2022 Update on Intracerebral Hemorrhage
Neurosurgical Management
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John Scholz Stroke Education Education Conference
Introduction

- Hemorrhagic Stroke accounts for 20% of total strokes
- High burden of disease – 30d mortality of 40%
- High rate of disability:
  - 10-25% return to functional independence
  - <10% when initial hematoma >30ml
- Prolonged ICU stay:
  - Ventilation
  - Nutrition support
  - Infections
Causes of Intracerebral Hemorrhage

- Trauma
- Anticoagulation or clotting disorders
- Aneurysms
- AVMs
- Cavernous Malformations
- Tumors
- Substance Abuse
  - EtoH
  - Sympathomimetics
- Ischemic Stroke with hemorrhagic conversion
  - Hypertension
- Vasculitis
- Amyloid Angiopathy
- Venous Sinus Thrombosis
- Idiopathic
- CNS Infections
  - HSV encephalitis
  - Mycotic aneurysms
ICH Etiology Determines Hemorrhage Location

Deep/Posterior Fossa ICH Etiologies

- Arteriolosclerosis
  - Penetrating arteriole lipohyalinosis due to HTN, DM, Age

Macrovascular

- AVM
- Aneurysm
- Dural AVF
- Cavernous Malformation/Cavernoma
- Cerebral Venous Thrombosis

Lobar ICH Etiologies

- Cerebral Amyloid Angiopathy
  - Amyloid deposition in vessel walls

- Arteriolosclerosis

- Macrovascular

Diagnostic Reasoning: CAA typically causes only lobar (or superficial cerebellar) hemorrhages. Arteriolosclerosis may cause both deep and lobar hemorrhages. Coexistent pathology is possible.

Abbreviations: AVF indicates arteriovenous fistula; AVM, arteriovenous malformation; CAA, cerebral amyloid angiopathy; DM, diabetes mellitus; HTN, hypertension; and ICH, intracerebral hemorrhage.
Diagnosis & Assessment | Work-Up for Acute ICH Course

**Time**
- Time of symptom onset

**Symptoms**
- Headache
- Focal neurologic deficits
- Seizures
- Decreased level of consciousness

**Vascular Risk Factors**
- Ischemic Stroke
- Prior ICH
- Hypertension
- Hyperlipidemia
- Diabetes mellitus
- Metabolic syndrome
- Imaging biomarkers
  - Cerebral microbleeds

**Medications**
- Antithrombotics:
- Anticoagulants, thrombolytics, antiplatelet agents, NSAIDS
- Vasoconstrictive Agents:
  - Triptans, SSRIs, decongestants, stimulants, phentermine, sympathomimetic drugs
- Antihypertensives:
- Estrogen-containing oral contraceptives

**Cognitive Impairment or Dementia**
- Associated with (but not specific for) amyloid angiopathy

**Substance Use**
- Smoking
- Alcohol use
- Marijuana
- Sympathomimetic drugs
- Amphetamines, methamphetamine, cocaine

**Liver disease, Uremia, Malignancy and Hematologic disorders**
- May be associated with coagulopathy

**Abbreviations:** ICH indicates intracerebral hemorrhage; NSAIDS, non-steroidal anti-inflammatory drugs, and SSRI, selective serotonin reuptake inhibitors.
AHA Clinical Update

ADAPTED FROM:
2022 Guideline for the Management of Patients With Spontaneous Intracerebral Hemorrhage: A Guideline From the American Heart Association/ American Stroke Association
<table>
<thead>
<tr>
<th>CLASS (STRENGTH) OF RECOMMENDATION</th>
<th>LEVEL (QUALITY) OF EVIDENCE*</th>
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<tbody>
<tr>
<td><strong>CLASS 1 (STRONG)</strong></td>
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<tr>
<td><strong>CLASS 2a (MODERATE)</strong></td>
<td><strong>LEVEL B-NR</strong></td>
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<td>(Randomized)</td>
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<tr>
<td>Risk</td>
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<tr>
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<tr>
<td>· Comparative-Effectiveness Phrases†:</td>
<td>· Randomized or nonrandomized observational or registry studies with limitations of design or execution</td>
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<tr>
<td>· Treatment/strategy A is probably recommended/indicated in preference to treatment B</td>
<td>· Meta-analyses of such studies</td>
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<tr>
<td>· It is reasonable to choose treatment A over treatment B</td>
<td>· Physiological or mechanistic studies in human subjects</td>
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<tr>
<td><strong>CLASS 2b (Weak)</strong></td>
<td><strong>LEVEL C-EO</strong></td>
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<tr>
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<td>(Expert Opinion)</td>
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| · May/might be reasonable           | A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.
| · May/might be considered           | · For comparative-effectiveness recommendation (COR 1 and 2a; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated. |
| · Usefulness/effectiveness is unknown/unclear/uncertain or not well-established | *The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information). |
| **CLASS 3: No Benefit (MODERATE)** | **LEVEL C-LD**              |
| Benefit =                          | (Limited Data)              |
| Risk                               | · Randomized or nonrandomized observational or registry studies with limitations of design or execution |
| Suggested phrases for writing recommendations: | · Meta-analyses of such studies |
| · Is not recommended               | **LEVEL C-EO**              |
| · Is not indicated/useful/effective/beneficial | (Expert Opinion)            |
| · Should not be performed/administered/other | · Consensus of expert opinion based on clinical experience. |
| **CLASS 3: Harm (STRONG)**         | *The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information). |
| Benefit >                          | **LEVEL C-LD**              |
| Risk                               | · Randomized or nonrandomized observational or registry studies with limitations of design or execution |
| Suggested phrases for writing recommendations: | · Meta-analyses of such studies |
| · Potentially harmful               | **LEVEL C-EO**              |
| · Causes harm                      | (Expert Opinion)            |
| · Associated with excess morbidity/mortality | · Consensus of expert opinion based on clinical experience. |
| · Should not be performed/administered/other | COR and LOE are determined independently (any COR may be paired with any LOE). |

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; and RCT, randomized controlled trial.

For comparative-effectiveness recommendation (COR 1 and 2a; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

*The method of assessing quality is evolving, including the application of standardized, widely-used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR and LOE are determined independently (any COR may be paired with any LOE).
Medical Management

• Acute Resuscitation/ABC
• BP Management
• ICP management
• Reversal of coagulopathy
### Diagnosis & Assessment | Work-Up in Acute ICH

#### Physical Examination
- **Airway, Breathing & Circulation**
- **Vital signs**
- **General**: Focused on the head, heart, lungs, abdomen, and extremities
- **Focused Neurological Exam** (NIHSS, GCS)

#### Serum
- CBC
- BUN and Creatinine
- LFTs
- Glucose
- Inflammatory markers
  - (ESR and/or CRP)
- PT (with INR)
- aPTT
- Specific tests for DOACs

#### Urine
- Urine toxicology screen
- Pregnancy test

#### Cardiac-specific
- Troponin
- ECG

**Abbreviations:**
- aPTT indicates activated partial thromboplastin time; BUN, blood urea nitrogen; CRP, C-reactive protein; DOAC, direct oral anticoagulant; ECG, electrocardiogram; ESR, erythrocyte sedimentation rate; GCS, Glasgow coma scale; ICH, intracerebral hemorrhage; INR, international normalized ratio; LFTs, liver function tests; NIHSS, National Institutes of Health Stroke Scale; and PT, prothrombin time.
**Diagnosis & Assessment | Neuroimaging to Diagnose ICH**

**Time of presentation with stroke-like symptoms:** Obtain rapid CT or MRI to confirm the diagnosis of spontaneous ICH (1)

**Serial head CT scans can be useful for:**
- Patients with spontaneous intracerebral and/or intraventricular hemorrhage within the first 24 hours after symptom onset to evaluate for HE
- Patients with low GCS score or neurological deterioration to evaluate for HE, hydrocephalus, perihematoma edema or herniation (2a)

**CT angiography within the first few hours of ICH onset:**
May be reasonable to detect some structural causes of secondary ICH (2b)

**Utilizing CT markers of HE to identify patients at risk for HE may be reasonable.**

**Imaging findings:**
- Non contrast CT:
  - **Heterogeneous densities within the hematoma**
  - **Irregularities at the hematoma margins**
- CT angiography/ Contrast enhanced CT:
  - **Spot sign**

**Beyond first 24 hours:** Serial imaging is generally guided by clinical picture of the patient

**Abbreviations:** CT indicates computed tomography; HE, hematoma expansion; ICH, intracerebral hemorrhage; and MRI, magnetic resonance imaging.
Medical Management

• BP is increased in up to 75 to 80% of patients with acute stroke then goes back to normal within a few days.

• Causes of the transient increase is unknown:
  • Physiologic reaction to the stroke itself due to disturbed cerebral autoregulation
  • Damage or compression of brain regions that regulate the ANS
  • Neuroendocrine factors
  • Nonstroke-specific factors: Headache, urine retention, infection, physiological stress of admission to the hospital...
Medical Management

Rationale for BP lowering in Acute Stroke

• High BP in hemorrhagic stroke:
  • Increased the risk of hematoma expansion
  • Growth of the perihematomal edema
  • Early rebleeding

• Lowering BP can also treat concomitant heart conditions (Heart failure, Takutsubo...)

Rationale against lowering BP

• End organ hypoperfusion
• Cerebral ischemia due to low cerebral blood flow:
  • Patients with chronic HTN
  • Autoregulatory curve shifted to the right
Medical and Neurointensive Treatment for ICH
Acute Blood Pressure Lowering in Spontaneous ICH
To improve functional outcomes.

Medication titration to ensure continuous smooth & sustained control of BP, avoiding peaks and large variability in SBP, can be beneficial. (2a)

Initiating tx within 2 hrs of ICH onset and reaching target within 1-hr can be beneficial to reduce the risk of HE. (2a)

In ICH of mild to moderate severity presenting with SBP between 150 and 220 mmHg, acute lowering of SBP to a target of 140 mmHg with the goal of maintaining in the range of 130 to 150 mmHg is safe and may be reasonable. (2b)

If presenting with large or severe ICH or those requiring surgical decompression, the safety and efficacy of intensive BP lowering are not well established. (2b)

If ICH is mild to moderate severity presenting with SBP >150 mmHg, acute lowering of SBP to hrs. <130 mmHg is potentially harmful. (3:Harm)

Abbreviations: HE indicates hematoma expansion; ICH, intracerebral hemorrhage; mmHg, millimeters of mercury; SBP, systolic blood pressure; and tx, treatment.
Reversal of Coagulopathy

• Patient with ICH on antithrombotics:
  • Higher likelihood of secondary hematoma expansion
  • Increased risk of death
  • Increased risk of poor functional outcomes

• Patients taking OAC constitute 12-20% of patients with ICH
Mechanisms of ICH Injury

0 - 6 hours

Primary Injury

Hematoma Expansion

↑ ICP

Hydrocephalus

Herniation

>6 hours

Secondary Injury

Cerebral Edema

Inflammation

Toxicity from Blood Products

General Principle: Acute ICH management targets these mechanisms.

Abbreviations: ICH indicates intracerebral hemorrhage; and ICP, intracranial pressure.
Diagnosis & Assessment | Work-Up in Acute ICH

Indicators of Increased Morbidity & Mortality:
- Thrombocytopenia
- Acute Kidney Injury
- Hyperglycemia
- Elevated troponin

Indicators of Increased HE:
- Anemia
- Identification of a spot sign on CTA or contrast-enhanced OR certain imaging features on NCCT such as heterogeneous densities within the hematoma or irregularities at its margins.

Anticoagulant-related hemorrhages

Abbreviations: CTA indicates computed tomography angiography; HE, hematoma expansion; ICH, intracerebral hemorrhage; and NCCT, noncontrast computed tomography.
Diagnosis & Assessment | Strategy to Determine ICH Etiology

For Patients With...

- **Lobar ICH**
  - Age <70 yrs
  - OR -

- **Deep/Posterior Fossa ICH**
  - Age <45
  - Age 45-70 yrs, NO HTN

Utilize This Diagnostic Strategy...

- **CT Angiogram/Venogram Recommended (1)**
  - AND -
  - **MRI + MR Angiogram Reasonable (2a)**
  - AND -
  - **Cerebral Angiogram Reasonable (2a)**

- **Spontaneous IVH with NO parenchymal hemorrhage (any age)**
- OR -

- **CTA/MRA suggestive of macrovascular ICH etiology (any age)**

- **Cerebral Angiogram Recommended (1)**

**Abbreviations:** CT indicates computed tomography; CTA, computed tomography angiogram; HTN, hypertension; ICH, intracerebral hemorrhage; IVH, intraventricular hemorrhage; MRA, magnetic resonance angiogram; and MRI, magnetic resonance imaging.
Patients with ICH on anticoagulation

Discontinue anticoagulation therapy immediately. Rapid reversal should be performed as soon as possible (1)

VITAMIN K ANTAGONISTS

INR 1.3 – 1.9

INR > 2.0

4-F PCC 10-20 IU/kg (2b)

4-F PCC 25-50 IU/kg (1)

4-F PCC 25-50 IU/kg (1)

VITAMIN K ANTAGONISTS

DABIGATRAN

FACTOR Xa-INHIBITORS

HEPARINS

History: When last dose taken

Activated charcoal if DOAC < 2 hrs (potential efficacy up to 8 hrs) (2b)

Is Idarucizumab available?

NO

YES

PCCs or aPCC and/or renal replacement therapy (2b)

Idarucizumab (2a)

Is Andexanet alfa available?

NO

YES

4 Factor PCCs or aPCC (2b)

Andexanet alfa (2a)

IV Vitamin K (1)

Vitamin K Antagonists

Dabigatran

Factor Xa-Inhibitors

Heparins

Abbreviations: 4-F PCC indicates four-factor prothrombin complex concentrate; aPCC, activated prothrombin complex concentrate; DOAC, direct oral anticoagulant; ICH, intracerebral hemorrhage; and INR, international normalized ratio.
Hemostasis & Coagulopathy

Antiplatelet-Related Hemorrhage in Spontaneous ICH

If the patient is being treated with aspirin, platelet transfusion might be considered to reduce postoperative bleeding and mortality. (2b)

If the patient is being treated with antiplatelet agents, the effectiveness of desmopressin with or without platelet transfusions to reduce the expansion of the hematoma is uncertain. (2b)

Abbreviations: ASA indicates aspirin; and ICH, intracerebral hemorrhage.
Hemostasis & Coagulopathy
General Hemostatic Treatments

Synopsis of the Evidence

• HE occurs in up to a third of patients after ICH and is associated with poor outcome.

• Hemostatic therapy for the prevention of HE remains an attractive therapeutic target after ICH.

• In patients with spontaneous ICH (with or without the spot sign), the effectiveness of recombinant factor VIIa to improve functional outcome is unclear. (2b)

• In patients with spontaneous ICH (with or without the spot sign, black hole sign, or blend sign), the effectiveness of TXA to improve functional outcome is not well established. (2b)

• ICH expansion most commonly occurs very early after onset, and future studies need to target earlier treatment

Abbreviations: CTA indicates computed tomography angiography; HE, hematoma expansion; and ICH, intracerebral hemorrhage.
General Inpatient Care
Considerations for Inpatient Care Setting

Initiation of Appropriate Life Sustaining Therapies
(1)

Provision of care in a specialized inpatient unit with a multidisciplinary team
(1)

If specialized unit is not available, then transfer to centers with full range of high-acuity care and expertise
(1)

In patients with spontaneous ICH and clinical hydrocephalus, transfer to centers with Neurosurgical capabilities for hydrocephalus management (e.g. EVD placement and monitoring)
(1)

Abbreviations: EVD indicates external ventricular drain; and ICH, intracerebral hemorrhage.
**Inpatient Care Checklist**

**In Non-Ambulatory Spontaneous ICH...**

<table>
<thead>
<tr>
<th>Prevention &amp; Management of Acute Medical Complications</th>
</tr>
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<tbody>
<tr>
<td>• Use of standardized protocols/order sets <strong>is recommended</strong> to reduce disability and mortality. (1)</td>
</tr>
<tr>
<td>• Formal dysphagia screening protocol <strong>should be implemented</strong> prior to initiation of oral intake to reduce disability and the risk of pneumonia. (1)</td>
</tr>
<tr>
<td>• Continuous cardiac monitoring for first 24 to 72 hrs <strong>is reasonable</strong> to monitor for cardiac arrhythmias &amp; new cardiac ischemia. (2a)</td>
</tr>
<tr>
<td>• Laboratory and radiographic testing for infection on admission and throughout the hospital course <strong>is reasonable</strong> to improve outcomes. (2a)</td>
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<td>• Frequent neurological assessments (including GCS) <strong>should be performed</strong> by ED nurses in the early hyperacute phase of care to assess change in status, neurological examination, or LOC. (1)</td>
</tr>
<tr>
<td>• Frequent neuro assessments in ICU/Stroke unit <strong>are reasonable</strong> up to 72 hrs from admission to detect early ND. (2a)</td>
</tr>
<tr>
<td>• Nursing staff with specialized stroke competency education <strong>can be effective</strong> in improving outcome &amp; mortality. (2a)</td>
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**Abbreviations:** DVT indicates deep vein thrombosis; ED, emergency department; HE, hematoma expansion; hrs, hours; GCS, Glasgow Coma Scale; ICH, intracerebral hemorrhage; ICU, intensive care unit; LMWH, low molecular weight heparin; LOC, level of consciousness; ND, neurological deterioration; PE, pulmonary embolism; Tx, treatment; UFH, unfractionated heparin; and VTE, venous thromboembolism.
### Inpatient Care Checklist

**In Non-Ambulatory Spontaneous ICH...**

**Thromboprophylaxis & Tx of Thrombosis**

<table>
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<th>Treatment</th>
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<td>... intermittent pneumatic compression starting on the day of diagnosis is recommended for VTE (DVT and PE) prophylaxis. (1)</td>
<td>... and proximal DVT who are not yet candidates for anticoagulation, temporary use of retrievable filter is reasonable as a bridge until anticoagulation initiated. (2a)</td>
</tr>
<tr>
<td>... low-dose UFH or LMWH can be useful to reduce risk of PE (2a)</td>
<td>... and proximal DVT or PE, delaying treatment with UFH or LMWH 1 to 2 weeks after onset of ICH might be considered. (2b)</td>
</tr>
<tr>
<td>... temporary use of retrievable filter as bridge until anticoagulation initiated. (2a)</td>
<td></td>
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<td>... low-dose UFH or LMWH prophylaxis at 24 to 48 hrs from ICH onset may be reasonable to optimize the benefits of preventing thrombosis relative to the risk of HE. 2b)</td>
<td></td>
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<tr>
<td>... graduated compression stockings of knee-high or thigh-high length alone are not beneficial for VTE prophylaxis. (3: No Benefit)</td>
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**Abbreviations:** DVT indicates deep vein thrombosis; HE, hematoma expansion; hrs, hours; ICH, intracerebral hemorrhage; LMWH, low molecular weight heparin; PE, pulmonary embolism; Tx, treatment; UFH, unfractionated heparin; and VTE, venous thromboembolism.
General Inpatient Care
Glucose and Temperature Management

Glucose Management

Monitor serum glucose to reduce both hyper/hypoglycemia. (1)

Treat serum glucose <40-60 mg/dL to reduce mortality. (1)

NICE-SUGAR trial findings:

• In critically ill, target of <180 mg/dL associated with lower mortality than target of 81-108 mg/dL.
• Intensive glucose control (target 81-108 mg/dL) more likely to result in severe hypoglycemic events compared to control.

Temperature Management

In patients with spontaneous ICH, pharmacologically treating an elevated temperature may be reasonable to improve functional outcomes. (2b)

The usefulness of therapeutic hypothermia (<35°C/95°F) to decrease peri-ICH edema is unclear. (2b)

Temperature abnormalities can occur in over 30% of acute ICH patients, with fever associated with higher clinical severity and worse outcomes.

In patients with spontaneous ICH, treating moderate to severe hyperglycemia (>180–200 mg/dL, >10.0–11.1 mmol/L) is reasonable to improve outcomes. (2a)

Abbreviations: dL indicates deciliter; ICH, intracerebral hemorrhage; mg/dL, milligram per deciliter; mmol/L, millimoles per liter; and NICE-SUGAR, Normoglycemia in Intensive Care Evaluation and Surviving Using Glucose Algorithm Regulation.
Seizures and Antiseizure Drugs
New onset seizures in sICH are relatively common (2.8-28%) and occur within the first 24 hrs of hemorrhage.

Unexplained abnormal or fluctuating mental status, or suspicious of seizures, cEEG is reasonable to diagnose electrographic seizures and epileptiform discharges (24 hours or longer) (2a)

**Confirmed clinical or electrographic seizures**

Administer ASD (1)

**sICH patients without suspicion of seizure**

Avoid ASD (3: No Benefit)

**Abbreviation:** ASD indicates antiseizure drugs; cEEG, continuous electroencephalography; hrs, hours; and sICH, spontaneous intracerebral hemorrhage.
Neuroinvasive Monitoring, Intracranial Pressure & Edema Treatment

sICH or IVH and hydrocephalus which is contributing to decreased level of consciousness:

**Ventricular drainage should be performed to reduce mortality (1)**

**ICP monitoring and treatment to reduce mortality and improve outcomes (2b)**

**Corticosteroids should not be administered for treatment of elevated ICP (3: No Benefit)**

**Early prophylactic hyperosmolar therapy for improving outcomes is not well established (2b)**

**Bolus hyperosmolar therapy may be considered for transiently reducing ICP (2b)**

**Abbreviation:** ICP indicates intracranial pressure; IVH, intraventricular hemorrhage; and sICH, spontaneous intracerebral hemorrhage.
Surgical Interventions
Minimally Invasive Surgical Evacuation of ICH

Patient Selection

MIS for ICH
Supratentorial ICH, hematoma volume >20-30 mL, GCS 5-12

Intervention

- MIS ± hematoma thrombolysis to improve mortality can be useful (2a)
- MIS ± hematoma thrombolysis to improve functional outcome is of uncertain effectiveness (2b)
- Choosing MIS rather than craniotomy to improve functional outcomes may be reasonable (2b)

Abbreviations: GCS indicates Glasgow Coma Scale; ICH, intracerebral hemorrhage; and MIS, minimally invasive surgery.
Surgical Interventions
Minimally Invasive Surgical Evacuation of Intraventricular Hemorrhage

IVH Surgical Management

- **Spontaneous IVH + Obstructive Hydrocephalus**
  - EVD
  - Mortality Reduction (I)
  - Functional Outcome Benefit (2b*)

- **Spontaneous ICH <30 mL IVH requiring EVD**
  - EVD + thrombolytic
  - Mortality Reduction (2a)
  - Functional Outcome Benefit (2b†)

- **Spontaneous ICH < 30 mL GCS >3 IVH requiring EVD**
  - Neuroendoscopy + EVD +/- thrombolytic
  - Functional Outcome Benefit (2b†)
  - Reduced Permanent Shunt Dependence (2b†)

---

**Abbreviations:** EVD indicates external ventricular drain; GCS, Glasgow coma scale; ICH, Intracerebral hemorrhage, and IVH, intraventricular hemorrhage.

Note: *Not well established. †Uncertain
Surgical Interventions
Craniotomy for Supratentorial Hemorrhage

Supratentorial ICH of moderate or greater severity*

Note: * >10 cc with a significant neurologic deficit

- Craniotomy for hemorrhage evacuation to improve mortality or functional outcomes is of uncertain usefulness (2b)
- Craniotomy for hemorrhage evacuation may be considered as a life-saving measure in patients who are deteriorating (2b)

Abbreviations: ICH indicates intracerebral hemorrhage.
Surgical Interventions
Craniotomy for Posterior Fossa Hemorrhage

Cerebellar ICH

If any of the following present

- Neurologic deterioration
- Brainstem compression
- Obstructive hydrocephalus
- ICH volume ≥ 15cc

Immediate surgical removal of hemorrhage ± EVD is recommended to reduce mortality (1)

Abbreviations: EVD indicates external ventricular drain; and ICH, intracerebral hemorrhage.
Surgical Interventions
Craniectomy for ICH

In patients with supratentorial ICH who are in a coma, have large hematomas with significant midline shift, or have elevated ICP refractory to medical management:

- decompressive craniectomy with or without hematoma evacuation may be considered to reduce mortality. (2b)
- effectiveness of decompressive craniectomy with or without hematoma evacuation to improve functional outcomes is uncertain. (2b)

Abbreviation: ICH indicates intracerebral hemorrhage; and ICP, intracranial pressure.
Craniotomy for ICH

• STITCH: No superiority of surgical group vs medical management
• Post-hoc analysis: Superficial Clots do benefit from surgery
• STITCH II:
  • Early surgery does not increase rate of death or disability
  • Small but clinically relevant survival advantage for surgical group
Craniotomy for ICH
Craniotomy for ICH
MIS ICH Evacuation

• 62 y.o. female presented as a stroke code

• CT head:
  • Large right basal ganglia hemorrhage
  • 12 mm of right-to-left midline shift.

• Exam:
  • GCS 12 on arrival (E2 V4 M6)
  • Sleepy, left plegic
Gentle end-hole aspiration without any exposed cutting elements.

Material first extrudes into the tip of the Wand under vacuum before the vibrational energy takes effect.
Methods

• This endoscopic aspiration system is introduced through one of the channels of the channel scope.
• Noncontrast head CT were obtained immediately post-op.
MIS ICH Evacuation
Trial Results

• ICH volume >30ml, Clot stability >6hrs; No obstructive HCP, no clinical herniation

• MISTIE II:
  • Adequate trajectory necessary
  • 1mg q8h for up to 9 doses

• MISTIE III:
  • No difference in good functional recovery at 1 year (mRS 0-3)
  • **Subgroup analysis: significant correlation between extent of removal and good functional outcome**
MISTIE
MISTIE
Beware of what lurks underneath!
45-year-old female herniating on arrival to ER
Case 2

- 51 yo male
- HTN, DL, A fib
- Collapsed at work
- GCS at presentation: 3
Clear IVH
Cerebral Angiography
Cerebral Angiography
Management

• Intraventricular tPA through the EVD
• Protocol:
  • 1mg TPA Q12
  • Total of 9 injections

• No revisions or replacement of EVD was necessary
• Resolution of casted 4th ventricle
Day 2
Day 3
Day 4
Day 5
Day 6
Day 7
Clinical Follow-up

- Pt initially comatose
- 24h post-hemorrhage: follow commands
- Slow improvement and mobilization
- 12th day: EVD removed
- 13th day: Transferred out of ICU
- 20th day:
  - discharged to rehab facility
  - Pt was alert and oriented
  - Back to neurologic baseline except for left hand (weaker)
Day 19 post hemorrhage
Outcome Prediction and Goals of Care

In patients with spontaneous ICH

... administering a baseline measure of overall hemorrhage severity is recommended as part of the initial evaluation to provide an overall measure of clinical severity. (1)

**Examples:**
- ICH-score
- Max-ICH

**Click to view Measures for Evaluating Overall Hemorrhage Severity**

... a baseline severity score might be reasonable to provide a general framework for communication with the patient and their caregivers. (2b)

... a baseline severity score should NOT be used as the sole basis for forecasting individual prognosis or limiting life-sustaining treatment. (3:Harm)

**Abbreviations:** ICH indicates intracerebral hemorrhage.
Uncontrolled HTN accounts for 74% of global population-attributable risk for ICH.

**Guiding Principle**

In patients with spontaneous ICH, it is reasonable to lower BP to 130/80 mmHg for long-term management to prevent hemorrhage recurrence (2a).

**Abbreviations:** BP indicates blood pressure; HTN, hypertension; ICH, intracerebral hemorrhage; and mmHg, millimeters of mercury.
Secondary Prevention
Management of Antithrombotic Agents and Other Medications

**High Risk of Thrombotic Events**
ex. Patient with mechanical valve, LVAD

- Early resumption of anticoagulation is reasonable (2a)

**Nonvalvular AF**

- WEIGH RISKS vs BENEFITS of restarting anticoagulation
  - risk > benefit

**Resumption of Anticoagulation**

- May be reasonable (2b)

**Consider initiation of anticoagulation 7-8 weeks after ICH** (2b)

**Resumption of Antiplatelet Therapy**

- May be reasonable based on consideration of benefit and risk (2b)

**LAA Closure**

- May be considered (2b)

**Statins**

- Risks and benefits of statins on ICH outcomes and recurrence are uncertain (2b)

**NSAIDs**

- Regular long-term use of NSAIDs is potentially harmful because of the increased risk of ICH (3: Harm)

**Abbreviations:** AF indicates atrial fibrillation; ICH, intracerebral hemorrhage; LAA, left atrial appendage; LVAD, left ventricular assist device; and NSAID, non-steroidal anti-inflammatory drugs.
Secondary Prevention
Lifestyle Modifications / Patient and Caregiver Education

**LIFESTYLE MODIFICATIONS**
- Blood pressure control
- Avoiding heavy alcohol use
- Supervised training and counseling

**PATIENT & CAREGIVER EDUCATION**
- Psychosocial education
- Caregiver support & training
Conclusion

• ICH score still key determinant of outcome
• Medical management initial step
• Surgery for select patients
Thank you