THE UNIVERSITY of TENNESSEE
HEALTH SCIENCE CENTER

Imaging in Mobile Stroke Units

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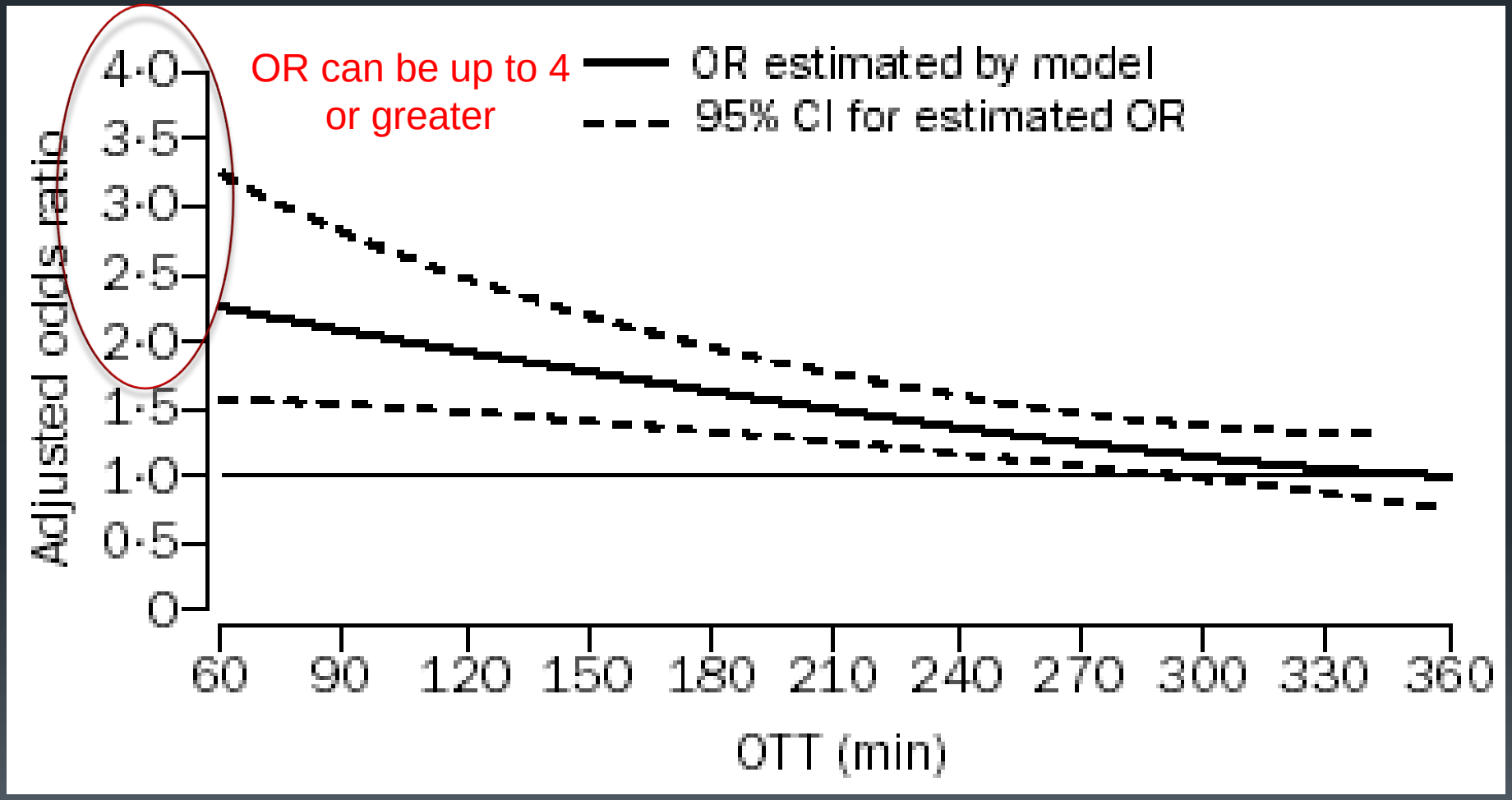
Disclosures

None

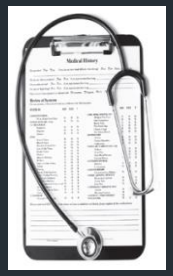
Thanks to Anne and Andrei Alexandrov for slides

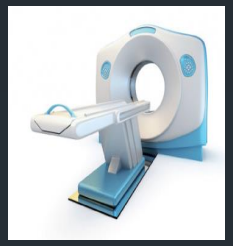
Reperfusion Rx: Faster is Better

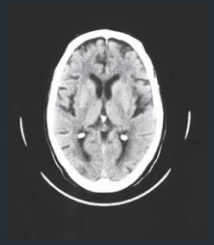


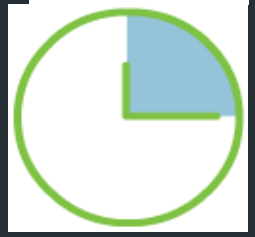
ATLANTIS, ECASS, and NINDS-rt-PA Stroke Study. Lancet 2004;363:768-774.

The “golden hour” is too long!









T=0
Suspected stroke patient arrives at stroke unit

≤10 min
Initial MD evaluation (including patient history, lab work initiation, & NIHSS)

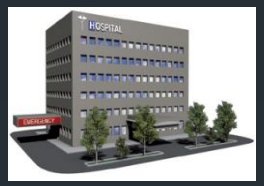
≤ 15 min
Stroke team Notified

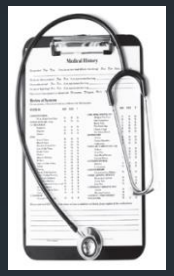
≤ 25 min
CT scan initiated

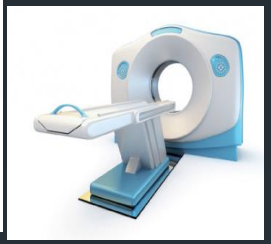
≤ 45 min
CT & labs interpreted

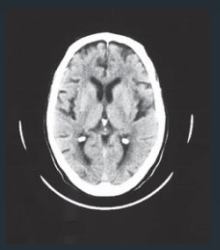
≤ 60 min
rt-PA given if patient is eligible

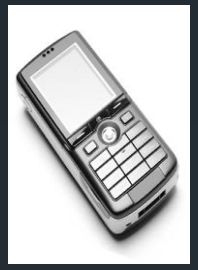
Cut the …!











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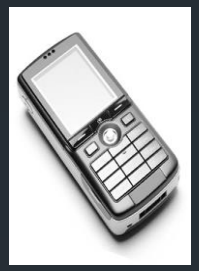
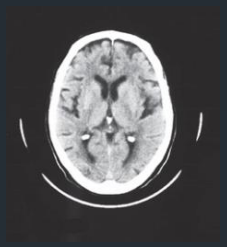
The “golden half-hour”



T= -10 min
Suspected stroke patient hospital pre-notification. Stroke team Notified

0 min
Patient arrives. Met at triage by stroke and ED team

≤ 10 min
Triage, direct-to-CT, rapid (basic) stroke assessment, IVB



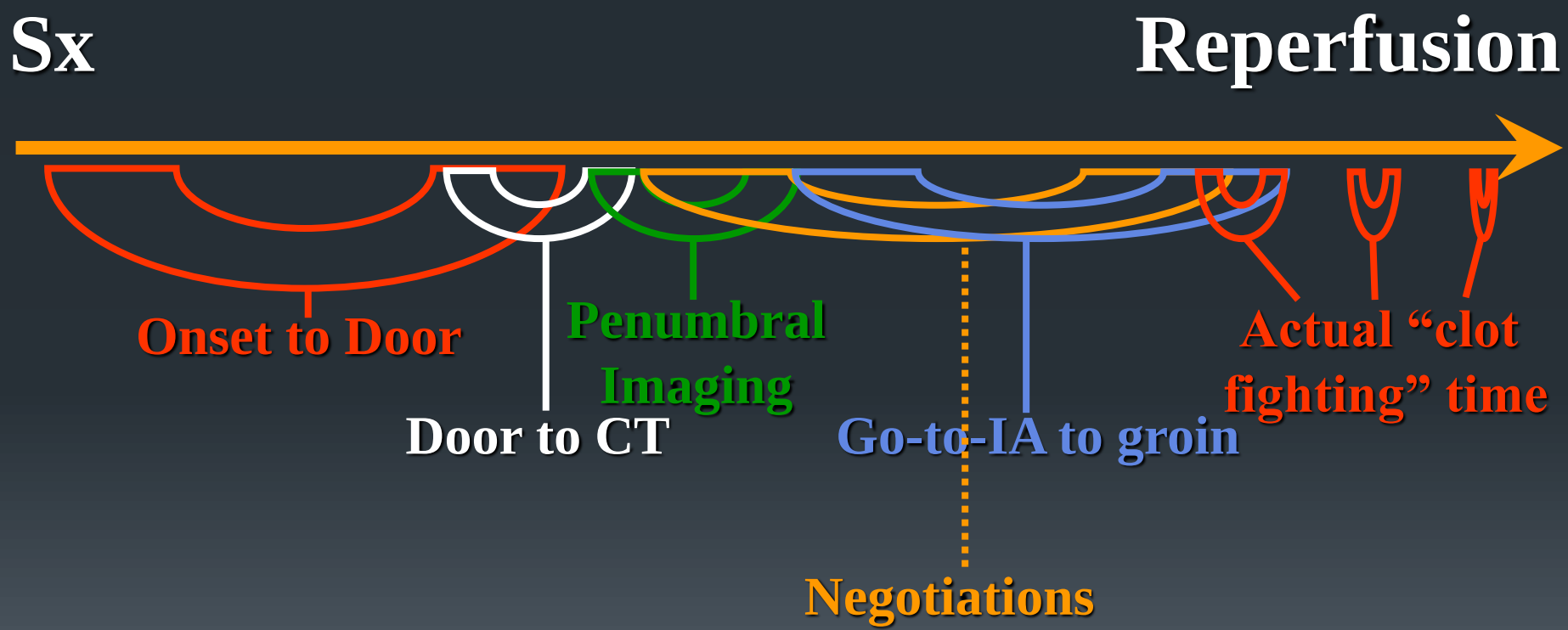
≤ 25 min
CT scan completed & interpreted

≤ 30 min
t-PA given if patient is eligible


Lef
1-8


20
1-8

Time from Symptom Onset



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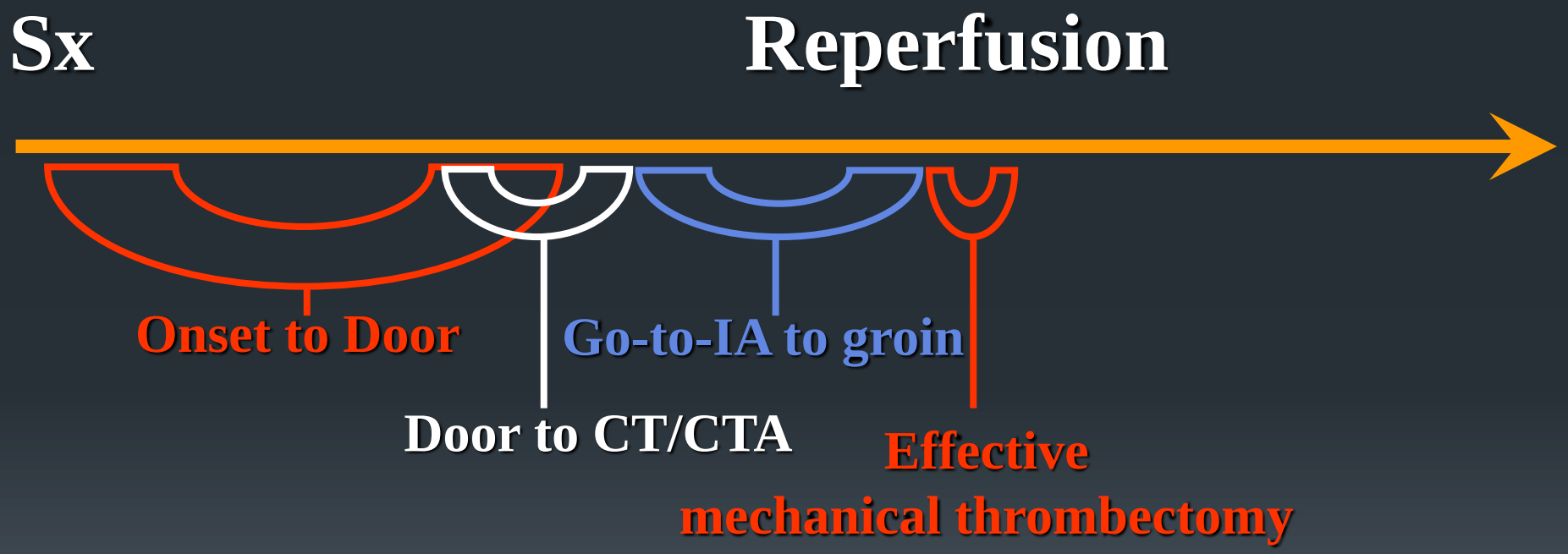


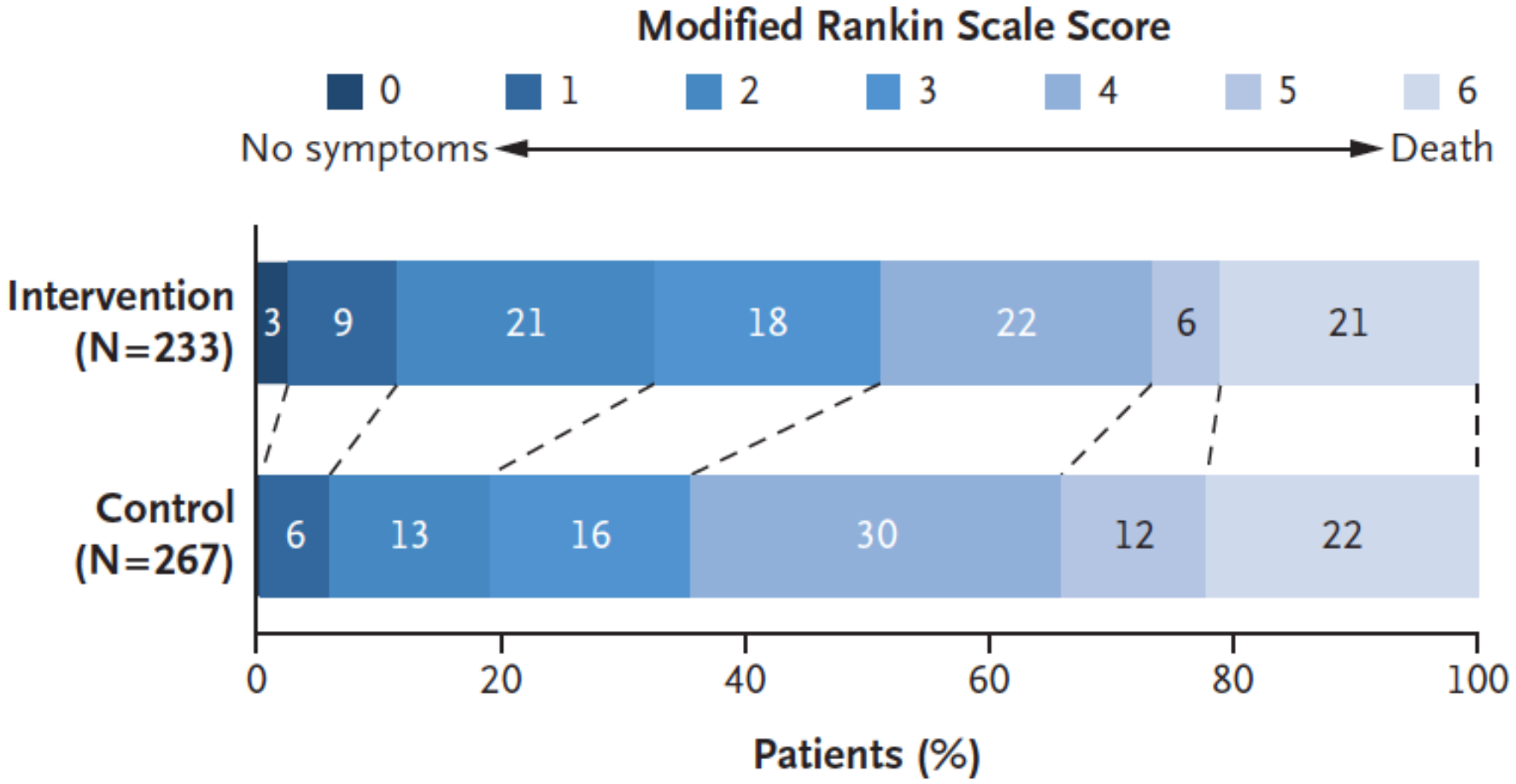


Figure 1. Modified Rankin Scale Scores at 90 Days in the Intention-to-Treat Population.

Emergent Large Vessel Occlusion

ELVO

1. Proximal occlusion
2. Favorable collateral pattern
3. NIHSS ≥6 or disabling deficit that in opinion of treating physicians justifies MT
4. Last seen normal 6 hours or extended time window with ASPECTS ≥7

Multiphase CTA

- Refine CTA
- 3 phases
- One injection
- Relatively easy to standardize and train
- Minimal post processing time

mgoyal@ucalgary.ca

Multiphase CTA

Collateral Scoring on mCTA

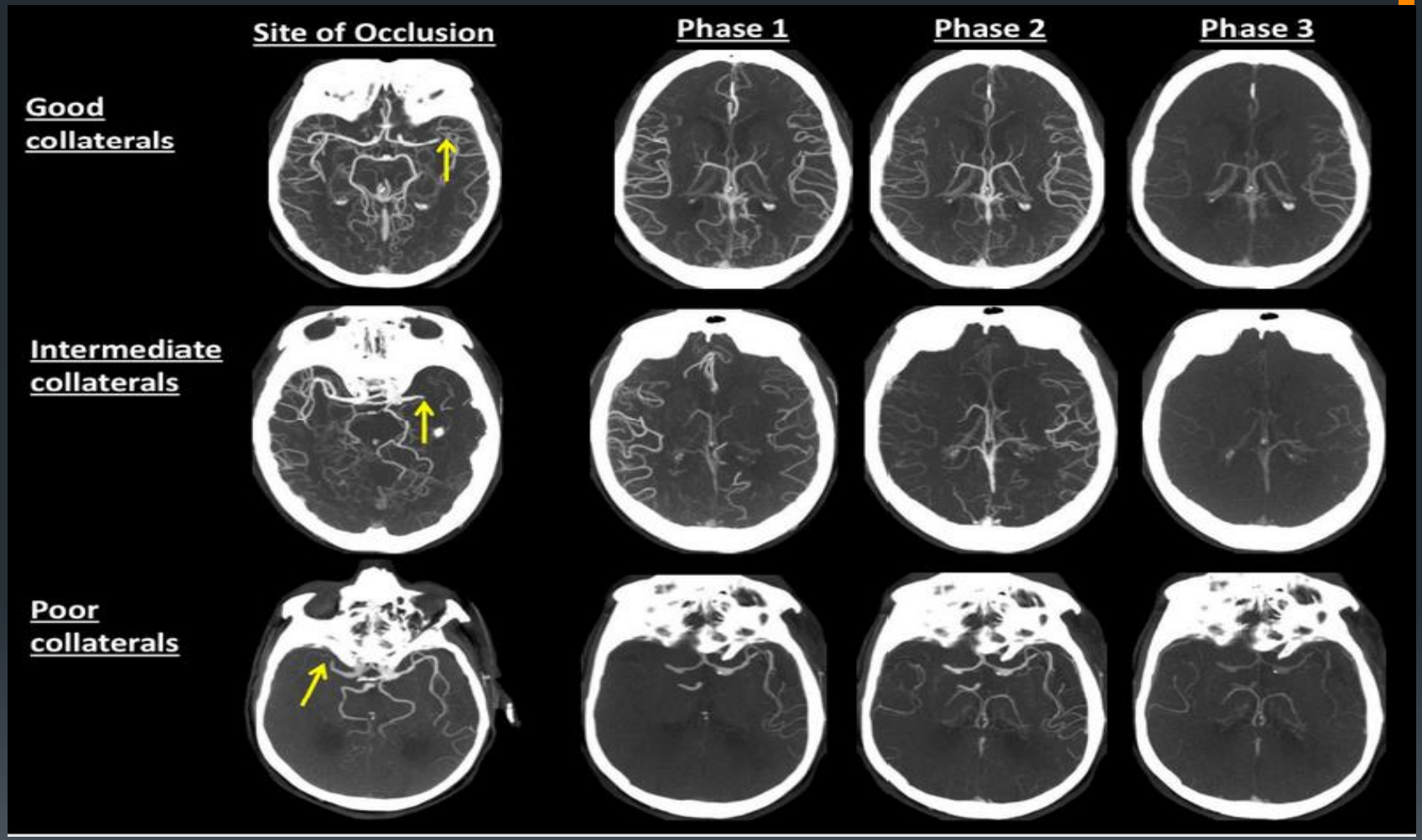


Figure. Upper panel shows a patient with a left M1 MCA occlusion (arrow) and good collaterals (backfilling arteries) on multi-phase CTA. Middle Panel shows a patient with a left M1 MCA occlusion (arrow) and intermediate collaterals. Lower panel shows a patient with a right M1 MCA occlsion (arrow) and poor collaterals (minimal backfilling arteries) on multi-phase CTA.

How to Dx Stroke?

- Prehospital scales FAST, LAMS
- RACE, G-FAST, CSTAT, PASS … – accuracy <80%, low PPV for LVO
- VAN 80%+ PPV for LVO
- NIHSS cutoffs
- Expert clinical evaluation
- CT/CTA

Current Rx Memphis, TN

Prompt Recognition
911 activation
Priority dispatch

Home

Hospital

911

EMS triage

Urgent brain imaging

Thrombolytic drug

~700 iv tPA/yr

Endo-vascular procedures

~200 MT/yr

MUH 2018

Neuro-rehabilitation

Admit to Stroke Unit

Catchment population 1.5M

Recovery

Prevention strategies

Current EMS Ambulance

Breakthrough: CT in EMS = Mobile Stroke Unit

MOBILE STROKE UNITS IN THE UNITED STATES

Houston 02/2014

Denver 01/2016

Toledo
02/2016

Cleveland 07/2014

… and in
New York
Chicago
Phoenix
LA
Providence
Summit, NJ
etc

Memphis 06/2016

MSU Effectiveness: Initial Evidence

- Faster and more frequent use of Alteplase (tPA)
- 40% received Alteplase within 60 min from symptom onset (Houston)
- 26% treated on MSU vs 14% brought by EMS (Cleveland)
- Patient encounter to Alteplase: 25 min (Houston and Germany)

Performance of CT Angiography on a Mobile Stroke Treatment Unit: Implications for Triage

Seby John, Sarah Stock, Thomas Masaryk, Andrew Bauer, Russell Cerejo, Ken Uchino, Stacey Winners, Peter Rasmussen, Muhammad S. Hussain

From the Cerebrovascular Center (SJ, TM, AB, RC, KU, SW, PR, MSH); and Department of Neuroradiology (SS, TM), Cleveland Clinic, Cleveland, OH.

ABSTRACT

BACKGROUND: There is a strong inverse relationship between outcome in patients with acute ischemic stroke from emergent large vessel occlusion (ELVO), and time to reperfusion from intra-arterial therapy. Delay in transferring patients to thrombectomy-capable centers is currently a major limitation. The mobile stroke unit (MSU) concept with onboard portable computed tomography (CT) scanner enables rapid performance of CT angiography (CTA) of the intracranial vessels to detect ELVO in the field, and allows for rapid triage of patients to interventional-capable centers.

METHODS: Our institution implemented a mobile stroke treatment unit (MSTU) program that started on July 2014, and CTA capability was added on April 2015. The eligibility criteria, equipment, and method of CTA imaging are described. We report the first case of CTA being performed in the field in the United States to aid in triage of ELVO patients.

RESULTS: MSTU was dispatched for reported new onset of right hemiparesis in a patient. Teleneurological assessment detected findings consistent with a severe left middle cerebral artery (MCA) syndrome. Noncontrast CT head revealed left lenticulostriate hypoattenuation. A CTA was performed subsequently on the MSTU that showed an MCA cutoff. Based on these findings, patient was immediately transferred to the main hospital with neurointerventional capability, where he underwent successful recanalization with improvement in symptoms.

CONCLUSION: CTA is possible on an MSTU, enabling rapid detection and triage of ELVO cases directly to thrombectomy-capable centers, which significantly reduces time to endovascular treatment.

J Neuroimaging 2016;26:391-394.
DOI: 10.1111/jon.12346

Additional MSU Benefits

- Patient access to stroke experts at the scene
- Improved pre-hospital triage to appropriate level of care (CSC vs PSC)
- Bypass the Emergency Department: Direct admission to Stroke Units or Cath Labs
- Earlier BP mgmt in intracerebral hemorrhage
- Ability to respond to comorbid problems alongside early stroke diagnosis and treatment

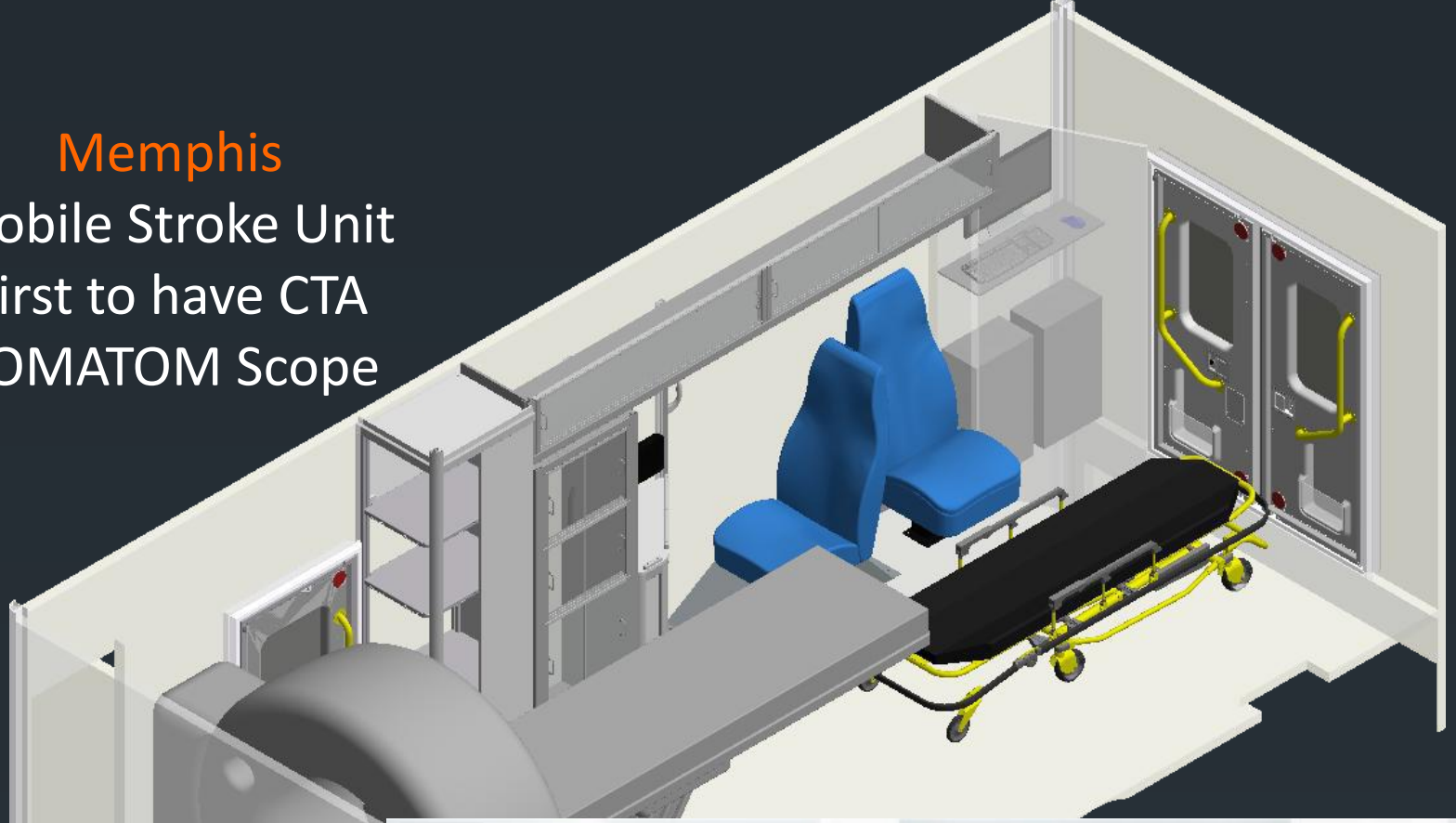
ACNP+Paramedic Model

Memphis

Mobile Stroke Unit

First to have CTA

SOMATOM Scope



- Small footprint
- Low power requirements
- 16 slices
- Flying Focal Spot
- UCF / Ultra Fast Ceramic Detector

- Automated setup
- Saved Customized Protocol
- Real time imaging
- 9s acquisition
- 10s reconstruction
- Dose Modulation (Care Dose 4D)
- Iterative Reconstruction (Iris)

Advanced Imaging on MSU

- Multi-modal CT and ultrasound are feasible
- Exciting opportunity for Neuroimagers and Vascular Neurologists
- Exploration of parenchymal, vascular imaging and real time hemodynamic monitoring within 60 minutes of cerebral ischemia
- Ultra-early detection and treatment of ELVO
- Ultra-early imaging and BP management of ICH

Memphis Performance

- 542 activations (transported 264 patients, 49%)
- mimics 44%
- confirmed strokes (56%), ICH 18%, TIA 9%
- Median NIHSS 9 IQR 7-17
- Median CT/head+neck CTA completion 3.5 min
- Scene arrival to tPA bolus 13 min IQR 11-16
- IV tPA given to 38% of ischemic strokes
- LVO found in 30% of ischemic strokes
- No patient required repeat imaging on arrival
- All patients were triaged to appropriate level hospital, CSC or PCS with no need for transfer

Memphis experience

- Arrival to CT 8 min
- Arrival to TPA~ 13-14 min
- % stroke ~55%
  - % ICH/SAH higher than 15%

More experience

- % non stroke ~40-45%
  - Seizures/pseudoseizures
  - Tumors
    - Includes head/neck/skull based
  - Headache
  - Bells Palsy

CT Imaging Issues

- 3 different scanners
  - Head only portable
  - Portable large bore
  - Fixed

Portable scanners

- Smaller
  - Can be mounted in a smaller vehicle
- Large bore can require more length if CTA desired
- Small bore scanners cannot do timed CTA and may or may not do neck CTA

Fixed CT

- Can do anything a ground based scanner can do
- Requires more power/batteries

All types

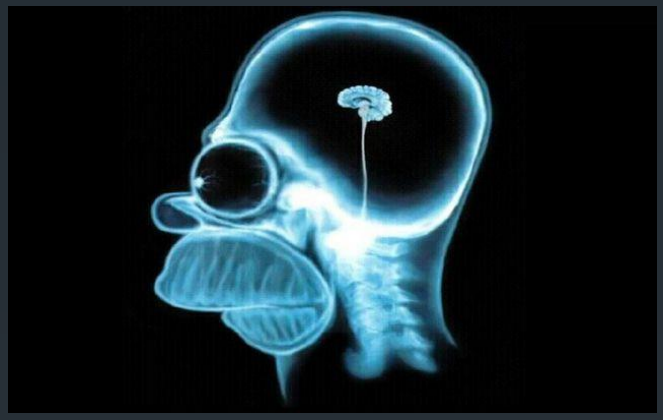
- Cannot scan while moving!!!
- Battery powered
- Batteries can handle several scans w/o recharge

Reading Issues

- Avoid fraud
- Preliminary read must done before TPA decision executed
- For billing must be accredited

Technical aspects

- Radiation safety
- Phantoms
- Techniques



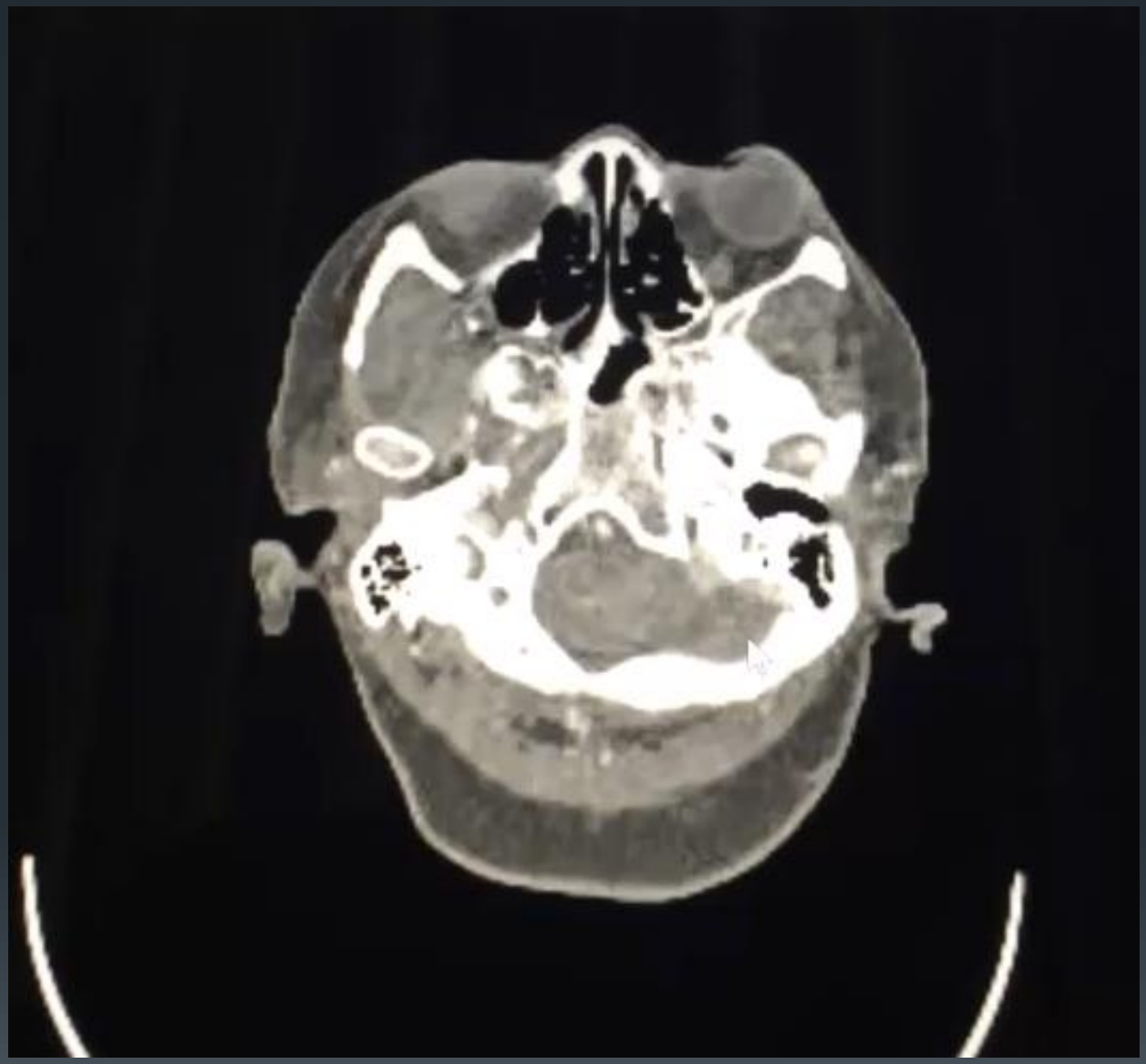
- All identical to any CT

Our Solutions

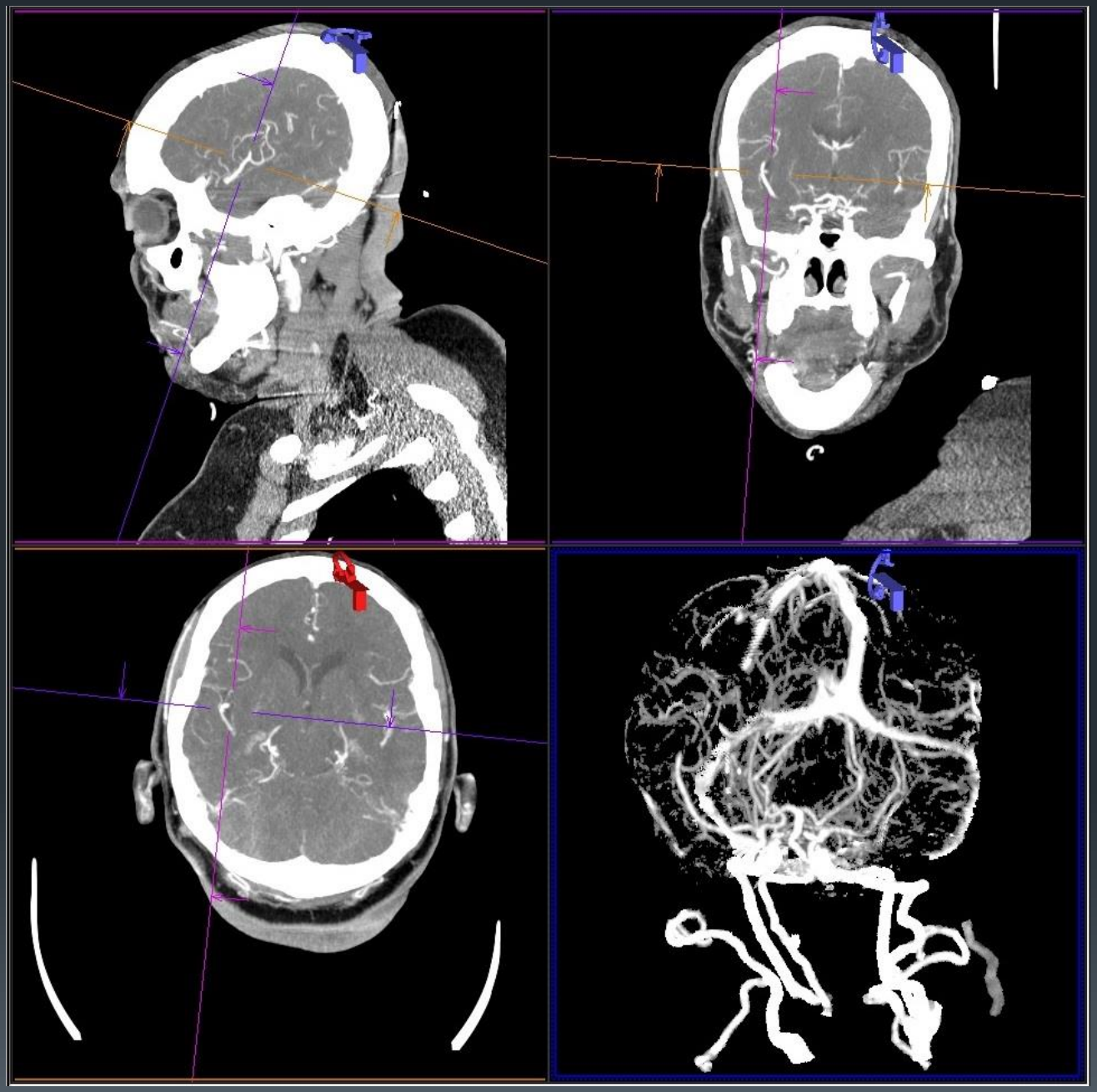
- Intersocietal accreditation
- NP wet reads
- Overreading by neuroimager
- Remaining issues
  - Use of “Sneakernet” to downloading images to hospital PAX
  - Memphis wifi too slow and unreliable for file transfer

Case Example

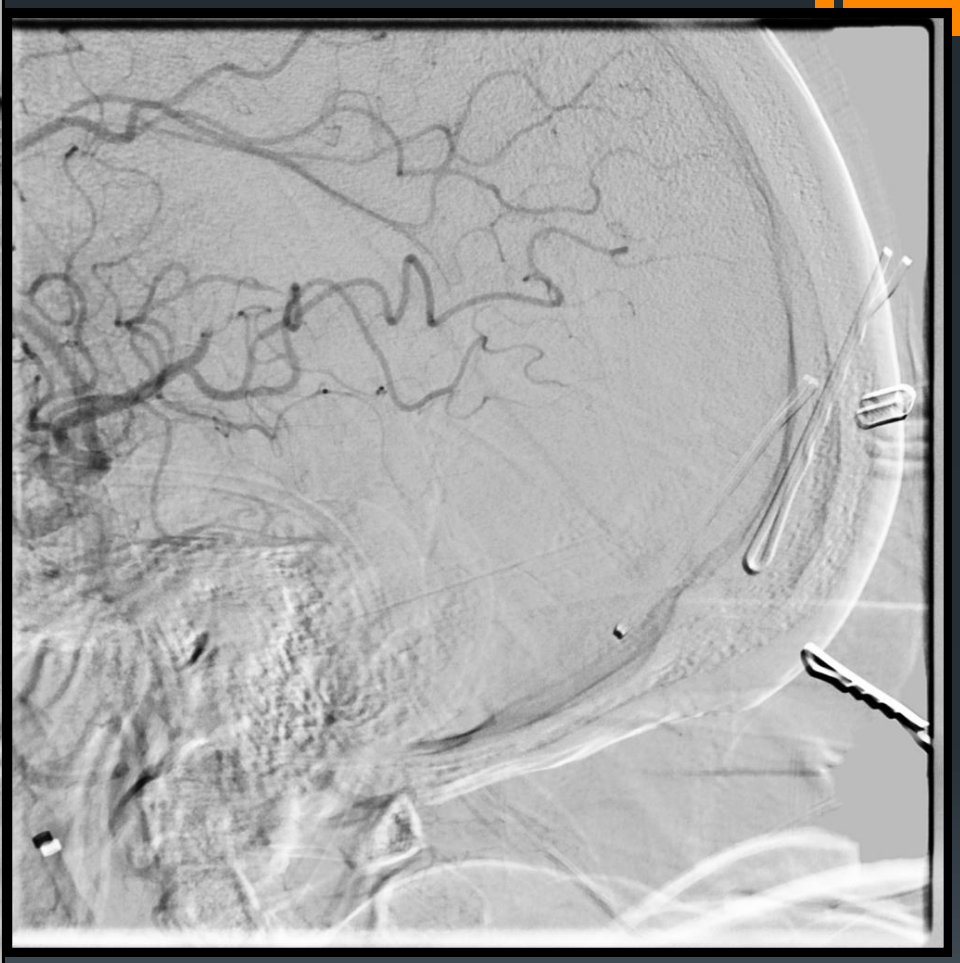
- A 77 y.o. woman presents with dysarthria and left hemiplegia with NIHSS of 9 points at head of bed flat.
- CTA on the mobile stroke unit shows a right M3 occlusion.
- When her head of bed is raised to 30 degrees, her NIHSS increased to 18.



CTA images from the Mobile Stroke Unit also show significant arch and RCCA tortuosity



CTA images from the Mobile Stroke Unit reconstructed in cath lab



Right M3 occlusion seen on DSA

THE UNIVERSITY of TENNESSEE

HEALTH SCIENCE CENTER - MEMPHIS

#1 USA STROKE tPA TREATMENT RATE

Catch Us If You Can