# Taming the Starfish of Death:
## Acute Management of Intracranial Hemorrhage

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# Disclosures & Disclaimers

- Disclosures: No conflicts of interest or other disclosures
- Off-Labels: Bicarb, AEDs, antihypertensives(?)
- Endorsements: Views, opinions, and recommendations are **my own** *and do not necessarily reflect those of my employer(s)*. Specific brands or products mentioned are for clarity only and should not be interpreted as endorsements.
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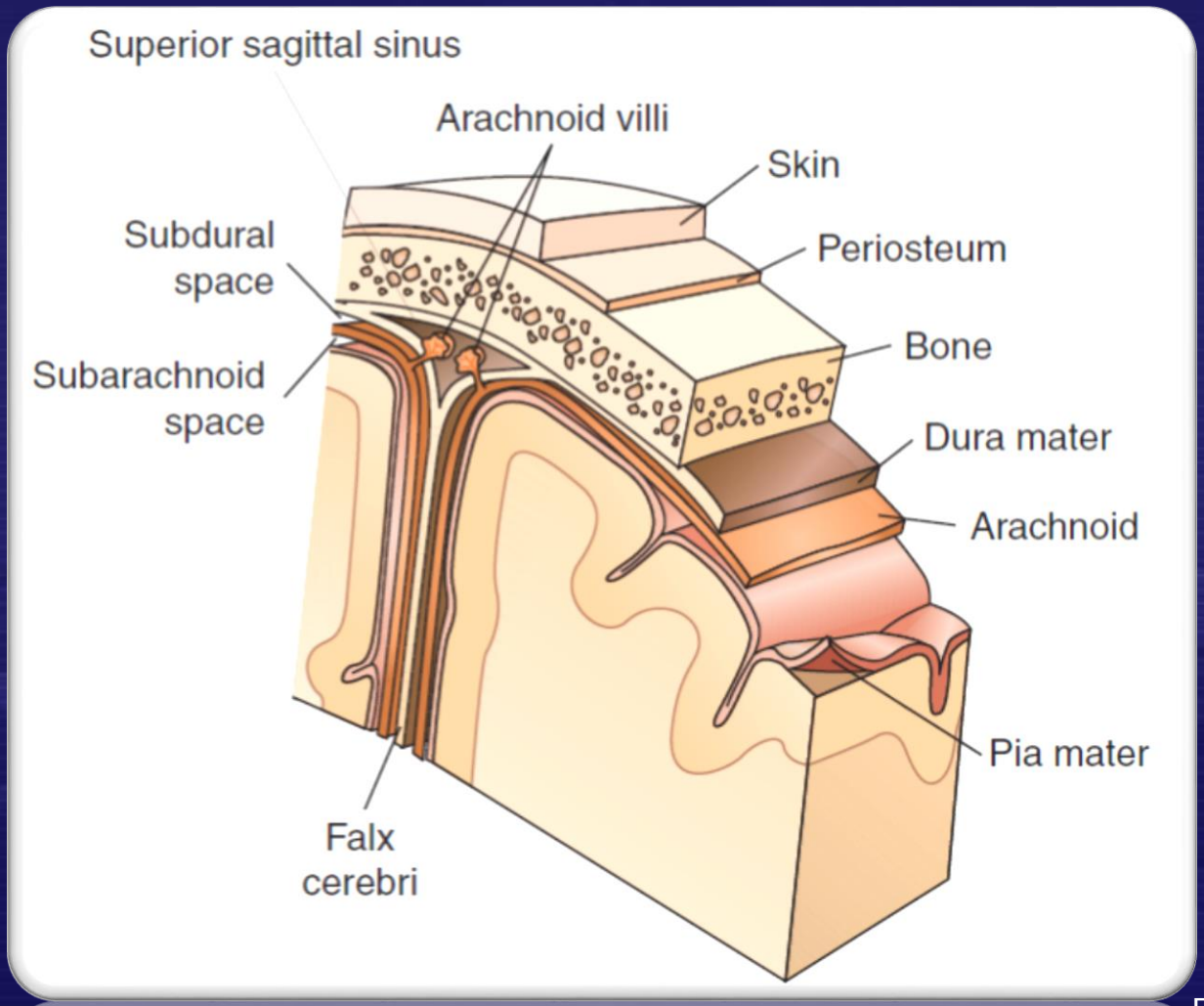
# Objectives

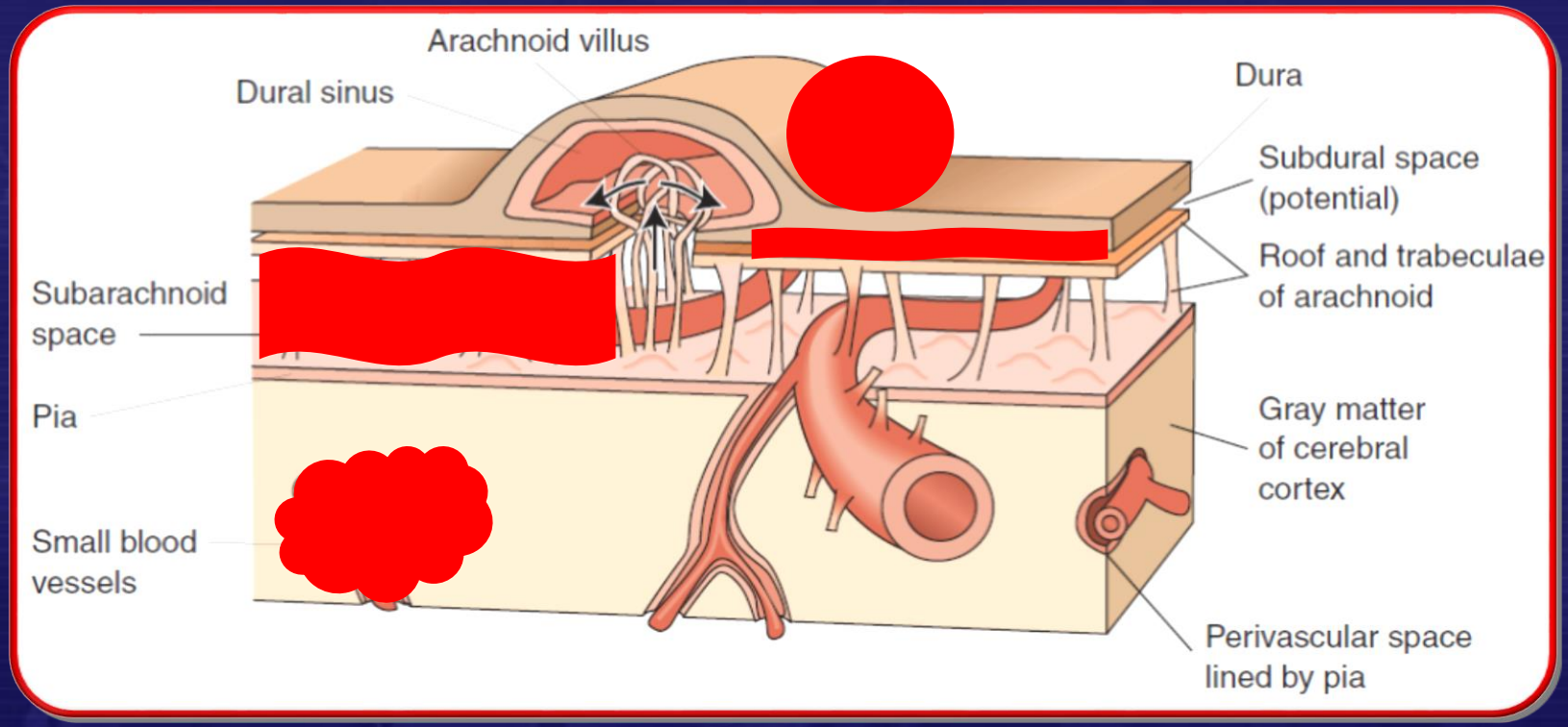
- Review basic neuroanatomy, physiology, and common pathophysiology
- Identify assessment and imaging findings suggestive of acute intracranial hemorrhage
- Describe an evidence-based approach to managing these patients in the emergent and acute environments

# Neuroanatomy, Physiology, Pathophysiology



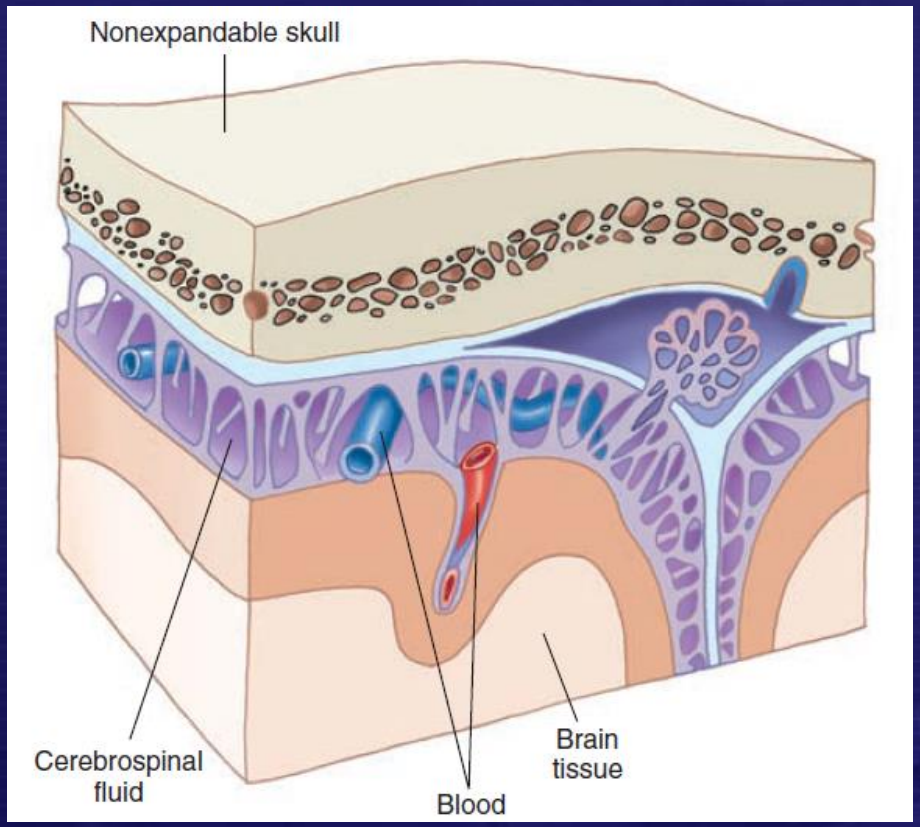

Pathophysiology 8th, 2009

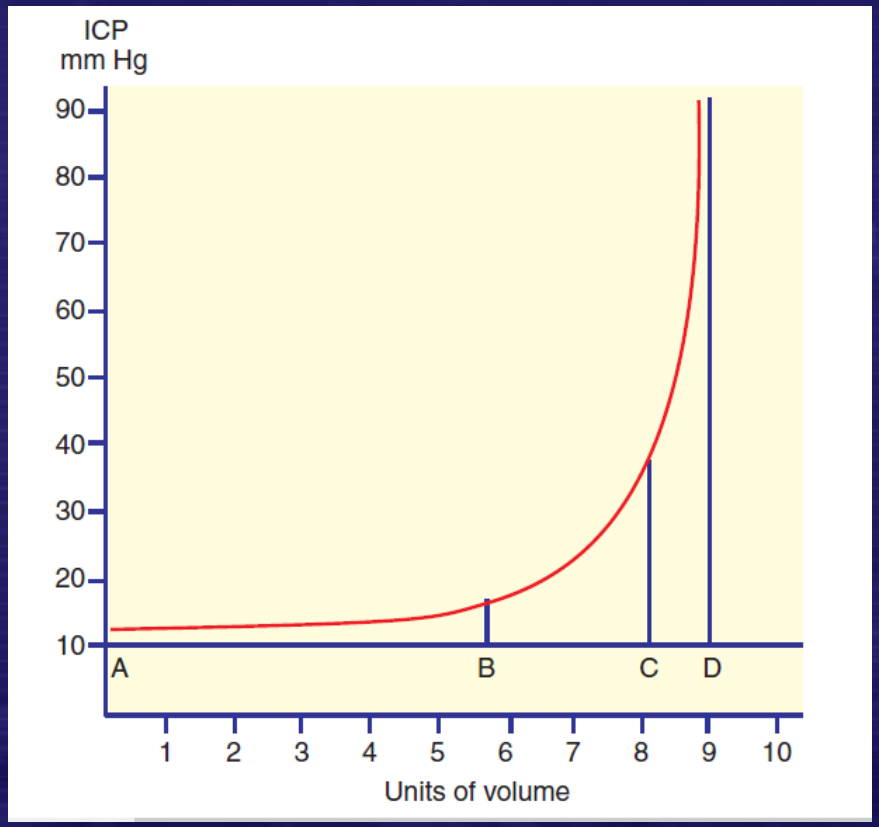
# Neuroanatomy, Physiology, Pathophysiology




Pathophysiology 8th, 2009

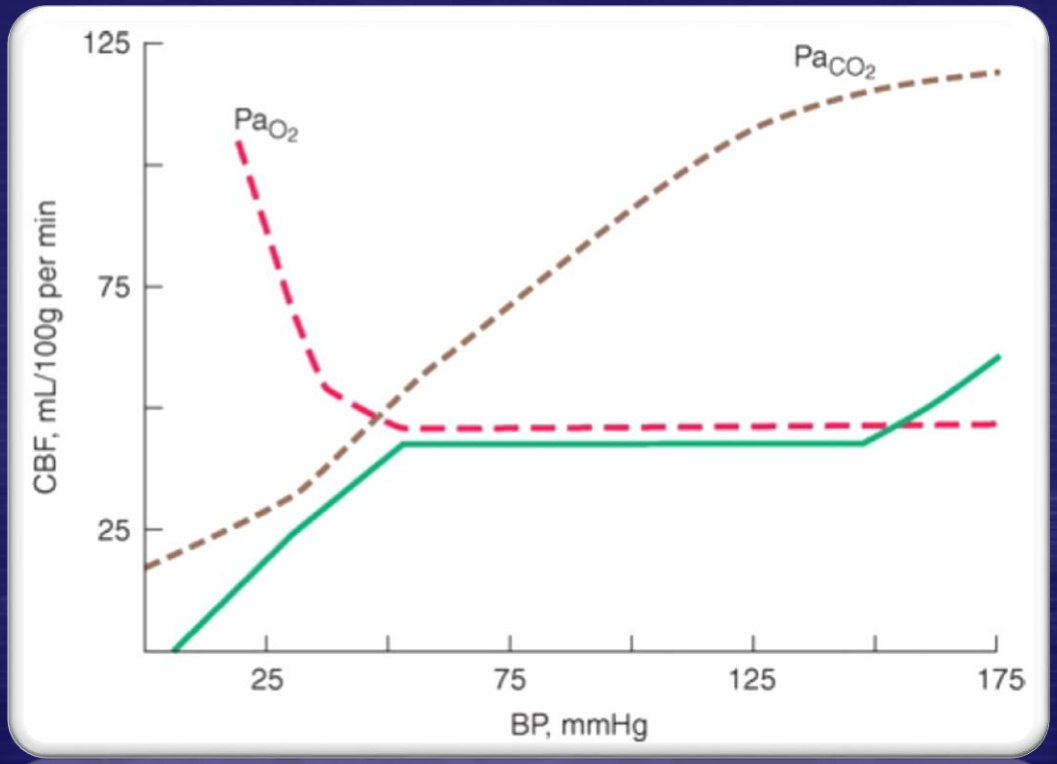
# Neuroanatomy, Physiology, Pathophysiology



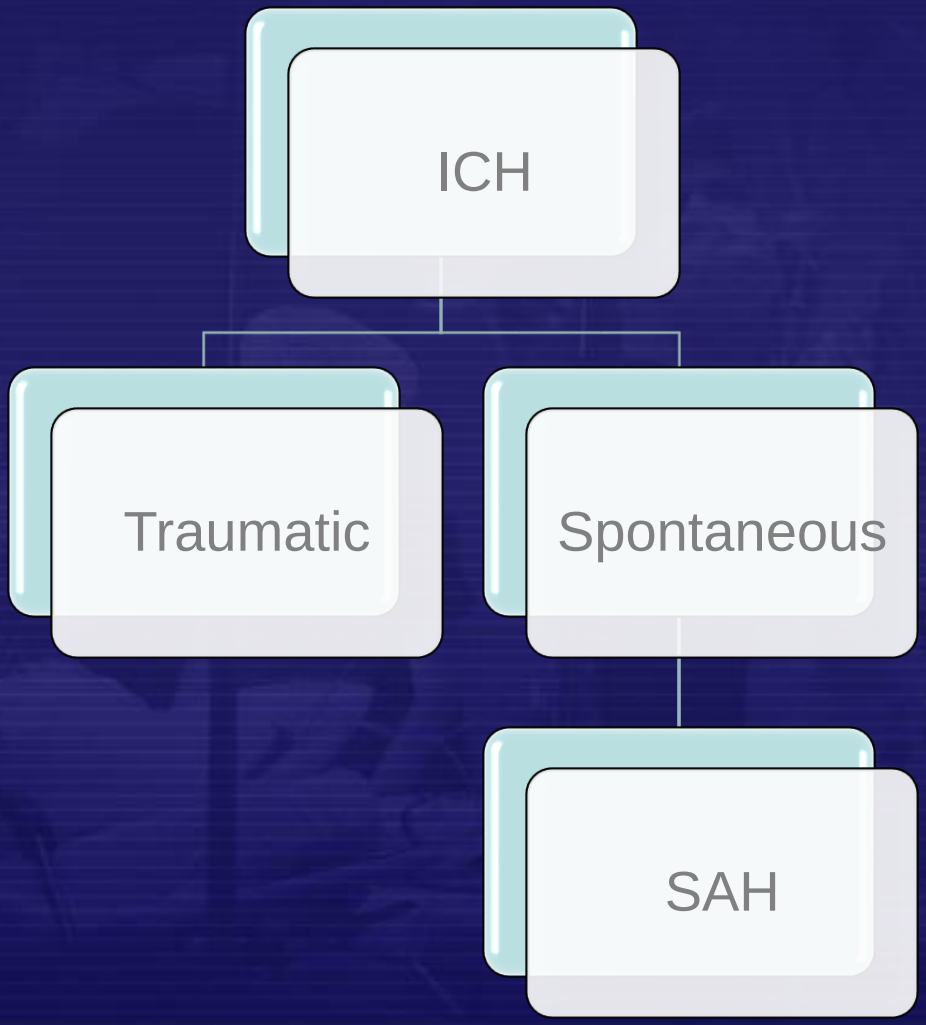

Pathophysiology 8th, 2009

# Neuroanatomy, Physiology, Pathophysiology




Harrison's 18th, 2012

# Assessment & Management of Acute ICH



# Assessment of Spontaneous ICH

- Suggestion of ICH:
  - Vomiting
  - SBP >220 mmHg
  - Severe headache (“WHOL”), coma, or decreased LOC
  - Rapid sx progression (minutes→hours)
- >20% drop GCS ≥ 2 between EMS & ED eval
- 15-23% continue deterioration in first few hours
- 28-38% hematoma expansion >1/3 initial volume on 3-hour rCTH.

Stroke. 2015;46:2032-60

# Management of Acute ICH

- Prehospital (i.e., undifferentiated stroke)
  - Support ABCs
  - Determine symptom onset time
  - Prehospital CTH if available



Stroke. 2015;46:2032-60

# Management of Acute ICH

- In-“Hospital” (CT confirmed)
  - Prompt diagnosis (CT/MRI)
  - Prompt neurosurgical consult
    - Consider tele-consultation
  - Prompt transfer to definitive care
  - Antihypertensive management
  - Anticoagulation reversal
  - Intracranial pressure management
  - Anticonvulsant administration (?)

Stroke. 2012;43:1711-37
Stroke. 2015;46:2032-60

# ICH Emergent/Acute Management Goals

- Hypertension management
- Coagulopathy management
- Intracranial pressure management
- Seizure management / prophylaxis

# Hypertension management

# Blood Pressure Goals for Spontaneous ICH

- INTERACT-2 Study:
  - No difference in death or disability between groups
  - SBP <140: Lower (improved) mRS at discharge
- 2015 AHA/ASA Guidelines & ENLS Protocols:
  - Reduction to <140 mmHg is safe
- 2012 aSAH Guidelines:
  - Reduction to <160 mmHg is probably reasonable
- ATACH-2 Study:
  - No difference in death or disability between groups

N Engl J Med. 2013;368:2355-65
Stroke. 2015;46:2032-60
N Engl J Med. 2016;375:1033-43
ENLS Protocols, 2016

# Blood Pressure Goals for Spontaneous ICH

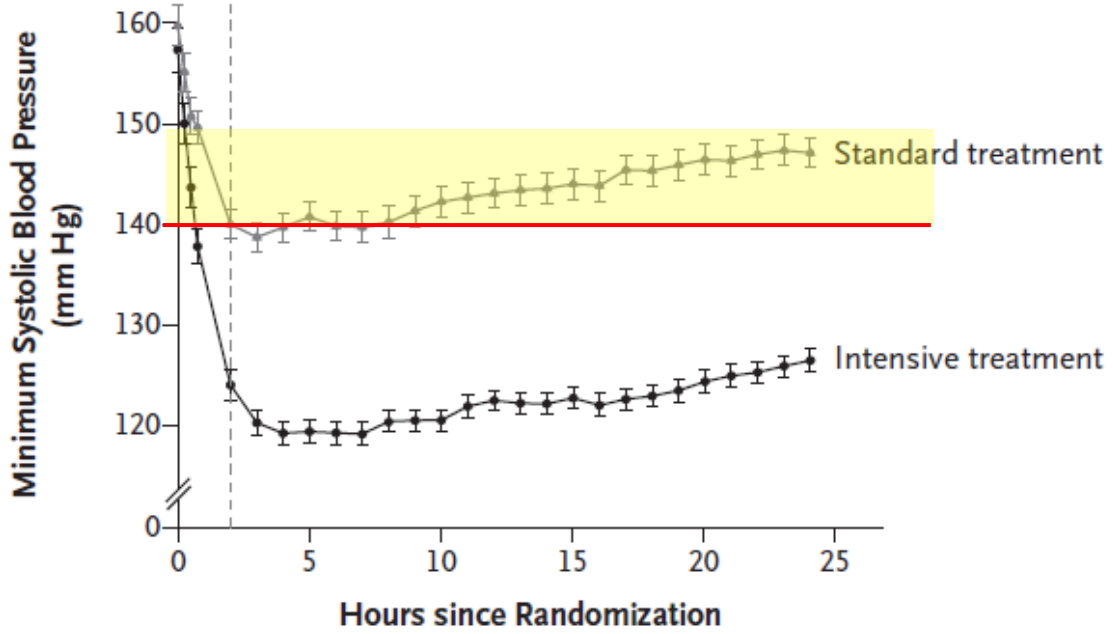



**Figure 1. Mean Hourly Minimum Systolic Blood Pressure during the First 24 Hours after Randomization, According to Treatment Group.**

The dashed vertical line indicates 2 hours, and I bars 95% confidence intervals.

N Engl J Med. 2016;375:1033-43

# Blood Pressure Goals for Spontaneous ICH

- Specific thresholds unclear
  - Consensus: target SBP < 140-160 mmHg
- No specific agents recommended in guidelines
- BBs: Labetalol / esmolol
- CCBs: Nicardipine / clevidipine
- Hydralazine (?)
  - Reflex tachycardia / myocardial ischemia
- Sodium nitroprusside (??)
  - Unpredictable dose-response; rHTN; IICP

N Engl J Med. 2013;368:2355-65
Neurol Clin Pract. 2014;4:419–26
Stroke. 2015;46:2032-60
N Engl J Med. 2016;375:1033-43
ENLS Protocols, 2016

# Blood Pressure Goals for Traumatic ICH

- No recommendation to *lower* SBP
- Age 50-69: Keep SBP >100 mmHg
- Age 14-49; 70+: Keep SBP >110 mmHg
- Avoid hypotension

ENLS Protocols, 2016
Neurosurgery. 2017;80:6-15

# Coagulopathy Management

# Coagulopathy Management

- Vitamin K Antagonist (e.g., warfarin)
  - Vitamin K 10 mg **IV**
  - 4-factor Prothrombin Complex Concentrate (PCC)
    - 4-factor > 3-factor
    - PCC > FFP
    - PCC alone > PCC + FFP
  - Fixed-dose PCC?
    - 1500 units
    - 2000 units if >100 kg
  - Use FFP if no PCC available
  - Avoid rFVIIa (higher thrombosis rate)

EMPharmD, 2017
ENLS Protocols, 2016
Neurocrit Care. 2016;24:6-46

# Coagulopathy Management

- Factor Xa Inhibitors (e.g., “-xabans”)
  - Determine last dose ($t_{½}$ usually ≤12hrs)
    - ?Activated charcoal if intubated & last dose <2 hours
  - 4-factor Prothrombin Complex Concentrate (PCC)
  - Andexanet alfa
- Direct Thrombin Inhibitors (e.g., dabigatran)
  - Determine last dose
    - ?Activated charcoal if intubated & last dose <2 hours
  - Idarucizumab (5 gms IV x 2 doses) – *dabigatran only*
  - PCC if idarucizumab not available or other DTI
  - Hemodialysis

J Blood Med. 2017;8:141-9
Neurocrit Care. 2016;24:6-46

# Coagulopathy Management

- Antiplatelets (e.g., ASA, NSAID, P2Y12, GP IIB/IIIA)
  - DDAVP 0.3-0.4 mcg/kg IV – *for ASA or anti-P2Y12*
  - PATCH Trial: AVOID platelet transfusions
- Heparins: Unfractionated heparin (UFH)
  - Protamine sulfate:
    - 1 mg / 100 units UFH given in previous 2-3 h; Max 50 mg
    - Repeat at 0.5 mg / 100 units UFH if aPTT remains elevated
- Heparins: LMWH (enoxaparin)
  - Can try protamine sulfate:
    - 1 mg / 1 mg of enoxaparin (if given in past 8 hrs)

ENLS Protocols, 2016
Lancet. 2016;387:2605-13
Neurocrit Care. 2016;24:6-46

# Coagulopathy Management

- Thrombolytics (alteplase, retaplase, tenecteplase)
  - Cryoprecipitate 10 units
  - Antifibrinolytic if no cryo available
    - tranexamic acid: 10-15 mg/kg IV
    - e-aminocaproic acid: 4-5 g IV
  - Redose cryo PRN if fibrinogen <150 mg/dL
  - Platelet use unclear

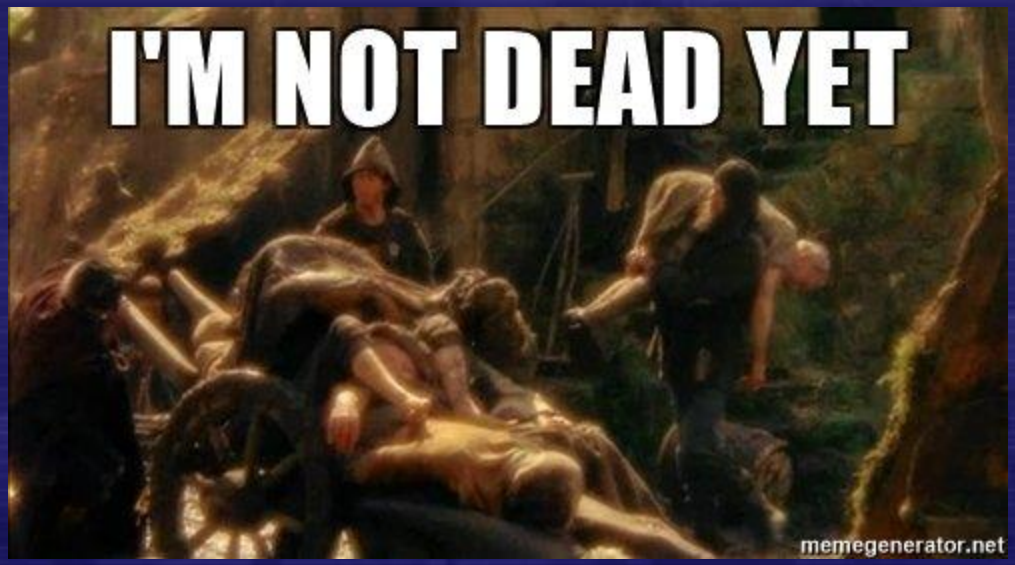
Neurocrit Care. 2016;24:6-46

# Summary: Coagulopathy Management

- Vitamin K Antagonists (warfarin):
  - Vitamin K (give **IV**) + Prothrombin Complex Concentrate
  - PCC preferred over FFP
- Factor Xa inhbitors ("-xabans"): Andexanet alfa**
  - PCC if not available or not indicated
- Direct Thrombin Inhibitors: Idarucizumab** or PCC
- ASA or P2Y12s: DDAVP
- UFH/LMWH: Protamine sulfate
- Thrombolytic: Cryoprecipitate

N Engl J Med 2015;373:2413-24
ENLS Protocols, 2016
Neurocrit Care. 2016;24:6-46

# Management of Other Badness




# Intracranial Pressure Management

- Basic ICP management:
  - HOB >30°
  - Neck neutral position
  - Adequate analgosedation
  - Avoid occluding neck veins
- CPP Thresholds:
  - Medical guidelines: 50-70 mmHg
  - Trauma guidelines: 60-70 mmHg
  - ENLS Protocols: 60-70 mmHg

ENLS Protocols, 2016
Stroke. 2015;46:2032-60
Neurosurgery. 2017;80:6-15
Image: Radiopaedia.org

# Cerebral Edema / ICP Management

- Mannitol or Hypertonic Saline?
  - Weakly favor HTS over mannitol
  - Weakly favor bolus-HTS over continuous-HTS
- Hypertonic Saline
  - 3%NaCl - **Safe** for peripheral administration
  - Consider bicarb if no HTS available
    - 8.5% $NaHCO_3$ (standard “amp”) equiosmolar to 5.8% NaCl
- Hyperventilation – **only** for herniation
  - *Brief* hyperventilation to $PaCO_2$ 25-35 mmHg

ENLS Protocols, 2016
Brain Edema XVI, 2016
J Neurosurg Anesthesiol. 2016;ePub
Nurs Clin N Am. 2017;52:249-60
J Neurosci Nurs. 2017;49:191-5

# Seizure Prophylaxis

- TBI:
  - Prophylaxis “not recommended”
  - PHT to manage early PTS
- sICH:
  - Treat seizures with AEDs
  - Prophylaxis “not recommended”
    - LEV → Worsened QOL
- aSAH:
  - Can consider AEDs in immediate posthemorrhagic period

Stroke. 2012;43:1711-37
Stroke. 2015;46:2032-60
Neurosurgery. 2017;80:6-15
Crit Care Med. 2018;46:1480-5

# Summary

- BP goal: <140 -160 ish …maybe?
- Coagulopathy: When in doubt, PCC > FFP
  - Aspirin: DDAVP
  - Heparins: protamine sulfate
  - Dabigatran: Idarucizumab
- IICP: HTS ?> Mannitol
  - Bicarb??
- Seizure prophylaxis: No, unless SAH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