



ICU Management of Acute Ischemic Stroke

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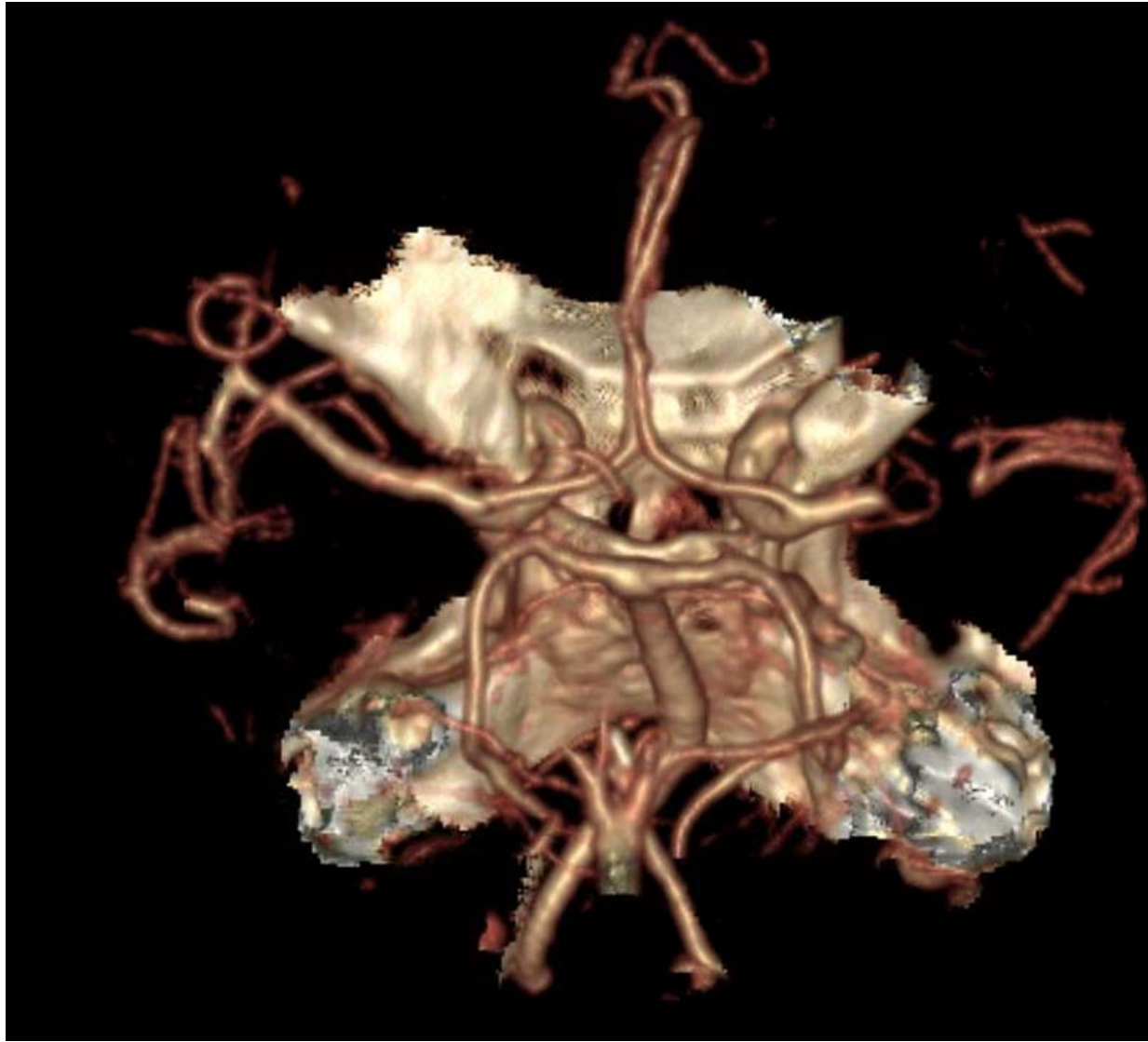


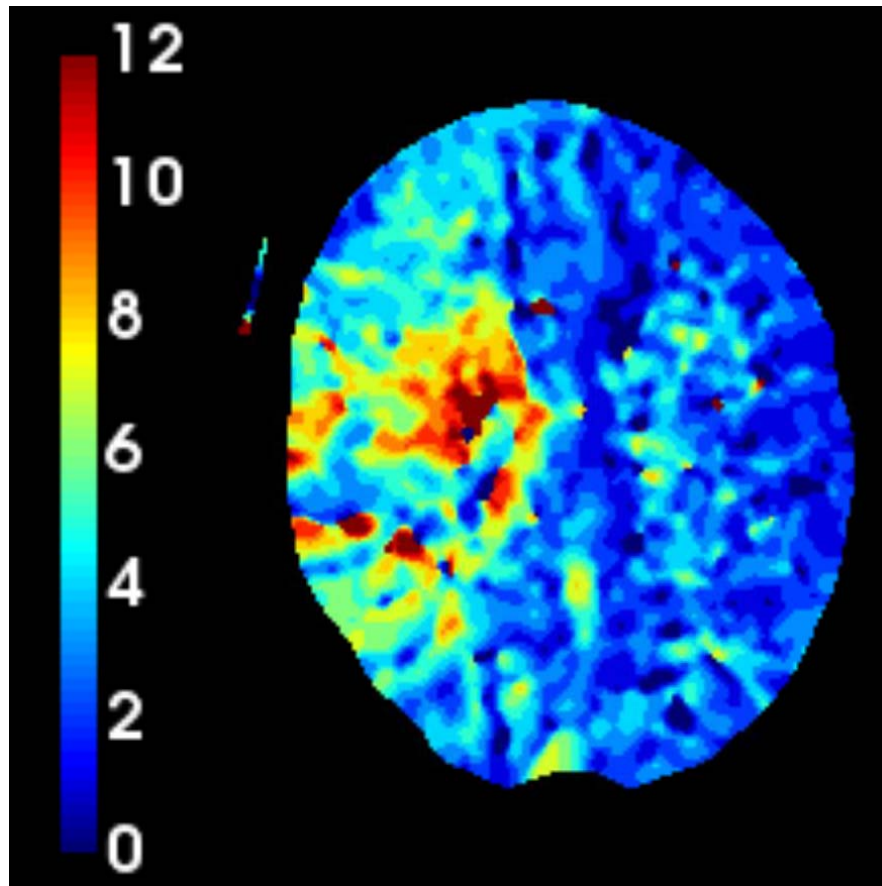
Objectives

- Discuss management of ischemic stroke in ICU
 - › Post thrombolytic/endovascular therapy
 - › Blood pressure
 - › Blood glucose
 - › Antithrombotic therapy
 - › Hemorrhagic Conversion of Infarct
 - › Decompressive hemicraniectomy

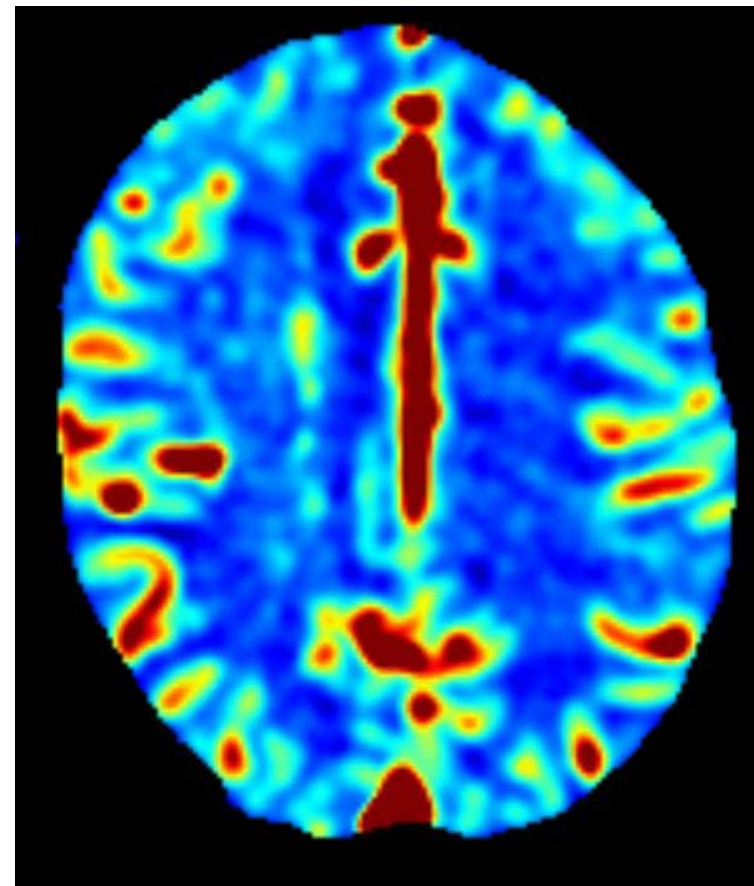
The Patient

- 67 year old woman with hypertension, CAD, current smoker, found “confused” by grandson
- EMS → Emergency Department
- Noted to have left-sided paralysis, left facial droop, and dysarthria
- CT head: No evidence of intracerebral hemorrhage or large infarct





TMAX



Cerebral Blood Flow

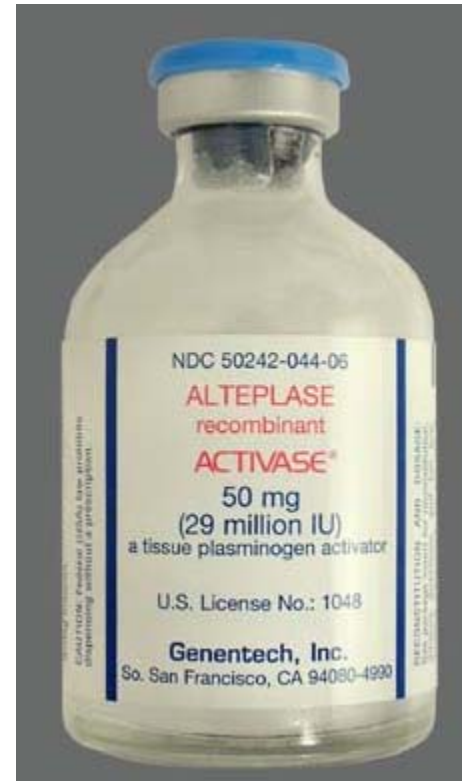
Intravenous tPA for Acute Ischemic Stroke

- IV tPA is FDA approved for patients presenting within 3 hours of onset of stroke symptoms
 - › Based on NINDS trial, showed 12% absolute increase in the number of patients with minimal or no disability
 - › Symptomatic ICH in 0.6% of placebo patients, 6.4% of IV tPA patients
 - › No difference in mortality at 90 days
- Used off-label up to 4.5 hours based on ECASS III results

The Patient

- Any contraindications to IV tPA?
 - › ICH on pretreatment CT
 - › Symptoms minor or rapidly improving
 - › No active internal bleeding
 - › No current use of oral anticoagulants with INR > 1.6
 - › No major surgery within 14 days
 - › No stroke, intracranial surgery, or serious head trauma within 3 months
 - › No GI or urinary tract hemorrhage within 21 days
 - › No recent lumbar puncture
 - › SBP <185/110
 - › No history of intracranial hemorrhage
 - › No seizure at onset of symptoms
 - › No known AVM or aneurysm

- No contraindications to IV tPA, so IV tPA started at 1h 35min after last seen normal
- Patient subsequently taken to cath lab



TICI score

0: No perfusion

1: Perfusion past the initial obstruction, but limited distal branch filling with little or slow distal perfusion

2a: Perfusion of $< 50\%$ of the vascular distribution of the occluded artery

2b: Perfusion of $\geq 50\%$ of the vascular distribution of the occluded artery

3: Full perfusion with filling of all distal branches

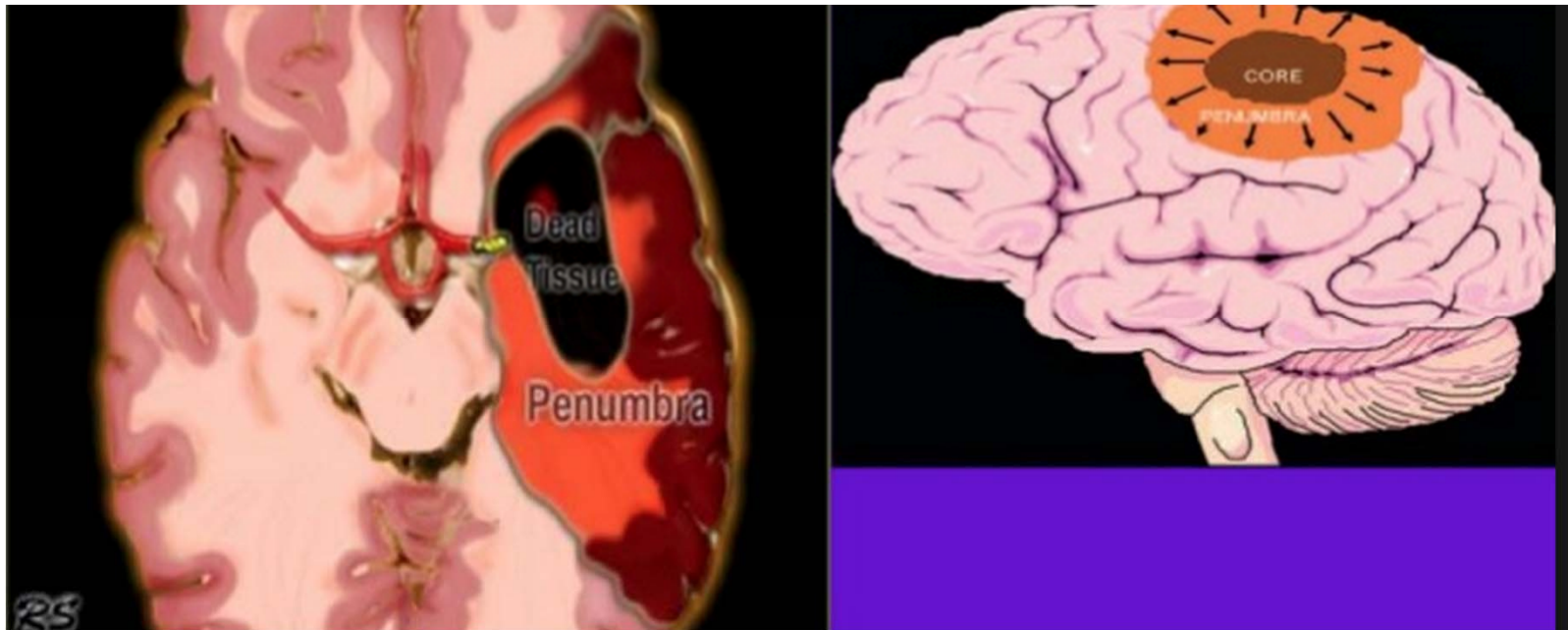



Post IV tPA Care

- Post IV tPA protocol:
 - › Q1 hour neurochecks x 24 hours
 - › No antiplatelet or anticoagulant medications x 24 hours
 - › BP < 185/100
 - › Avoid unnecessary lines, catheters, etc.
 - › Stat CT head for any neuro worsening or headache

ICU Management of Acute Stroke

Blood Pressure management has to do with CORE vs PENUMBRA



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- Our patient initially had little to no core, but large penumbra
 - How do we preserve the penumbra?
 - › Rapid revascularization: IV tPA, endovascular intervention
 - › Maintenance of adequate blood flow until sufficient stable collateral flow develops
 - › Blood pressure augmentation

Blood Pressure in AIS

- Elevated blood pressure common in acute ischemic stroke
- Extreme arterial hypertension detrimental
 - › Encephalopathy, cardiac complications, renal insufficiency
- Hypotension runs the risk of hypoperfusing the penumbra
- Ideal blood pressure range not known



Blood Pressure in AIS

AHA guidelines: "...recommendation not to lower the blood pressure during the initial 24 hours of AIS unless the blood pressure is $>220/120$ mm Hg or there is a concomitant specific medical condition that would benefit from blood pressure lowering remains reasonable."

- Concern for hemorrhagic transformation?



Blood Pressure Management in AIS

- Certain conditions (myocardial ischemia, aortic dissection, heart failure) may be exacerbated by HTN
- Unclear what optimal lowering is.
- Reasonable to lower by 15%, and monitor for neurologic deterioration
- Heart vs brain

Blood Pressure Management in AIS

- The perfusion-dependent patient: Worsening of symptoms at lower BP and improvement of symptoms at higher BP.
- Often suggested by perfusion imaging, but nothing beats the clinical exam
- If patient's exam worsens when blood pressure drops, you've found the pressure their brain requires to maintain perfusion

Blood Pressure Management in AIS

- Induced HTN:
 - › Make sure patient is volume replete
 - › Discontinuation of outpatient antihypertensives
 - › If no significant pre-existing cardiac disease, usually use neosynephrine drip
 - › MAP or systolic goals are usually somewhat arbitrary (suggest 20 mm Hg higher than BP at which patient is symptomatic)
 - › Escalate if no effect but suspicion of perfusion dependence is high
 - › Time limited trial

Blood Pressure Management in AIS

- In the post IV tPA patient:
 - › Protocol mandates BP < 185/110 prior to giving IV tPA
 - › BP < 185/105 x 24 hours after IV tPA
 - › Can allow permissive hypertension until this number is reached.
 - › Nicardipine/enalaprilat infusion over labetalol/hydralazine pushes

Blood Glucose

- Hyperglycemia common in the immediate post-stroke period
 - Likely due to non-fasting state and impaired glucose metabolism from stress state
- In hospital hyperglycemia associated with:
 - Worse clinical outcomes
 - Increased risk of sICH after tPA
 - Larger MRI infarct volumes
- Current guidelines suggest targeting blood glucose 140-180 mg/dL
- Stroke Hyperglycemia Insulin Network Effort (SHINE) Trial is currently enrolling
 - Intensive glucose control (80-130) vs standard care (< 180)



Jauch EC et al. AHA/ASA Guidelines, *Stroke*, 2013.

Antithrombotic Therapy in AIS

- Antithrombotic therapy usually started in the ICU for secondary stroke prevention
- No antiplatelets or anticoagulants x 24 hours post IV tPA
- Choice of antiplatelets (aspirin or Plavix) vs anticoagulants (heparin, enoxaparin, warfarin, NOAC) depends on stroke etiology
- Do not routinely use heparin drips for acute ischemic stroke
 - Recent Cochrane Review: Anticoagulation within 48 hours of stroke
 - Decreased risk of recurrent ischemic stroke, PE
 - Significant increase in intracranial and extracranial hemorrhage
 - No mortality benefit

Sandercock et al, The Cochrane Library 2015

Antithrombotic Therapy in AIS

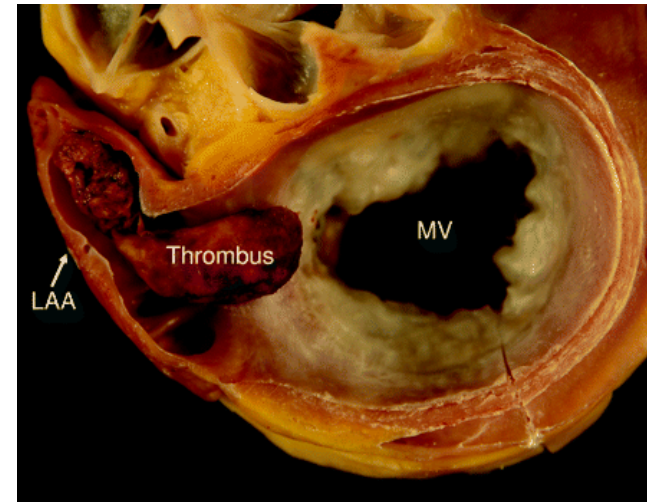
- Usually start ASA 325mg once 24 hours post IV tPA, then 81mg daily (or immediately if no tPA given)
- If severe atherosclerosis, or post stenting, will start dual antiplatelet therapy (ASA + Plavix)
- Rare occasions in which full-dose anticoagulation will be started soon after ischemic stroke



Antithrombotic Therapy in AIS

When to consider early anticoagulation?

- Intracardiac thrombus
- ? Critical stenosis in arterial dissection
- Atrial fibrillation carries risk of repeat embolism, but risk is anywhere from 0.5% per day to ~8% in the first week
- If small, punctate infarct, can usually start oral anticoagulation immediately in the setting of a-fib
- If stroke is moderate to large, usually wait 1-2 weeks prior to starting oral anticoagulation (bridge with ASA)



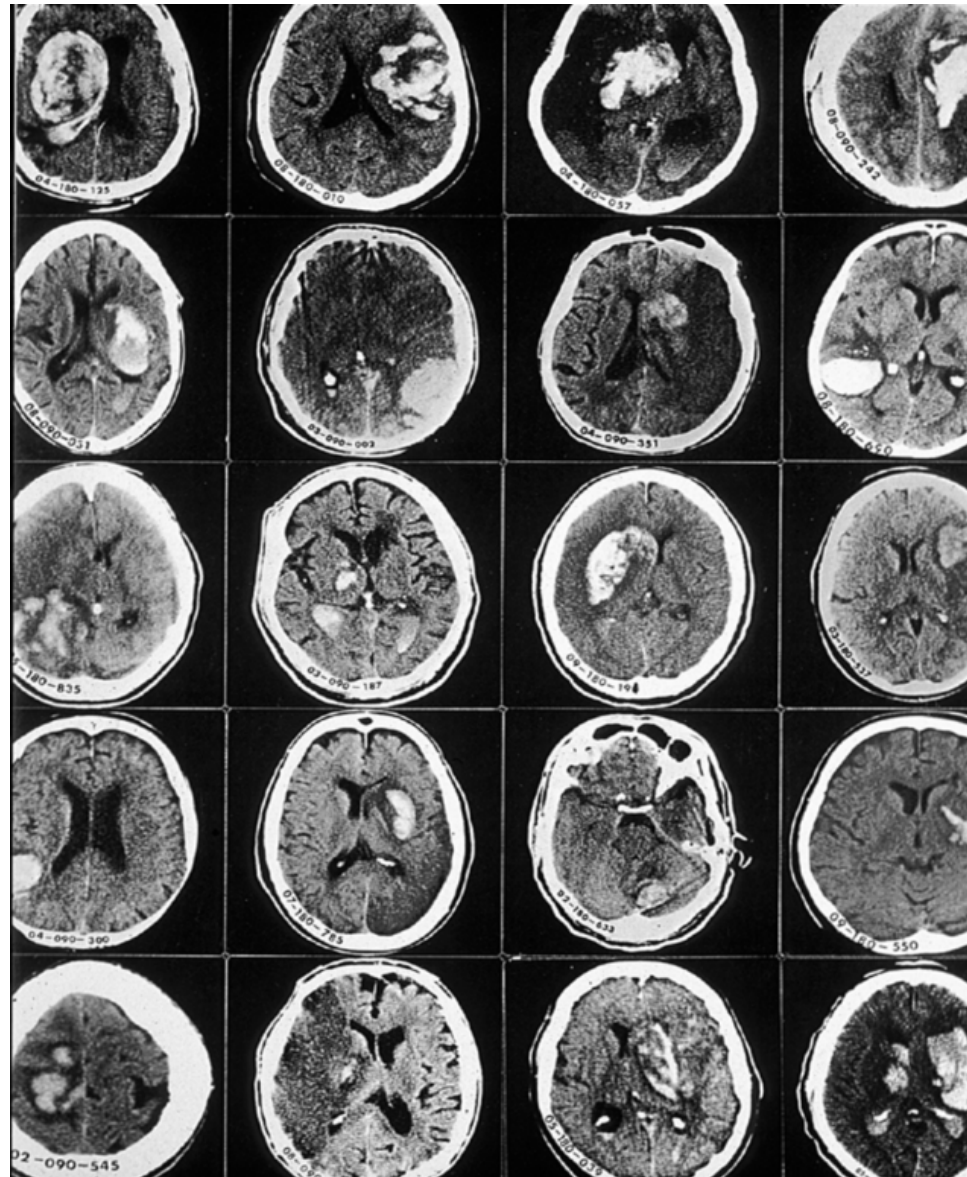
Feng D. *Circulation* 2007.

Hemorrhagic Conversion of Ischemic Stroke

- Can occur with or without IV tPA administration
- Suggested risk factors:
 - Size of infarction
 - Cardioembolic stroke
 - High NIHSS
 - Hyperglycemia
 - Low total cholesterol and LDL levels
 - Thrombocytopenia
 - Thrombolytic administration

Zhang J, et al. *Ann Transl Med* 2014.

Hemorrhagic Conversion of Ischemic Stroke



Management of ICH after IV tPA

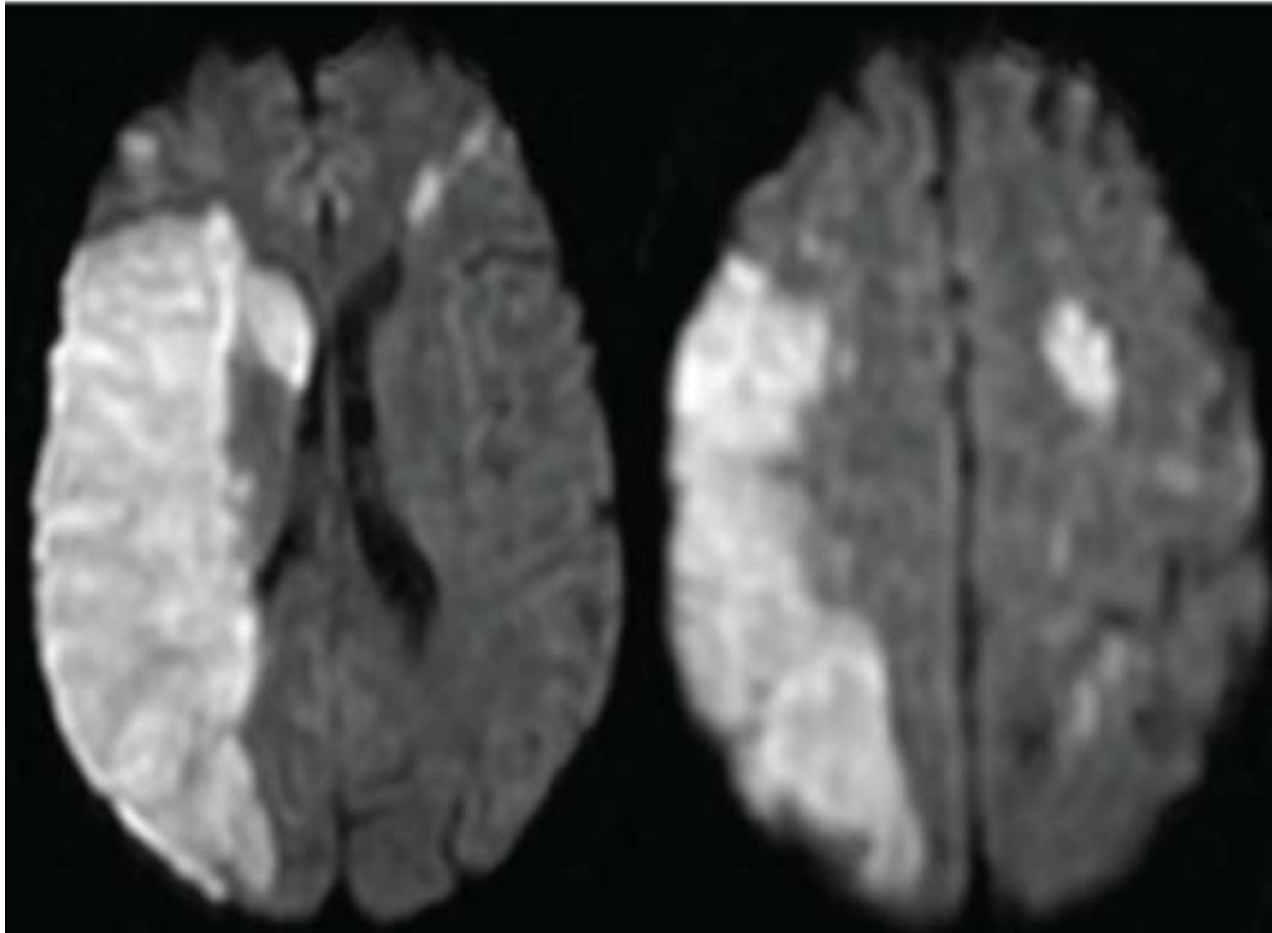
- Symptomatic ICH occurs in ~6% of post IV tPA patients
- Strict adherence to post IV tPA protocols minimizes risk
- Hemorrhagic transformation can occur in patients who did not receive IV tPA
- Risk factors for symptomatic ICH:
 - › Large strokes
 - › Older age
 - › Cardioembolic pathogenesis
- Usually occur within 24 hours of IV tPA administration

Management of ICH after IV tPA

- No universal protocol exists
- If infusion still running, stop immediately
- Stat head CT
- Stat fibrinogen, PT/INR, PTT, CBC
- Stat type and cross
- Order 6-8 units of cryoprecipitate or FFP
- ENLS recommends giving 6-8 units platelets in addition to cryo
- Consider protamine as well if endovascular case, especially if PTT is high
- Consider aFVII while awaiting cryo and platelets
- Neurosurgical consultation

AHA/ASA Acute Ischemic Stroke Guidelines 2013

Malignant MCA Infarcts



Malignant MCA infarction

- Massive, space occupying lesion from post-stroke edema
- Occurs in 10% of all strokes
- ~13% of all proximal MCA occlusions develop severe brain swelling and herniation
- ~7% die in the first week secondary to brain edema

Moulin et al. *Stroke* 1985;16:282

Malignant MCA Infarcts

- Post stroke, infarcted tissue will develop edema
- “Malignant” MCA infarcts occur when enough tissue has been infarcted that the subsequent edema will be life-threatening
- General rule is peak edema from day 2-5 (but can have early or late edema!)
- Volume criteria on initial imaging:
 - Early hypodensity of >50% of MCA territory on CT
 - DWI lesion of 82cc on < 6 hour MRI
 - DWI lesion of 145cc on \geq 14 hour MRI

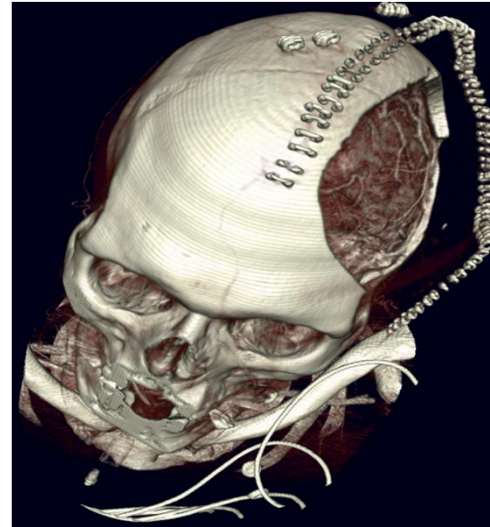
Treatment of Malignant MCA Infarct

Aggressive medical therapy is the same as for any other space occupying lesion causing raised ICP:

- HOB 30 degrees, head midline
- Sedation, intubation if necessary
- Osmotherapy: Hypertonic saline/mannitol
- Avoidance of fever/therapeutic hypothermia
- Hyperventilation – only briefly, in emergency

Malignant MCA Infarct

- Despite medical therapy, mortality reported at up to 80%
- Most effective treatment is *decompressive hemicraniectomy*
- 3 trials performed concurrently
 - › DESTINY
 - › DECIMAL
 - › HAMLET



Malignant MCA Infarct

Pooled analysis of these 3 trials:

- 93 patients included
- Decompressive hemicraniectomy within 48 hours vs medical management
- DHC group had increased survival (78% vs 29%)
 - › DH increased likelihood of mRS ≤ 3 (43% vs 21%)
 - › Increased likelihood of mRS ≤ 4 (75% vs 24%)
- Conclusion: Decompressive surgery in malignant MCA infarction within 48h reduces mortality and increases likelihood of favorable functional outcome

Vahedi et al. *Lancet Neurol* 2007; 6:21

The Modified Rankin Scale

- 0 No symptoms
- 1 No significant disability, despite symptoms; able to perform all usual duties and activities
- 2 Slight disability; unable to perform all previous activities but able to look after own affairs without assistance
- 3 Moderate disability; requires some help, but able to walk without assistance
- 4 Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
- 5 Severe disability; bedridden, incontinent, and requires constant nursing care and attention
- 6 Death

Malignant MCA Infarction

- These three trials excluded patients > 60
- Subsequent study analyzed patients age 60-80
 - › Again found significant decrease in mortality and mRS > 4 in DHC group

PROPHYLACTIC measure: DHC should be undertaken within 48 hours

Zhao et al. *Neurocrit Care* 2012; 17(2):161-71

Another Case...

- 54 year old male with uncontrolled HTN who was found to have a Type A aortic dissection
- Transferred emergently to Stanford, underwent complicated repair
- Postoperative hypoxia, so sedated for 2 days
- On POD #3, patient was noted to be weak on the left side, with right gaze deviation, able to briskly follow commands



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Hospital Course

- Patient started hypertonic saline, Na goal > 150
- Neurosurgical consult: Given unclear time of infarct (presumably intraop), patient felt to be near peak swelling. Watchful waiting.
- Exam on POD #3-8 stable except for slightly worsening anisocoria




POD #9: Call from night float neurology resident at 6 AM

- “Patient has blown his right pupil and is unresponsive”
- STAT head CT:



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- Markedly worsened cerebral edema with increased midline shift, uncal herniation and compression of midbrain
 - Patient given 23% saline and mannitol
 - Neurosurgery rushed him to the OR for decompression
 - Despite surgery, patient subsequently met criteria for brain death
 - Organ donor



2nd Patient

- 61 year old woman admitted to the CVICU after emergent repair of an acute type A aortic dissection
- Sedation lightened ~4 hours post-op
 - Patient now with left hemiplegia, could move right side and follow commands
- CT head:

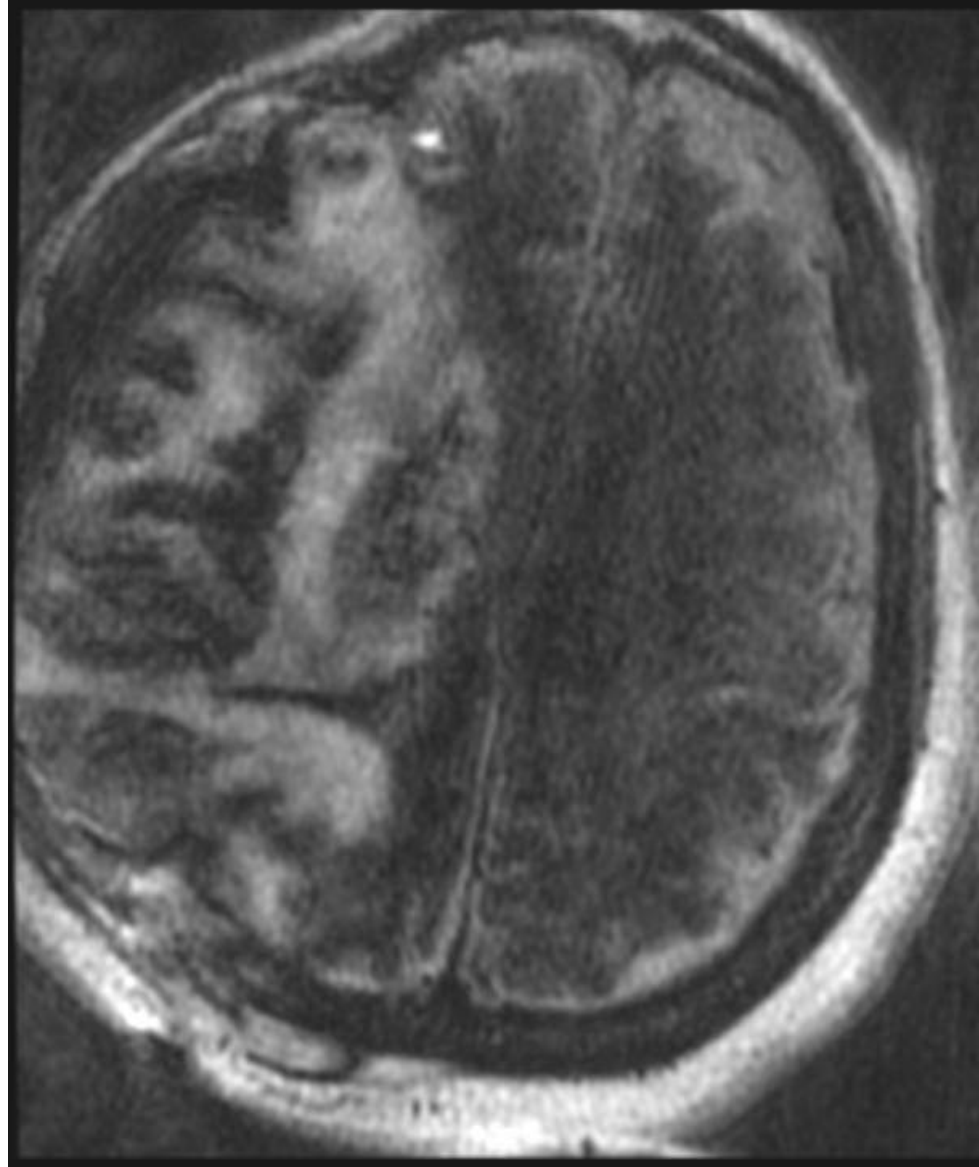


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- Patient taken that evening for prophylactic decompressive hemicraniectomy



Day 9 MRI





The Lesson

- Decompressive hemicraniectomy in malignant MCA infarct is PROPHYLACTIC – No role in waiting until patient is in trouble
- Discussion with family about whether patient would be accepting of a quality of life in which they were dependent

Thank You



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