Neurocritical Care Management of Acute Ischemic Stroke

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Disclosure information

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FINANCIAL DISCLOSURE: none

UNLABELED/UNAPPROVED USE DISCLOSURE: none

Neurocritical care: the golden triangle

Cerebral Perfusion
- Blood pressure
- Cardiac output
- Volume status
- ICP (CPP)
- PaCO₂

Cerebral Metabolism
- Sedation
- Seizure screening/therapy
- Thermoregulatory mgmt
- Shivering mgmt
- Glucose mgmt

Cerebral Oxygenation
- PaO₂
- Hgb
Ischemic stroke: neurocritical care

- Airway and ventilation
- Blood pressure
- Induced hypertension using pressors (AHA IC)
- Volume status and hemoglobin goals to maximize cerebral oxygen delivery
- Normothermia with advanced thermoregulatory devices (AHA IC)
- Glycemic control (AHA IIC)
- Aggressive DVT ppx (AHA IA)
- Medical (AHA IA) & surgical (AHA IB) cerebral edema/ICP management
- Consider transfer of pts w/ major infarctions to institutions that perform medical & surgical ICP mgmt

Ischemic Stroke: pathophysiology

No blood
No glucose or oxygen
Aerobic -> anaerobic metabolism
2 MILLION NEURONS DIE EVERY MINUTE

Ischemic Stroke: treatments

- Acute Stroke Treatments
  - tPA within 3 h window: 32 / 100 pts benefit
  - tPA within 3-4.5h window: 16 / 100 pts benefit
  - Intervention (up to 6h anterior, 12h posterior): 21/100 benefit
    - Intraarterial tPA, mechanical embolectomy
Neurocritical Care Management of AIS: Airway

Who to intubate?

- Patients with decreased level of consciousness
- Patients with bulbar dysfunction that compromises airway (AHA IC)

PNA: 23% vs 14% (p<0.05)
Poor outcome at discharge (mRS 3-6): OR 2.7 (p=0.03)
In hospital mortality: OR 4.4 (p=0.005)
Neurocritical Care Management of AIS: Airway

Who to extubate?
- Extubation delay increases rates of VAP, hospital LOS, and mortality
- Daily spontaneous breathing trials when adapted for NCC patients, may facilitate rapid liberation from ventilation
- NCC patients with GCS <4-8, without high airway care requirements, + cough/gag, may be extubated safely (Coplin 2000, Manno 2008, Navalesi 2008)

Neurocritical Care Management of AIS: Blood pressure

For patients eligible for tPA (AHA IB)
- SBP<185/110 (labetalol IVP, nicardipine)

For patients who are not receiving tPA (AHA IC)
- SBP<220/120 (labetalol IVP or nicardipine)

For patients during or post-tPA (AHA IB)
- SBP<180 (labetalol IVP or nicardipine)

Induced hypertension
- In exceptional cases, a physician may prescribe vasopressors to improve cerebral blood flow. If drug-induced hypertension is used, close neurological and cardiac monitoring is recommended (AHA IC)
  - In small studies, patients who respond clinically demonstrate improved neurologic status at discharge
  - DWI/PWI may be used to guide therapy (target 20-30% above baseline SBP/MAP)
Neurocritical Care Management of AIS: Volume status & hematocrit

- Target euvolemia
  - Hypervolemia and hemodilution do not improve outcome and should be avoided (AHA Class IIIA)

- Probably target hematocrit >30
  - Hematocrit <30 decreases cerebral oxygen carrying capacity, impaired cerebral autoregulation
  - Hct <30 independently associated with mortality (OR 4.17) in patients after ischemic stroke

- Middle, Lancet 2011: AIS/ICH protocol to treat any temp≥37.5, (+glycemic control, dysphagia screening) decreases death/dependence from 58% to 42%, NNT 6.4

- Treat sources of fever and target normothermia using antipyretic medications (AHA IC)

- Consider thermoregulatory devices like endovascular or surface cooling

Neurocritical Care Management of AIS: Temperature

- Fever accelerates the secondary injury cascade, causing neuronal death, increased infarct volume, cerebral edema, midline shift, morbidity, and mortality after ischemic stroke

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Neurocritical Care Management of AIS: Glycemic control

- Hyperglycemia is present on admission in 1/3 of AIS patients, and hyperglycemia >140 is associated with poor outcome.
- Persistent hyperglycemia (>200 mg/dL) during first 24h after stroke independently predicts expansion of ischemic stroke volume and poor outcome.
- Serum glucose >140-185 should trigger insulin administration (AHA IIc).

Neurocritical Care Management of AIS: DVT prophylaxis

- Pulmonary embolism accounts for 10% of deaths after AIS, overall incidence of PE = 1-10%.
- Heparinoids ↓DVT incidence 81%, PE 60%.
- SC heparin/LWMH should be used in immobilized AIS patients for DVT prophylaxis (AHA IA).

Neurocritical Care Management of AIS: Cerebral edema /ICP

Main complications of cerebral edema after AIS:
- Mass effect and herniation
- Ventricular entrapment and hydrocephalus

If treated effectively, 43% of anterior infarcts (<60yo) and 40% of cerebellar infarcts (any age) will have a good outcome.
Neurocritical Care Management of AIS: Cerebral edema / ICP

- Risk of malignant transformation in anterior circulation AIS: 10-20%
  - Highest risk: Early CT hypodensity (<12h after onset) of >50% of MCA territory or hyperdense MCA
    - Mortality without intervention: 80% (die of herniation)

- Risk of mass effect in cerebellum AIS: 10-25%
  - Highest risk: Full territory PICA or SCA infarcts
Neurocritical Care Management of AIS: Cerebral edema/ICP

- Hemicraniectomy for hemispheric stroke (AHA IB)
  - Indication: 50-66% infarction of MCA territory
  - Age: <50-60 yo
  - Dominance: no difference in functional outcome between L and R (Vahedi, Lancet Neurology 2007)
  - When: Early (<24-48 hrs)
  - How: >12cm hemicraniectomy

Neurocritical Care Management of AIS: Cerebral edema/ICP

- Reversal of transtentorial herniation with hypertonic saline
  - 253 cases TTH (acute onset unilateral/pupillary dilation, reactivity, GCS decrease >2 pts, intracranial space occupying lesion)
  - 30cc 23.4% saline bolus reversed clinical signs of TTH in 75%
  - Transient hypotension in 17%, no CPM on MRI at 17 days

Neurocritical Care Management of AIS: Cerebral edema/ICP

- Reflection Coefficient
  - Sodium = 1.0
  - Mannitol = 0.90

Stroke American Stroke Association

- 22 episodes of ICP refractory to mannitol
- 75cc 10% saline bolus normalized ICP in all
- No unexpected side effects

MA Koenig, M Bryan, JL Lewin, III, MA Mirski, RG Geocadin, and RD Stevens
Neurology 2008;70;1023-1029; originally published online Feb 13, 2008

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Critical Care Medicine

- Congenital outcome after medical reversal of transtentorial herniation in patients with supratentorial mass lesions
  - 11/28 (40%) survived to discharge
  - 7/11 (59%) survivors functionally independent

Long-term outcome after medical reversal of transtentorial herniation in patients with supratentorial mass lesions
Qureshi, Geocadin, Suarez, Ulatowski, CRITICAL CARE MEDICINE 2000;28:1556-1564

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- 7/11 (59%) survivors functionally independent
Neurocritical Care Management of AIS: Cerebral edema/ICP

- **Hemicraniectomy for hemispheric stroke (AHA IB)**
- If >60yo w/ >50% territory MCA stroke:
  - With hemicrani: 38% survived w/ mRS of 4 or better
  - Without hemicrani: 18% survived w/ mRS of 4 or better
  - Of note: after hemicrani, nobody had mRS of 0–2, 7% were mRS 3, 32% were mRS 4 (needs assistance for most bodily needs).
  - Of note, medical management was suboptimal

- **Suboccipital craniotomy for cerebellar stroke (AHA IB)**
  - **Indications:**
    - Deterioration of mental status or new brainstem signs
    - Complete effacement of 4th ventricle, compression of the brainstem or basal cisterns
    - Median cerebellar infarction
  - **Timing:** emergent
  - **EVD:**
    - only if pt is hydrocephalic and has partial (not complete) effacement of 4th ventricle
    - must be done with care because of concern for upward herniation
  - **Outcome:** 40% functionally independent (mRS 0–2)

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**AHA 2013 guidelines**

- Treatment of Acute Neurological Complications
  - Determination after initial clinical assessment is necessary, occurring in 23% of patients. **In the group with clinical deterioration, one third occurs because of stroke progression, one third because of brain edema, 3% because of hemorrhage, and 1% because of infectious etiology. The potential for life-threatening deterioration highlights the need for close observation and assessment, again, free ( provisional) ICP
  - Monitoring of severe systemic and potential complications, including cerebrospinal fluid leakage, neurological, and neuroendocrine, as well as anticonvulsant drugs, are essential to optimally manage these complex patients.
Neurocritical Care Management of AIS: Systems management

Admission of ICU-level stroke patients to a neuroICU w/ neurointensivist:
• Reduces mortality 20-50%
• Decreases ICU length of stay 1-2 days
• Increases discharges to home 15-30%

- AHRQ 2009/Leapfrog 2008:
  "NeuroICU patients must be managed ...
  ...by neurointensivists or critical care intensivists...
  ...during daytime hours a minimum of 8 h/day, 7 days/wk, who during this time provide clinical care exclusively in the ICU. When not present ...
  ...intensivists must return more than 95% of ICU pages within 5 minutes and can rely on a physician or...non-physician effector who is in the hospital and able to reach ICU patients within 5 minutes

TIME IS BRAIN!

Acknowledgements

Thomas Hemmen
Alex Khalessi
Brian Lemkuil
Anush Minokadeh
Patricia Graham
Jim Dunford
Bruce Haynes
San Diego County EMS
UC-San Diego Health System Staff