Intracerebral Hemorrhage

Medical & Surgical Management

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Disclosures

• We have no relevant disclosures

• We graciously thank Dr. Claude Hemphill for providing some content used in this talk
Outline

• Brief review of some basics
• Prognostic indicators
• Evidence-based, Guideline-driven Medical Management
• Surgical Aspects of care
Non-Traumatic Intracerebral Hemorrhage

- Bleeding into brain parenchyma
- Not due to trauma
- Distinct from Subarachnoid Hemorrhage (SAH) & Isolated Intraventricular Hemorrhage (IVH)
Some Factoids

• 50,000-70,000 annually in the USA
• ~15% of all strokes
• 35-52% dead at 1 month
  – ½ of the deaths within 2 days
• 10% living independently at 1 month
• 20% independent at 6 months
• Annual Cost for U.S. cases > $4B
Common Etiologies

- Hypertension
- Cerebral Amyloid Angiopathy (CAA)
- Vascular malformation: AVM, cavernous hemangioma
- Aneurysm
- Tumor
- Coagulopathy (AAICH, Thrombolysis)
- Vasculitis
- Venous Sinus Thrombosis
- Cocaine or sympathomimetic drug exposure
ICH Locations

• **Basal ganglia** (50%)
  - Contralateral hemiparesis, sensory loss, conjugate gaze

• **Lobar regions** (20-30%)
  - Contralateral hemiparesis or sensory loss, aphasia, neglect, visual symptoms, or confusion

• **Thalamus** (10-15%)
  - Contralateral hemiparesis, sensory loss, gaze paresis

• **Pons** (5-12%)
  - Quadriparesis, facial weakness, decreased level consciousness

• **Cerebellum** (1-5%)
  - Ataxia, miosis, gaze paresis
Hyptertensive Hemorrhages
Lobar Hemorrhage

May be Hypertensive, but rule out other causes
**ICH Prognosis: ICH Score**

<table>
<thead>
<tr>
<th>Component</th>
<th>ICH Score Points</th>
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<tbody>
<tr>
<td>GCS score</td>
<td></td>
</tr>
<tr>
<td>3–4</td>
<td>2</td>
</tr>
<tr>
<td>5–12</td>
<td>1</td>
</tr>
<tr>
<td>13–15</td>
<td>0</td>
</tr>
<tr>
<td>ICH volume, cm³</td>
<td></td>
</tr>
<tr>
<td>≥30</td>
<td>1</td>
</tr>
<tr>
<td>&lt;30</td>
<td>0</td>
</tr>
<tr>
<td>IVH</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Intracranial origin of ICH</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td>No</td>
<td>0</td>
</tr>
<tr>
<td>Age, y</td>
<td></td>
</tr>
<tr>
<td>≥80</td>
<td>1</td>
</tr>
<tr>
<td>&lt;80</td>
<td>0</td>
</tr>
<tr>
<td>Total ICH Score</td>
<td>0–6</td>
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</tbody>
</table>

GCS score indicates GCS score on initial presentation (or after resuscitation); ICH volume, volume on initial CT calculated using ABQ2 method; and IVH, presence of any IVH on initial CT.

The ICH Score and 30-day mortality. Thirty-day mortality increases as ICH Score increases. No patient with an ICH Score of 0 died. All patients with an ICH Score of 5 died. No patient in the UCSF ICH cohort had an ICH Score of 6, although this would be expected to be associated with mortality.

Reading a Head CT

- Blood / CSF / brain
- Location
- Volume
- Mass effect
- Hydrocephalus
Volume estimation is important

\[
\frac{A \times B \times C}{2}
\]

Select CT slice with largest ICH
A = longest axis (cm)
B = longest axis perpendicular to A (cm)
C = # of slices x slice thickness (cm)

Estimated volume of spheroid
Correlates well w/ planimetric CT analysis
Volume Examples

Ping Pong ball
diameter=4.00 cm
Volume=33 cc (ml)

Racquetball ball
diameter=5.72 cm
Volume=97 cc (ml)
Hematoma Enlargement

• **Old concept:**
  – Hemorrhage static process; bleeding complete in minutes.

• **Current concept:**
  – Hemorrhage is dynamic; process continues for several hours (longer with anticoagulant-associated ICH).
Figure 3. Rapid Expansion of Hematoma.

The first CT scan (Panel A) was obtained one hour after the patient presented and was followed by neurologic deterioration and expansion of the hematoma visible on the CT scan obtained six hours after presentation (Panel B).
Hematoma Enlargement

• Brott et al, *Stroke* 1997:
  - 38% have >33% early hematoma enlargement.
  - Hematoma enlargement is associated with neurologic deterioration.

• Predictors (Brott 2007):
  - High glucose, BMI, creatinine, large initial ICH volume, short onset CT time, low cholesterol, warfarin.
Predicting Hematoma Enlargement
ICH Spot Sign
Clinical Presentation / Diagnosis

• Sudden, focal neuro deficit
• Nausea, vomiting, LOC
• Hypertension
• 50-60% have a smooth progression of sx's
  – Ongoing bleeding
  – Enlargement
  – Mass effect
• ~35% have maximal sx at presentation
First Steps

• General ABC resuscitation
• Decision of intubation
  – Respiratory insufficiency vs. GCS
  – LOC, brainstem dysfunction
  – Hypoxia/hypercarbia/impaired oxygenation
  – Aspiration risk
• Neurologic exam
• CT head
  – ? Contrast: for suspected vascular lesions ?
  – ? CTA for Spot Sign ?
Lab WorkUp

- CBC
- PT, PTT
- electrolytes
- EKG
- CXR
Treatment

There is NO approved treatment proven to decrease mortality and morbidity
Treatment

AHA/ASA Guideline

Guidelines for the Management of Spontaneous Intracerebral Hemorrhage in Adults
2007 Update

A Guideline From the American Heart Association/American Stroke Association Stroke Council, High Blood Pressure Research Council, and the Quality of Care and Outcomes in Research Interdisciplinary Working Group

The American Academy of Neurology affirms the value of this guideline as an educational tool for neurologists.

Joseph Broderick, MD, FAHA, Chair; Sander Connolly, MD, FAHA, Vice-Chair; Edward Feldmann, MD, FAHA; Daniel Hanley, MD, FAHA; Carlos Kase, MD, FAHA; Derk Krieger, MD; Marc Mayberg, MD, FAHA; Lewis Morgenstern, MD, FAHA; Christopher S. Ogilvy, MD; Paul Vespa, MD; Mario Zuccarello, MD
“Nihilism Is Not an Effective Therapy”

J. Claude Hemphill, III, MD
Director, SFGH Neurocritical Care Program

• Physicians tend to underestimate the chances of a good outcome”—Mayer & Rincon, Lancet Neurol 2005.


• “Neurocritical Care Units reduce ICH Mortality”—Diringer, Crit Care Med 2001.
Withdrawal of Support

Recommendation for Withdrawal of Technological Support

Class II

1. We recommend careful consideration of aggressive full care during the first 24 hours after ICH onset and postponement of new DNR orders during that time (Class IIb, Level of Evidence B). Patients with previous DNR orders are not included in this recommendation. In all cases, physicians and nurses caring for ICH patients who are given DNR status should be reminded that the designation relates only to the circumstance of cardiopulmonary arrest and that patients should receive all other appropriate medical and surgical interventions.
Evidence-based, Guideline-driven Medical Management

- DVT Prophylaxis
- Fluids & Nutrition
- Temperature
- Glucose
- Anticonvulsants
- BP
- Elevated ICP
- Arrhythmia
- Anticoagulant Associated ICH (AAICH) and Warfarin reversal
DVT Prophylaxis in ICH

• Lacut et al, *Neurology* 2005:
  – Asymptomatic DVT was detected at day 10 in 15.9% of patients wearing elastic stockings alone. SCDS significantly lowered the risk.

• May consider LMWH after 72 hours.
Fluids & Nutrition

• Use isotonic, non-glucose-containing fluids (0.9% NaCl) at ~1ml/kg/hr if euglycemic.

• Correct serum osmolality < 280 mmol/kg with 3% normal saline.

• Many centers use 3% NaCl @ 1ml/kg/h to serum osmolality of 300-230 & serum Na⁺ of 150-155. for cerebral edema to prevent ICP crises. Must carefully taper to prevent rebound if this is done.

• As with all neurocritically ill patients, enteral nutrition should be started within 48 hours to avoid malnutrition.
Temperature

• Sustained fever (>38.3) is independently associated with poor outcomes. However, evidence that control improves outcome is meager at best.

• Consensus is that euthermia should be maintained with acetaminophen and external cooling devices.
Glucose

- Maintain euglycemia as with other critically ill patients (<140 or 150 mg/dL?).
Anticonvulsants

• 28% of stuporous or comatose ICH patients have subclinical seizures or status epilepticus.
• 8% of all ICH patients have clinical seizures.
• Higher early epilepsy rate in lobar hemorrhages.

• **Recommendation:**
  – Treat clinical seizures.
  – “May” prophylactically treat seizures for 1 month and then discontinue AED if no seizures.
BP Control

• **Old Concept:**
  – Lowering BP will result in ischemic injury to “perihematomal penumbra”.

• **Current Concept:**
  – No reduced flow to perihematomal region in several experimental and clinical blood flow studies.
Current BP Guideline

• Maintain MAP < 110 or SBP < 160 and SBP > 90 for first 24-48 hrs if no ICP monitor present.

• Always keep CPP > 70 if ICP monitor present.
  – Position ICP monitor and arterial transducer 2 cm in front of and 2-2.5 cm above auditory meatus.

  – HOB at 30°.
Choosing BP agents

• To raise BP:

- Start at 50 mcg/kg/min.
- If SBP < 90, give Normal Saline 500ml IV as rapidly as possible.
- If SBP remains < 90, call physician to consider central line placement and initiate initial pressor:
  - Choose one for initial pressor therapy (If tachycardic, phenylephrine preferred; if bradycardic, norepinephrine or dopamine preferred):
  - Phenylephrine 0-180 micrograms/min IV to keep SBP > 90, start at 40 mcg/kg/min.
  - Norepinephrine 0-40 micrograms/min IV to keep SBP > 90 start at 2 mcg/kg/min.
  - Dopamine 0-10 micrograms/kg/min IV to keep SBP > 90, start at 2.5 mcg/kg/min.
Choosing BP Agents

- To lower BP:

  - **Nicardipine** 5 mg/hr IV infusion; titrate up by additional 2.5 mg/hr at 5-15 min intervals to a maximum rate of 15 mg/hr to maintain goal.

  - **Labetalol** 20 mg IV over 2 minutes
    - If not at goal after 10 minutes, give 40 mg IV over 2 min
    - If not at goal after 10 minutes, give 80 mg IV over 2 min
    - If not at goal after 10 min, give additional 80 mg IV over 2 min
    - If not at goal after 10 minutes, call MD

  - Titrate **labetalol** 0.5-2 mg/min IV to maintain goal.

  - Titrate **esmolol** 0-300 micrograms/kg/min IV to keep MAP less than 130. Start at 50 mcg/kg/min.

- Nitroprusside for DBP>140 ONLY (briefly)
ICP Management

Panel 2: Stepwise treatment protocol for high ICP in monitored patients

1. Surgical decompression: consider repeat CT scanning, and definitive surgical intervention or ventricular drainage
2. Sedation: intravenous sedation to attain a motionless, quiet state
3. CPP optimisation: pressor infusion if CPP is <70 mm Hg, or reduction of blood pressure if CPP is >110 mm Hg
4. Osmotherapy: mannitol (0.25–1.5 g/kg IV or 0.5–2.0 mL/kg) and 23.4% hypertonic saline (repeat every 1–6 h as needed)
5. Hyperventilation: target pCO₂ 26–30 mm Hg
6. High dose pentobarbital therapy: load with 5–20 mg/kg, infuse 1–4 mg/kg/h
7. Hypothermia: cool core body temperature to 32–33°C

CPP = cerebral perfusion pressure

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Arrhythmia

- Cerebrogenic Sudden Death
- QT Prolongation
- Late ventricular potentials
- Frequent PVC’s
- Polymorphic PVC’s
- R-on-T phenomenon
- Runs of V tach
- Abnormal heart rate variability
AAICH

Greater Cincinnati / Northern KY Stroke Study

![Bar chart showing data for 1988, 1993/4, and 1999.](chart.png)

- **1988**: 5% (Bland ICH) 9% (AAICH)
- **1993/4**: 9% (Bland ICH) 17% (AAICH)
- **1999**: 17% (Bland ICH) 17% (AAICH)

Statistical significance: $p < 0.001$
**AAICH**

Greater Cincinnati / Northern KY Stroke Study

**INR Intensity and AAICH, 1999**

- Warfarin accounted for:
  - 91% of AAICH cases in 1993/4
  - 98% of AAICH cases in 1999

- In 1999, INR values were available for 46 of 53 cases

<table>
<thead>
<tr>
<th>INR Value Range</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>&gt;4</td>
<td>24%</td>
</tr>
<tr>
<td>3 to 4</td>
<td>17%</td>
</tr>
<tr>
<td>2 to 3</td>
<td>26%</td>
</tr>
<tr>
<td>&lt;2</td>
<td>33%</td>
</tr>
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</table>
Warfarin-related Hemorrhage

- Warfarin doubles ICH mortality
- Warfarin increases risk of hematoma expansion (OR 6.22)
- Hematoma expansion occurs over more prolonged time course

Flibotte, et al. Neurology 2004
Warfarin Reversal

- Traditional: FFP, PCC, phytonadione
- rFVIIa (NovoSeven)?
Brief Review
Role of Angiography and MRI

- For ICH in the **youger** patient (<50 y.o.)
- Suspicion for vascular **lesion**
  - SAH, intraventricular blood, Ca, site, prominent vessels
- Angiography should be considered for all patients **without** a clear cause of hemorrhage who are surgical candidates, particularly young, normotensive patients who are clinically stable
- **Not** required for **older** hypertensive patients who have a hemorrhage in the basal ganglia, thalamus, cerebellum, or brain stem and in whom CT findings do not suggest a structural lesion.
- **Timing** of cerebral angiography depends on the patient's clinical state and the neurosurgeon's judgment concerning the urgency of surgery, if needed.
- MRI and MRA are helpful and may obviate the need for contrast cerebral angiography in selected patients. They should also be considered to look for **cavernous malformations** in normotensive patients with lobar hemorrhages and normal angiographic results who are surgical candidates (level of evidence V, grade C recommendation).

*J Neurol Neurosurg Psychiatry. 1994;57:1180–1186*
Surgical Options for ICH

• Craniotomy
• Stereotactic aspiration
  – Description of techniques
Early Surgery for ICH

"C'mon, c'mon — it's either one or the other."
Randomized Trials: Surgical ICH Removal

  - PreCT era
  - Surgical pts did worse
- Batjer *Arch Neurol*. 1990;47:1103–1106
- STITCH trial
International Surgical Trial in Intracerebral Haemorrhage (STICH Trial)

- Prospective randomised trial to compare early surgery with initial conservative treatment for patients with intracerebral haemorrhage.
- Early surgery within 24 h vs. initial conservative treatment used medical treatment, although later evacuation was allowed if necessary.
- Glasgow outcome scale
  - Good prognosis = good recovery or moderate disability
  - Poor prognosis group

Findings 1033 patients from 83 centres in 27 countries were randomised to early surgery (503) or initial conservative treatment (530).
- 6 months: 468 patients randomised to early surgery, 122 (26%) had a favourable outcome compared with 118 (24%) of 496 randomised to initial conservative treatment (odds ratio 0.89 [95% CI 0.66–1.19], p=0.414); absolute benefit 2.3% (−3.2 to 7.7), relative benefit 10% (−13 to 33).

Interpretation Patients with spontaneous supratentorial intracerebral haemorrhage in neurosurgical units show no overall benefit from early surgery when compared with initial conservative treatment.

The Lancet 2005; 365:387-397
## Data trends for ICH DC’s

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<tbody>
<tr>
<td># discharges</td>
<td>63,439</td>
<td>74,482</td>
<td>67,407</td>
<td>67,428</td>
</tr>
<tr>
<td>Inhospital death %</td>
<td>33</td>
<td>32</td>
<td>31</td>
<td>30</td>
</tr>
<tr>
<td>Routine DC</td>
<td>24</td>
<td>20</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Charges $</td>
<td>19,847</td>
<td>23,386</td>
<td>34,776</td>
<td>43,199</td>
</tr>
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Andaluz & Zuccarello, 2009
Associated diagnoses

- Arterial hypertension 60%
- Atrial fibrillation 16%
- Diabetes mellitus 15%
- Coronary artery dz 9%
- COPD 7%

Andaluz & Zuccarello, 2009
Association with craniotomy

• Occurred in 25%
• In hospital mortality was 14% lower … but
• Routine discharges were much lower
• Hospital stays doubled
• Charges tripled

• Mortality rates highest in patients with ventriculostomy (average 51%)

Andaluz & Zuccarello, 2009
Treatment of intracerebral hemorrhage

- Apart from management in a specialised stroke or neurological intensive care unit, until very recently no specific therapies improved outcome after intracerebral haemorrhage (ICH). In a recent phase II trial, recombinant activated factor VII (eptacog alfa) reduced haematoma expansion, mortality, and disability when given within 4 h of ICH onset; a phase III trial (the FAST trial) is now in progress.

- Ventilatory support, blood-pressure reduction, intracranial-pressure monitoring, osmotherapy, fever control, seizure prophylaxis, and nutritional supplementation are the cornerstones of supportive care in intensive care units.

- Ventricular drainage should be considered in all stuporous or comatose patients with intraventricular haemorrhage and acute hydrocephalus.

- Given the lack of benefit seen in the recent STICH trial, emergency surgical evacuation within 72 h of onset should be reserved for patients with large (>3 cm) cerebellar haemorrhages, or those with large lobar haemorrhages, substantial mass effect, and rapidly deteriorating condition.

Size Matters

- Small <10 cc
- Moderate 10-30 cc
- Large >30cc
- In one series, no patient with a massive hemorrhage >85cc lived

*Neurosurgery, 15:663-6, 1984*
Guidelines for Surgery

• Cerebellar hemorrhages >3cm, deteriorating, brainstem compression, hydrocephalus
• Younger patients with large lobar hemorrhages clinically deteriorating
• ICH with structural lesion if lesion accessible and chance of recovery is good

*Stroke.* 1999;30:905-915.)
Nonsurgical candidates

- Smaller hemorrhages (<10cm³)
- Minimal neurological deficits
- GCS ≤4
- Cerebellar hemorrhages with absent BSR’s and flaccid
- And many, many others

*Stroke*. 1999;30:905-915
Thank You for your kind attention