

# Inpatient Length of Stay and Procedure Disparities in Acute Myocardial Infarction Treatment

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# Presentation Plan

- Introduction
- Literature Review
- Methodology
- Results
- Discussion
- Summary

# Background

- One of the two overarching goals of Healthy People 2010 national agenda
- Disparity: difference or inequality
- Health disparity & health care disparity
- Inequity & Inequality
- Causes of disparities: related to many complicated factors (Gibbons, 2005). Multifactorial, complex, and specific to each health care area

# Background

- Acute myocardial infarction (AMI): heart attack
- In U.S., 7.2 million people with AMI.
- 865,000 patients experienced a new or recurrent AMI in 2003
- Leading cause of death. mortality 171,000 in 2003 (AHA, 2006)

# Statement of the Problem

- We need to know how AMI patient characteristics and other personal factors are related to their hospital utilization
- And especially we need to determine the impact of patient non-clinical factors upon some patient level outcomes

# Purpose

- Understand how disparities in AMI hospital utilization are associated with different factors of patients and hospitals in different settings
- Provide a national level overview of AMI inpatient care disparities from perspectives of Length of Stay (LOS) and Number of Procedures (NOP)

# Objectives

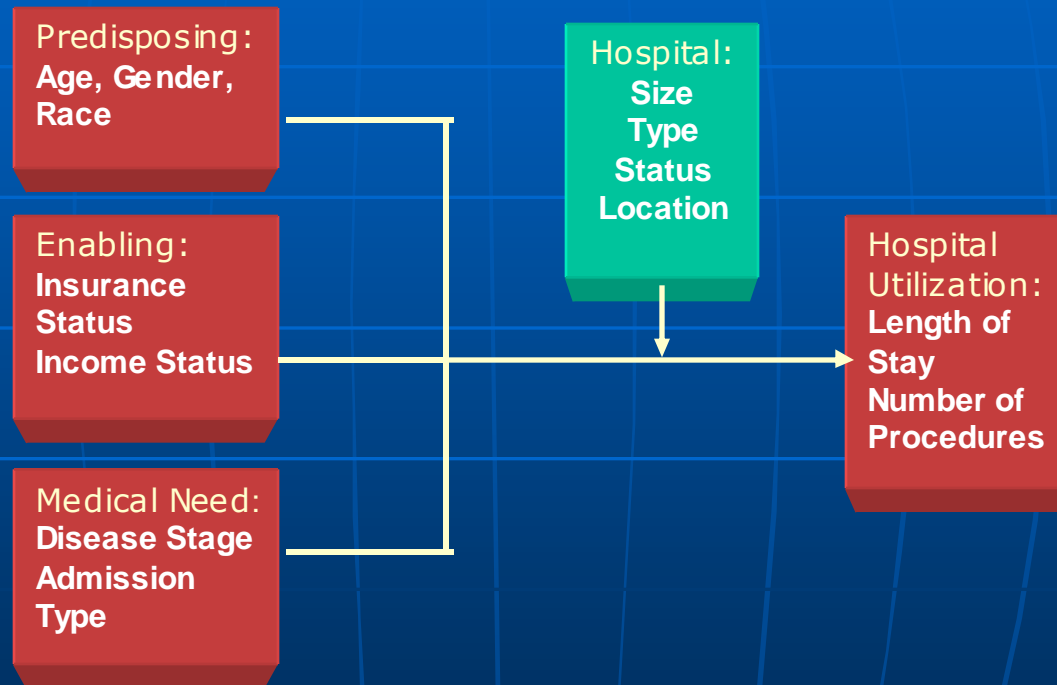
- Examined the two hierarchical level factors of patients and hospitals and their relationship with inpatient NOP or LOS disparities by inspecting different AMI patient groups
  - Examined AMI patients' NOP variations across patient and hospital factors
  - Examined patients' LOS variations across different patient and hospital factors by inspecting two typical AMI procedures
    - coronary artery bypass graft (CABG)
    - percutaneous coronary angioplasty (PTCA)
  - Examined samples both including and excluding death cases

# Significance of the Study

- No previous studies examined patient LOS and NOP variations in AMI treatment from both patient and hospital perspectives
- Patient and hospital factors are often studied separately. How such disparities relate to many combined patient and hospital factors is relatively unstudied in AMI
- This research contributed to AMI health care disparity literature by being the first to examine the variations in this way through analysis of national data. A national view was provided
- Provided an improved foundation for the understanding of AMI hospital care disparities



# Inpatient Utilization Disparity Model



# Literature Review

- Literature has described many different personal level factors contribute to the disparities in health care including race, age, gender, insurance status, and socioeconomic status
- Factors in the hospital organizational characteristics such as type, region, bed size, location and teaching status were observed to also have impacts on treatment

# Literature Review

Type	Source	Finding
Race/ Ethnicity	McBean & Gornick, 1994	White hospitalized patients received more surgical procedures than African American patients in 17 most frequently conducted categories
Race/ Ethnicity	Gornick et al. 1996	also found a similar situation significantly existed within Medicare
Race/ Ethnicity	Bertoni et al. 2005	examined current trends and literature from 1980s to 1990s in catheterization use for AMI. The data shows that hospitalized minority AMI patients received fewer procedures than white AMI patients

# Literature Review

Type	Source	Procedure Illness	Findings
Race/ Ethnicity	Daumit, Hermann, Coresh, and Powe, 1999	Ethnic differences in use of Cardiovascular procedures	During follow up white patients were 1.4 times more likely to have a procedure.
Race/ Ethnicity	Petersen et al,2002	Assessed racial differences in treatment for AMI	African Americans were less likely to receive bypass surgery, even when only high risk coronary anatomic subgroups were assessed.
Race/ Ethnicity	Hannan, van Ryn, Burke et al., 1999	Coronary artery bypass graft (CABG) surgery.	African American and Hispanic patients were significantly less likely to undergo CABG than white non Hispanics.
Race/ Ethnicity	Taylor, Meyer, Morse, and Pearson, 1997	Assessed rates of cardiovascular procedures by race in military health services system.	No differences found in rates of catheterization procedures between white and "nonwhite" patients during AMI admission.

# Literature Review

Type	Source	Finding
Race/ Ethnicity	Smedley & Nelson, 2002	Disparities existed in the type and quality of health care patients received, and these disparities were originated not by medical factors but by non-medical factors
Race/ Ethnicity	Mukamel et al. 2000	Minorities are more likely to receive health care from lower quality level hospitals when they have a chance to receive CABG procedures
Race/ Ethnicity	Shi, 1996	When compared with white patients, African-American patients with some diseases were more likely to have short Length of Stay
Race/ Ethnicity	Ayanian et al., 1999	African-American Medicare beneficiaries were more likely to receive lower levels of quality health care than white beneficiaries

# Literature Review

Type	Source	Finding
Insurance Status	Weissman & Epstein, (1989)	Uninsured: fewer procedures, shorter inpatient stays
Insurance Status	Kelz et al, (2004)	Medicaid and Uninsured: at greater risk of developing postoperative complications
Insurance Status	Hiestand et al (2004)	Uninsured: less-expensive therapies

# Literature Review

Type	Source	Finding
Insurance Status	Smedley & Nelson, 2002	Patients have different health insurance status may receive different care and have different surgical outcomes
Insurance Status	Burstin et al. 1992	Insurance status was associated with quality of health care. Uninsured patients have increased risk for receipt of substandard health services.
Insurance Status	Daumit et al, 1999; Taylor et al., 1997	Health insurance influence number and quality of Procedures they will receive

# Literature Review

Type	Source	Finding
Insurance Status	Kennedy, 2005 Taylor et al., 1997; Leape et al., 1999	Studies suggest that insurance coverage may narrow the health services gaps between different groups of people once a serious illness developed
Insurance Status	Sin et al., 2003	Canadian health care system can reduce, but not fully eliminate, the disparities in some health utilization across income groups
Insurance Status	Hemingway, et al., 2001	Great Britain, National Health Services; minority patients still received lower level of medical care than whites
Insurance Status	Rao et al. 2004	In U.S., treatment disparities in hospitalized AMI patients still exist in Medicare.



# Literature Review

Type	Source	Finding
Gender	Shi, 1996	When compared with male patients, female patients were more likely to have longer LOS
Gender	Mensah et al. 2005	Males and females differences may lead to LOS difference for different diseases
Gender	Schulman et al. 1999	significant disparities in cardiac care procedures based on gender and other factors.

# Literature Review

Type	Source	Finding
Socioeconomic	Philbin et al., 2000	Low income patients are predictors of lower rates of invasive cardiac procedures use
Socioeconomic	Gornick, 2003	Medicare utilization data show that Medicare beneficiaries' income or education levels are positively associated with rates of surgical procedures and use of preventive services
Socioeconomic	Benzeval, 1994	socio-economic factors have some influence on hospital utilization.

# Literature Review

## Hospital factors

- Hospitals are more or less different in their mission, policies, finances (Brooks et al., 2001; Meurer et al., 1998)
- Different hospitals have different levels of performance in different examined areas. The way health care systems are organized and operated can contribute to these differences (Smedley & Nelson, 2002)

# Literature Review

Type	Source	Finding
Hospital Region	AHRQ, 2005	In northeastern United States, hospitals LOS tend to be longer
Hospital Region	Wennberg & Cooper, 1999	Dartmouth researchers observed that there are substantial utilization and outcomes variations in health care by region
Hospital Region	Saleh et al. 2005	Examined geographic variations in AMI practice patterns and treatment outcomes across 11 states, and found that large differences in practice patterns and treatment outcomes may exist state by state

# Literature Review

Type	Source	Finding
Hospital Teaching	Yuan et al, 2000	Teaching hospitals had an overall better performance; However, patients at teaching hospitals had relatively longer LOS
Hospital Size	Leape, et al., 1999	Rates of revascularization were significantly lower among hospitals that did not provide the procedure services
Hospital Region	Jha, 2005	Characteristics associated with significant increases in procedures included being an academic hospital, being in the Northeast or Midwest
Hospital Teaching	Cox et al, 1994	Teaching hospitals may provide care that is of higher quality but more costly when compared with nonteaching hospitals.
Hospital Size	Kuhn, 1991	A higher number of beds, a higher proportion of nurses teaching Hospitals had more procedure rates and lower problems rates
Hospital Factors	Dowell ( 2004), Barnato et al (2005), Havranek, ( 2004), Wright et al (1997), Yedidia, (1994), Whittle et al ( 1998), Rissanen et al, ( 1996). Meurer et al, ( 1998), Woolhandler & Himmelstein, (1997), Reed et al (2001), Mechanic et al (1998), Every et al (1996).	

# Literature Review Summary

- Female patients, White patients, Medicare patients, and patients with better socioeconomic status comparatively have higher hospital utilization.
- Urban hospitals, teaching hospitals, large hospitals, hospitals from northeast region may lead to more patient hospital utilization.

# Research Questions

## General Question:

- How different AMI patient characteristics are related to their hospital utilization?
- How hospital characteristics influence AMI patients' hospital utilization?

# Hypotheses

## 1. Patient level characteristics are associated with AMI patient hospital utilization.

- 1.1 Female patients, rather than male patients, have more NOP or longer LOS.
- 1.2 White patients, rather than African American patients, have more NOP or longer LOS.
- 1.3 Patients with public insurance status of Medicare, compared with patients with no insurance, have more NOP or longer LOS.
- 1.4 Patients admitted to hospitals as emergency or urgent admission type, compared with patients admitted to hospitals as elective admission type, have more NOP or longer LOS.
- 1.5 Patients from higher income areas, compared with patients from lower income areas, have more NOP or longer LOS.



# Hypotheses

## 2. Hospital characteristics are associated with patient hospital utilization.

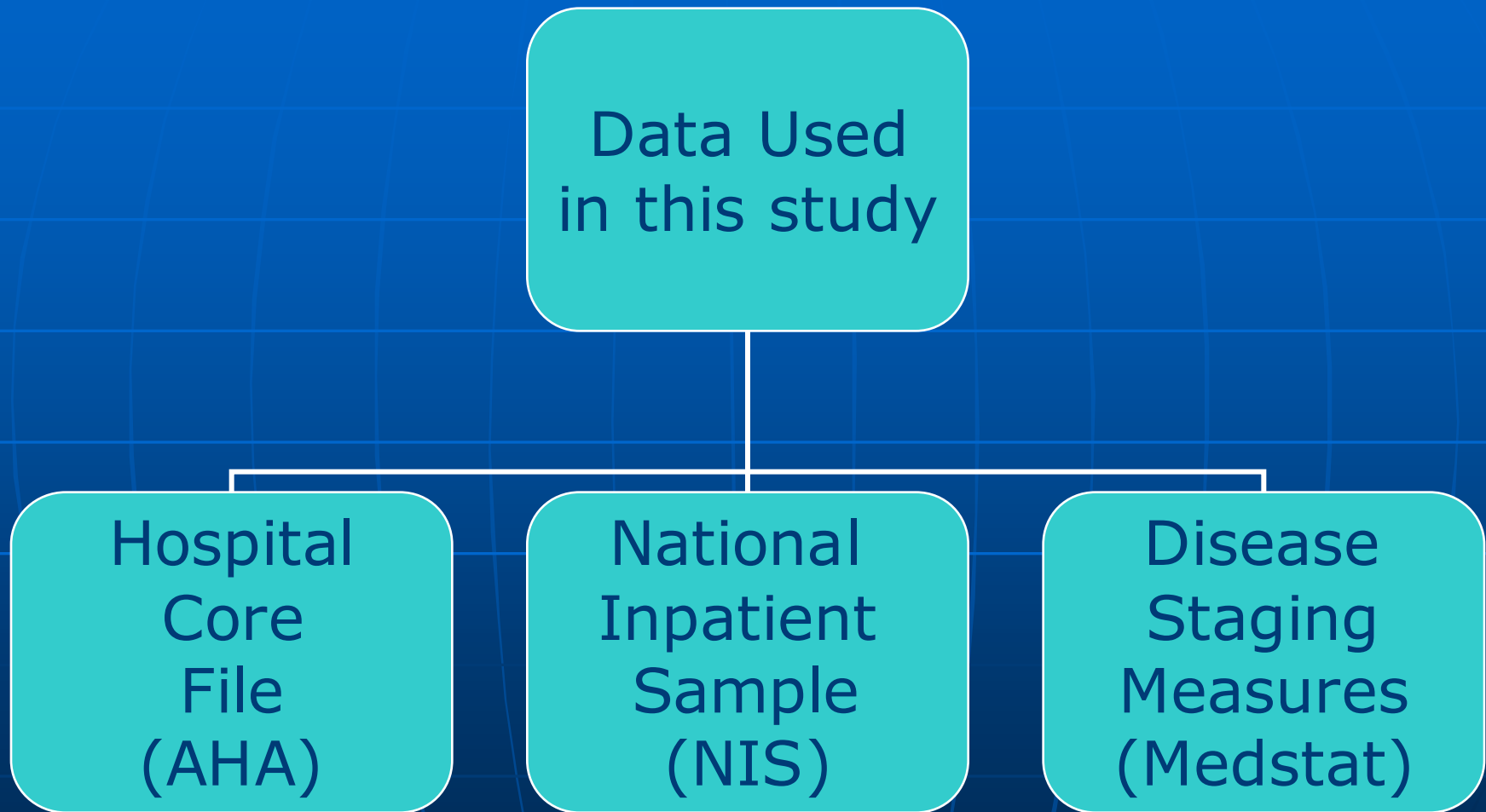
- 2.1 Urban hospitals, rather than rural hospitals, lead to more NOP or longer LOS for patients.
- 2.2 Teaching hospitals, rather than non-teaching hospitals, lead to more NOP or longer LOS for patients.
- 2.3 Hospitals from northeast region, rather than hospitals from other regions, lead to more NOP or longer LOS for patients.
- 2.4 Large hospitals, rather than medium or small hospitals, lead to more NOP or longer LOS for patients.
- 2.5 Hospitals with higher percentage of Medicaid patients, compared with hospitals with lower percentage of Medicaid patients, lead to more patient NOP or longer LOS.

# METHODOLOGY

## Data Sources

- Data Source: HCUP—Nationwide Inpatient Sample (NIS) 2003
- Largest all-payer inpatient care database: 8 million hospital stays, 994 hospitals
- Only national hospital database with information on all patients, regardless of payer, including Medicare, Medicaid, private and uninsured

# Methodology



# Methodology

## Study Cases

- Hospitalized with a primary diagnosis of AMI from the Health Care Cost and Utilization Project NIS database for the year 2003(ICD-9-CM code 410)
- Age 21 and older
- Death cases were included and excluded in the study
- Extreme outliers were excluded. Extreme cases are 3 times the inter-quartile range above quartile 3 in the sample.
- The study examined a sample of 154, 657 AMI patients from 927 hospitals

# Methodology

D.V. : NOP and LOS (Logarithmic transformation of LOS)

I.V. :

## Patient:

- Age
- Gender
- Race
- Insurance Status
- Area Income Status
- Disease Stage
- Admission Type

## Hospital:

- Size
- Teaching Status
- Location
- Region
- Type

# Data Analysis and Rationale

- Traditional regression analysis is less useful in analyzing these complex relationships in this data since it cannot separate out the independent influence of variables
- The assumption is violated if some of the observed patients are from the same hospital. (Raudenbush & Bryk, 2002)
- To appropriately model patient level and hospital level covariates simultaneously, a two level hierarchical model was developed

# Methodology

## *Unconditional Means Model*

- $LOS/NOP = \beta_{0j} + r_{ij}$       $r_{ij} \sim N(0, \sigma^2)$
- $\beta_{0j} = \gamma_{00} + \mu_{0j}$       $\mu_{0j} \sim N(0, \tau_{00}),$
- The mixed model:  
 $LOS/NOP = \gamma_{00} + \mu_{0j} + r_{ij}$   
where  $\mu_{0j} \sim N(0, \tau_{00}),$       $r_{ij} \sim N(0, \sigma^2).$
- $\rho = \tau_{00}/(\sigma^2 + \tau_{00})$

# Methodology

## *Random Intercept Model*

- $LOS_{ij}/NOP_{ij} = \beta_{0j} + \beta_{1j}(AGE) + \beta_{2j}(FEMALE) + \beta_{3j}(African\ American) + \beta_{4j}(HISPANIC) + \beta_{5j}(OTHERRACE) + \beta_{6j}(MEDICAID) + \beta_{7j}(PRIVATE) + \beta_{8j}(SELPAY) + \beta_{9j}(OTHERPAY) + \beta_{10j}(EMERGENCY) + \beta_{11j}(URGENT) + \beta_{12j}(ZIPINCOME1) + \beta_{13j}(ZIPINCOME2) + \beta_{14j}(ZIPINCOME3) + \beta_{15j}(DSTAGE2) + \beta_{16j}(DSTAGE3) + \beta_{17j}(DSTAGE4) + r_{ij}$ .
- where  $r_{ij} \sim N(0, \sigma^2)$
- The coefficients in above equation  $\beta_{1j}$  to  $\beta_{17j}$  are specified as fixed in the hospital level model.
- $\beta_{0j} = \gamma_{00} + \mu_{0j}$  where  $\mu_{0j} \sim N(0, \tau_{00})$
- $\beta_{1j} = \gamma_{10}$
- $\beta_{2j} = \gamma_{20}$
- $\beta_{3j} = \gamma_{30}$
- .....
- $\beta_{17j} = \gamma_{170}$



# Methodology

## *Intercepts as Outcomes Model*

- $\text{LOGLOS}_{ij}/\text{NOP}_{ij} = \beta_{0j} + \beta_{1j}(\text{AGE}) + \beta_{2j}(\text{FEMALE}) + \beta_{3j}(\text{African American}) + \beta_{4j}(\text{HISPANIC}) + \beta_{5j}(\text{OTHERRACE}) + \beta_{6j}(\text{MEDICAID}) + \beta_{7j}(\text{PRIVATE}) + \beta_{8j}(\text{SELPAY}) + \beta_{9j}(\text{OTHERPAY}) + \beta_{10j}(\text{EMERGENCY}) + \beta_{11j}(\text{URGENT}) + \beta_{12j}(\text{ZIPINCOME1}) + \beta_{13j}(\text{ZIPINCOME2}) + \beta_{14j}(\text{ZIPINCOME3}) + \beta_{15j}(\text{DSTAGE2}) + \beta_{16j}(\text{DSTAGE3}) + \beta_{17j}(\text{DSTAGE4}) + r_{ij}$ , where  $r_{ij} \sim N(0, \sigma^2)$ .
- The coefficients in above equation  $\beta_{0j}$  to  $\beta_{17j}$  are specified as fixed in the hospital level model.
- $\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{MEDICAID}\%) + \gamma_{02}(\text{MEDIUM}) + \gamma_{03}(\text{LARGE}) + \gamma_{04}(\text{MIDWEST}) + \gamma_{05}(\text{SOUTH}) + \gamma_{06}(\text{WEST}) + \gamma_{07}(\text{RURAL}) + \gamma_{08}(\text{URBANTEACHING}) + \mu_{0j}$  where  $\mu_{0j} \sim N(0, \tau_{00})$
- $\beta_{1j} = \gamma_{10}$
- $\beta_{2j} = \gamma_{20}$
- $\beta_{3j} = \gamma_{30}$
- .....
- $\beta_{17j} = \gamma_{170}$

# Results

## Descriptive statistics of NOP for patient variables in AMI patients including death cases

Variables	Frequency (Percent)	Mean NOP (standard Deviation)
<45	8899(5.75)	4.08(2.32)
45-54	22414(14.49)	4.24(2.43)
55-64	31256(20.21)	4.15(2.56)
65-74	33875(21.90)	3.78(2.75)
75-84	37773(24.42)	3.05(2.81)
>84	20440(13.22)	1.54(2.24)
Male*	91503(59.18)	3.77(2.69)
Female	63111(40.82)	3.03(2.74)
Whites*	87810(78.09)	3.41(2.78)
African Americans	9892(8.80)	3.39(2.67)
Hispanics	9338(8.30)	3.25(2.81)
Others	5401(4.80)	3.74(3.04)
Medicare*	91436(59.22)	3.01(2.79)
Medicaid	7705(4.99)	3.80(2.63)
Private	44496(28.82)	4.23(2.49)
Self-pay	6562(4.25)	3.92(2.48)
Other	4200(2.72)	3.94(2.55)

## Descriptive statistics of NOP for hospital variables in AMI patients including death cases

Variables	Frequency (Percent)	Mean NOP (standard deviation)
Urban non-teaching*	68328(44.20)	3.25(2.72)
Urban Teaching	66011(42.70)	4.19(2.56)
Rural	20236(13.09)	1.85(2.50)
Small*	16062(10.39)	2.28(2.54)
Medium	38827(25.12)	2.93(2.67)
Large	99686(64.49)	3.86(2.70)
Northeast*	32159(20.79)	3.22(2.72)
Midwest	34770(22.48)	3.72(2.87)
South	3329(40.95)	3.41(2.55)
West	24399(15.78)	3.53(2.97)
Medicaid <10%*	48214(31.17)	3.57(2.73)
10%-20%	64548(41.74)	3.50(2.71)
20%-30%	28212(18.24)	3.48(2.82)
>30%	13683(8.85)	2.88(2.62)
Total	154657(100)	3.47(2.74)

Note: Frequency values do not always add up to total cases due to missing values.

\* Used as reference category when dummy variables were created.

## NOP analysis in AMI with Death Cases: Fixed Effect of Random-Intercept Model

Fixed Effect	Coefficient	t Ratio	p-value
Age, $\gamma_{10}$	-0.036	-27.157	<0.001*
Female, $\gamma_{20}$	-0.203	-15.054	<0.001*
African Americans, $\gamma_{30}$	-0.242	-6.885	<0.001*
Hispanics, $\gamma_{40}$	-0.019	-0.462	0.644
Other race, $\gamma_{50}$	0.142	3.845	<0.001*
Medicaid pay, $\gamma_{60}$	-0.171	-5.271	<0.001*
Private insurance, $\gamma_{70}$	0.051	2.471	0.014†
Self pay, $\gamma_{80}$	-0.187	-3.909	<0.001*
Other pay, $\gamma_{90}$	-0.053	-1.248	0.212
Emergency, $\gamma_{100}$	-0.362	-6.797	<0.001*
Urgent, $\gamma_{110}$	-0.005	-0.109	0.914

## NOP analysis in AMI with Death Cases: Fixed Effect of Intercept as Outcome Model1

	Coefficient	t Ratio	p-value
Fixed Effect			
Hospital Mean, $\gamma_{00}$	4.069	17.296	<0.001*
Medicaid %, $\gamma_{01}$	0.000	1.811	0.070
Medium size, $\gamma_{02}$	0.361	3.651	<0.001*
Large size, $\gamma_{03}$	1.314	11.916	<0.001*
Midwest, $\gamma_{04}$	-0.026	-0.161	0.872
South, $\gamma_{05}$	-0.052	-0.337	0.736
West, $\gamma_{06}$	-0.107	-0.579	0.562
Rural, $\gamma_{07}$	-1.302	-13.575	<0.001*
Urban teaching, $\gamma_{08}$	1.210	8.691	<0.001*

# LOS analysis in CABG with Death Cases: Fixed Effect of Random-Intercept Model

Fixed Effect	Coefficient	t Ratio	p-value
Age, $\gamma_{10}$	0.007	14.682	<0.001*
Female, $\gamma_{20}$	0.079	8.016	<0.001*
African Americans, $\gamma_{30}$	0.071	3.834	<0.001*
Hispanics, $\gamma_{40}$	0.044	2.545	0.011†
Other race, $\gamma_{50}$	0.042	1.985	0.047†
Medicaid pay, $\gamma_{60}$	0.029	1.720	0.085
Private insurance, $\gamma_{70}$	-0.084	-7.570	<0.001*
Self pay, $\gamma_{80}$	-0.094	-4.943	<0.001*
Other pay, $\gamma_{90}$	-0.051	-2.327	0.020†
Emergency, $\gamma_{100}$	0.088	6.712	<0.001*
Urgent, $\gamma_{110}$	0.027	1.964	0.049†

## LOS analysis in CABG with Death Cases: Fixed Effect of Intercept as Outcome Model

Fixed Effect	Coefficient	t Ratio	p-value
Hospital Mean, $\gamma_{00}$	1.784	26.267	<0.001*
Medicaid %, $\gamma_{01}$	0.001	0.345	0.730
Medium size, $\gamma_{02}$	-0.021	-0.446	0.656
Large size, $\gamma_{03}$	0.028	0.623	0.534
Midwest, $\gamma_{04}$	-0.091	-3.015	0.003*
South, $\gamma_{05}$	-0.072	-2.554	0.012†
West, $\gamma_{06}$	-0.059	-1.657	0.098
Rural, $\gamma_{07}$	0.010	0.284	0.777
Urban teaching, $\gamma_{08}$	0.042	2.138	0.033†



## LOS analysis in PTCA with Death Cases: Fixed Effect of Random-Intercept Model

Fixed Effect	Coefficient	t Ratio	p-value
Age, $\gamma_{10}$	0.006	19.141	<0.001*
Female, $\gamma_{20}$	0.076	12.745	<0.001*
African Americans, $\gamma_{30}$	0.063	4.291	<0.001*
Hispanics, $\gamma_{40}$	0.048	2.711	0.007*
Other race, $\gamma_{50}$	0.045	2.330	0.020†
Medicaid pay, $\gamma_{60}$	-0.004	-0.211	0.833
Private insurance, $\gamma_{70}$	-0.082	-10.822	<0.001*
Self pay, $\gamma_{80}$	-0.093	-7.724	<0.001*
Other pay, $\gamma_{90}$	-0.062	-3.222	0.002*
Emergency, $\gamma_{100}$	0.196	9.811	<0.001*
Urgent, $\gamma_{110}$	0.067	3.419	0.001*

## LOS analysis in PTCA with Death Cases: Fixed Effect of Intercept as Outcome Model

Fixed Effect	Coefficient	t Ratio	p-value
Hospital Mean, $\gamma_{00}$	0.980	16.714	<0.001*
Medicaid %, $\gamma_{01}$	0.001	2.049	0.041†
Medium size, $\gamma_{02}$	0.001	0.028	0.978
Large size, $\gamma_{03}$	0.019	0.441	0.659
Midwest, $\gamma_{04}$	0.049	1.470	0.143
South, $\gamma_{05}$	0.055	1.758	0.079
West, $\gamma_{06}$	0.026	0.669	0.504
Rural, $\gamma_{07}$	-0.038	-1.081	0.281
Urban teaching, $\gamma_{08}$	-0.011	-0.511	0.609

# Summary of Patient Level Hypotheses Test Results

Hypothesis	NOP		CABG LOS		PTCA LOS	
	Inc.D.	Exc.D.	Inc.D.	Exc.D.	Inc.D.	Exc.D.
1.1 Gender	×	×	✓	✓	✓	✓
1.2 Race	✓	✓	×	×	×	×
1.3 Insurance	✓	✓	✓	✓	✓	✓
1.4 Admission	×	×	✓	✓	✓	✓
1.5 Area Ave.income	×	×	×	×	×	×

Inc.D. Including Death Cases.

Exc.D. Excluding Death Cases

# Summary of Hospital Level Hypotheses Test Results

Hypothesis	NOP		CABG LOS		PTCA LOS	
	Inc.D.	Exc.D.	Inc.D.	Exc.D.	Inc.D.	Exc.D.
2.1 Location	✓	✓	✓	✓	×	×
2.2 Teaching	✓	✓	✓	✓	✓	×
2.3 Region	×	×	✓	✓	×	✓
2.4 Size	✓	✓	×	✓	×	×
2.5 Medicaid %	×	×	×	✓	×	×

Inc.D. Including Death Cases.    Exc.D. Excluding Death Cases

# Discussion

- The research indicated that patients with no health insurance tended to have shorter LOS and received fewer NOP.
- African American patients tended to receive fewer NOP compared with white patients.
- A reverse racial disparity found in this research indicated that minority patients rather than white patients tended to have longer LOS in all procedures examined.
- Five hospital factors were also found to be related to LOS in different procedures examined. In general, patients in urban hospitals, teaching hospitals, large hospitals, hospitals from northeast states, hospitals with higher percentages of Medicaid patients have longer LOS compared with others.

# Discussion

## Limitations

- NIS is administrative data
- Data is limited also by the extent of measured variables Patients
- hospitalized more than once a year may be recorded in the NIS multiple times
- Missing values on the race variable

# Summary

- Significant associations were found specifically on different groups of patients and procedures examined.
- Including or excluding death cases may lead to small different conclusions. Complex reasons need to be further examined.
- The findings indicated that health care utilization disparities existed in hospitalized patients.
- In general, the validity of the findings was enhanced by the large nationally representative sample of AMI patients treated at all kinds of hospitals.