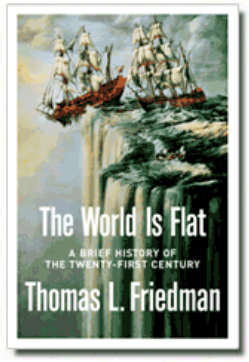
The World is “Flat”: A Brief History and Future of Acute Stroke Care



MCG Class of 2020

David C Hess MD
Dean and Executive VP for Medical Affairs and Integration
Presidential Distinguished Chair
Medical College of Georgia
Augusta University

Disclosures

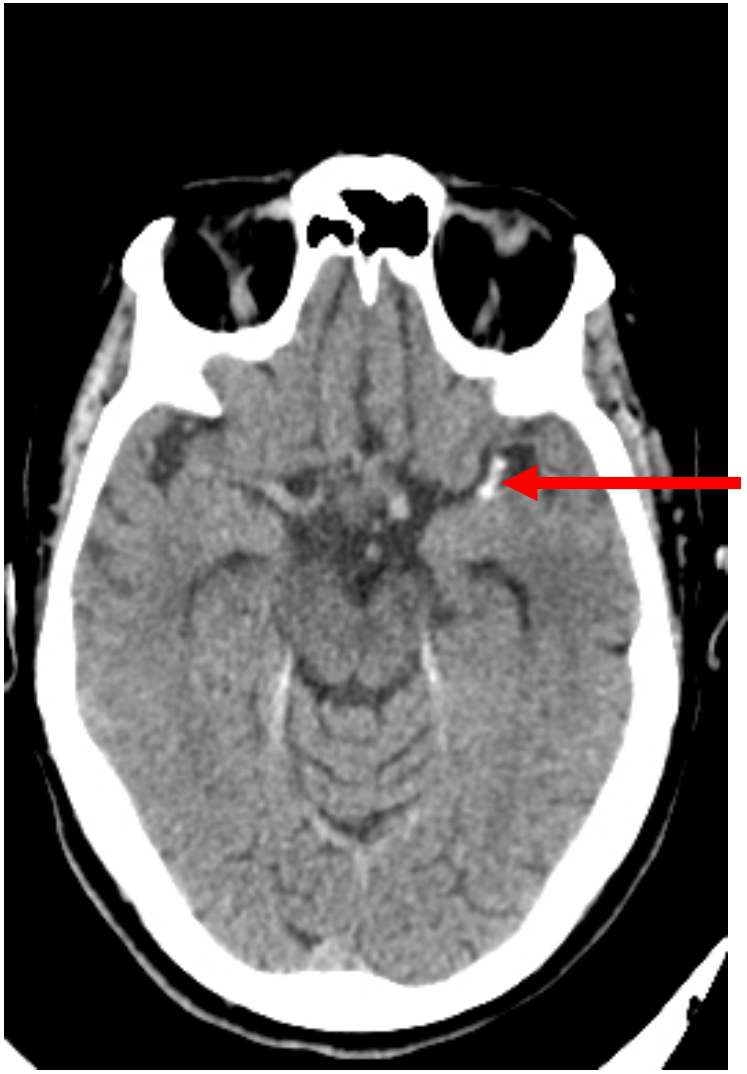
- Co-Founder and Chairman REACH Health Inc, Board of Directors; company sold to InTouch, no conflicts as of 2019

Elderly woman with sudden onset of aphasia, right hemiparesis

- 88 yo WF with hx of HTN and pacemaker for SSS
- Develops sudden onset of aphasia and right sided weakness at 11:45 am
- Arrives at community hospital (JC Primary Stroke Center) at 12:25 pm
- Evaluated by “telestroke”: NIHSS of 24 –Global aphasia and right hemiparesis

Telestroke Consultation

- Treated with IV tPA at 1:15 pm (90 minutes from symptom onset)
- Next decision: is she an endovascular thrombectomy candidate? YES

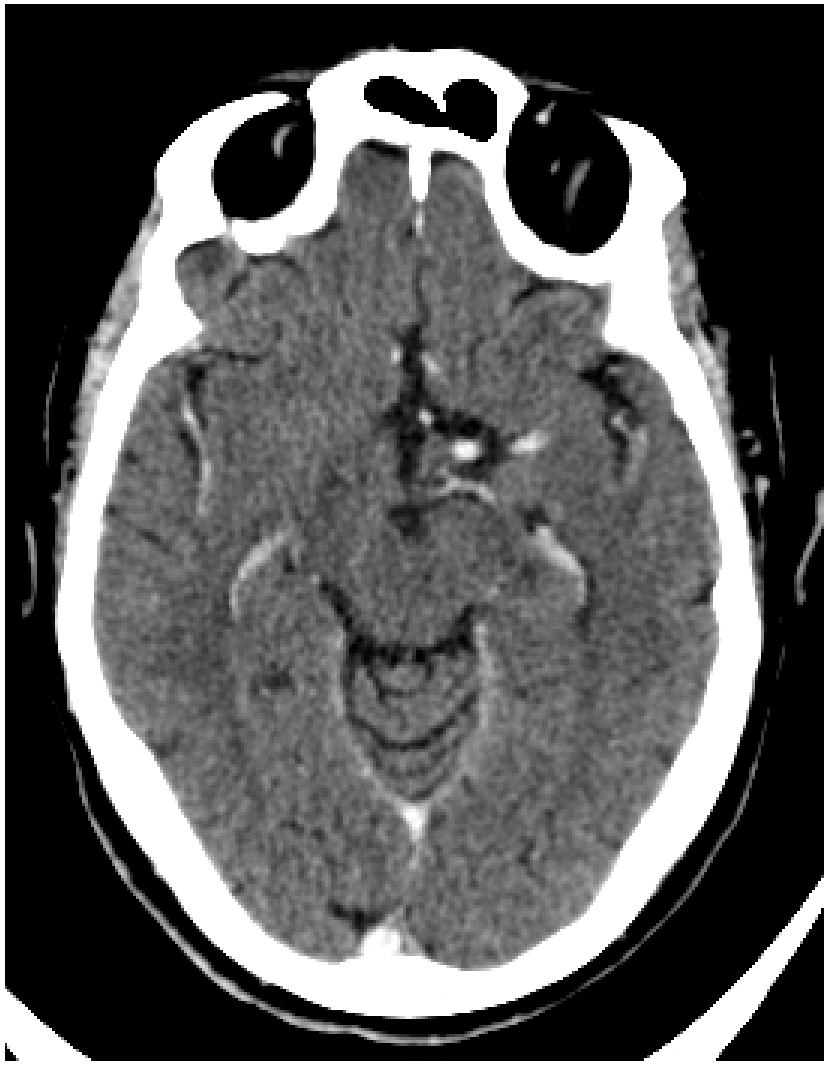


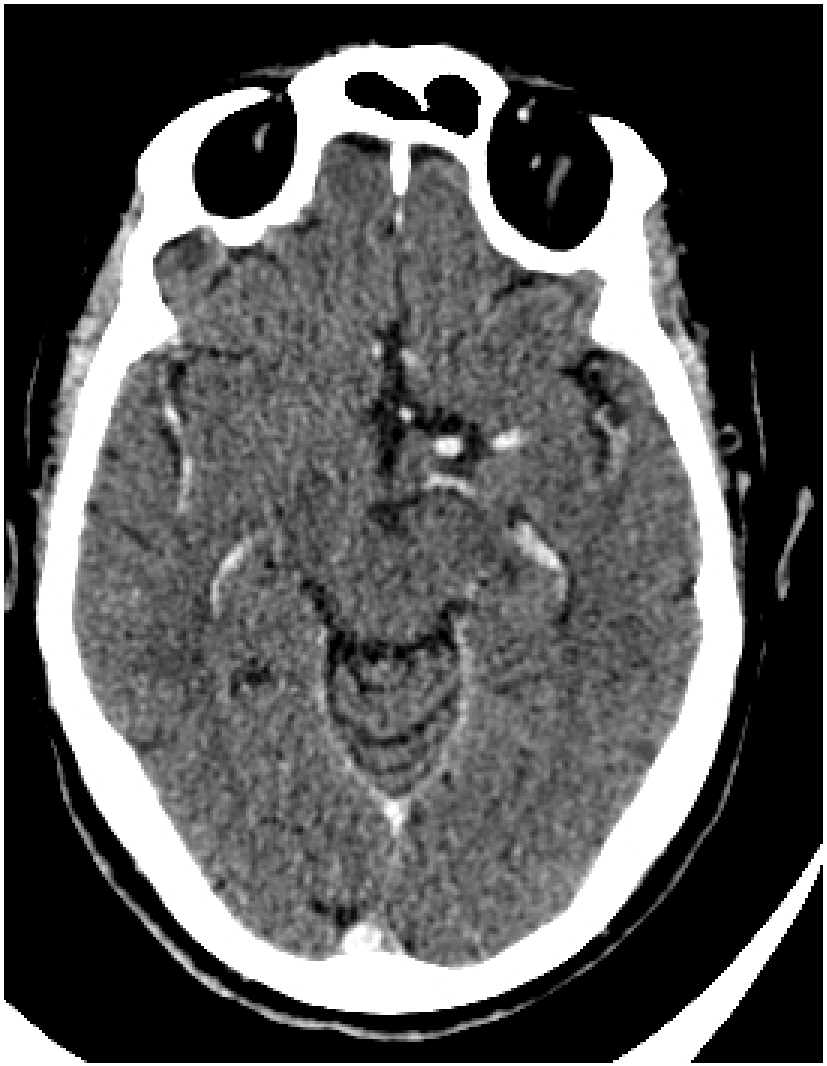

TN
SC
AL
GA
FL
Barrow
St. Marys
Athens
Atlanta
Wills
Morgan
GRMC
Augusta
Good Samaritan
Aiken Regional
University
McDuffie
West
Georgia
Washington
Burke
Jefferson
Jenkins
Emanuel
Effingham
Candler
St. Joes/Candler
Savannah
Evans
Appling
Coffee
Tift
Wayne
Archbold
South Georgia
30 mi.

Transfer to CSC

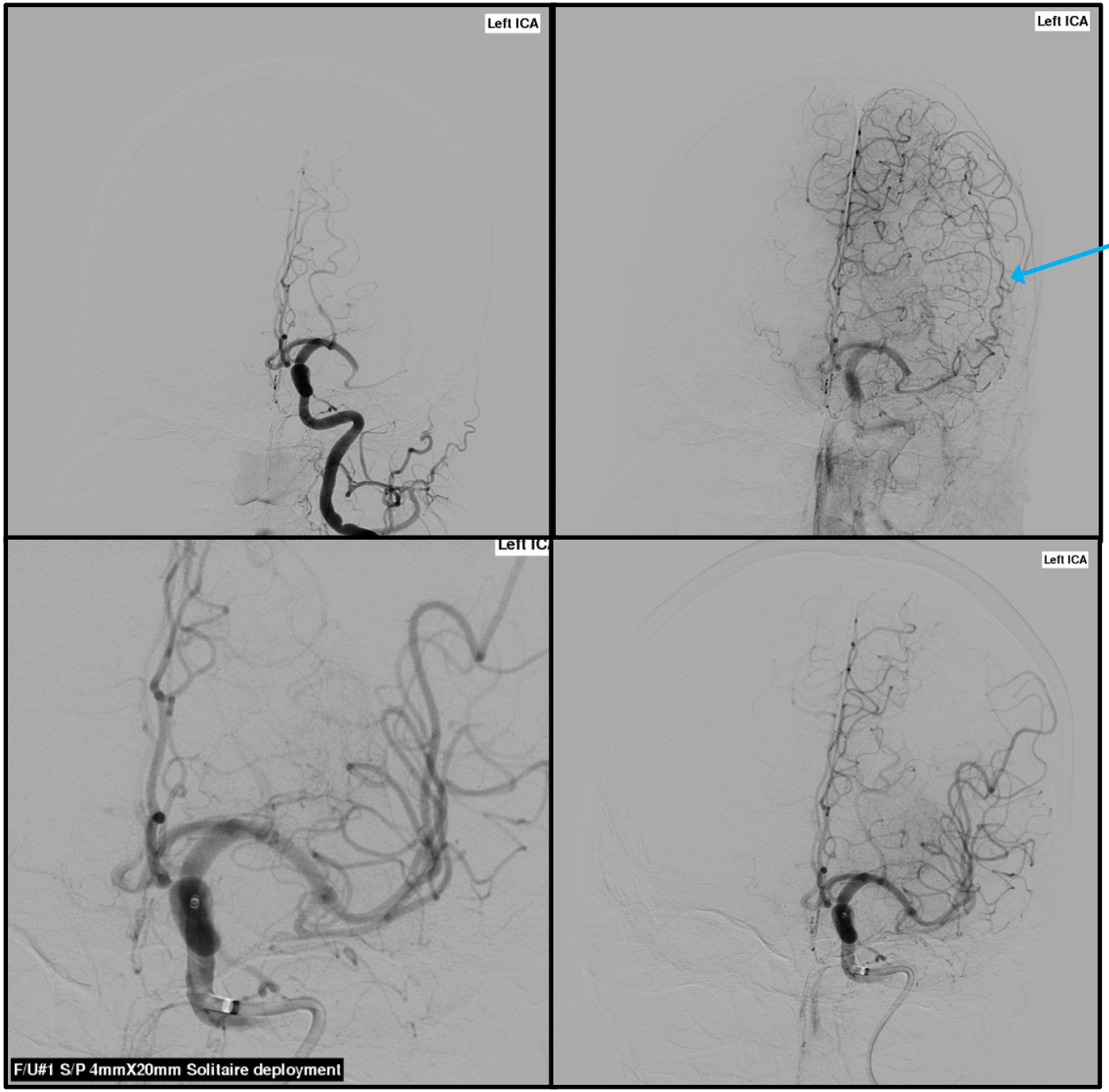
- Transferred to Comprehensive Stroke Center (CSC) for consideration of mechanical thrombectomy
- Arrives to CSC- AUMC. NIHSS of 18
- CT angiogram done

CT Angiogram





Reconstruction of CT Angiogram



Leptomeningeal Collaterals

Endovascular Thrombectomy

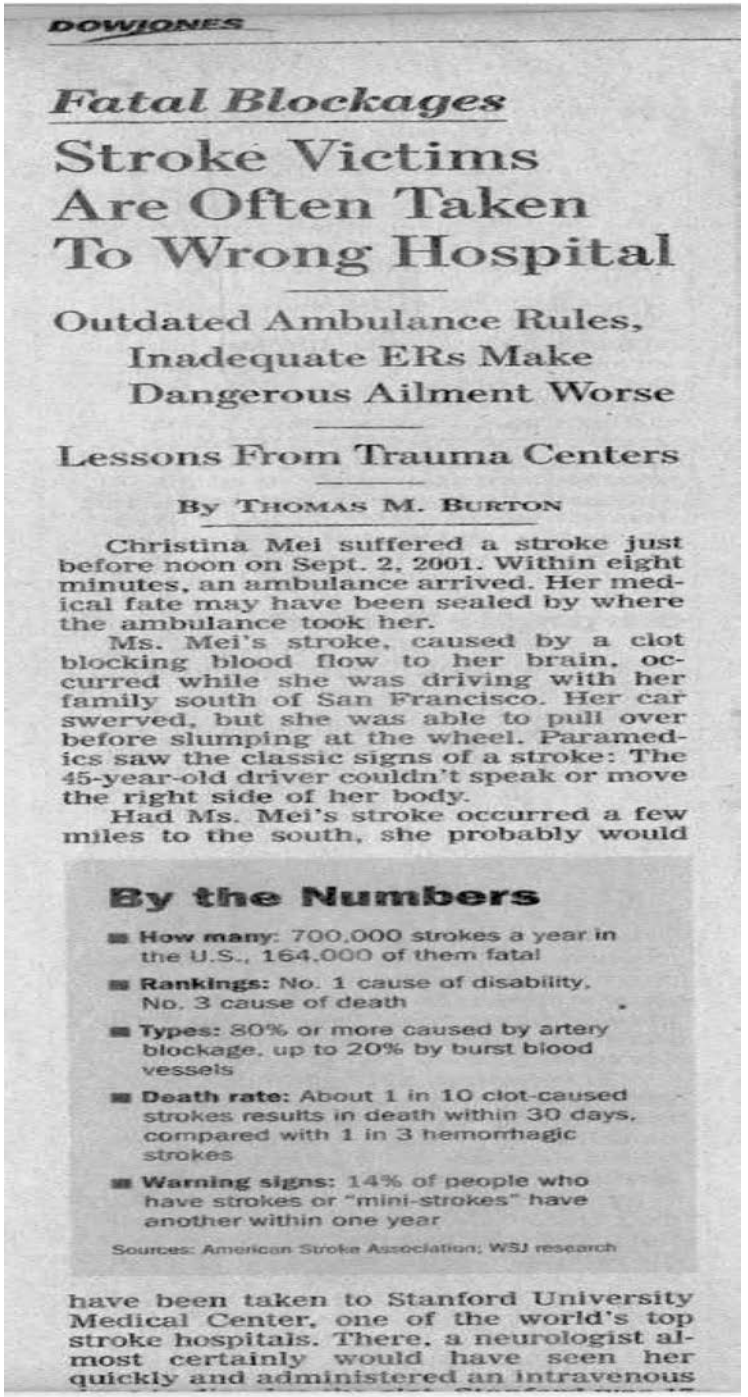
- Has M1 occlusion and “good collaterals”
- Taken to interventional suite
- Solitaire Stent Retriever
- Recanalized 16:40 with TICI 3 flow (about 5 hrs from time of onset)

Follow Up

- Has mild aphasia
- Right side strength improves
- Found to have atrial fibrillation
- Started on apixaban
- Inpatient rehab back in the Primary Stroke Center Rehab facility

Front page of Wall Street Journal

Tragic case of young stroke victim taken to the “wrong hospital”



DOWJONES

Fatal Blockages

Stroke Victims Are Often Taken To Wrong Hospital

Outdated Ambulance Rules, Inadequate ERs Make Dangerous Ailment Worse

Lessons From Trauma Centers

By Thomas M. Burton

Christina Mei suffered a stroke just before noon on Sept. 2, 2001. Within eight minutes, an ambulance arrived. Her medical fate may have been sealed by where the ambulance took her.

Ms. Mei's stroke, caused by a clot blocking blood flow to her brain, occurred while she was driving with her family south of San Francisco. Her car swerved, but she was able to pull over before slumping at the wheel. Paramedics saw the classic signs of a stroke: The 45-year-old driver couldn't speak or move the right side of her body.

Had Ms. Mei's stroke occurred a few miles to the south, she probably would

By the Numbers

- **How many:** 700,000 strokes a year in the U.S., 164,000 of them fatal
- **Rankings:** No. 1 cause of disability, No. 3 cause of death
- **Types:** 80% or more caused by artery blockage, up to 20% by burst blood vessels
- **Death rate:** About 1 in 10 clot-caused strokes results in death within 30 days, compared with 1 in 3 hemorrhagic strokes
- **Warning signs:** 14% of people who have strokes or "mini-strokes" have another within one year

Sources: American Stroke Association; WSJ research

have been taken to Stanford University Medical Center, one of the world's top stroke hospitals. There, a neurologist almost certainly would have seen her quickly and administered an intravenous

Many/Most US Hospitals NOT treating stroke patients with IV tPA

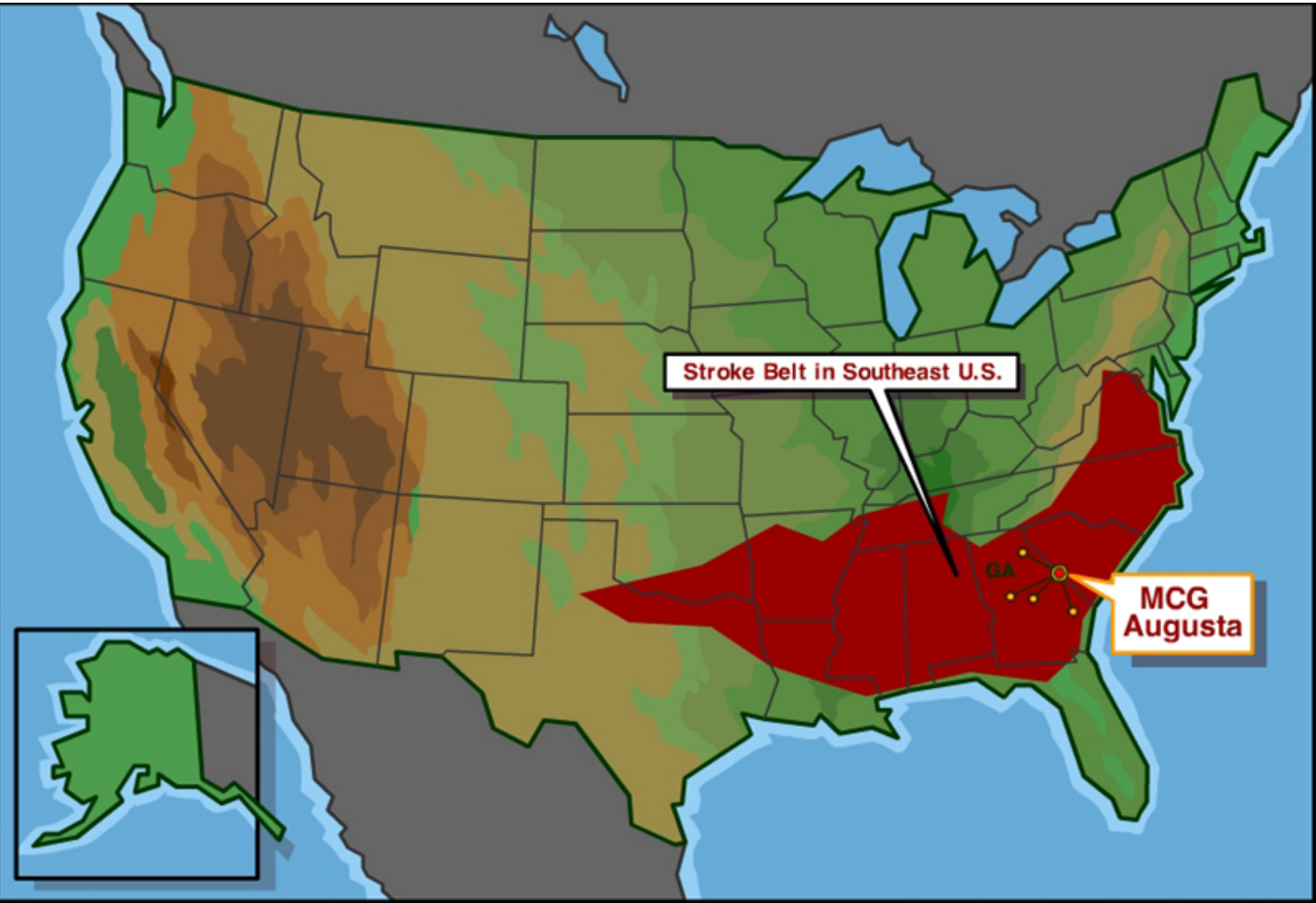
- MEDPAR database revealed that **64%** of US hospitals did not treat a single Medicare patient with tPA over a 2 year period

	Univariate Mean Rt-PA Treatment Rate (95% CI)*	Multivariable Regression χ^2	*P* Value
Bed size (# of beds/hospital)		397.9	<0.001
<50	0.3% (0.2% to 0.4%)		
50–200	1.1% (1.0% to 1.2%)		
>200	2.6% (2.4% to 2.8%)		
Region of United States		53.2	<0.001
Midwest	2.0% (1.7% to 2.2%)		
Northeast	2.7% (2.3% to 3.1%)		
South	1.8% (1.6% to 2.1%)		
West	2.5% (2.1% to 2.9%)		
Population density (persons/sq. mile)		21.3	<0.001
<50	0.9% (0.7% to 1.1%)		
50–500	1.7% (1.6% to 1.9%)		
>500	2.7% (2.5% to 3.0%)		

*Means are weighted by the total No. of stroke admissions to the hospital during the study period.

Bed size, region, and population density associated with low tPA usage

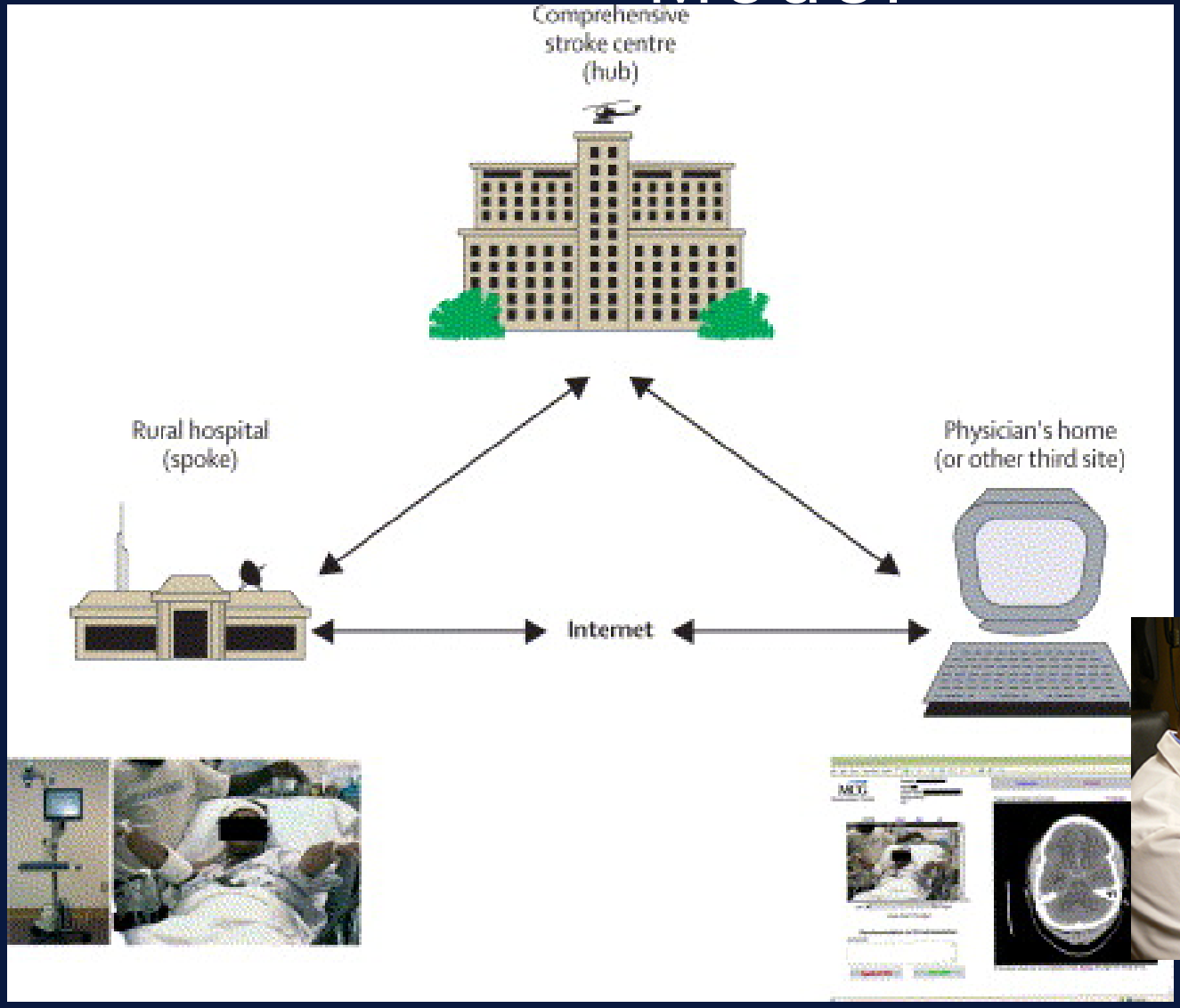
Stroke Belt in Southeastern US….



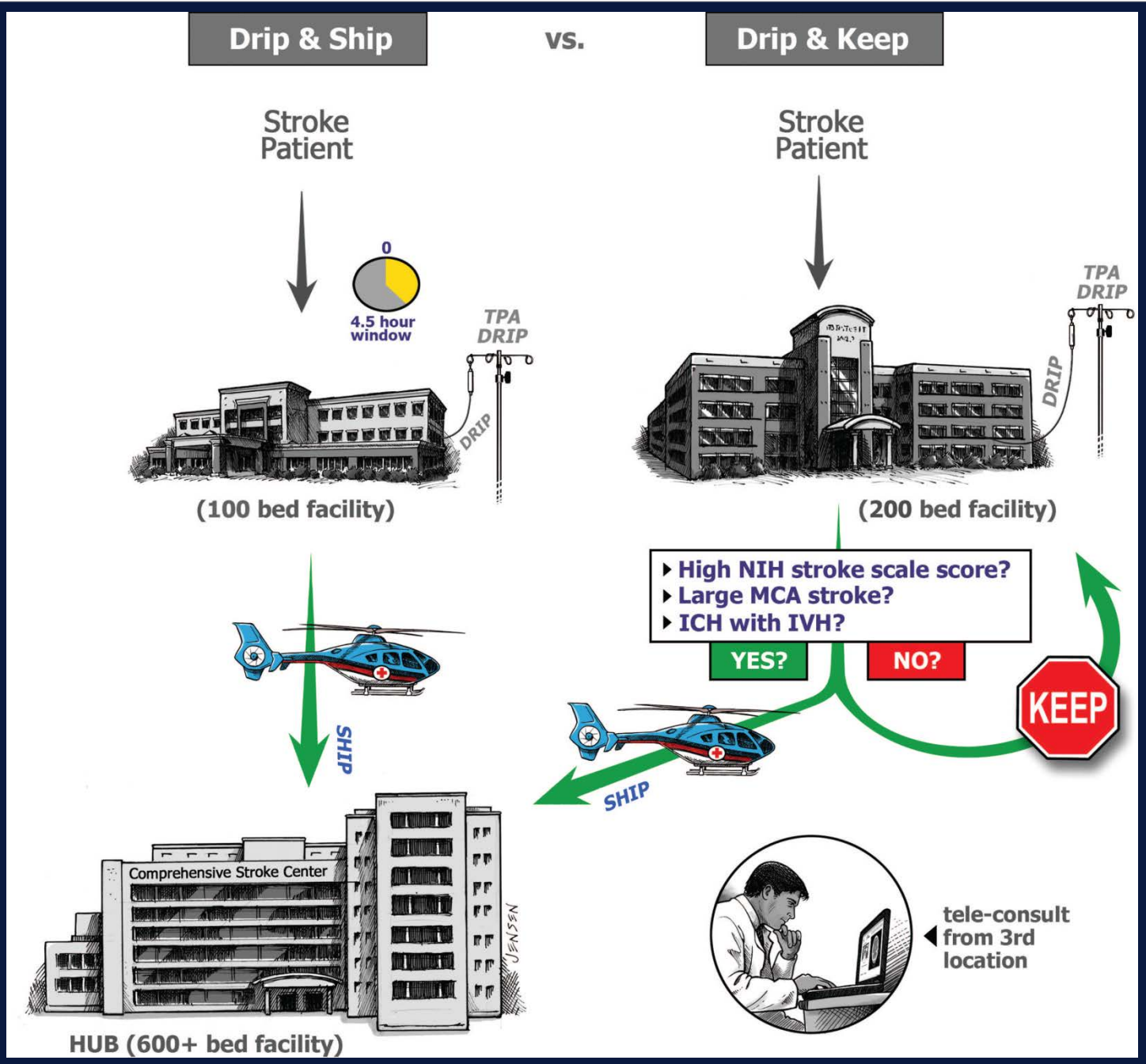
The Geographic Penalty

- The quality of stroke care is dependent upon the hospital you go to
- If you live in a rural area or “underserved acute stroke care” area you will NEVER receive tPA
- Of the 5779 US hospitals, 2003 are “rural”
- There is a GEOGRAPHIC penalty for stroke

REACH Hub & Spoke Telestroke Model



Hess DC, et al. *Lancet Neurol*. 2006;36:5:275-8



Hess DC, et al. *Neurology.* 2011;76(13):1121-3

Feasibility and Reliability of NIHSS via Telestroke

	Shafqat S (Stroke,1999)	Wang S (Stroke, 2003)	Handschu R (Stroke, 2003)	Meyer BC (Neurology, 2005)
System	Point-to-point ISDN lines	Web-based, Mobile consultant	Point-to-point*	Web-based, Mobile consultant
Number of patients	20	20	41 (ED)	25
Reliability	Kappa r=.97	Pearson r=.95	Kappa r=.85 to .99	Kappa r=.94
Time	9.70 min vs 6.55 min	9.11 min vs 6.24 min	11.4 min vs 10.8 min	NR
Comments	Remote vs on site NIH all $\leq$3	Remote vs on site NIH all $\leq$3	Facial paresis least reliable	Modified NIHSS also reliable

Prospective, Randomized Trial of Telemedicine vs Telephone

Acute Stroke Patients
(4 Community Hospital Emergency Rooms)

Telemedicine
28% (31/111) tPA
Correct Treatment Decision: **98%***

Telephone
23% (25/111) tPA
Correct Treatment Decision: **82%**

Meyer BC, et al. *Lancet Neurol.* 2008;7(9):787-95

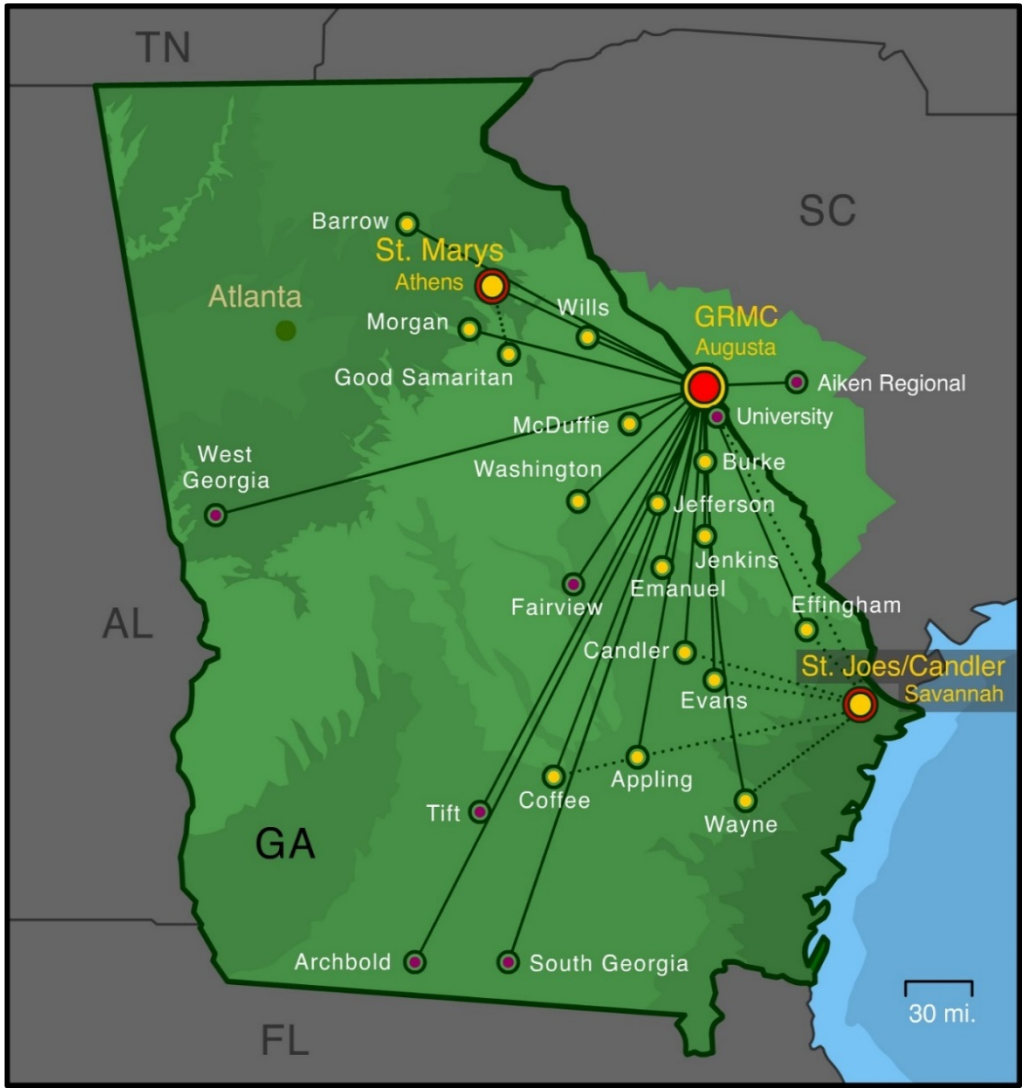
ASA Review of Evidence and Guidelines (Stroke, 2009)

- The NIHSS-telestroke examination, when administered by a stroke specialist using HQ-VTC, is recommended when an NIHSS-bedside assessment by a stroke specialist is not immediately available for patients in the acute stroke setting, and this assessment is comparable to an NIHSS-bedside assessment (Class I, Level of Evidence A).

ASA Review of Evidence and Guidelines (Stroke, 2009)

- It is recommended that a stroke specialist using HQ-VTC provide a medical opinion in favor of or against the use of intravenous tPA in patients with suspected acute ischemic stroke when on-site stroke expertise is not immediately available (Class I, Level of Evidence B)

AU Mega Multi Hub and Spoke Stroke System



A Tale of Two Spokes

Type A-Rural

- < 100 beds
- ED volume <20,000/yr
- No ICU/limited ICU
- No neurologist on staff

- “Drip and ship” tPA
- Most strokes transferred

Type B-Suburban/Urban

- > 150 beds
- ED volume >30,000/yr
- ICU
- Neurologist on staff
- RN Stroke Coordinator
- “Drip and keep” tPA
- Most strokes kept
- Transfer ICH and some large ischemic strokes (basilar, NIH >15)

Phenomenal Growth of Telestroke in U.S

- Increase in telestroke programs (more than 50 “hub and spoke” in U.S)
- Increase in mean number of spokes per hub from 2007 to 2009 (3.78 to 7.90, $p<.05$)[1]
- Most academic and integrated service delivery networks have a telestroke program or considering a program; often driven by “competition” and the health care “marketplace”

[1]Silva GS, et al. *Stroke*. 2012;43(8):2078-85

Human factors more important than the technology

Disruptive Health Care Innovations

"The Innovator's Prescription" Clayton Christensen

- Telemedicine and Telehealth
  - Telestroke
  - Home monitoring

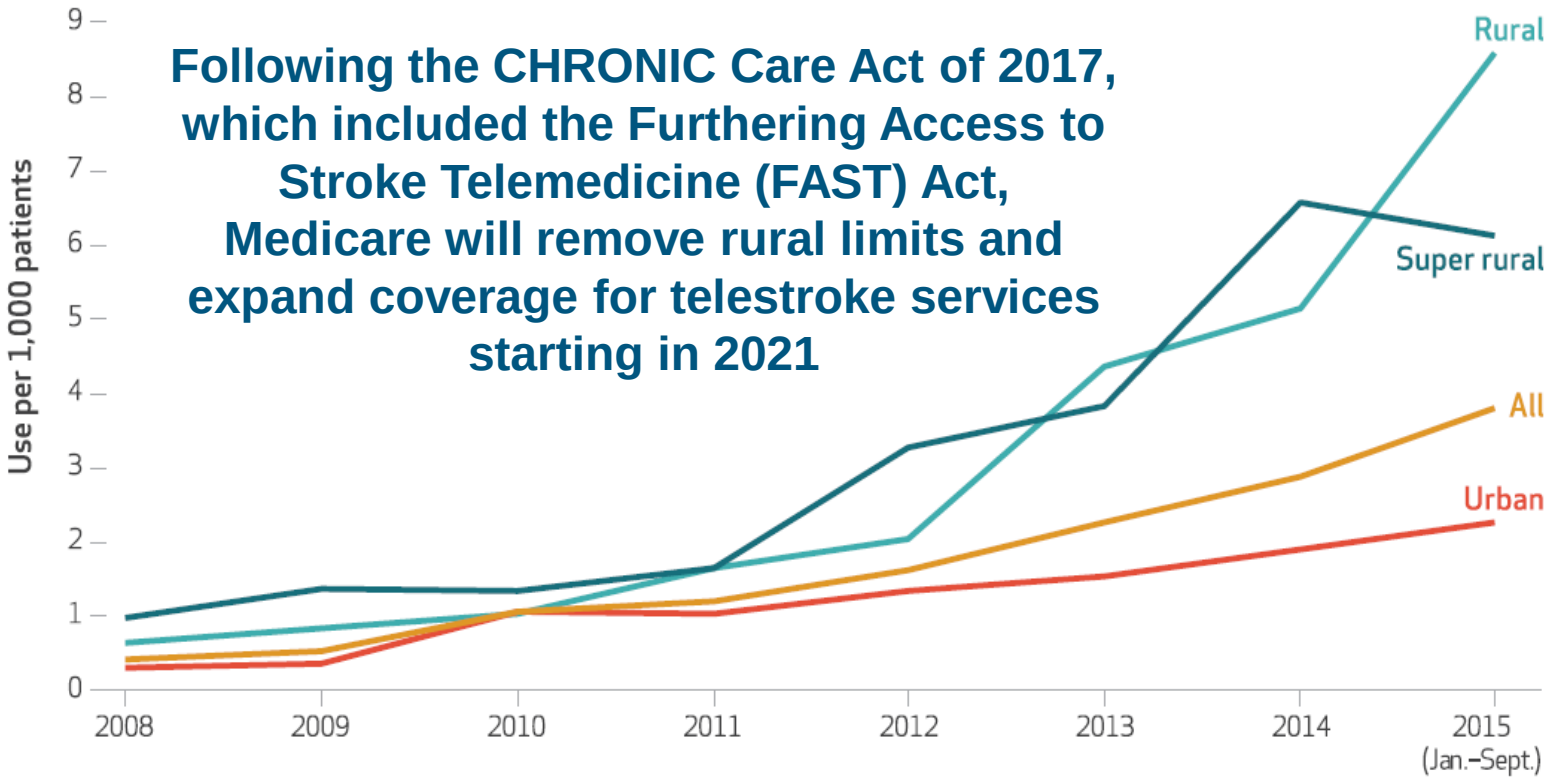
Expansion Of Telestroke Services Improves Quality Of Care Provided In Super Rural Areas

Super rural areas: most rural places defined for purposes of CMS fee schedule

- Donglan Zhang[1], Guijing Wang[4], Weiming Zhu[4], Janani R. Thapa[1], Jeffrey A. Switzer[2], David C. Hess[2], Matthew L. Smith[3], and Matthew D. Ritchey[4]

- **Study objectives**
  - a) Describe the trend in recent use of telestroke services
  - b) Assess the association between telestroke services and quality of care in urban and rural places
- **Database**
  - CMS inpatient claims and outpatient claims in the emergency department from January 2008 to September 2015
  - In the cross-sectional data, among patients with acute ischemic stroke, **1,663** received telestroke services

Objective 1: Description of telestroke utilization from 2008 to 2015



SOURCE Authors' analysis of fee-for-service Medicare claims data for the period January 1, 2008–September 30, 2015. **NOTE** Urban, rural, and super rural areas are explained in the notes to exhibit 1.

Is "Hub and Spoke" Telestroke Cost-Effective?

- **YES (U.S.)** Nelson RE, et al. *Neurology*. 2011;77(17):1590-8
  - Decision analytic model for 90 day and lifetime horizons with Hub and 8 spokes
  - ICER of $108, 363/QALY for 90 day and $2449 for lifetime horizon (societal perspective) (< threshold of $50,000/QALY

- **YES (Denmark)** Ehlers L, et al. *CNS Drugs*. 2008;22(1):73-81.
  - ICER about $50,000/QALY at one year
  - Telestroke "dominant" in quality and cost after 2 years and improved over longer time scale

Is Telestroke Cost Effective from the Hospital Perspective (Hub, Spoke, Hub + Spoke)? YES

- Decision analytic model using “real data” from Georgia Health Sciences (REACH network) and Mayo Clinic Scottsdale, AZ
- Assumes 1 Hub and 7 Spokes and 5 year horizon
- Each year, network was associated with $358 435 in cost savings; cost sharing can be arranged so that each hospital could achieve an equal amount of cost savings ($44 804/y)
- 6.1 more home discharges per year

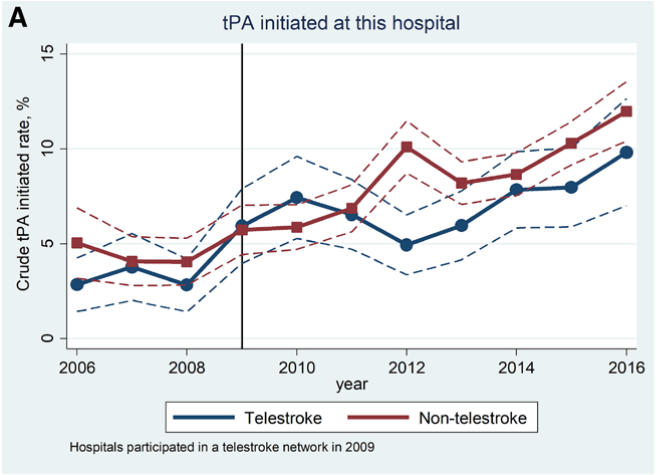
Switzer JA, et al. *Circ Cardiovasc Qual Outcomes*. 2012 Dec 4.

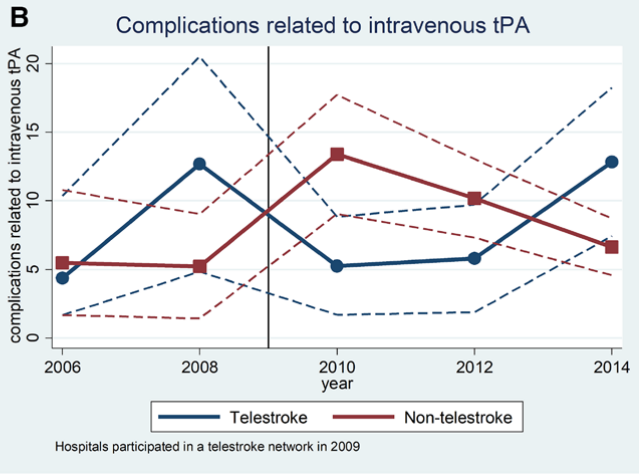
Impact of Participation in Telestroke Network on Clinical Outcomes

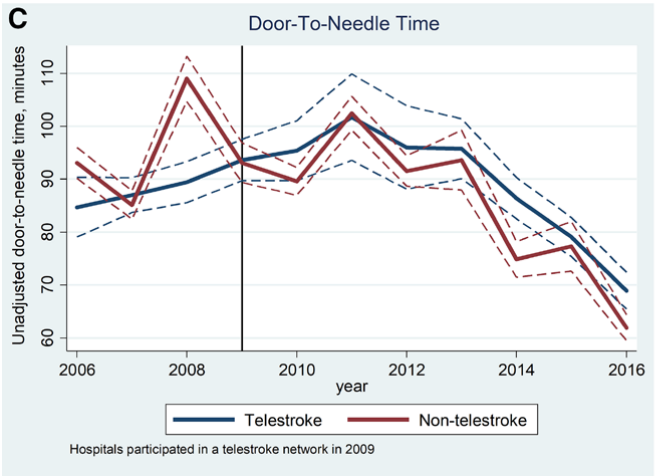
Evidence from the Georgia Coverdell Acute Stroke Registry

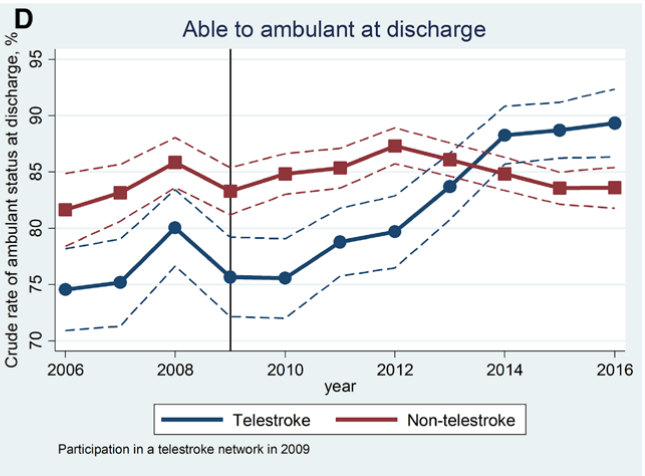
Zhang D, Shi L, Ido MS, Green DE, Li Y, Su D, Hess DC. Circulation: Cardiovas Care Outcomes 2019

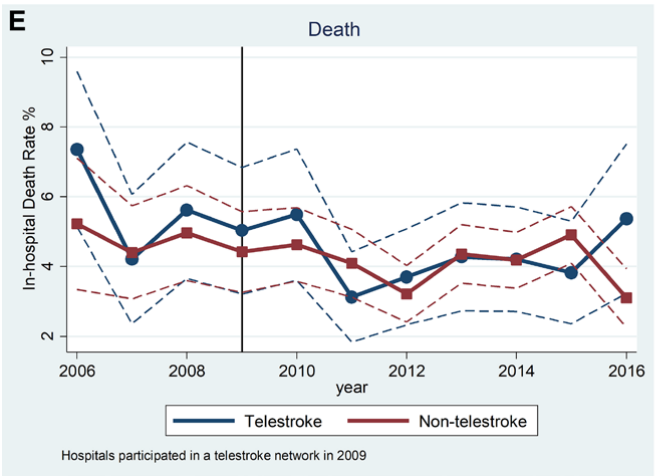
- 25,494 patients at 15 nonteaching hospitals located outside of Atlanta in GCASP
- All hospitals in Georgia Coverdell Acute Stroke Registry
- 4 hospitals with telestroke (REACH system) compared to 11 without telestroke; pre and post (2009)
- Propensity score weighting

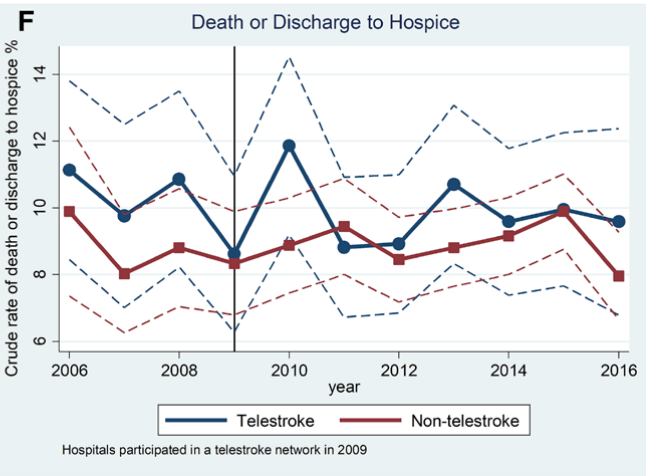

A
tPA initiated at this hospital
Crude tPA initiated rate, %
0
5
10
15
2006
2008
2010
2012
2014
2016
year
Telestroke
Non-telestroke
Hospitals participated in a telestroke network in 2009


B
Complications related to intravenous tPA
complications related to intravenous tPA
0
5
10
15
20
2006
2008
2010
2012
2014
year
Telestroke
Non-telestroke
Hospitals participated in a telestroke network in 2009


C
Door-To-Needle Time
Unadjusted door-to-needle time, minutes
60
70
80
90
100
110
2006
2008
2010
2012
2014
2016
year
Telestroke
Non-telestroke
Hospitals participated in a telestroke network in 2009


D
Able to ambulant at discharge
Crude rate of ambulant status at discharge, %
70
75
80
85
90
95
2006
2008
2010
2012
2014
2016
year
Telestroke
Non-telestroke
Participation in a telestroke network in 2009


E
Death
In-hospital Death Rate %
2
4
6
8
10
2006
2008
2010
2012
2014
2016
year
Telestroke
Non-telestroke
Hospitals participated in a telestroke network in 2009


F
Death or Discharge to Hospice
Crude rate of death or discharge to hospice %
6
8
10
12
14
2006
2008
2010
2012
2014
2016
year
Telestroke
Non-telestroke
Hospitals participated in a telestroke network in 2009

Conclusions from telestroke within the GCASR

- Slight decrease in tPA complications amongst telestroke hospitals
- No increase in tPA use and an increase in door to needle time
- Overall, no significant effect of telestroke participation on hospital's stroke care quality

Conclusions

- Telestroke can “flatten” stroke care and bring a stroke specialist to ANY rural, community hospital IMMEDIATELY regardless of geography
- Human factors – “local spoke champions” and education critical to success
- Use to triage for mechanical thrombectomy after IV tPA
- Next frontier is using telestroke for acute stroke and emergency neurology clinical trials
- Academic and **Regional Medical Centers** should become Hubs (Comprehensive Stroke Centers) and support community hospitals as Spokes

Acknowledgements

MCG REACH TEAM