Critical Care Management of Subarachnoid Hemorrhage

Nerissa U. Ko, MD, MAS
UCSF Department of Neurology
September 7, 2013

Objectives

• Highlight evidence-based recommendations
• Acute evaluation and emergency management
• Neurocritical care management
  – Rebleeding
  – Delayed cerebral ischemia
  – Hyponatremia and volume management
  – Seizure management
  – ICU care: Glucose, anemia, temperature control and DVT prophylaxis

Disclosures

• Nothing to disclose
• Grant funding from American Heart Association, HHMI and NIH
Acute evaluation

- Life-threatening illness that warrants a high index of suspicion
- Misdiagnosis of SAH occurred in as many as 64% of cases prior to 1985, and remains approximately 12% currently
- Misdiagnosis is associated with a 4-fold higher likelihood of 1-year death or disability.


AHA recommendations for evaluation

- CT scanning for suspected SAH, and lumbar puncture for analysis of CSF is strongly recommended when the CT scan is negative.
- Selective cerebral angiography to document the presence and anatomic features of aneurysms is strongly recommended in patients with documented SAH.
- MRA or CTA can serve as useful alternative (Class II).
High volume centers

- Treatment volume is an important determinant of outcome for intracranial aneurysms – higher volume (>60 cases per year) equals lower mortality and better long-term outcomes
- High volume centers should have appropriate specialty neurointensive care units, neurointensivists, vascular neurosurgeons and interventional neuroradiologists to provide the essential elements of care

Why does it matter?

- Transfer from low volume centers is only 15%
- High-volume centers are under utilized <4.5%
- Transfer of patients may be cost-effective
- Lack of awareness of these benefits

![Figure 1: Outcomes after SAH](Cross DT, et al. J Neurosurg. 2003;99(5):810-817.

Rebleeding

- Up to 14% of SAH patients may experience re-bleeding within 2 hours of the initial hemorrhage
- Re-bleeding was more common in those with a systolic blood pressure >160mm Hg
- Anti-fibrinolytic therapy may reduce re-bleeding

- Increased time to treatment is associated with increased rates of preoperative re-bleeding
  - 0 to 3 days, 5.7%
  - 4 to 6 days, 9.4%
  - 7 to 10 days, 12.7%
  - 11 to 14 days, 13.9%
  - 15 to 32 days, 21.5%
- Post-op re-bleeding did not differ among time intervals (1.6% overall)

Antifibrinolytic therapy

- Avoid delayed or prolonged antifibrinolytic therapy
- Antifibrinolytic therapy is relatively contraindicated in patients with risk factors for thromboembolism
- Patients treated with antifibrinolytic therapy should have close screening for deep venous thrombosis
- Consider an early, short course of antifibrinolytic therapy (<72 hours)
- Antifibrinolytic therapy should be discontinued 2 hours before planned endovascular aneurysm ablation

Preventing Rebleeding

- Early aneurysm repair.
- Surgical clipping or endovascular coiling is strongly recommended to reduce the rate of rebleeding.
- Blood pressure should be monitored and controlled to balance the risk of strokes, hypertension-related re-bleeding, and maintenance of cerebral perfusion pressure
- Treat extreme hypertension (MAP >110 mmHg) with an unsecured, recently ruptured aneurysm

Hydrocephalus

- Acute hydrocephalus occurs in 15% to 87% of patients with aSAH.
- Shunt dependence for hydrocephalus occurs in about 8.9% to 48% of patients with aSAH.
- Acute hydrocephalus in aSAH is usually managed by external ventricular drainage (EVD).
- Lumbar drainage has also been used to manage hydrocephalus associated with aSAH.

Delayed cerebral ischemia

- Clinical trials should use only radiographic evidence of cerebral infarction and functional outcome as the primary outcome
- Frequent repeat neurological assessment by qualified providers
- Monitoring should take place in an environment with substantial multidisciplinary expertise in the management of SAH
- Imaging to confirm a diagnosis of DCI in monitored good grade patients who show a change in neurologic exam or TCD variables
- DSA is the gold standard for detection of large artery vasospasm
- TCD may be used for monitoring and detection of large artery vasospasm with variable sensitivity.
- High quality CTA can be used for screening for vasospasm with CTP findings or elevated MTT may be additive
- EEG, pbtO2 and CMD may all be useful for DCI detection; the relative value of these monitors individually vs. part of a multi-modality monitoring strategy is not known
DCI Treatment

Nimodipine
- Oral nimodipine (60 mg every 4 h) should be administered after SAH for a period of 21 days
- The value of other calcium antagonists, whether administered orally or intravenously, remains uncertain
- With hypotension, dosing intervals should be changed, or may be discontinued.

Pressors
- Patients clinically suspected of DCI should undergo a trial of induced hypertension
- Choice of vasopressor should be based on the other pharmacologic properties of the agents
- Blood pressure augmentation should progress in a stepwise fashion with assessment of neurologic function

DCI Treatment (contd.)

Volume
- The goal should be maintaining euvolemia, rather than attempting to induce hypervolemia
- Consider a saline bolus to increase CBF in areas of ischemia as a prelude to other interventions
- Hemodilution in an attempt to improve rheology should not be undertaken except in cases of erythrocythemia.

Endovascular
- The use of routine prophylactic angioplasty is not recommended
- Endovascular treatment using intra-arterial vasodilators and/or angioplasty may be considered for vasospasm related DCI
- Rescue therapy for ischemic symptoms that remain refractory to medical treatment

Hyponatremia
- Na <135 mEq/l occurs in 30-50% of patients
- Associated with hypovolemia in cerebral salt wasting; euvolemia or hypervolemia in SIADH
- Complex interplay of both with neurohormonal effects

Sodium Management
- Do not treat with fluid restriction
- Use extreme caution to avoid hypovolemia if vasopressin-receptor antagonists are used
- Mild hypertonic saline solutions can be used to treat hyponatremia
- Limit free water intake via intravenous and enteral routes
- Hydrocortisone or fludrocortisone may be used to limit natriuresis and hyponatremia
- High dose corticosteroids are not recommended
- Hormonal replacement with stress-dose corticosteroids may be considered
Seizures

- Retrospective reviews report that early seizures occur in 6% to 18% of SAH patients
- Non-convulsive seizures may occur in 19% of stuporous or comatose SAH patients
- The relationship between seizures and outcome is uncertain

Routine use of anticonvulsant prophylaxis with phenytoin is not recommended.
Consider cEEG monitoring in patients with poor-grade SAH who fail to improve or who have neurological deterioration of undetermined etiology.


Medical complications

- Fever, hyperglycemia and anemia requiring transfusion were most associated poor neurological outcomes (mRS>2)
- Deep venous thrombosis (DVT) is an important quality outcome with wide practice variability.
- Recommendations for use of statin and magnesium
  - Cardiac and pulmonary complications are common.
  - Troponin leak and cardiac dysfunction have been associated with worse outcome
  - Target euvolemia in cases of pulmonary edema or acute lung injury
  - Standard management of heart failure

Fever

- Growing evidence that fever is associated with poor neurological outcomes
- May worsen DCI outcomes
- 25% from non-infectious etiologies
- Small studies of safety of aggressive fever control
- Significant practice variability
- Concern for shivering with more aggressive measures

Aggressive Fever Management

- Monitor temperature frequently; always seek and treat infectious causes of fever
- Pharmacologic therapy: acetaminophen, NSAIDS
- Surface: ice packs, cooling blankets, devices
- Endovascular: iced saline, catheter devices

- During the period of risk for DCI control of fever is desirable; intensity should reflect the individual patient’s relative risk of ischemia
- Shivering control remains the most common challenge
  - Surface counterwarming
  - Buspirone, magnesium, meperidine
  - Sedatives, paralytics
Glucose control

- Hyperglycemia is associated with worse outcomes
- Aggressive treatment of hypoglycemia after SAH generally beneficial in subgroup analyses
- Limited safety data on insulin infusion in SAH
  - Microdialysis studies showing cerebral hypoglycemia with low normal serum glucose
  - Target serum glucose <200 mg/dl (140-180 mg/dl goal)

Optimal Hgb/Hct?

- Anemia (Hgb <11 g/dl) occurs in over 80% SAH patients
- Anemia requiring transfusion associated with worse outcome
- Optimal Hgb target is unknown
- Hemodilution advocated for vasospasm
  - Target Hct 30% to optimize O2 delivery and blood viscosity
  - New measures of PbtO2 and microdialysis suggest cerebral hypoxia at these levels

Anemia Management

- Measures should be taken to minimize blood loss from blood drawing
- Patients should receive packed RBC transfusions to maintain hemoglobin concentration above 8–10 g/dl
- Transfusion criteria for general medical patients should not be applied to decisions in SAH patients.
- Higher hemoglobin concentrations may be appropriate for patients as risk for DCI, but whether transfusion is useful cannot be determined from the available data
- Erythropoietin unknown
- Determining cerebral hypoxemia/ischemia using multimodal monitoring

DVT prophylaxis

- Incidence of DVT 1.5-18%, worse in poor grade patients
- Sequential compression devices should be routinely used in all patients
- Unfractionated heparin for prophylaxis could be started 24 h after undergoing surgery
- Unfractionated heparin and low molecular weighted heparin should be withheld 24 h before and after intracranial procedures
Other Management

**Statins**
- Patients on statins prior to presentation with aneurysmal SAH should have their medication continued in the acute phase.
- Acute statin therapy in statin-naive patients may be considered for reducing DCI following aneurysmal SAH, pending the outcome of ongoing trials.

**Magnesium**
- Inducing hypermagnesemia is not recommended pending the conclusion of current randomized trials.
- Hypomagnesemia should be avoided.

Conclusions

- New evidence-based guidelines can improve our practice variability and target areas for future studies.
- Starts with emergency management and triage.
- Neurological and medical complications are common, and have a significant burden on outcomes after SAH.
- Future challenge is to incorporate emerging evidence and new technologies to improve our understanding and refine current management strategies.