to OR
Case Presentation

- Day 2 – Stopped following commands, sent to CT
- Day 6: fully awake, oriented x 4, left hemiplegia, taking po (dysphagia diet)
- Day 8 to rehab

- cEEG, showed epileptiform discharges, started LEV
Critical Care Issues

- Blood Pressure Control
- Stroke team, Neurology, or Neurosurgery?
  - How early after onset?
  - What type of stroke
- Medical Co-morbidities
- Mass Effect / Intracranial Hypertension
BP Contributing Factors

- Agitation / Pain
- Vomiting
- Seizures
  - Prophylaxis?
- Increased ICP
  - Avoid hypoxia, fever, hyperglycemia / D5
  - Raise HOB, ventilatory rate
  - Hyperosmotic vs hypertonic therapy
BP after Cerebrovascular Insult

- Data regarding prognostic value of BP is conflicting
- High BP has been associated with increased stroke mortality, impairment of functional outcome and stroke recurrence
- Other studies indicate low BP correlated with poor prognosis
- Problems with studies:
  - variable dx – AIS (embolic, lacunar), ICH
  - Select patients (stroke unit, study group)
  - Timing of BP control
BP Control: AIS

- **Acute Ischemic Stroke (no tPA)**
  - Generally < 220 / 120
  - Fluctuating symptoms: induced HTN w/ MAP $\uparrow$ by 20 – 25%
  - Exceptions
    - aortic dissection; acute MI; heart failure; acute renal failure; hypertensive encephalopathy

- **Acute Ischemic Stroke (tPA)**
  - < 185 / 110 before; < 180 / 105 after
BP Control in AIS

- Admission SBP associated with 1 & 12 month mortality\(^1\)
  - Best mortality 121-140 mm Hg (13% / 25%). Mortality highest in SBP < 101 (35% / 52%); > 220 (29% / 57%)
  - Low SBP associated with heart failure & CAD
  - High SBP associated with hx of HTN, lacunar stroke and death from cerebral edema

- Changes in SBP also associated with mortality, ‘END’ & functional outcome\(^2\)
  - Best outcome with SBP 180 – 200, DBP 101 – 110
  - SBP changes of 0 – 20 mm Hg had better mortality, lower END / poor outcome, & smaller stroke volumes

Poor outcome after AIS Relative to Admission BP

Castillo et al. Stroke, 2004; 35:520-26
BP Control Agents

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

- **Acute Ischemic Stroke (no tPA)**
  - General: labetolol, esmolol or nicardipine IV
  - Fluctuating symptoms / inducing HTN: phenylephrine, dopamine, norepinephrine

- **Acute Ischemic Stroke (tPA)**
  - Labetolol, esmolol or nicardipine IV
BP Control Agent ‘Whys’

- Lower BP
  - Tachycardia: labetolol, esmolol
  - Bradycardia, CHF, COPD: nicardipine
- Raise BP
  - Tachycardia: phenylephrine
  - Bradycardia: norepinephrine, HD dopamine
- Augment CO when BP up
  - Dobutamine
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
ICP control in CVA

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

- General principles
  - Steroids NOT effective
  - ICP monitoring is controversial
  - Penumbra at risk with traditional ICP therapies
  - Follow AANS guidelines and monitor for GCS ≤ 8
ICP Control in CVA: Treatments

- HOB > 30° to help venous drainage
- Hyperventilation
  - adjust tidal volume & rate to pCO₂ = 25 – 30
  - Usually only effective for 6 hrs
  - Rebound ICP elevation if stopped abruptly
- Diuretic/osmotic therapy
  - Lasix or mannitol to ↓ intravascular volume and free H₂O, must replace fluids. Limited data
  - ?? Hypertonic saline
Mannitol In Stroke

- 5 RCTs using mannitol for stroke, 4 of these used combination therapy, thus confounding results.
- Remaining study assessed 166 pts, with 3 treatment groups (ergot, dexamethasone, mannitol).
  - 36 patients received mannitol (0.8 – 0.9 gm/kg x 10 days)
- OUTCOME: Change in clinical condition

<table>
<thead>
<tr>
<th></th>
<th>Improved</th>
<th>Worsened</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control (N = 41)</td>
<td>14 (34%)</td>
<td>18 (44%)</td>
</tr>
<tr>
<td>Treatment (N = 36)</td>
<td>12 (33%)</td>
<td>16 (44%)</td>
</tr>
</tbody>
</table>

Mannitol in AIS

- Mannitol bolus preferentially shrinks non infarcted brain
  - \( n = 6 \) MCA infarcts, 1.5gm/kg bolus
  - MRI done 50 – 55 minutes after baseline scan showed a \( \downarrow \) in brain volume by 8.1 +/− 2.8 ml (0.6%, \( p < 0.005 \))
    - Non-infarcted hemisphere shrank 0.8 +/− 0.4%
    - Infarcted hemisphere shrank 0 +/− 0.5%.

- Mannitol impact on mortality
  - \( n = 806 \), 2/3 treated with mannitol
  - Treated within 24 hrs: 1 yr mortality = 35% (26% plc)
  - Treated within 72 hours: 1mo mortality = 25% (16% plc); 1 yr = 38% (26% plc)

ICP Control in CVA: Treatments

- CSF drainage
  - Consider with hydrocephalus or IVH

- Mass evacuation / decompression
  - Cerebral vs. cerebellar lesion

- Barbiturate coma
  - No role due to side effects and no benefit
HTS in CVA

- Extremely limited studies; small numbers
  - Usually as rescue therapy

- ICP control
  - Variable concentrations & solutions
  - Bolus therapy vs continuous infusions
  - Most report Na$^+$ levels of 145 – 155
  - Results generally show effectiveness

- TUH: 10 AIS patients started on HTS
  - 7 had improved GCS of 1 – 3 points
  - CT done in 8 – worse in 2, stable in 6
  - 1 had decompressive hemicraniectomy 2$^\circ$ worsening
  - Adverse effects: pulmonary edema (1), persistent hypernatremia (1)
Steroids in Stroke

NO BENEFIT!!!
Pop the Top
Decompressive Hemicraniectomy: AIS

- Pooled analysis of 3 RCTs
  - DECIMAL, DESTINY, HAMLET
- Study design
  - 18 – 60 years treated within 48 h after stroke onset
  - Primary outcome measure: dichotomized mRS at 1 year between favorable (0–4) and unfavorable (5 and death)
  - Secondary outcome measures: case fatality rate at 1 year & dichotomized mRS between 0–3 and 4 to death
- Results
  - N = 93 patients
  - NNT = 2 for survival with mRS≤4
  - 4 for survival with mRS≤3;
  - 2 for survival irrespective of functional outcome

## mRS

### Table 1: Modified Rankin Scores

<table>
<thead>
<tr>
<th>Score</th>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>No significant disability</td>
<td>Able to carry on all usual activities</td>
</tr>
<tr>
<td>2</td>
<td>Slight disability</td>
<td>Some limitations in prior activities, but manages own affairs</td>
</tr>
<tr>
<td>3</td>
<td>Moderate disability</td>
<td>Requires help, but able to walk without assistance</td>
</tr>
<tr>
<td>4</td>
<td>Mod – severe disability</td>
<td>Requires assistance to walk &amp; carry out bodily needs</td>
</tr>
<tr>
<td>5</td>
<td>Severe disability</td>
<td>Requires constant nursing care, bedridden</td>
</tr>
<tr>
<td>6</td>
<td>Death</td>
<td>Self explanatory</td>
</tr>
</tbody>
</table>
mRS Results

Figure 1: Distributions of the scores on the mRS and death after 12 months for patients treated with or without decompressive surgery.
Decompressive Hemicraniectomy: TUH AIS Protocol

- Eligibility criteria
  - Age 18–60 years
  - Clinical deficits suggest MCA infarction with a NIHSS score >12 for dominant, > 10 for non-dominant.
  - Decrease in LOC to a score of 1 (ie, not alert, but arousable with minimal stimulation) or greater on item 1a of the NIHSS.
  - Infarct on CT/MRI involving at least 50% of MCA

- Triggers for decompression
  - Above + either clinical deterioration not explained by meds/other medical conditions; or CT with \( \geq 4 \) mm \( \uparrow \) MLS
  - Family discussion
  - 6 hrs since thrombolytic therapy
Decompressive Hemicraniectomy: TUH AIS Protocol

Exclusion criteria

- **Absolute contraindications**
  - Pre-stroke score on the mRS ≥ 3
  - Two fixed dilated pupils
  - GCS ≤ 4 without improvement in the first 24 hours.
  - Space-occupying hemorrhagic transformation
  - Life expectancy <3 years
  - Irreversible coagulopathy or systemic bleeding disorder

- **Relative contraindications**
  - Complete ICA distribution ischemia on affected side
  - Contralateral ischemia or other brain lesion
  - Other serious illness that could affect outcome
<table>
<thead>
<tr>
<th>Sub-category</th>
<th>Early surgery n/N</th>
<th>Initial conservative n/N</th>
<th>OR (fixed) 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>187/262</td>
<td>204/284</td>
<td>0.89 [0.67, 1.29]</td>
</tr>
<tr>
<td>65</td>
<td>164/206</td>
<td>174/212</td>
<td>0.85 [0.62, 1.13]</td>
</tr>
<tr>
<td><strong>OSS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CS 6-8</td>
<td>98/80</td>
<td>82/99</td>
<td>1.23 [0.79, 1.87]</td>
</tr>
<tr>
<td>CS 9-12</td>
<td>140/107</td>
<td>159/196</td>
<td>0.72 [0.44, 1.16]</td>
</tr>
<tr>
<td>CS 13-15</td>
<td>126/193</td>
<td>137/201</td>
<td>0.98 [0.58, 1.64]</td>
</tr>
<tr>
<td><strong>Side</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left hemisphere</td>
<td>166/246</td>
<td>200/265</td>
<td>0.85 [0.56, 1.29]</td>
</tr>
<tr>
<td>Right hemisphere</td>
<td>160/222</td>
<td>170/231</td>
<td>0.93 [0.61, 1.40]</td>
</tr>
<tr>
<td><strong>Ecto</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eye ganglia/thalam</td>
<td>107/181</td>
<td>130/194</td>
<td>0.71 [0.47, 1.08]</td>
</tr>
<tr>
<td><strong>Neuro</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume</td>
<td>211/302</td>
<td>230/323</td>
<td>0.63 [0.40, 1.00]</td>
</tr>
<tr>
<td>90ml</td>
<td>135/106</td>
<td>140/107</td>
<td>1.09 [0.66, 1.77]</td>
</tr>
<tr>
<td><strong>Depth</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From cortical surface 1cm</td>
<td>170/257</td>
<td>192/260</td>
<td>0.69 [0.47, 1.01]</td>
</tr>
<tr>
<td>2cm</td>
<td>174/206</td>
<td>184/234</td>
<td>1.39 [0.86, 2.25]</td>
</tr>
<tr>
<td><strong>Intended method of evacuation anatomy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Anes</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deficit of affected arm</td>
<td>110/182</td>
<td>135/206</td>
<td>0.80 [0.53, 1.21]</td>
</tr>
<tr>
<td>Normal/weak</td>
<td>231/279</td>
<td>230/264</td>
<td>0.83 [0.60, 1.15]</td>
</tr>
<tr>
<td><strong>Deficit of affected leg</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal/weak</td>
<td>150/229</td>
<td>169/249</td>
<td>0.89 [0.61, 1.30]</td>
</tr>
<tr>
<td>Ralysed</td>
<td>192/33</td>
<td>201/239</td>
<td>0.91 [0.56, 1.48]</td>
</tr>
<tr>
<td><strong>Deficit of speech</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>72/124</td>
<td>92/136</td>
<td>0.66 [0.40, 1.01]</td>
</tr>
<tr>
<td>Aphasic/aphasic</td>
<td>216/276</td>
<td>220/209</td>
<td>0.96 [0.64, 1.44]</td>
</tr>
<tr>
<td>Amot acepoce</td>
<td>50/60</td>
<td>59/71</td>
<td>1.00 [0.59, 1.80]</td>
</tr>
<tr>
<td><strong>Any antithrombotic or anticoagulant therapy</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anticoagulant therapy</td>
<td>24/34</td>
<td>38/45</td>
<td>0.51 [0.17, 1.46]</td>
</tr>
<tr>
<td>None</td>
<td>322/434</td>
<td>340/450</td>
<td>0.33 [0.08, 1.62]</td>
</tr>
<tr>
<td><strong>Country</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>USA</td>
<td>49/62</td>
<td>49/62</td>
<td>0.67 [0.29, 1.54]</td>
</tr>
<tr>
<td>China</td>
<td>51/85</td>
<td>66/79</td>
<td>1.00 [0.21, 4.76]</td>
</tr>
<tr>
<td>China</td>
<td>15/19</td>
<td>15/19</td>
<td>0.85 [0.29, 2.52]</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>25/33</td>
<td>33/42</td>
<td>1.13 [0.36, 3.52]</td>
</tr>
<tr>
<td>Russia</td>
<td>16/20</td>
<td>16/25</td>
<td>0.69 [0.21, 2.29]</td>
</tr>
<tr>
<td>Estonia</td>
<td>19/26</td>
<td>15/20</td>
<td>0.90 [0.24, 3.43]</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>39/41</td>
<td>39/43</td>
<td>2.30 [0.73, 7.61]</td>
</tr>
<tr>
<td>Macedonia</td>
<td>24/36</td>
<td>30/43</td>
<td>0.87 [0.33, 2.34]</td>
</tr>
<tr>
<td>South Africa</td>
<td>29/34</td>
<td>27/34</td>
<td>0.84 [0.18, 3.53]</td>
</tr>
<tr>
<td>Italy</td>
<td>26/36</td>
<td>35/43</td>
<td>0.90 [0.18, 4.39]</td>
</tr>
<tr>
<td>Others with &lt;20 pats</td>
<td>44/58</td>
<td>39/58</td>
<td>1.79 [0.77, 4.14]</td>
</tr>
</tbody>
</table>
Other Management Issues

- **Fluids**
  - Start with NS (no dextrose), aggressively treat low Na⁺
  - Use ½ NS cautiously for high Na⁺, can ↑ ICP
  - Avoid hypovolemia (associated w/ worse outcomes)

- **Glucose control**
  - Early hyperglycemia associated with poor outcomes
  - Recent study found patients w/ intensive glucose control had improved ICP & CPP control, fewer seizures, similar mortality (w/ lower GCS), and better 6 & 12 month outcomes
Other Management Issues

- **Nutrition**
  - Start tube feeds early, TPN if necessary

- **DVT Prophylaxis**
  - Start 24 hr after injury unless known hemorrhagic lesions or post-op. If so, start when CT stable.
  - SQ heparin and mechanical prophylaxis.
  - Surveillance: day 3 after admission, then q week

- **Early rehabilitation**
  - PM&R, PT, OT, Speech
  - positioning, splints, monitor for HO
Questions?

http://www.ucneurocriticalcare.com/physicians