THE UNIVERSITY of TENNESSEE
HEALTH SCIENCE CENTER

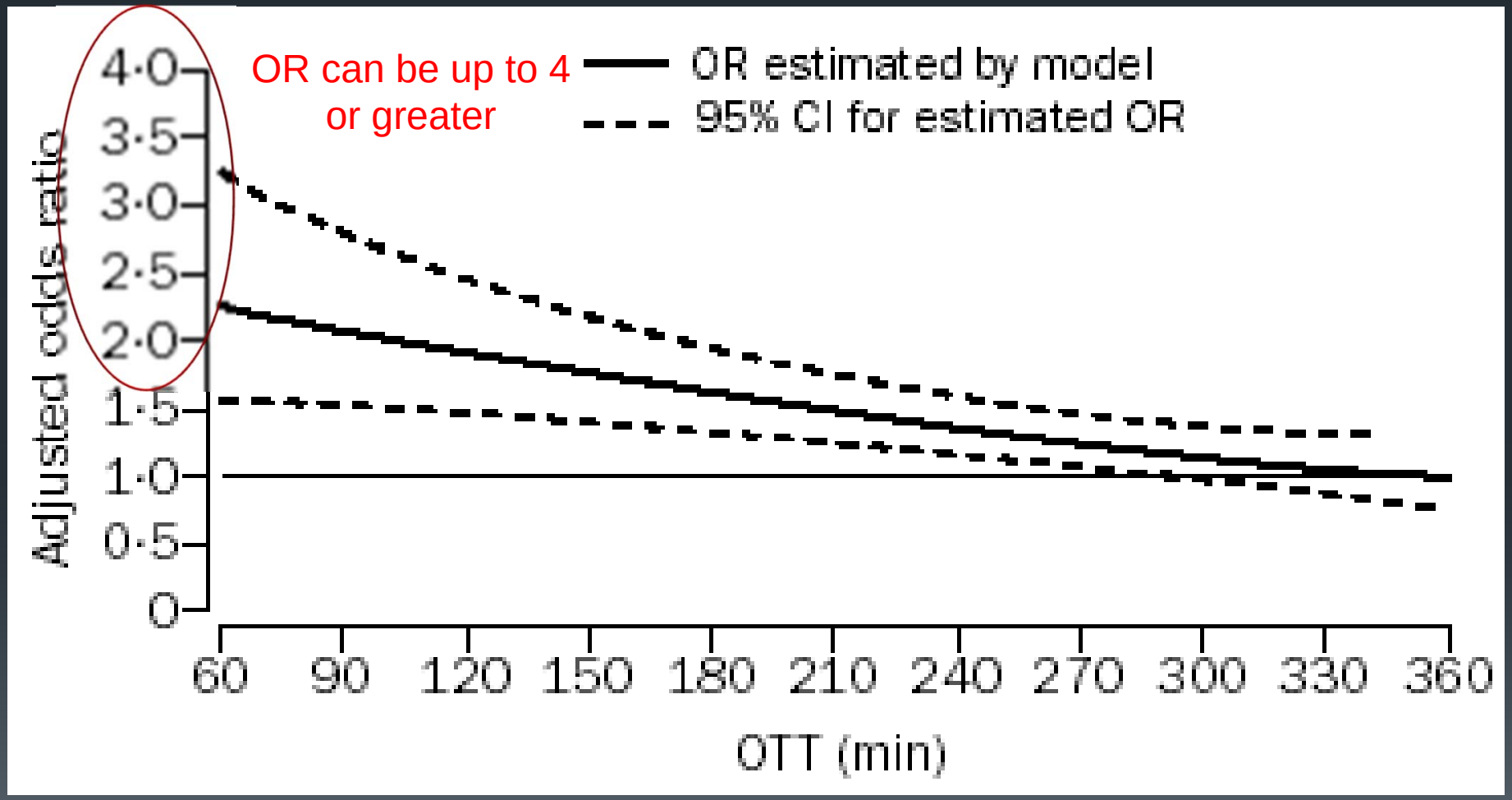
Are Mobile Stroke Units Useful and Financially Viable?

Andrei V. Alexandrov, MD
Semmes-Murphey Professor and Chairman
Department of Neurology
Medical Director, Mobile Stroke Unit and
City-wide Stroke Team
Memphis, TN

Disclosures

Funding: Assisi and Durham Foundations
Speaker Bureau: Genentech
Consultant: Siemens

Reperfusion Rx: Faster is Better



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

Current Stroke Chain of Survival

Prompt Recognition
911 activation
Priority dispatch

Home

Hospital

911

EMS triage

Urgent brain imaging

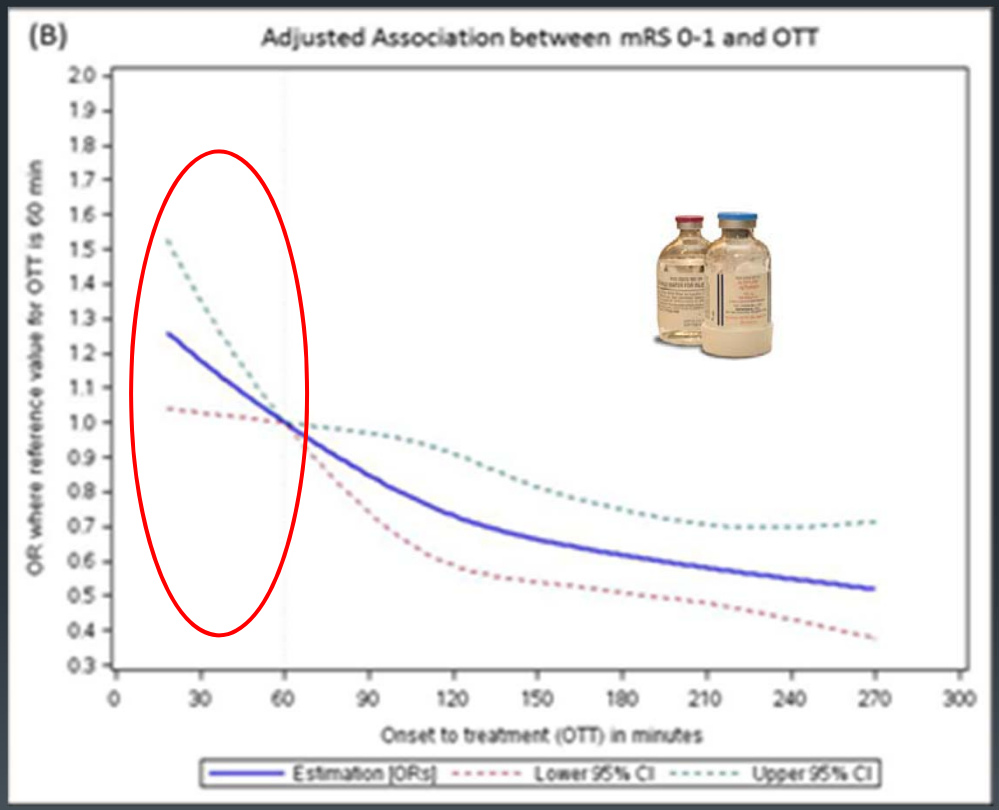
Neuro-rehabilitation

Admit to Stroke Unit

Recovery

Prevention strategies

Faster-Ultra-Early Rx is the Goal



Kim et al, GWTG, Circulation 11/4/16

The only way to accomplish this….
Is to bring the treatment to the patient

Courtesy: J.C. Grotta, MD.

Current EMS Ambulance

Breakthrough: CT in EMS = Mobile Stroke Unit

MOBILE STROKE UNITS IN THE UNITED STATES

Houston 02/2014

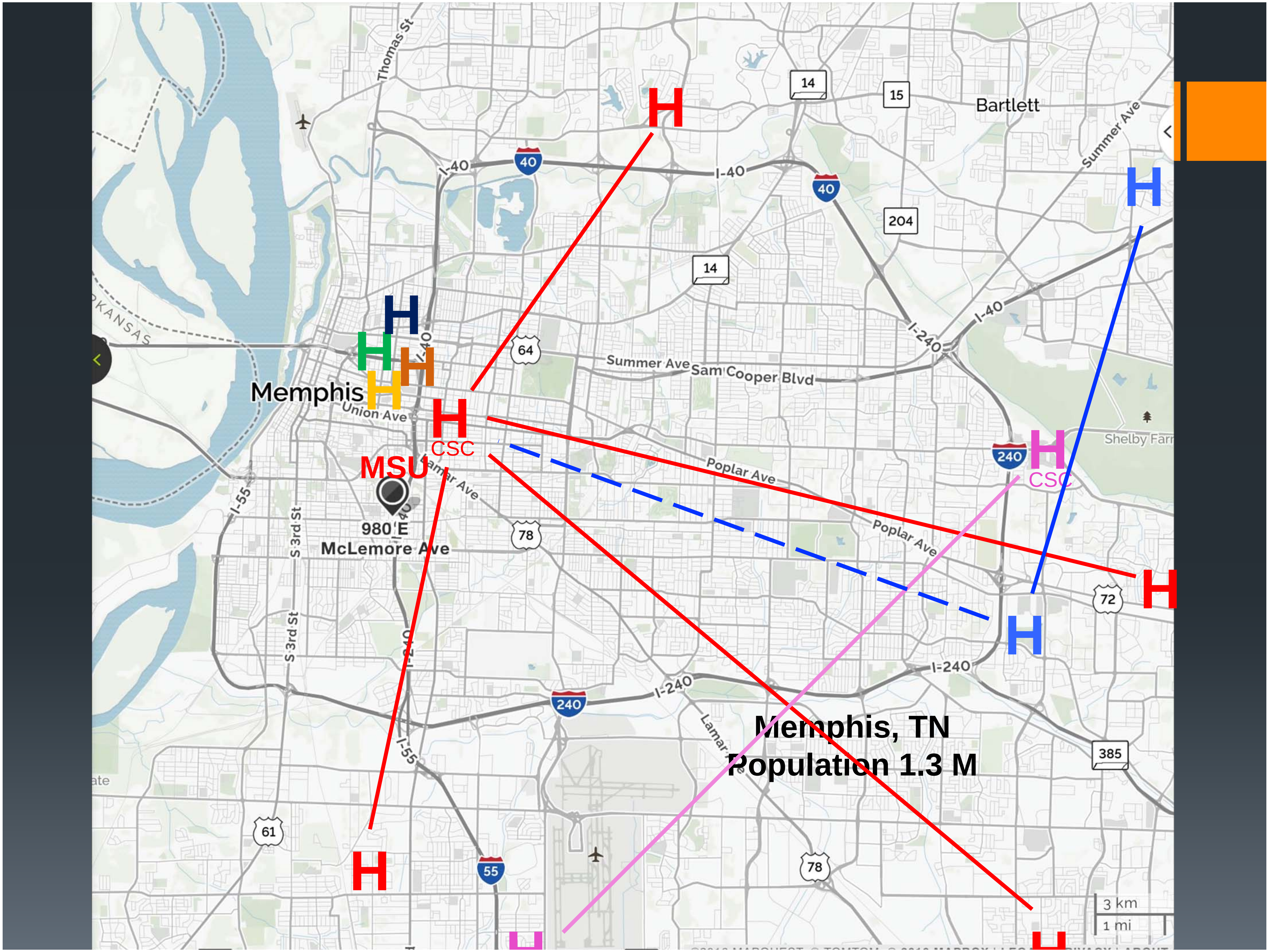
Denver 01/2016

Toledo
02/2016

Cleveland 07/2014

… and in
New York
Chicago
Phoenix
LA
…
…

Memphis 06/2016



Memphis, TN
Population 1.3 M
MSU
980 E
McLemore Ave
CSC
CSC
Memphis
Bartlett
Union Ave
Summer Ave
Sam Cooper Blvd
Poplar Ave
Poplar Ave
Lamar Ave
Thomas St
S 3rd St
Shelby Farms
I-40
I-240
I-55

Respond, Evaluate, Cure, Heal: Mobile Stroke Unit

REACH – MOST

University of Tennessee

Memphis

Major Donor: Assisi Foundation

Building MSU in Memphis

- Obtain philanthropic funding/IRB approval
- Propose a non-denominational model
- Hire EMS executive to direct MSTU
- Integrate with Fire Department
- Install angiography capable CT scanner
- Partner with competing institutions
- Explore different practice models (MD, ACNP, telemedicine)
- Deliver sustainable product to the city

Building Consensus

- Memphis “non-denominational” model:
  - MSU is operated under a hospital-independent physician practice and Memphis Fire Department
  - MSU is able to deliver patients to competing institutions
  - MSU can deliver patients to their hospital of choice
  - MSU imaging capabilities allow bypass of PSCs and ER for LVO or OR patients without use of any clinical scales

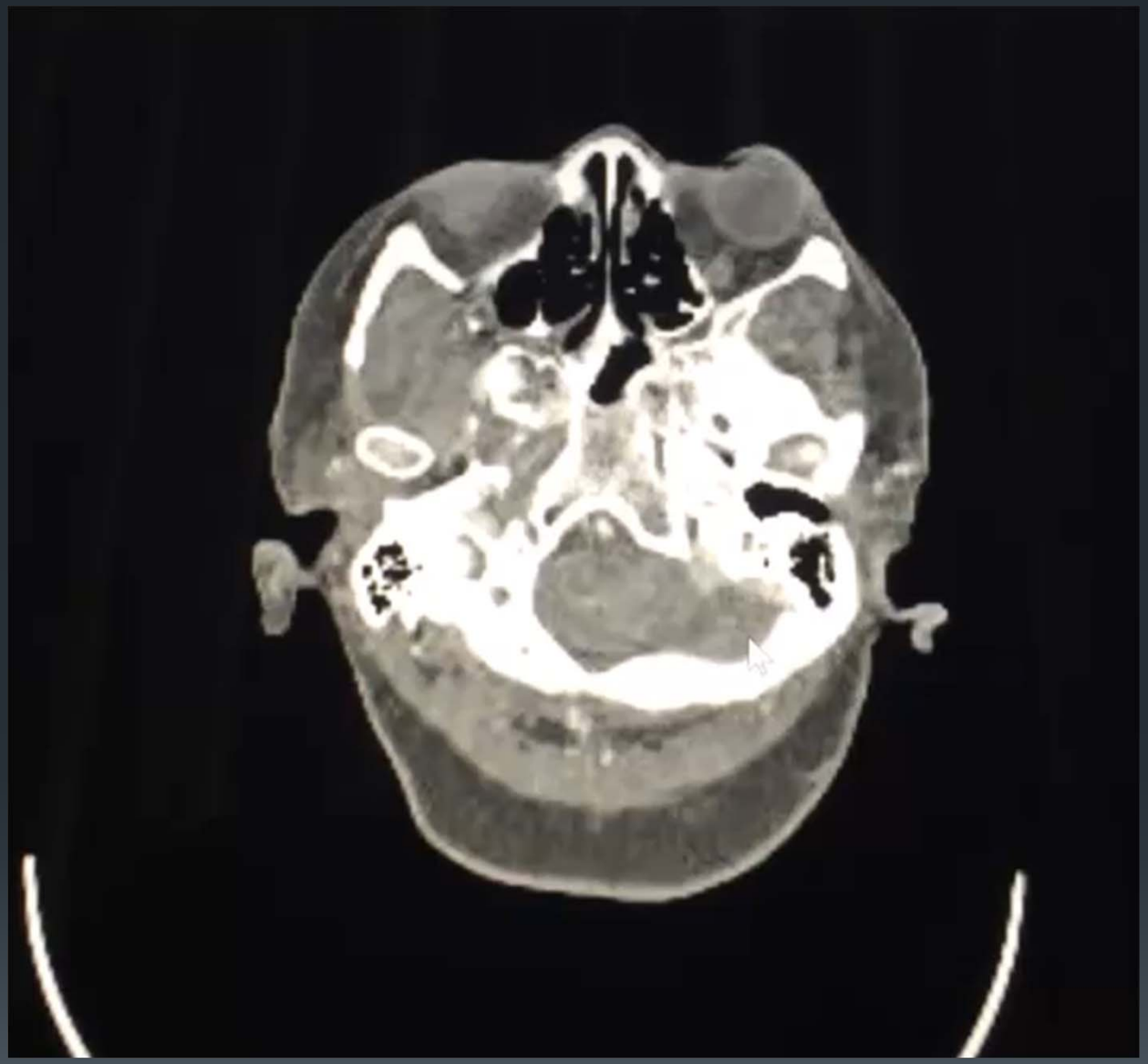
First CT Scanner in the U.S.

Oneonta, NY 1978

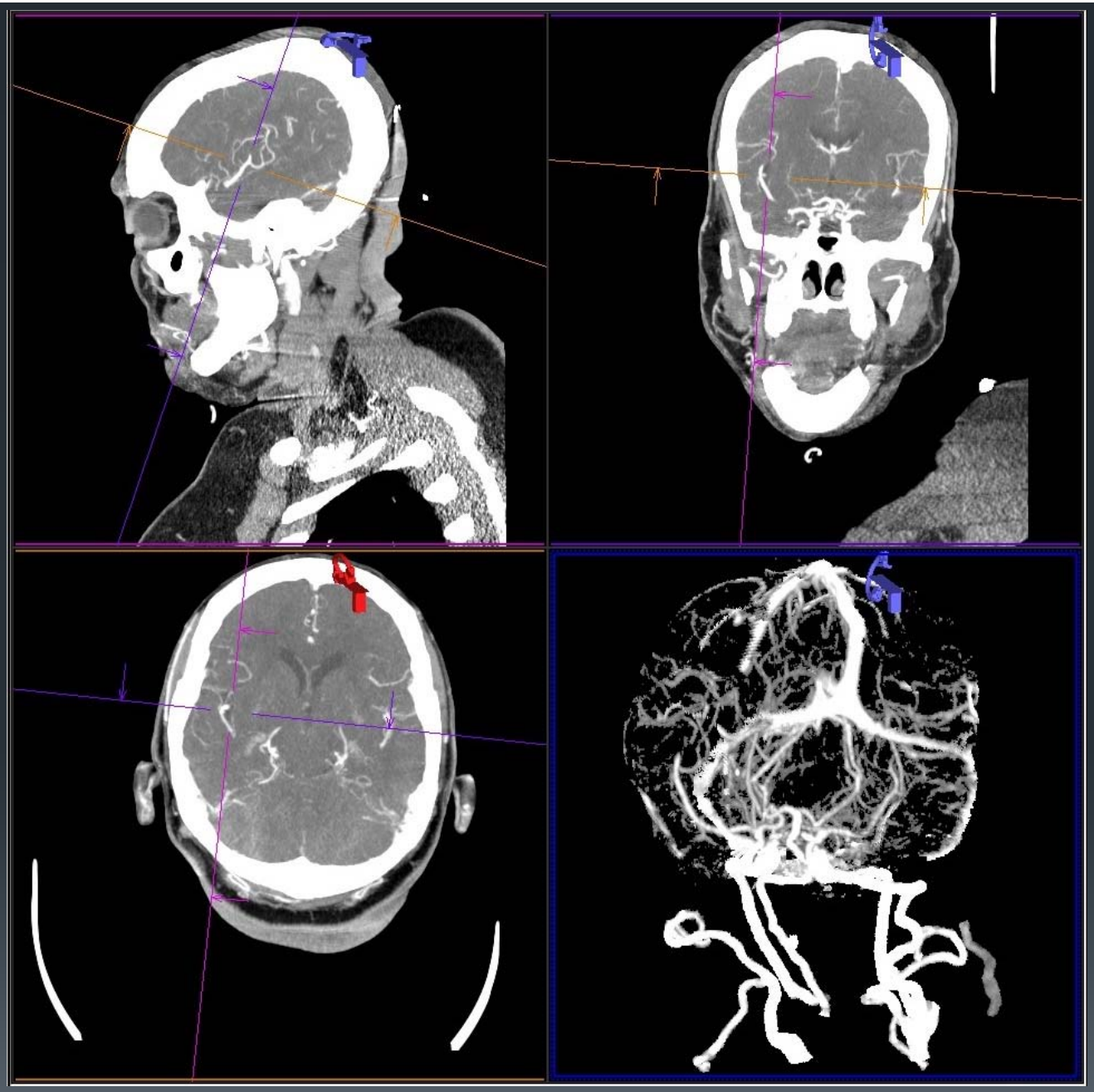
ACNP+Paramedic Model

Case Example

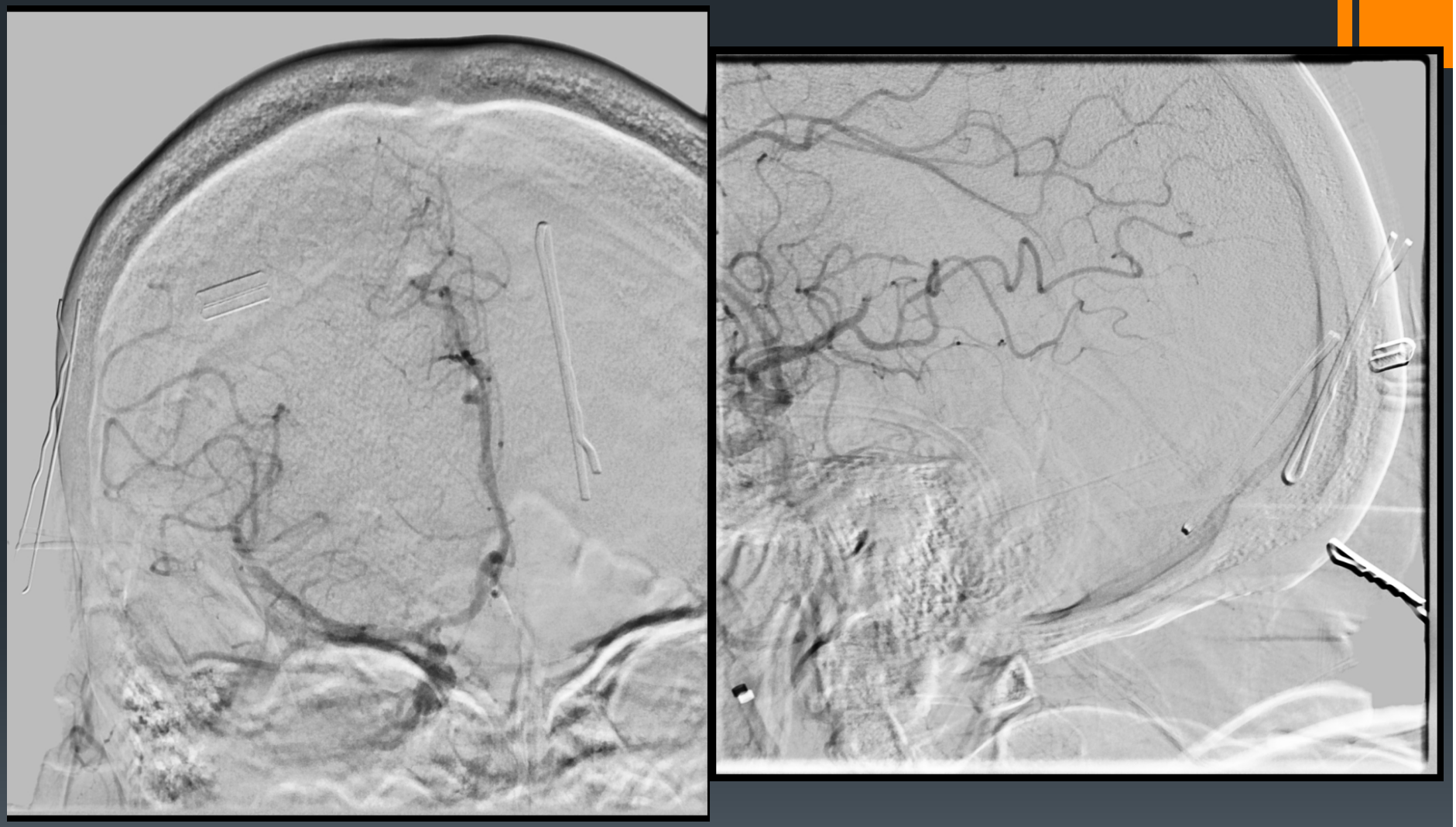
- A 77 y.o. woman presents with dysarthria and left hemiplegia with NIHSS of 9 points at head of bed flat.
- CTA on the mobile stroke unit shows a right M3 occlusion.
- When her head of bed is raised to 30 degrees, her NIHSS increased to 18.



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

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 scene to Alteplase: 25 min (Houston and Germany) saving entire US door-to-needle time
- Equivalence of TM MD vs on board MD

BEST-MSU Study

Benefits of Stroke Treatment Delivered Using a Mobile Stroke Unit Compared to Standard Management by Emergency Medical Services

Started 2014: PCORI start 2016

Colorado (Aurora and Colo Spgs) 2017

Memphis 2017

Indianapolis 2019

LA-UCLA 2018

Sutter-Peninsula 2019

New York 2018

Courtesy: J.C. Grotta, MD.

BEST-MSU Study

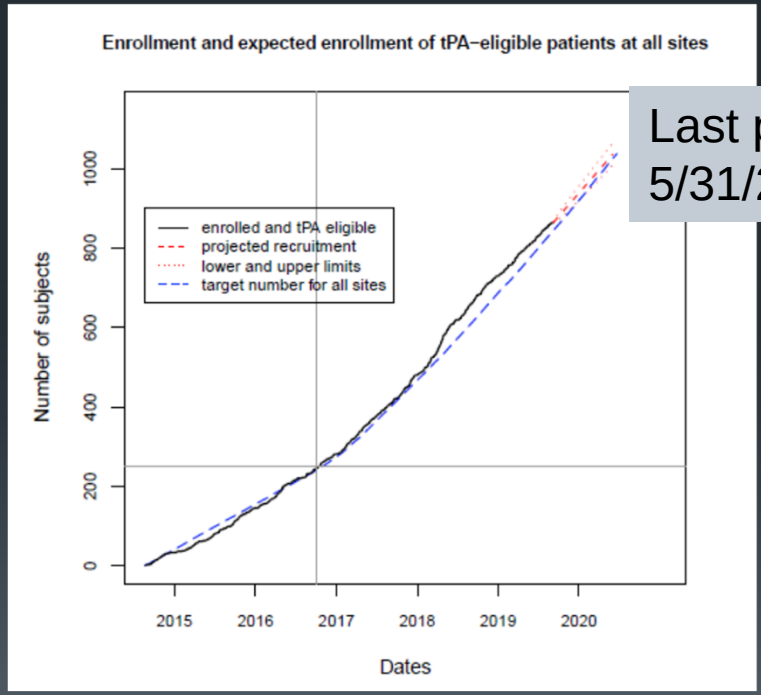
Benefits of Stroke Treatment Delivered Using a Mobile Stroke Unit Compared to Standard Management by Emergency Medical Services

Patient Centered Outcomes Research Institute (PCORI)
$6M over 6 years
"If I have a stroke and call 911, am I better off if treated in a MSU vs EMS?"

SPECIFIC AIMS

1. How much less disability at 3 months?

2. Health Utilities/Cost-Effectiveness
   - pts followed up to 1 year

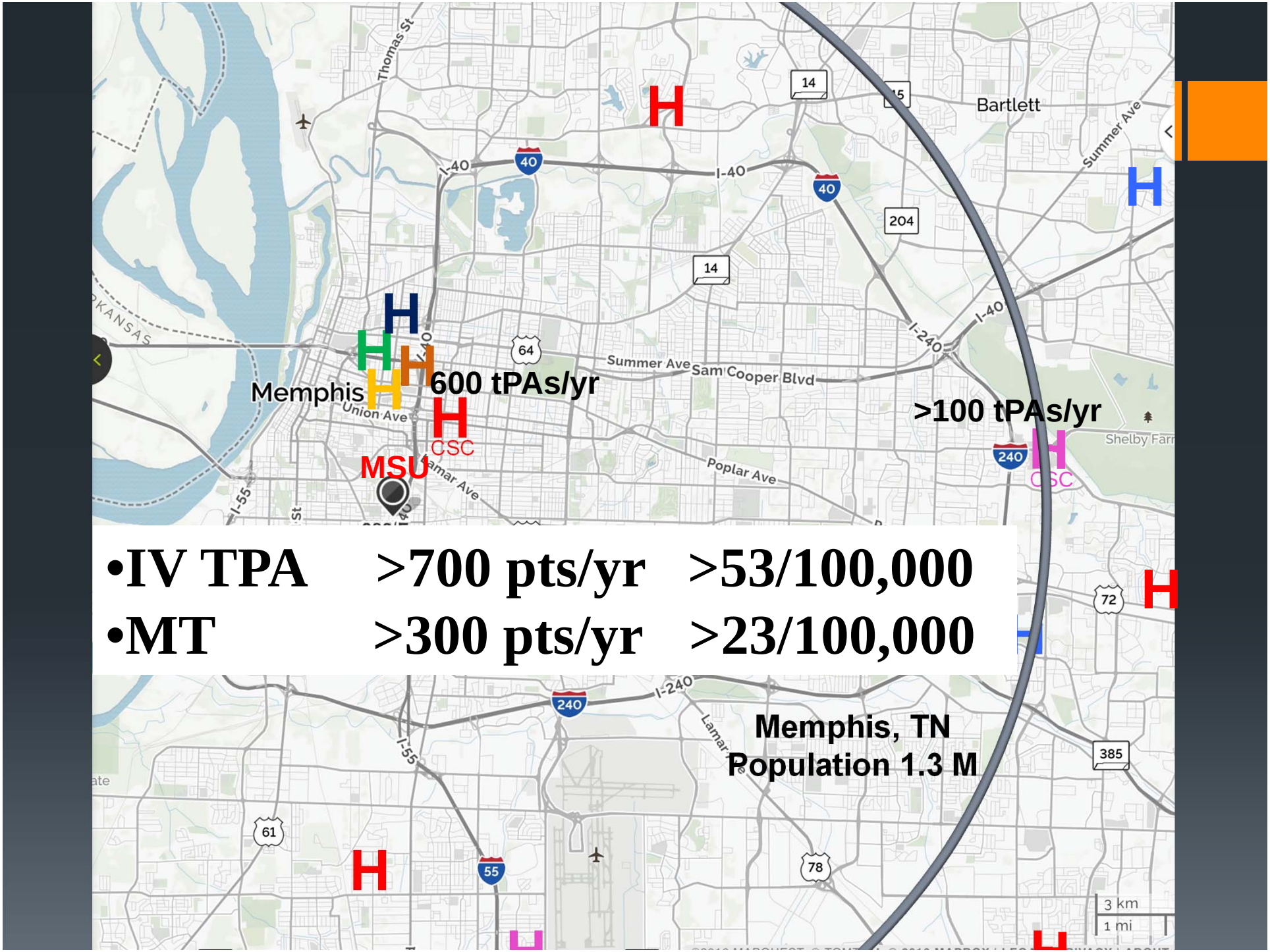


Last pt 5/31/20

Courtesy: J.C. Grotta, MD.

Additional MSU Benefits

- Patient access to stroke experts on 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 / hemostasis in ICH
- Ability to respond to comorbid problems alongside early stroke diagnosis and treatment



- **IV TPA >700 pts/yr >53/100,000**
- **MT >300 pts/yr >23/100,000**

Memphis MSU First 365 Days

THE UNIVERSITY of TENNESSEE HEALTH SCIENCE CENTER

- 1,031 activations by 911 dispatchers
- 629 (61%) were disregarded with unrelated diagnoses
- 402 patients transported (1.1/day):
  - 245 (61%) stroke
  - 17 (4%) TIA
  - 140 (35%) other neurologic emergencies
- Stroke/TIA patients:
  - 59% female
  - 72% African American
  - 66±15 (median 65) years
  - Median NIHSS score 6 (IQR 3-12)
- Total time from start CT, to images ready for viewing in multiple planes for combined non-contrast CT with CTA: 4.0 (IQR 3.5-4.5) min

- Hemorrhagic stroke (n=24, 10%):
  - Basal ganglia 15; thalamic 4; brainstem 1; aneurysmal SAH 3; hemorrhagic transformation of infarction 1
  - In 20 intraparenchymal hemorrhages, median ICH score was 2 (IQR 1-3); 4 (20%) were spot sign positive
- Ischemic strokes (n=221, 90%):
  - LVO on CTA in 62 (28%); 9 (15%) extracranial
  - 73 (33%) received field tPA
    - Scene arrival to tPA bolus 23 (IQR 13-36) minutes
    - 1 intra-osseous tPA
    - 1 angioedema at 20 minutes post tPA in hospital
    - 1 sICH at 18 hours post tPA associated with hypertensive event in MRI
    - 31.5% treated within 1st 60 minutes from onset
- No imaging needed to be repeated for image quality and all patients were triaged correctly

Median Field-to-LVO diagnosis time 13 min (IQR 7-20 min)

Fastest Field-to-Cath Lab times in BEST-MSU Study

The FAST Act

Union Calendar No. 328

115TH CONGRESS
1ST SESSION

H. R. 1148

[Report No. 115–444, Part I]

To amend title XVIII of the Social Security Act to expand access to telehealth-eligible stroke services under the Medicare program.

"(iii) TELEHEALTH-ELIGIBLE STROKE SERVICES.—With respect to telehealth-eligible stroke services, the term 'originating site' means any hospital (as defined in section 1861(e)) or critical access hospital (as defined in section 1861(mm)(1)), or any mobile stroke unit, at which the eligible tele-

5 Year Cost Effectiveness

Cost of CT Scanner	$ 400,000
Ambulance /Chassis/ALS Equip	$ 600,000
TM equipment	$ 30,000
Other Stuff	$ 70,000
Operating Costs X 5 yrs	$ 500,000
Staff: Paramedic/EMT/Nurse and TM MD X 5 yrs (1 shift/d)	$ 2,000,000
Total fixed and continuing costs for 1 MSTU X 5 yrs	$ 3,600,000

$$
=
$$

Lifetime direct cost per stroke (1999 dollars) $ 140,000 (*Circulation.* 2009;119:e21-e181)

Therefore, cost neutral if:

1 MSU results in 5 more patients/yr completely recovering

Courtesy: J.C. Grotta, MD.

5 Year Hospital Pro-Forma

Costs:	
Cost of CT Scanner	$ 400,000
Ambulance /Chassis/ALS Equip	$ 600,000
TM equipment	$ 30,000
Other Stuff	$ 70,000
Operating Costs X 5 yrs	$ 500,000
Staff: Paramedic/EMT/Nurse and TM MD X 5 yrs (1 shift/d)	$ 2,000,000
Total fixed and continuing costs for 1 MSTU X 5 yrs	$ 3,600,000

Revenue (also projecting 1 shift/d)	
Transports (3/wk @ $500 ea)	$ 390,000
Incremental tPA cases (1/mo @ $28,795 collect- 11,814 cost)	$ 1,018,860
Incremental MT cases (1/mo @ $54,074 collect- 13,419 cost)	$ 2,439,300
Total revenue	$ 3,848,160

(excluding tPA costs/reimbursement, TM and CT reimbursement)

Courtesy: J.C. Grotta, MD.

Memphis MSU Model

- IV tPA is re-stocked on MSU by receiving hospitals that bill for Rx if MSU brings stroke patient with iv tPA still running and the patient is registered as in-patient en route
- IV tPA patients bypass ER and cared from arrival by on-site Stroke Team
- ER MDs can be consulted on these patients
- ER is bypassed for MT patients completely

Memphis MSU Model

- First MSU accredited by IAC as CT Laboratory areas: Acute Stroke CT, Vascular CT

Memphis MSU Model Billing Codes

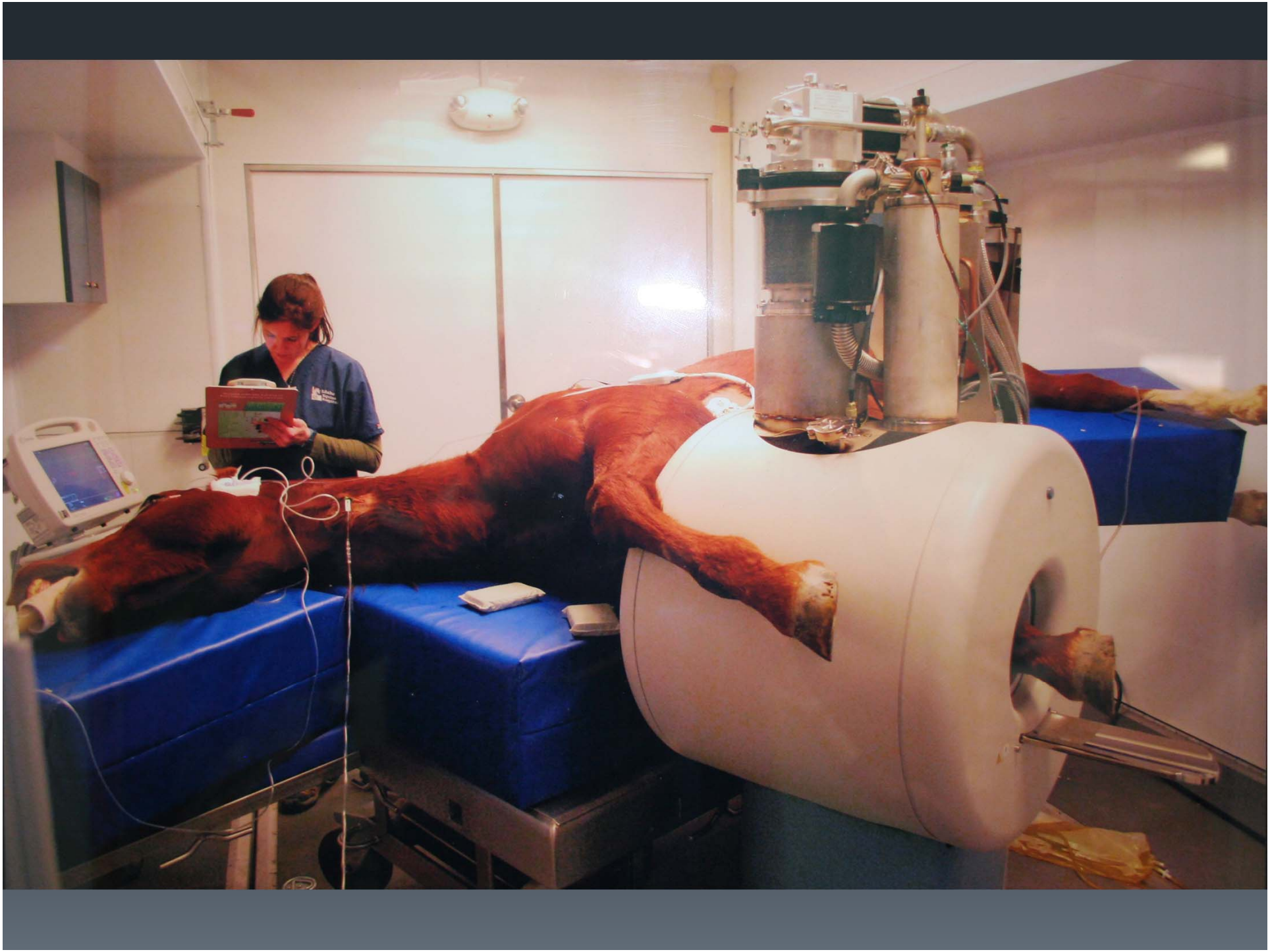
▪ ALS transport	$ 495
▪ 99291 Critical Care service (ACNP)	$ 466
▪ 70470 CT	$ 535
▪ 70498 CTA	$ 815
Total:	**$ 2,311**

or

▪ A0434 ALS 4 Specialty transport	$ 935

Memphis MSU Model is Break-Even

- Medicare NPI for MSU and CT Laboratory are being merged under FAST Act
- Prior billing: charges up to $ 2,400/run resulted in average $ 1K collections that are increasing
- 30 days of business hours operation that yield 20 on scene patients and 20 inter-facility specialty transports (1.3 paid runs/day) are needed to break even. This includes also non-tPA, non-MT, ICH and clinical trial patient transports



THE UNIVERSITY of TENNESSEE

HEALTH SCIENCE CENTER - MEMPHIS

#1 USA STROKE tPA TREATMENT RATE

Catch Us If You Can