Neuro-Critical Care for Acute Ischemic Stroke
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I have no actual or potential conflict of interest in relation to this presentation.
Goal of initial evaluation in the Critical Care Center (CCC) should include ensuring medical stability with particular attention to airway, breathing and circulation.

Patients with increased intracranial pressure (ICP) due to vertebrobasilar ischemia, or bihemispheric ischemia or large stroke can present with vomiting, decreased respiratory drive, or musculoskeletal airway obstruction.

Hypoventilation with a resulting increase in carbon dioxide may lead to cerebral vasodilation and elevate ICP.

Intubation may be necessary to restore adequate ventilation and to protect airway from aspiration.
Airway, Breathing and Oxygenation

- Patient’s with adequate ventilation should have oxygen saturation monitored.
- Patient’s who are hypoxic should receive supplemental oxygen to maintain oxygen saturation greater than 94%.
- Supplemental oxygen is not recommended in non-hypoxic patients with acute ischemic stroke.
Blood Pressure

- In patients with Acute Ischemic Stroke (AIS), early treatment of hypertension is indicated when required by comorbid conditions (e.g. concomitant acute coronary event, acute heart failure, aortic dissection, post thrombolysis ICH, or preeclampsia/eclampsia). Lowering BP initially by 15% is probably safe.

- In patients with BP <220/120 mm Hg who did not receive IV alteplase or EVT and do not have a comorbid condition requiring acute antihypertensive treatment, initiating or reinitiating treatment of hypertension within the first 48 to 72 hours after an AIS is not effective to prevent death or dependency.
In patients with BP ≥220/120 mmHg who did not receive IV alteplase or EVT and have no comorbid conditions requiring acute antihypertensive treatment, the benefit of initiating or reinitiating treatment of hypertension within the first 48 to 72 hours is uncertain.

- It might be reasonable to lower BP by 15% during the first 24 hours after onset of stroke.

BP should be maintained <180/105 mm Hg for at least the first 24 hours after IV alteplase treatment.
Blood Pressure

- In patients who undergo mechanical thrombectomy, it is reasonable to maintain the BP ≤180/105 mm Hg during and for 24 hours after the procedure.

- In patients who undergo mechanical thrombectomy with successful reperfusion, it might be reasonable to maintain BP at a level <180/105 mm Hg.

- Starting or restarting antihypertensive therapy during hospitalization in patients with BP >140/90 mm Hg who are neurologically stable is safe and is reasonable to improve long-term BP control, unless contraindicated.
Hypertension Treatment Options for Patients with AIS Who Are Candidates for Acute Reperfusion Therapy* (AHA/ASA)

AIS indicates acute ischemic stroke; BP, blood pressure; IV, intravenous; and LOE, Level of Evidence.

*Different treatment options may be appropriate in patients who have comorbid conditions that may benefit from acute reductions in BP such as acute coronary event, acute heart failure, aortic dissection, or preeclampsia/eclampsia (Jauch et al.)

<table>
<thead>
<tr>
<th>Class IIb, LOE C-EQ</th>
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<tbody>
<tr>
<td><strong>Patient otherwise eligible for acute reperfusion therapy except that BP is &gt;185/110 mm Hg:</strong></td>
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<tr>
<td>Labetalol 10–20 mg IV over 1–2 min, may repeat 1 time; or</td>
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<tr>
<td>Nicardipine 5 mg/h IV, titrate up by 2.5 mg/h every 5–15 min, maximum 15 mg/h; when desired BP reached, adjust to maintain proper BP limits; or</td>
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<tr>
<td>Clevidipine 1–2 mg/h IV, titrate by doubling the dose every 2–5 min until desired BP reached; maximum 21 mg/h</td>
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<tr>
<td>Other agents (eg, hydralazine, enalaprilat) may also be considered</td>
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<td>If BP is not maintained ≤185/110 mm Hg, do not administer alteplase</td>
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**Management of BP during and after alteplase or other acute reperfusion therapy to maintain BP ≤180/105 mm Hg:**

Monitor BP every 15 min for 2 h from the start of alteplase therapy, then every 30 min for 6 h, and then every hour for 16 h

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 min, maximum 15 mg/h; or |
| Clevidipine 1–2 mg/h IV, titrate by doubling the dose every 2–5 min until desired BP reached; maximum 21 mg/h |
| If BP not controlled or diastolic BP >140 mm Hg, consider IV sodium nitroprusside |

AIS indicates acute ischemic stroke; BP, blood pressure; IV, intravenous; and LOE, Level of Evidence.
Hypotension and hypovolemia should be corrected to maintain systemic perfusion levels necessary to support organ function.

Intravascular volume depletion is frequent in the setting of acute stroke, particularly in older adult patients, and may worsen cerebral blood flow.
Hypotension and Hypovolemia

- For most patients with acute stroke and volume depletion, isotonic saline without dextrose is the agent of choice for intravascular fluid repletion and maintenance fluid therapy.

- It is best to avoid excess free water (e.g. 1/2 isotonic saline)
  - Hypotonic fluids may exacerbate cerebral edema in acute stroke

**CEREBRAL EDEMA**

[Images of normal CT scan and cerebral edema]
Hypotension and Hypovolemia

- The BP level that should be maintained in patients with AIS to ensure the best outcome is not known.
  - Some observational studies show an association between worse outcomes and lower BPs, whereas other have not.

- No studies have addressed the treatment of low BP in patient’s with stroke. The usefulness of drug induced hypertension in patients with acute ischemic stroke is not well established.

- In a systemic analysis of 12 studies comparing colloids with crystalloids, the odds of death or dependence were similar.

- No studies have compared different isotonic fluids
Sources of hyperthermia (temperature >38°C) should be identified and treated.

- Antipyretic medications should be administered to lower temperature in hyperthermic patients with stroke.

The benefit of induced hypothermia for treating patients with ischemic stroke is not well established.

- Hypothermia should be offered only in the context of ongoing clinical trials.
Blood Glucose

- Persistent in-hospital hyperglycemia during the first 24 hours after AIS is associated with worse outcomes than normoglycemia.
  - It is reasonable to treat hyperglycemia to achieve blood glucose levels in a range of 140 to 180 mg/dL.
  - Closely monitor to prevent hypoglycemia in patients with AIS.

- Hypoglycemia (blood glucose <60 mg/dL) should be treated.
Dysphagia is common after stroke and is a major risk factor for developing aspiration pneumonia.

- It is important to assess swallowing function prior to administering oral medications or food.
- Thus, prevention of aspiration in patients with acute stroke includes (NPO) status until swallowing function is evaluated by a SLP.

It is reasonable for dysphagia screening to be performed by a Speech-language Pathologist (SLP) or other trained healthcare provider.
At PIH Health, “Stroke Swallow screen” can be performed for administration of **oral medications**.

One or more positive findings and the patient is to be kept NPO (including medications) till evaluated by a Speech –language pathologist.

### Stroke Swallow Screen

<table>
<thead>
<tr>
<th>Check if Positive Findings</th>
<th>Findings</th>
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<tbody>
<tr>
<td>□ Patient has history of swallowing difficulty</td>
<td>□ 1 or more findings-patient to be kept NPO (including meds)</td>
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<tr>
<td>□ Facial and/or tongue weakness-1 or both sides</td>
<td>□ NEGATIVE on ALL observations-will proceed with PO trial</td>
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<tr>
<td>□ Air escapes from closed lips</td>
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<tr>
<td>□ Unable to swallow secretions</td>
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<tr>
<td>□ Drooling observed</td>
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<tr>
<td>□ Unable to produce strong cough</td>
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<tr>
<td>□ Slurred speech</td>
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<tr>
<td>□ Voice sounds wet or gurgly</td>
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<tr>
<td>□ Respirations more rapid than 25 breaths per minute</td>
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<tr>
<td>□ Inability to remain awake/attentive for more than 10 minutes</td>
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Nutrition

- Enteral diet should be started within 7 days of admission after an acute stroke.

- For patients with dysphagia, it is reasonable to initially use nasogastric or nasojejunal tubes for feeding in the early phase of stroke (starting within the first 7 days).
  - In patients with longer anticipated persistent inability to swallow safely (>2–3 weeks), it is reasonable to place a percutaneous gastrostomy tube.
The head of bed should be individualized with respect to the risk of elevated intracranial pressure and aspiration, and the presence of comorbid cardiopulmonary disease.

Keep the head in neutral alignment with the body and elevate the head of the bed to 30 degrees for patients in the acute phase of stroke who are at risk for any of the following problems:

1. Elevated intracranial pressure
2. Aspiration (e.g. those with dysphagia and/or diminished consciousness)
3. Cardiopulmonary decompensation or oxygen desaturation (e.g. those with chronic cardiac and pulmonary disease)
DVT Prophylaxis

- In immobile stroke patients without contraindications, intermittent pneumatic compression (IPC) is recommended for prevention of deep vein thrombosis (DVT).

- Contraindications to IPC include leg conditions such as:
  - Dermatitis, gangrene, severe edema, venous stasis, severe peripheral vascular disease, postoperative vein ligation, or grafting, as well as existing swelling or other signs of an existing DVT
The benefit of prophylactic-dose subcutaneous heparin (unfractionated heparin [UFH] or LMWH) in immobile patients with AIS is not well established.

The most recent and comprehensive meta-analysis of pharmacological interventions for VTE prophylaxis in AIS revealed that anticoagulants were not associated with any significant effect on mortality or functional status at final follow-up.

There were statistically significant reductions in symptomatic pulmonary embolisms and in DVTs, most of which were asymptomatic.
There were statistically significant increases in symptomatic intracranial hemorrhage and symptomatic extracranial hemorrhages.

There may be a subgroup of patients in whom the benefits of reducing the risk of venous thromboembolism are high enough to offset the increased risks of intracranial and extracranial bleeding.

- No prediction tool to identify such a subgroup has been derived.

When prophylactic anticoagulation is used, the benefit of prophylactic-dose LMWH over prophylactic-dose UFH is uncertain.
Antiplatelet Treatment

- Administration of aspirin is recommended in patients with AIS within 24 to 48 hours after onset.

- For those treated with IV alteplase, aspirin is generally delayed until 24 hours later, but might be considered in the presence of additional conditions for which such treatment given in the absence of IV alteplase is known to provide substantial benefit or withholding such treatment is known to cause substantial risk.

- In patients with contraindication to aspirin, administering alternative antiplatelet agent may be reasonable.
Management of ICH Within 24 hours after Alteplase administration

- Cryoprecipitate (includes factor VIII): 10 U infused over 10–30 min (onset in 1 hr, peaks in 12 hrs); administer additional dose for fibrinogen level of <200 mg/dL

- Tranexamic acid 1000 mg IV infused over 10 min OR ε-aminocaproic acid 4–5 g over 1 hr, followed by 1 g IV until bleeding is controlled (peak onset in 3 hrs)

- Supportive therapy, including:
  - BP management
  - ICP
  - CPP
  - MAP
  - Temperature
  - Glucose control
Cerebellar and Cerebral Edema

- Ventriculostomy is recommended in the treatment of obstructive hydrocephalus after a cerebellar infarct.

- Concomitant or subsequent decompressive craniectomy may or may not be necessary on basis of factors such as:
  - Infarct size
  - Neurological condition
  - Degree of brainstem compression
  - And effectiveness of medical management

- If cerebrospinal diversion by ventriculostomy fails to improve neurological function, decompressive suboccipital craniectomy should be performed.
Cerebellar and Cerebral Edema

- Patients with large territorial supratentorial infarctions are at high risk for complicating brain edema and increased intracranial pressure.

- Discussion of care options and possible outcomes should take place quickly with patients (if possible) and caregivers.

- In patients ≤60 years of age with unilateral MCA infarctions who deteriorate neurologically within 48 hours despite medical therapy, decompressive craniectomy with dural expansion is reasonable because;
  - It reduces mortality by close to 50%
  - With 55% of the surgical survivors achieving moderate disability (able to walk) or better (mRS score 2 or 3)
  - And 18% achieving independence (mRS score 2) at 12 months
Cerebellar and Cerebral Edema

- In patients >60 years of age with unilateral MCA infarctions who deteriorate neurologically within 48 hours despite medical therapy, decompressive craniectomy with dural expansion may be considered because;
  - It reduces mortality by close to 50%
    - With 11% of the surgical survivors achieving moderate disability (able to walk [mRS score 3])
    - And none achieving independence (mRS score ≤2) at 12 months

- Although the optimal trigger for decompressive craniectomy is unknown, it is reasonable to use a decrease in level of consciousness attributed to brain swelling as selection criteria.
Cerebral and Cerebellar Edema

- Use of osmotic therapy (i.e. Mannitol or Hypertonic Saline) for patients with clinical deterioration from cerebral swelling associated with cerebral infarction is reasonable.

- Use of brief moderate hyperventilation (Pco2 target 30–34 mmHg) is a reasonable treatment for patients with acute severe neurological decline from brain swelling as a bridge to more definitive therapy.

- Hyperventilation works by inducing cerebral vasoconstriction, which can worsen ischemia if the hypocapnia is sustained or profound.

- Hyperventilation should be induced rapidly but should be used as briefly as possible and avoid excessive hypocapnia (<30 mm Hg).
Because of a lack of evidence of efficacy and the potential to increase the risk of infectious complications, corticosteroids (in conventional or large doses) should not be administered for the treatment of cerebral edema and increased intracranial pressure complicating ischemic stroke.

Hypothermia or barbiturates in the setting of ischemic cerebral or cerebellar swelling are not recommended.

Prophylactic use of anti-seizure drugs is not recommended.
Questions?