

## Introduction

- Time is critical in the management of acute stroke patients.
- For every minute that passes without reperfusion, acute ischemic stroke patients lose two million neurons.<sup>1,2</sup>
- Patients with acute stroke need to be transported swiftly to stroke-ready hospitals for a better outcome.
- Primary stroke centers (PSCs) are certified by the Joint Commission as stroke-ready facilities.<sup>3,4</sup>
- The Coverdell-Murphy act promulgated by the Georgia state legislature establishes a two-tier stroke systems of care with primary stroke centers and remote treatment centers.
- North central (Macon) health district currently has two PSCs

## Study Objective

- This study assesses the differential impact of drive time to primary stroke centers on patient outcome.

## Methods

- **Data source:** 2006-2010 Georgia Discharge Data System
- **Study population:** adults 18 years old or older admitted with principal diagnosis of acute ischemic stroke (ICD-9-CM codes: 433 & 434, excluding those with 433.10)
- Drive time to healthcare facility was the main predictor; age, gender, race, primary source of healthcare insurance, day of admission, calendar year, hospital bed size and primary stroke center status, and co-morbidities were considered as covariates
- Co-morbidities were defined using the Healthcare Cost and Utilization Project software from the Agency for Healthcare Research and Quality
- Drive times from patients' residences to the hospitals where they were cared for were calculated applying a network multistep route solver process over a street network using Esri's (ArcGIS 10.2.2) Network Analyst route solver functionality.
- Discharge disposition was the outcome measure and patients were classified into three categories: died in hospital or discharged to hospice care, discharged to another acute or chronic care facility but not hospice, and discharged to home.
- Ordinal logistic regression was applied to estimate the odds for unfavorable outcome controlling for correlation within a hospital and other covariates.
- Multivariable analysis included patients only from hospitals which provided care both as PSC and non-PSC during the five year period (Table 2).

## Results

- 4,331 acute ischemic stroke patients were included in the analysis with a median age of 68 years (IQR: 58, 79).
- Of the 4,331 stroke patients, 53% were female and 54% were whites
- Patients received care in 58 hospitals across the state; however, the majority (70%) were cared for by three hospitals
- The median drive time was 14.3 minutes (IQR: 7.3, 32.8)
- None of the hospitals located in the district were stroke-ready in 2006, and only 3.6% of the district resident with acute ischemic stroke were treated at PSCs outside the district
- In 2010, two hospitals in the district became PSC and the proportion of patients cared for by PSCs rose to 66.5%
- 45.6% were discharged home, and 4.3% died in hospital

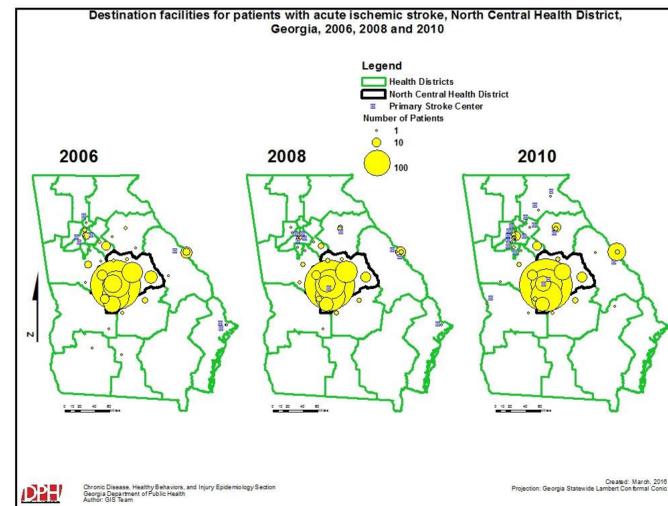


Table 1. Discharge disposition by drive-time and primary stroke status

Characteristics	Discharged		
	Home	Healthcare facility but not hospice	Hospice or Died
<b>Drive Time</b>			
< 30 minutes	1,429 (44.3)	1,550 (48.1)	244 (7.6)
30-60 minutes	336 (49.8)	280 (41.5)	59 (8.7)
> 60 minutes	191 (48.8)	174 (44.5)	26 (6.7)
<b>Primary stroke Center Status</b>			
Non-Primary Stroke Centers	1,250 (44.3)	1,379 (48.9)	192 (6.8)
Primary Stroke Centers	706 (48.1)	625 (42.6)	137 (9.3)

## Results

- In multivariable analysis controlling for covariates, among patients treated at PSCs, those who lived within 30 min and 30-60 min drive-times had a 0.58 (95%CI: 0.43, 0.79) and a 0.60 (95% CI: 0.42, 0.85), respectively, odds of having an unfavorable outcome versus those who lived 60 or more minute drive-time away from the PSCs.
- The odds ratios for 30 min and 30-60 min drives were 0.81 (95%CI: 0.68, 0.98) and 0.70 (95% CI: 0.5, 0.96) before the hospitals got primary stroke center status

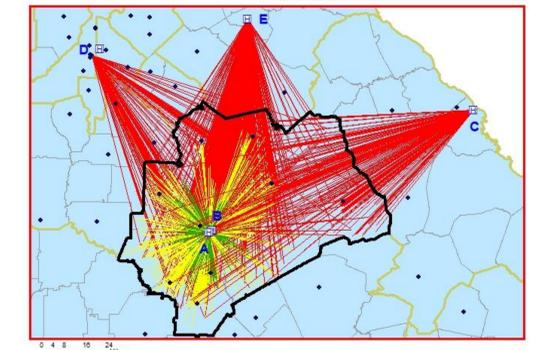
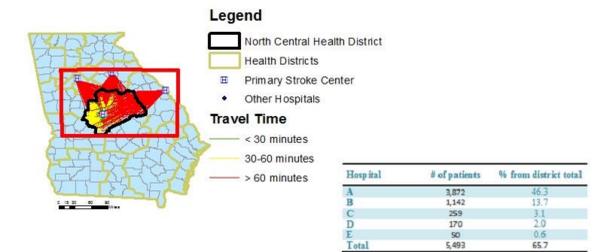
Table 2. The relative odds of having unfavorable<sup>§</sup> discharge disposition among ischemic stroke patients, North Central Health District, Georgia, 2006-2010

Characteristics	Estimate <sup>  </sup>	95% CL	p-value
Age (year)	1.05	1.04, 1.05	<.0001
Sex			
Male	0.93	0.85, 1.01	0.0963
Female	Referent	Referent	
Race			
Non-white	1.39	1.22, 1.59	<.0001
White	Referent	Referent	
Primary source of health insurance – Medicare			
No	0.75	0.61, 0.93	0.0096
Yes	Referent	Referent	
Calendar Year			
2006	1.16	0.98, 1.38	
2007	1.69	1.32, 2.17	
2008	1.25	1.13, 1.38	<.0001
2009	1.07	0.83, 1.37	
2010	Referent	Referent	
Day of the week			
Weekday	0.88	0.86, 0.89	<.0001
Weekend	Referent	Referent	
Hospital bed size			
251-400	1.20	1.15, 1.25	<.0001
>400	Referent	Referent	
Drive time			
Primary stroke centers			
<= 30 minutes	0.58	0.43, 0.79	
>30 – 60 minutes	0.60	0.42, 0.85	
>60 minutes	Referent	Referent	<.0001
Non-primary stroke centers			
<= 30 minutes	0.81	0.68, 0.98	
>30 – 60 minutes	0.70	0.5, 0.96	
>60 minutes	Referent	Referent	

§: Order of discharge disposition from favorable to unfavorable was: discharged to home, discharged to facilities other than hospice, and died or discharged to hospice  
||: Odds ratios are adjusted for co-morbidities

## Results

Destination primary stroke centers and travel time for acute stroke and transient ischemic attack patients, North Central Health District, Georgia, 2006-2010



## Conclusions

- Stroke patients who lived close to healthcare facilities had a better outcome.
- This difference in outcome attributed to drive time was more pronounced after hospitals became primary stroke centers.
- Co-morbidities don't capture disease severity adequately and the effect measures underestimate the actual impact of PSC because most severe patients are presumably treated at these stroke-ready facilities.
- Efforts should be made to encourage more hospitals become stroke-ready either as primary stroke centers or remote treatment centers.

## Limitations

- ICD-9 coding may not capture all acute ischemic stroke patients; leads more likely to be to non-differential patient misclassification
- Actual location of stroke incident is not known; the analysis did not account for time between symptom onset and hospital arrival
- Use of co-morbidity may not account fully for disease severity

## References

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2. Lees KR, et al. Time to treatment with intravenous alteplase and outcome in stroke: an updated pooled analysis of ECASS, ATLANTIS, NINDS, and EPITHET trials. *Lancet*. 2010;375:1695–1703.
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4. Alberts MJ, et al. Recommendations for the Establishment of Primary Stroke Centers. *JAMA*. 2000;283:3102-3109.

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