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Hospital Variation In Performance For Acute Myocardial Infarction With The Ncdr Action Registry-Gwtg "all-Or-None" Composite Measure

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ABSTRACT

Background: While mortality rates for cardiovascular disease have declined, many patients still fail to receive effective and timely care. Studies report that characteristics including census region of the United States (Midwest, West, Northeast and South), neighborhood classification (urban, rural, suburban), and teaching status are all associated with the quality of care provided. It has been reported that national quality improvement campaigns have been shown improve the quality of AMI care for these patients and increase compliance to guideline recommended treatment. Use of defect-free composite measures is increasing as they promote full execution of all processes of care, encourage a focus on the whole sequence of care instead of individual components, and offer a more sensitive scale to judge improvement in situations of already high compliance. The aforementioned hospital characteristics have not been analyzed using this defect-free composite measure as the outcome. This study aims to evaluate the degree to which hospital performance varied on the "all-or-none" composite measure and to identify hospital characteristics that were predictive of higher rates of defect-free care.

Methods: Using data from the National Cardiovascular Data Registry (NCDR) – Acute Coronary Treatment and Intervention Outcomes Network (ACTION) – Get With the Guidelines (AR-G) [NCDR AR-G] a total of 791,354 patients and 1,332 hospitals were analyzed. The "all-or-none" defect-free composite consisting of 11 ACC/AHA recommended guidelines was the primary outcome. The association between defect-free care and the hospital characteristics of interest was determined by multivariate logistic regression.

Results: Hospitals located in the Midwest and Northeast regions of the US were more likely to provide defect-free care (OR [95% CI]: 1.79 [1.73, 1.86] and 1.13 [1.07, 1.20], respectively) than hospitals in the South; while hospitals located in rural or suburban areas were less likely (OR [95% CI]: 0.83 [0.80, 0.87] and 0.95 [0.92, 0.98]) to provide defect-free care than hospitals in urban areas. In addition, teaching hospitals are less likely to provide defect-free care (OR [95% CI]: 0.96 [0.93, 0.99]) than hospitals that are non-teaching. Hospitals in all categories demonstrated positive trends in compliance throughout the study period.

Conclusions: In order to move from already high rates of compliance to full compliance, it must be recognized that hospital level variations in care still exist. This continued variation in care by hospital characteristics suggests that the institutions within each category face unique challenges. Studies are needed to identify these challenges and propose potential solutions.

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BACKGROUND

Cardiovascular disease remains the leading cause of mortality in the US. While mortality rates have declined, many patients still fail to receive effective and timely care [1]. National quality improvement campaigns have been implemented in an effort to improve care for individuals with the disease and to reduce morbidity and mortality [2]. These quality improvement campaigns utilize evidence based performance indicators, including process of care measures, to reflect the quality of care at each institution [3]. Quality of care is assessed based upon performance on the recommendations individually, or by performance on composite measures [4].

The defect-free composite outcome is an "all-or-none" summary measure. The measure contains the aforementioned treatment recommendations for AMI care such as pharmacotherapy, timely reperfusion and referral to cardiac rehabilitation programs [5]. This measure presents information different from that of an item-by-item approach as it describes overall quality of care and adherence to guidelines and promotes a high standard of excellence [4-5]. The use of the defect-free composite measure is increasing because it promotes full execution of all processes of care, encourages a focus on the whole sequence of care instead of individual components, and offers a more sensitive scale to judge improvement in situations of already high compliance [4]. Additionally, studies have found an inverse association between composite compliance and in hospital mortality [3,7].

Studies report that characteristics including census region of the United States (Midwest, West, Northeast and South), neighborhood classification (urban, rural, suburban), and teaching status are all associated with quality of care provided, with higher compliance to guideline recommended care in the northeast, urban hospitals and teaching hospitals [8-13]. Previous studies have identified that the campaigns have been shown to improve the quality of care for patients with coronary artery disease (CAD) [14-15] and investigators have reported positive trends in adherence to individual process of care measures [16]. However, the aforementioned hospital characteristics have not been analyzed using the defect-free composite measure as the outcome.

Therefore, using data from the National Cardiovascular Data Registry (NCDR) – Acute Coronary Treatment and Intervention Outcomes Network (ACTION) – Get With the Guidelines (AR-G) [NCDR AR-G], this study examines the association between teaching status, census region of the US and

neighborhood classification of hospitals and use of defect-free care in order to evaluate the degree to which hospital performance varied on the "all-or-none" composite measure and to identify hospital characteristics that were predictive of higher rates of defect-free care.

METHODS

NCDR ACTION Registry Get With the Guidelines (NCDR AR-G)

NCDR ACTION Registry Get With the Guidelines Program was launched in 2007 through a merger of the American College of Cardiology's (ACC) ACTION with the National Registry of Myocardial Infarction and Can Rapid risk stratification of Unstable angina patients Suppress ADverse outcomes with Early (CRUSADE) of the ACC/American Heart Association (AHA). A year later the registry again merged with the AHA's GWTG-Coronary Artery Disease Program [17]. The final registry represents a unified effort to assess the characteristics and outcomes of patients with AMI and utilize evidence based treatment methods to improve national acute myocardial infarction care and improve patient outcomes [5].

The methods of the NCDR AR-G have been described previously [5]. Briefly, all data elements are abstracted via chart review of participating hospitals and submitted via a secure, password-protected, web based server programmed to optimize data quality at the time of entry. The collected data elements were selected by the AR-G Steering Committee and chosen to maximize quality improvement efforts. They are composed of the core set of ACC/AHA Performance Measures and Class I Recommendations of the ACC/AHA clinical practice guidelines [18]. These two sets of practice guidelines are used as definitions of performance and quality metrics and are presented in quarterly benchmarked reports to participating hospitals [17]. In addition to performance measures and clinical practice guidelines, patient demographics, presenting features, prehospital therapy, in-hospital therapy, hospital discharge therapy, timing of care delivery, laboratory tests, procedures, and patient outcomes are collected [5]. The ACC/AHA Performance Measures, as well as examples of additional ACTION AR-G data elements are presented in Tables 1 and 2 in the Appendix. Data elements are abstracted by trained personnel via chart review and entered into a secure, password-protected, web-based, server system [5].

The AR-G includes patients with a primary diagnosed of STEMI or NSTEMI as defined by (1) ischemic symptoms at rest, lasting ≥ 10 minutes, occurring within 24 hours before admission or up to 72 hours for STEMI; (2) ECG changes associated with STEMI (new left bundle-branch block [LBBB] or persistent ST segment elevation ≥ 1 mm in 2 or more contiguous electrocardiographic leads); or (3) positive cardiac

markers associated with NSTEMI (CK-MB or Troponin I/T > local laboratory upper limit of normal values) within 24 hours after initial presentation. Transfer patients meeting these criteria must arrive at the participating hospital within 72 hours of the time of initial presentation to the outside hospital. Patients are ineligible for the AR-G if ischemic symptoms are developed during the hospital stay, but originally presented with symptoms unrelated to STEMI or NSTEMI. Cases are identified retrospectively through chart review [5].

Exclusion Criteria

This analysis includes all eligible adults (age ≥ 18) cared for at hospitals in the registry between January 1, 2010 and December 31, 2014. Since previous research has shown that participation in GWTG is independently associated with improvements in guideline adherence, the study cohort was further limited to hospitals that continuously participated in the registry during the study period [19]. Continuous participation was defined as a minimum of 50 cases per year during the study period to ensure adequate sample size to estimate hospital performance. The institutional review board for the AR-G Analytic Center located at the Duke Clinical Research Institute approved use of this data.

"All-or-None" Defect-Free Composite Measure

An evidence based composite quality measure was used to describe quality of care by hospital characteristics. This composite score is composed of the following for the STEMI population: (1) Aspirin at Arrival, (2) Aspirin prescribed at Discharge, (3) Beta-Blocker Prescribed at Discharge, (4) Statin Prescribed at Discharge, (5) Evaluation of LV Systolic Function, (6) ACEI or ARB for LVSD at Discharge, (7) Time to Fibrinolytic Therapy, (8) Time to Primary PCI, (9) Reperfusion Therapy, (10) Adult Smoking Cessation Advice Counseling, and (11) Cardiac Rehabilitation Patient Referral From an Inpatient Setting; and for the NSTEMI population: (1) Aspirin at Arrival, (2) Aspirin prescribed at Discharge, (3) Beta-Blocker Prescribed at Discharge, (4) Statin Prescribed at Discharge, (5) Evaluation of LV Systolic Function, (6) ACEI or ARB for LVSD at Discharge, (7) Adult Smoking Cessation Advice Counseling, and (8) Cardiac Rehabilitation Patient Referral From an Inpatient Setting. A list of the aforementioned performance indicators and their definitions is presented in Table 3 of the Appendix. The defect-free care measure was achieved if the patient received all interventions in which they were eligible.

Statistical Analysis

The association between defect-free care and the hospital characteristics of interest: census region of the United States, neighborhood classification, and teaching status was determined by logistic regression. The census region variable was characterized as either Northeast, Midwest, South or West, according to the US Census Bureau definition (Northeast included Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York and Pennsylvania; Midwest included Indiana, Illinois, Michigan, Ohio, Wisconsin, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota; South included Delaware, District of Colombia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Oklahoma and Texas; West included Arizona, Colorado, Idaho, New Mexico, Montana, Utah, Nevada, Wyoming, Alaska, California, Hawaii, Oregon and Washington). Neighborhood classification was determined by location of the hospital and defined as being in either a rural, urban or suburban community. Teaching status was determined by the hospital's academic status.

An unadjusted, bivariate model was run for each characteristic independently. A multivariate logistic regression was then performed. This model included all aforementioned characteristics along with additional patient and hospital characteristics that were identified as significant through prior literature review. The patient-level covariates included in each model were age, sex, race, cocaine use, presenting heart rate, initial ECG findings, troponin ratio and creatinine clearance upon presentation, smoking status, previous diagnosis of lung disease, diabetes, coronary artery disease, heart failure and atrial fibrillation, as well as prior percutaneous coronary intervention or coronary artery bypass grafting. Age was divided into 4 categories: age < 55, 55-64, 65-74, >= 75; race was defined as white, black, Hispanic or other, and initial ECG findings were either ST elevation, left bundle branch block (LBBB), or isolated posterior MI. Troponin ration was calculated as the initial troponin value (upon presentation) over the initial troponin URL, while creatinine clearance was calculated using the following formula: *(140-age)*weight*(0.85 for female or 1 for male)/(72*(initial Creatinine Value))*. Coronary artery disease was defined as prior incidence of MI, PCI, or CABG.

Additional hospital characteristics of interest include bed size, hospital type (government, community, or university), annual number of cardiac catheterizations, annual number of percutaneous coronary interventions, public/private classification, and percentage of the hospital's patient volume covered by Medicare. Bed size, annual number of cardiac caths, annual number of PCIs, and percentage of Medicare patients were divided into quartiles. The quartile divisions are as follows: bed size:

Q1=0-258, Q2=259-389, Q3=390-572, Q4=573-2,000; annual number of cardiac caths: Q1=0-850, Q2=851-1,499; Q3=1,500-2,562; Q4=2,563-13,500; annual number of PCIs: Q1=0-357, Q2=358-675, Q3=676-1,129, Q4=1,130-4,722; and finally percentage of Medicare patients: Q1=0-42%, Q2=43-52%, Q3=53-60%, Q4=61-100%. Descriptive statistics for variables in the multivariate model can be found in Tables 4 and 5 in the appendix. All p-values were compared to a two-sided alpha level of 0.05.

The analyses for Tables 1 consisted of calculating frequencies for categorical variables and the median and interquartile range for continuous variables, stratified by hospital characteristic. The analysis for Table 2 consisted of calculating the median and interquartile range for the defect-free care variable, stratified by year.

Data was analyzed using SAS version 9.3.

RESULTS

A total of 791,354 patients were admitted to 1,332 hospitals during the study period. After excluding cases that did not meet the quality check (n=136,811 patients; 494 hospitals), non-adults (n=144 patients; 5 hospitals), cases outside the study period (n=134,279 patients; 80 hospitals), hospitals with less than 50 cases per year throughout study period (n=157,295 patients, 458 hospitals) and patients not eligible for defect-free care (n=41,996 patients, 25 hospitals) the final cohort contained 320,829 individuals and 270 hospitals. Key characteristics and patient demographics within each hospital category are presented in Table 1.

Number of individuals varied by region of the US, with the highest representation from the South with 191,271 individuals, followed by 105,724 individuals from the Midwest, 44,787 individuals from the West and 25,672 individuals from the South. The median age between the regions are similar (63-65 years); however, the regions vary by sex and race. The Northeast had the highest representation of females (36.95%), followed by the Midwest (34.79%) and the South (34.41%), and finally the West (32.27%). The West had the highest percentage of Hispanics (9.55%), followed by the South (4.64%), then the Northeast (3.81%) and the Midwest (2.84). Distribution of whites also varied by US region. The population from Northeast was composed of 90.32% white individuals, followed by the Midwest and the West with 89.57% and 89.31% white individuals, respectively, and lastly the South with 80.38% white individuals. The highest percent of black individuals was found in the South (16.94 %), followed by the Midwest (8.24%), the Northeast (6.85), and the West (3.66), while 5.29% of the West, 2.26% of the Northeast, 2.11% of the South and 1.86% of the Midwest are composed of individuals of other

ethnicities. Among the study cohort 39.72% of individuals from the West presented with STEMI, followed by 39.40% in the South, 37.86% in the Northeast and 36.52% in the Midwest. The South had the highest rates of smokers (36.77%) followed by the Midwest (35.94%), the Northeast (30.25%) and the West (29.73%).

Number of patients again varied by community location; 212,246 individuals were from an urban hospital, 51,292 were from a rural hospital, and 103,916 were from a suburban hospital. Median age was similar between community locations (63-64 years) as was percent female (approx. 34%). However, like region of the US, race varied across types of communities. Urban hospitals had the highest percentage of Hispanic individuals (5.02%), followed by suburban hospitals (4.98%), then rural hospitals (2.51%). The highest percentage of whites was found at rural hospitals (89.55%), followed by suburban hospitals (85.02%), then urban hospitals (83.56%). Urban hospitals were composed of 13.61% blacks, while the suburban and rural hospitals were composed of 10.84% and 8.51%, respectively. Other ethnicities had the highest representation in suburban hospitals (3.41%), followed by urban hospitals (2.13%), and finally rural hospitals (1.73%). Smoking status varied slightly between community locations. Rural hospitals were composed of 37.75% smokers, followed by 36.64% in urban hospitals, and 31.06% in suburban hospitals.

Among patients in the cohort, 176,945 were treated at a teaching hospital and 190,479 were treated at a non-teaching hospital. Proportion of females was similar between hospital types (approximately 34%); median age was also similar (63-64 years). Race varied with non-teaching hospitals having 87.14% whites as opposed to 82.64% in teaching hospitals. Teaching hospitals had a higher percentage of blacks (14.42%) but a lower percentage of Hispanics (3.97%) as compared to non-teaching hospitals (9.63% and 5.41%, respectively). Percentage of other ethnicity was similar (approximately 2%).

Clinical presentation and risk factors were similar within all characteristics. Heart rate ranged from 80-82 bpm and BMI ranged from 28.4 to 29. Hypertension was present in approximately 70-75% of individuals; diabetes was present in approximately 30-34% of individuals. Approximately 32-38% had a history of coronary artery disease, 21-25% had a history of MI, 10-12% had a history of cerebrovascular disease, 10-12% had a history of heart failure and 6-8% had a history of stroke. Approximately 21-25% had undergone a previous PCI and 11-14% had undergone a previous CABG.

Table 1: Selected Patient Characteristics by Hospital Characteristic

	Region of the US				Community Location			Teaching Status	
Description	**Midwest**	**West**	**Northeast**	**South**	**Urban**	**Rural**	**Suburban**	**Teaching**	**Non-Teaching**
Total Patients:	105724	44787	25672	191271	212246	51292	103916	176975	190479
Demographics									
Age (y):	64.00 (55.00, 75.00)	65.00 (56.00, 75.00)	65.00 (55.00, 77.00)	63.00 (54.00, 73.00)	63.00 (54.00, 74.00)	64.00 (54.00, 74.00)	64.00 (55.00, 75.00)	64.00 (55.00, 74.00)	63.00 (54.00, 74.00)
Female	34.79	32.27	36.95	34.41	34.12	34.51	34.91	34.32	34.48
Race									
Hispanic	2.84	9.55	3.81	4.64	5.02	2.51	4.98	3.97	5.41
White non-hispanic	89.57	89.31	90.32	80.38	83.56	89.55	85.02	82.64	87.14
Black non-Hispanic	8.24	3.66	6.85	16.94	13.61	8.51	10.84	14.42	9.63
Other	1.86	5.29	2.26	2.11	2.13	1.73	3.41	2.27	2.62
Clinical features on presentation									
Heart Rate (beat/min)	82.00 (69.00, 97.00)	80.00 (68.00, 95.00)	82.00 (70.00, 97.00)	82.00 (69.00, 97.00)	81.00 (69.00, 96.00)	82.00 (69.00, 97.00)	82.00 (69.00, 97.00)	82.00 (69.00, 97.00)	82.00 (69.00, 96.00)
STEMI	36.52	39.72	37.86	39.4	39.91	35.86	36.94	38.17	38.86
History and Risk Factors									
BMI	29.00 (25.50, 33.40)	28.10 (24.80, 32.20)	28.40 (25.10, 36.20)	28.50 (25.10, 32.80)	28.70 (25.10, 33.00)	28.70 (25.20, 33.00)	28.40 (25.10, 32.70)	28.50 (25.10, 32.90)	28.7 (25.10, 32.90)
Current/Recent Smoker (w/in 1 year)	35.94	29.73	30.25	36.77	36.64	37.75	31.06	35.98	34.40
Hypertension	73.35	70.27	72.87	75.41	73.94	74.93	73.72	74.83	73.14
Diabetes Mellitus	32.32	30.58	30.88	34.44	33.37	33.72	32.28	33.4	32.80
Prior CAD	36.14	32.48	32.46	37.86	36.18	38.42	35.62	36.77	35.86
Prior MI	24.18	22.59	21.49	25.81	24.95	25.83	23.45	25.55	23.68
Prior PCI	25.04	21.69	20.92	25.53	24.59	25.83	24	24.66	24.54
Prior CABG	13.63	10.93	12.59	14.06	12.99	15.29	13.47	13.6	13.29
Prior Heart Failure	11.84	9.99	9.88	12.27	11.55	12.66	11.53	12.38	10.97
Cerebrovascular Disease	12.25	10.94	10.43	12.27	12.09	12.36	11.54	12.43	11.48
Prior Stroke	7.46	6.83	6.41	8.16	7.68	7.97	7.52	7.88	7.46

*Categorical variables are presented as percentages

**Continuous variables are presentes as Median (Q1, Q3)

Table 2 presents use of the defect-free care measure among hospital groups, stratified by year. Hospitals in the Northeast had higher rates of compliance than its counterparts; however, hospitals within each region demonstrated increasing use of defect-free measure indicating increasing compliance. Teaching hospitals started at a higher rate of use of defect-free care, however this gap closed as compliance increased in both groups throughout the study period. Urban and suburban hospitals demonstrated similar rates of defect-free care throughout the study period, starting at higher levels of compliance when compared to rural hospitals. While there were positive trends among all hospitals in this category, gaps between urban/suburban and rural hospitals persist.

Table 2: Use of The Defect-Free Care Measure Among Hospital Groups

		Median (Q1, Q3)				
Description	**N**	**2010**	**2011**	**2012**	**2013**	**2014**
Total	270	67.0 (47.1, 80.6)	74.2 (56.9, 83.7)	75.8 (62.6, 85.7)	78.1 (68.0, 86.1)	79.7 (67.8, 86.6)
Region						
Northeast	16	75.4 (62.4, 84.4)	78.8 (70.0, 87.8)	81.6 (72.7, 89.2)	81.2 (73.5, 88.3)	81.3 (72.2, 88.6)
Midwest	83	56.7 (45.8, 79.6)	67.9 (46.8, 81.7)	73.0 (62.2, 81.1)	77.4 (70.4, 86.4)	82.3 (71.0, 86.3)
South	133	62.0 (40.0, 75.9)	68.8 (50.0, 82.3)	74.1 (58.0, 82.6)	76.9 (65.4, 85.1)	78.4 (66.7, 85.6)
West	38	62.2 (38.9, 80.7)	70.7 (50.0, 82.7)	73.3 (45.5, 81.9)	74.1 (54.3, 83.7)	77.7 (62.1, 85.7)
Teaching status						
No	154	66.3 (44.6, 80.1)	75.1 (56.0, 83.9)	75.8 (59.4, 85.7)	79.1 (68.0, 85.6)	80.0 (67.9, 86.6)
Yes	116	68.0 (50.3, 81.0)	70.9 (57.4, 83.2)	75.9 (67.6, 85.7)	77.2 (68.2, 86.5)	79.3 (67.4, 86.3)
Community						
Urban	147	67.9 (45.9, 81.0)	74.2 (57.9, 84.6)	75.6 (62.6, 84.9)	77.6 (67.4, 85.8)	80.0 (67.5, 85.7)
Rural	43	62.9 (51.5, 75.4)	70.5 (56.0, 83.9)	73.5 (58.3, 84.3)	77.5 (63.9, 84.4)	75.2 (63.3, 89.6)
Suburban	80	67.1 (41.3, 81.6)	75.6 (55.7, 83.5)	77.3 (65.4, 86.9)	80.3 (68.5, 87.3)	79.5 (68.9, 87.2)

The results of the logistic regression analyses are found in Table 3. In the adjusted analyses, hospitals located in the Midwest and Northeast regions of the US were more likely to provide defect-free care (OR [95% CI]: 1.79 [1.73, 1.86] and 1.13 [1.07, 1.20], respectively) than hospitals in the South; while hospitals located in rural or suburban areas were less likely (OR [95% CI]: 0.83 [0.80, 0.87] and 0.95 [0.92, 0.98]) to provide defect-free care than hospitals in urban areas. . In addition, teaching hospitals are less likely to provide defect-free care (OR [95% CI]: 0.96 [0.93, 0.99]) than hospitals that are non-teaching.

Table 3: Unajusted and Adjusted associations between defect-free care and hospital characteristics.

		UNADJUSTED LOGISTIC REGRESSION[a]				ADJUSTED LOGISTIC REGRESSION				
Characteristic	**DEFECT-FREE CARE USE** Median (Q1, Q3)	**ESTIMATE ± SE**	**ODDS RATIO**	**95% CI**		**P VALUE**	**ESTIMATE ± SE**	**ODDS RATIO**	**95% CI**		**P VALUE[a]**
Region of US:											
Midwest	65.7 (63.5, 77.4)	0.44 ± 0.01	1.55	1.53	1.58	**<.0001**	0.58 ± 0.02	1.79	1.73	1.86	**<.0001**
Northeast	78.3 (71.8, 86.4)	0.10 ± 0.02	1.11	1.07	1.14	**<.0001**	0.12 ± 0.03	1.13	1.07	1.20	**<.0001**
West	72.3 (52.5, 81.4)	-0.13 ± 0.01	0.88	0.86	0.90	**<.0001**	-0.05 ± 0.02	0.95	0.91	0.99	**0.026**
South	72.3 (56.7, 80.4)	REFERENCE	--	--		--	REFERENCE	--	--		--
Hospital Location:											
Rural	72.8 (56.8, 80.2)	-0.06 ± 0.00	0.94	0.92	0.96	**<.0001**	-0.18 ± 0.02	0.83	0.80	0.87	**<.0001**
Suburban	75.0 (61.2, 84.2)	-0.07 ± 0.01	0.94	0.92	0.95	**<.0001**	-0.05 ± 0.02	0.95	0.92	0.98	**0.001**
Urban	75.1 (59.6, 82.2)	REFERENCE	--	--		--	REFERENCE	--	--		--
Teaching Status:											
Teaching	74.4 (61.2, 81.8)	0.87 ± 0.01	1.19	1.17	1.21	**<.0001**	-0.04 ± 0.02	0.96	0.93	0.99	**0.010**
Non-Teaching	75.3 (57.9, 82.4)	REFERENCE	--	--		--	REFERENCE	--	--		--

[a]All p values are compared to a two-sided 0.05 significance level ($p<0.05$). All significant p values are bolded.

DISCUSSION

Previous work utilizing data from the National Cardiovascular Data Registry (NCDR) – Acute Coronary Treatment and Intervention Outcomes Network (ACTION) – Get With the Guidelines (AR-G) program shows improving quality of AMI care over time [14-15]. In order to focus on overall quality of care and to examine improvement in situations of already high compliance, a defect free "all-or-none" composite measure is utilized. The findings of this study suggest that each of the characteristics of interest: census region of the US, and neighborhood classification, and teaching status, are significantly associated with providing defect-free care.

These significant findings imply that while quality of care has improved since the inception of national quality improvement programs, significant variations in performance and gaps in care remain. Additionally, the use of the defect-free composite measure highlights the opportunity for improvement in both quality of care and patient outcomes, as studies have shown an inverse relationship between composite adherence and in-hospital mortality [3,7].

Results from previous studies examining the association between regional variation and quality of care are conflicting. While some have found significant regional variation [10-11], a study by Laskey and colleagues utilizing GWTG-CAD data from 2000-2008 found no significant difference in use of defect-free care by region [20]. However, since this study, the guidelines have been expanded from 6 measures to the current 11 for STEMI or 9 for NSTEMI. This suggests the possibility of undetected variation by one of the newer measures.

Studies examining urban/rural status and quality of care have also presented conflicting results. A study performed by Ambardekar and colleagues examining individuals in the GWTG-CAD program from 2000-2008 found no independent association between rural status and lower compliance to performance measures [21]. However, a study done by Baldwin and colleagues examining Medicare beneficiaries from 2000-2001 found that patients admitted to small, rural hospitals were significantly less likely to receive guideline-recommended treatment. Additionally, the study found no difference in quality of care between large rural hospitals and urban hospitals [13]. The findings of this study differ from this previous research, as it was determined that hospitals located in a rural setting are significantly less likely to provide defect-free care. In the study performed by Ambardekar et al., association was determined with each performance measure independently, and high rates of compliance were observed [21]. Thus, a potential explanation for the difference in findings is the presence of a "ceiling effect." By choosing the defect-free composite as the outcome of interest, this study was able to gain an understanding of the overall quality of care and was more sensitive to difference in adherence to guidelines that may have not been evident because of high compliance to individual measures.

The study's findings on the association between teaching hospitals and lower quality care differ from previous studies that have found an association between teaching hospitals and higher quality of care [8,12]. While the difference in findings could be a result of random variation, another explanation could be the nature of the composite outcome. It is possible that teaching hospitals perform well when considering the guidelines independently, but have lower rates of achieving the composite outcome because of its "all-or-none" nature. For example, a teaching hospital may comply with the first 10 of the composite measure components 99% of the time, but only give cardiac rehabilitation referrals 75% of the time. When measuring compliance by individual components this hospital would be considered to have a high level of compliance. However, when measuring compliance with the defect-free composite, this hospital's compliance is dependent upon providing cardiac rehabilitation referrals. Additionally, a study performed by Patel et al. that examined compliance using a composite outcome found high rates of variation among individual centers in these categories, with higher variation among non-teaching hospitals. In fact, 15 of the 20 highest performing sites and 19 of the 20 lowest performing sites were non-teaching hospitals [9].

The findings of the present study add to the evidence that variations exist by hospital characteristics. Previous studies proved that variations in care are present when considering

characteristics of the patient such as race or sex [22]. As a result, quality improvement efforts began emphasizing and targeting these gaps. Like the earlier studies, the findings of this study highlight gaps at the hospital level and indicate that these should qualities be taken into account when pursuing quality improvement. Continued variation in care by hospital characteristics suggests that the institutions within each category face unique challenges. For example, the expanded chain of command in teaching hospitals may hinder timely administration of medications. In order to take the next step and move from already high rates of compliance to full compliance, it must be recognized that hospital level variations in care still exist. Further research examining the reasons behind variations in care would be useful in determining where to focus further improvement efforts. Studies are needed to examine potential challenges in individual hospital protocols and their association with higher or lower compliance on individual performance measures. Once challenges are identified, solutions such as potential penalties, incentives, process changes, and education programs, can be proposed.

This study has several limitations. First, the ACTION Registry-GWTG registry is voluntary, and thus, participating hospitals tend to be larger, tertiary centers that may have better baseline performance. Therefore, the extent of the variation in care based upon these characteristics may be attenuated. Next, the study period for this analysis was limited to 2010-2015. Research has shown that duration of time in quality improvement programs is associated with higher rates of compliance and higher quality care [23]. Because the program began before 2010, it is possible that time in the program differed by hospital as some may have joined before the start of our study period. This also may have influenced the effects seen in the analysis. Additionally, there is a possibility that contraindications to specific elements are not captured in the medical record.

CONCLUSIONS

This study evaluated the degree to which hospital performance varied on the "all-or-none" defect-free composite measure in order to identify hospital characteristics that were predictive of higher rates of defect-free care and provide insight into successful processes of care. Overall, the analyses determined that use of defect-free care was significantly associated with the hospital's region of the US, community location (urban, rural, or suburban) and teaching status. These findings suggest that institutions within the aforementioned categories face unique challenges. Understanding the reasons for differences among hospitals in each category warrants further investigation.

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APPENDIX

Table 1: ACC/AHA STEMI/NSTEMI Performance Measures: Inpatient Measure Descriptions

Measure Name	Measure Description
Performance measures	
1. Aspirin at arrival	AMI patients who received aspirin within 24 h before or after hospital arrival
2. Aspirin prescribed at discharge	AMI patients who are prescribed aspirin at hospital discharge
3. Beta-blocker prescribed at discharge	AMI patients who are prescribed a beta-blocker at hospital discharge
4. Statin at discharge	AMI patients who are prescribed a statin at hospital discharge
5. Evaluation of LVSF†	AMI patients with documentation in the hospital record that LVSF was evaluated during hospitalization or is planned after discharge
6. ACEI or ARB for LVSD	AMI patients with LVSD who are prescribed an ACEI or ARB at hospital discharge (for purposes of this measure, LVSD is defined as chart documentation of an LVEF less than 40% or a narrative description of LVSF consistent with moderate or severe systolic dysfunction)
7. Time to fibrinolytic therapy	Median time from hospital arrival to administration of fibrinolytic therapy in AMI patients with ST-segment elevation or LBBB on the ECG performed closest to hospital arrival time; AMI patients with ST-segment elevation or LBBB on the ECG closest to hospital arrival time receiving fibrinolytic therapy during the hospital stay with a time from hospital arrival to fibrinolysis of 30 min or less
8. Time to PCI	Median time from hospital arrival to primary PCI in AMI patients with ST-segment elevation or LBBB on the ECG performed closest to arrival time; AMI patients with ST-segment elevation or LBBB on the ECG closest to hospital arrival time receiving primary PCI during the hospital stay with a time from hospital arrival to PCI of 90 min or less
9. Reperfusion therapy	AMI patients with ST-segment elevation or LBBB on the ECG performed closest to arrival receiving either fibrinolysis or primary PCI or who are transferred to another facility for primary PCI
10. Time from ED arrival at STEMI referral facility to ED discharge from STEMI referral facility in patients transferred for primary PCI†	Median time from ED arrival at STEMI referral facility to ED discharge from STEMI referral facility for AMI patients with ST-segment elevation or LBBB on the ECG performed closest to hospital arrival time who are transferred to a STEMI receiving facility for primary PCI
11. Time from ED arrival at STEMI referral facility to primary PCI at STEMI receiving facility among transferred patients †	Median time from patient arrival at a STEMI referral facility's ED to time of primary PCI at a STEMI receiving facility for AMI patients presenting with ST-segment elevation or LBBB on the ECG performed closest to first hospital arrival time who are transferred to a STEMI receiving facility for primary PCI
12. Adult smoking cessation advice/counseling	AMI patients with a history of smoking cigarettes who are given smoking cessation advice or counseling during hospital stay
13. Cardiac rehabilitation patient referral from an inpatient setting†(6)	All patients hospitalized with a primary diagnosis of AMI referred to an early outpatient CR program
Test measures	
T-1. LDL cholesterol assessment	AMI patients with documentation of LDL cholesterol level in the hospital record or documentation that LDL cholesterol testing was done during the hospital stay or is planned after discharge
T-2. Excessive initial heparin dose†	AMI patients who receive excess dosing of UFH initially
T-3. Excessive initial enoxaparin dose†	AMI patients who receive excess dosing of subcutaneous enoxaparin initially
T-4. Excessive initial abciximab dose†	AMI patients who receive excess dosing of abciximab initially
T-5. Excessive initial eptifibatide dose†	AMI patients who receive excess dosing of eptifibatide initially
T-6. Excessive initial tirofiban dose†	AMI patients who receive excess dosing of tirofiban initially
T-7. Anticoagulant dosing protocol†	Presence of a protocol or other clinical aid (eg, nomogram, electronic order entry) in the hospital record of AMI patients that addresses dosing of anticoagulant therapy and parenteral antiplatelet therapy (ie, UFH, low-molecular-weight heparin, and glycoprotein IIb/IIIa inhibitors)
T-8. Anticoagulant error tracking system†	Evidence of a tracking system for identifying dosing errors in anticoagulation therapy in the hospital record of AMI patients.
T-9. Clopidogrel prescribed at discharge for medically treated AMI patients†	Medically treated AMI patients who are prescribed clopidogrel or ticlopidine at hospital discharge

Test measures have been designated for use in internal quality improvement programs only and are not appropriate for any other use, eg, pay for performance, physician ranking, or public reporting programs.

†New measures.

LVEF indicates left ventricular ejection fraction; LBBB, left bundle-branch block; ECG, electrocardiographic; ED, emergency department; CR, cardiac rehabilitation/secondary prevention; and UFH, unfractionated heparin.

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Table 2: ACTION-GWTG Data Elements

Category	Example Elements
Patient demographics	Age, sex, race, insurance status
Medical history and risk factors	Height, weight, hypertension, diabetes mellitus, dyslipidemia, peripheral arterial disease, current smoker, prior cardiac history, prior revascularization
Hospital presentation	Transfer status, date/time of first medical contact, arrival date/time, date/time of first ECG, location of initial evaluation
Initial cardiac status	ECG findings, heart rate, systolic blood pressure, cardiogenic shock, heart failure
Medications and associated doses	Antiplatelet agents, warfarin, unfractionated heparin, low molecular weight heparin, bivalirudin, fondaparinux, GP IIb-IIIa inhibitors, β-blockers, ACE inhibitors, angiotensin receptor blockers, aldosterone blocking agents, lipid-lowering agents
Reperfusion strategy	Thrombolytic date/time, primary PCI date/time, rescue PCI date/time, nonsystems reason for delay in reperfusion
Procedures	LVEF assessment, diagnostic catheterization, PCI (other than primary), CABG
Lab values	Cardiac markers, lipid panel, creatinine, hemoglobin, hemoglobin A1C, INR, BNP
Outcomes	Death, re-MI, bleeding, transfusion, heart failure cardiogenic shock, stroke

GP indicates glycoprotein; ACE, angiotensin-converting enzyme; PCI, percutaneous coronary intervention; LVEF, left ventricular ejection fraction; CAGB, coronary artery bypass graft; INR, international normalized ratio; and BNP, b-type natriuretic peptide.

Table 3: NCDR AR-G "All-or-None" Defect-Free Composite Measure Components

Performance Indicator	Definition
(1) Aspirin at Arrival	AMI patients who received aspirin within 24 h before or after hospital arrival
(2) Aspirin prescribed at Discharge	AMI patients who are prescribed aspirin at hospital discharge
(3) Beta-Blocker Prescribed at Discharge	AMI patients who are prescribed a beta-blocker at hospital discharge
(4) Statin Prescribed at Discharge	AMI patients who are prescribed a statin at hospital discharge
(5) Evaluation of LV Systolic Function	AMI patients with documentation in the hospital record that LVSF was evaluated during hospitalization or is planned after discharge
(6) ACEI or ARB for LVSD at Discharge	AMI patients with LVSD who are prescribed an ACEI or ARB at hospital discharge (for purposes of this measure, LVSD is defined as chart documentation of an LVEF less than 40% or a narrative description of LVSF consistent with moderate or severe systolic dysfunction)
(7) Time to Fibrinolytic Therapy	Median time from hospital arrival to administration of fibrinolytic therapy in AMI patients with ST-segment elevation or LBBB on the ECG performed closest to hospital arrival time; AMI patients with ST-segment elevation or LBBB on the ECG closest to hospital arrival time receiving fibrinolytic therapy during the hospital stay with a time from hospital arrival to fibrinolysis of 30 min or less
(8) Time to Primary PCI	Median time from hospital arrival to primary PCI in AMI patients with ST-segment elevation or LBBB on the ECG performed closest to arrival time; AMI patients with ST-segment elevation or LBBB on the ECG closest to hospital arrival time receiving primary PCI during the hospital stay with a time from hospital arrival to PCI of 90 min or less
(9) Reperfusion Therapy	AMI patients with ST-segment elevation or LBBB on the ECG performed closest to arrival receiving either fibrinolysis or primary PCI or who are transferred to another facility for primary PCI
(10) Adult Smoking Cessation Advice Counseling	AMI patients with a history of smoking cigarettes who are given smoking cessation advice or counseling during hospital stay
(11) Cardiac Rehabilitation Patient Referral From an Inpatient Setting	All patients hospitalized with a primary diagnosis of AMI referred to an early outpatient CR program

Table 4: Selected Patient Characteristics by Hospital Characteristic

	Region of the US			
Description	**Midwest**	**West**	**Northeast**	**South**
N	105724	44787	25672	191271
Demographics				
Age (y):	64.00 (55.00, 75.00)	65.00 (56.00, 75.00)	65.00 (55.00, 77.00)	63.00 (54.00, 73.00)
Age Groups				
Age<55	24.92	22.16	23.17	26.74
Age 55 to <64	26.57	27.47	25.44	27.42
Age 65 to <74	22.63	24.15	22.04	23.62
Age>=75	25.88	26.21	29.35	22.21
Female	34.79	32.27	36.95	34.41
Race				
Hispanic	2.84	9.55	3.81	4.64
White non-hispanic	89.57	89.31	90.32	80.38
Black non-Hispanic	8.24	3.66	6.85	16.94
Other	1.86	5.29	2.26	2.11
Insurance				
Medicare	49.47	48.12	50.76	49.94
Medicaid or not private	14.27	19.04	10.97	14.61
Private	62.57	57.19	72.26	53.33
None	10.47	9.84	4.89	13.78
Clinical features on presentation				
Heart Rate (beat/min)	82.00 (69.00, 97.00)	80.00 (68.00, 95.00)	82.00 (70.00, 97.00)	82.00 (69.00, 97.00)
Systolic Blood Pressure (mm Hg)	147.00 (126.00, 168.00)	144.00 (124.00, 165.00)	145.00 (125.00, 166.00)	146.00 (126.00, 168.00)
STEMI	36.52	39.72	37.86	39.4
Cardiogenic Shock	3.36	4.32	2.91	3.51
History and Risk Factors				
BMI	29.00 (25.50, 33.40)	28.10 (24.80, 32.20)	28.40 (25.10, 36.20)	28.50 (25.10, 32.80)
Current/Recent Smoker (w/in 1 year)	35.94	29.73	30.25	36.77
Hypertension	73.35	70.27	72.87	75.41
Dyslipidemia	60.66	57.88	60.72	60.06
Currently on Dialysis	2.36	2.27	1.97	2.55
Chronic Lung Disease	15.03	11.96	11.22	13.89
Diabetes Mellitus	32.32	30.58	30.88	34.44
Prior CAD	36.14	32.48	32.46	37.86
Prior MI	24.18	22.59	21.49	25.81
Prior PCI	25.04	21.69	20.92	25.53
Prior CABG	13.63	10.93	12.59	14.06
Prior Heart Failure	11.84	9.99	9.88	12.27
Atrial Fibrillation or Flutter Past 2 Weeks	6.77	6.91	7.48	6.65
Cerebrovascular Disease	12.25	10.94	10.43	12.27
Prior Stroke	7.46	6.83	6.41	8.16
Peripheral Arterial Disease	10.34	8.18	8.13	9.65
Lab values on presentation				
Troponin Ratio	2.00 (0.43, 12.38)	2.33 (0.47, 14.25)	3.27 (0.67, 20.00)	2.00 (0.500, 13.14)
CKMB Ratio	1.05 (0.45, 3.675	1.21 (0.49, 4.84)	1.32 (0.55, 4.86)	1.16 (0.48, 4.24)
Creatinine (mg/dL)	1.00 (0.90, 1.30)	1.00 (0.90, 1.30)	1.00 (0.80, 1.30)	1.00 (0.90, 1.30)
Creatinine Clearance	81.20 (54.22, 111.65)	79.42 (53.91, 107.78)	80.95 (52.76, 112.38)	81.92 (55.39, 111.61)
Hemoglobin (g/dL)	14.1 (12.6, 15.3)	14.30 (12.90, 15.60)	13.90 (12.50, 15.20)	14.00 (12.50, 15.20)
Hemoglobin A1c	6.20 (5.70, 7.50)	6.10 (5.60, 7.40)	6.00 (5.60, 7.10)	6.10 (5.60, 7.50)
INR	1.00 (1.00, 1.10)	1.00 (1.00, 1.10)	1.00 (1.00, 1.10)	1.00 (1.00, 1.10)
Total Cholesterol (mg/dL)	164.00 (135.00, 195.00)	162.00 (134.00, 195.00)	164.00 (136.00, 196.00)	165.00 (136.00, 197.00)
HDL Cholesterol (mg/dL)	38.00 (31.00, 46.00)	38.00 (31.00, 46.00)	40.00 (33.00, 49.00)	37.00 (30.00, 46.00)
LDL Cholesterol (mg/dL)	95.00 (70.00, 123.00)	94.00 (69.00, 122.00)	94.00 (69.00, 122.00)	97.00 (72.00, 125.00)
Triglycerides (mg/dL)	123.00 (85.00, 183.00)	122.00 (84.00, 182.00)	119.00 (83.00, 175.00)	124.00 (84.00, 186.00)
Lipid Panel Values Out of Range	6.45	4.89	4.69	7.3
BNP (pg/mL)	213.00 (60.00, 627.00)	236.00 (71.00, 622.00)	297.00 (84.00, 811.00)	203.00 (58.00, 599.00)
NT-proBNP (pg/mL)	1255.00 (253.00, 4463.00)	1165.50 (220.00, 4422.00)	1019.00 (214.00, 3699.00)	1200.00 (247.00, 4610.00)

*Categorical variables are presented as percentages

**Continuous variables are presentes as Median (Q1, Q3)

Table 4: Selected Patient Characteristics by Hospital Characteristic (con't)

	Community Location			Teaching Status	
Description	**Urban**	**Rural**	**Suburban**	**Teaching**	**Non-Teaching**
N	212246	51292	103916	176975	190479
Demographics					
Age (y):	63.00 (54.00, 74.00)	64.00 (54.00, 74.00)	64.00 (55.00, 75.00)	64.00 (55.00, 74.00)	63.00 (54.00, 74.00)
Age Groups					
Age<55	26.16	25.04	24.07	25.98	24.80
Age 55 to <64	27.6	26.82	26	27.51	26.53
Age 65 to <75	23.13	24.05	23.23	22.93	23.67
Age>=75	23.1	24.08	26.69	23.57	24.99
Female	34.12	34.51	34.91	34.32	34.48
Race					
Hispanic	5.02	2.51	4.98	3.97	5.41
White non-hispanic	83.56	89.55	85.02	82.64	87.14
Black non-Hispanic	13.61	8.51	10.84	14.42	9.63
Other	2.13	1.73	3.41	2.27	2.62
Insurance					
Medicare	49.25	52.67	48.18	49.64	49.64
Medicaid or not private	16.51	17.14	10.19	16.03	13.48
Private	55.76	54.47	64.03	57.59	57.98
None	12.00	12.36	10.86	11.78	11.67
Clinical features on presentation					
Heart Rate (beat/min)	81.00 (69.00, 96.00)	82.00 (69.00, 97.00)	82.00 (69.00, 97.00)	82.00 (69.00, 97.00)	82.00 (69.00, 96.00)
Systolic Blood Pressure (mm Hg)	146.00 (125.00, 167.00)	146.00 (126.00, 168.00)	147.00 (126.00, 168.00)	146.00 (126.00, 168.00)	146.00 (125.00, 167.00)
STEMI	39.91	35.86	36.94	38.17	38.86
Cardiogenic Shock	3.65	3.38	3.33	3.34	3.72
History and Risk Factors					
BMI	28.70 (25.10, 33.00)	28.70 (25.20, 33.00)	28.40 (25.10, 32.70)	28.50 (25.10, 32.90)	28.7 (25.10, 32.90)
Current/Recent Smoker (w/in 1 year)	36.64	37.75	31.06	35.98	34.40
Hypertension	73.94	74.93	73.72	74.83	73.14
Dyslipidemia	58.78	62.63	61.24	61.73	58.17
Currently on Dialysis	2.48	2.08	2.46	2.45	2.38
Chronic Lung Disease	13.61	16.71	12.74	13.27	14.04
Diabetes Mellitus	33.37	33.72	32.28	33.4	32.80
Prior CAD	36.18	38.42	35.62	36.77	35.86
Prior MI	24.95	25.83	23.45	25.55	23.68
Prior PCI	24.59	25.83	24	24.66	24.54
Prior CABG	12.99	15.29	13.47	13.6	13.29
Prior Heart Failure	11.55	12.66	11.53	12.38	10.97
Atrial Fibrillation or Flutter Past 2 Weeks	6.42	6.9	7.43	6.75	6.80
Cerebrovascular Disease	12.09	12.36	11.54	12.43	11.48
Prior Stroke	7.68	7.97	7.52	7.88	7.46
Peripheral Arterial Disease	9.51	10.01	9.45	9.98	9.12
Lab values on presentation					
Troponin Ratio	2.20 (0.50, 14.33)	2.00 (0.50, 11.20)	2.07 (0.50, 13.15)	1.75 (0.40, 10.60)	2.56 (0.56, 16.56)
CKMB Ratio	1319 (0.50, 4.49)	1.03 (0.45, 3.39)	1.13 (0.47, 4.06)	1.12 (0.48, 3.89)	1.18 (0.48, 4.47)
Creatinine (mg/dL)	1.00 (0.90, 1.30)	1.00 (0.90, 1.30)	1.10 (0.90, 1.30)	1.00 (0.90, 1.30)	1.00 (0.80, 1.30
Creatinine Clearance	82.56 (55.71, 112.47)	81.24 (55.03, 115.51)	79.01 (52.48, 108.55)	80.21 (54.06, 109.86)	82.39 (55.27, 112.45)
Hemoglobin (g/dL)	14.10 (12.60, 15.30)	14.10 (12.60, 15.30)	14.00 (12.60, 15.30)	14.10 (12.60, 15.30)	14.00 (12.50, 15.30)
Hemoglobin A1c	6.10 (5.60, 7.50)	6.20 (5.70, 7.50)	6.10 (5.60, 7.50)	6.20 (5.70, 7.60)	6.10 (5.60, 7.40)
INR	1.00 (1.00, 1.10)	1.00 (1.00, 1.10)	1.00 (1.00, 1.10)	1.00 (1.00, 1.10)	1.00 (1.00, 1.10)
Total Cholesterol (mg/dL)	164.00 (136.00, 196.00)	165.00 (137.00, 197.00)	163.00 (135.00, 195.00)	164.00 (136.00, 195.00)	165.00 (136.00, 196.00)
HDL Cholesterol (mg/dL)	37.00 (31.00, 46.00)	37.00 (31.00, 45.00)	38.00 (31.00, 47.00)	37.00 (31.00, 46.00)	38.00 (31.00, 46.00)
LDL Cholesterol (mg/dL)	96.00 (71.00, 124.00)	96.00 (71.00, 124.00)	95.00 (70.00, 123.00)	95.00 (71.00, 123.00)	96.00 (71.00, 124.00)
Triglycerides (mg/dL)	123.00 (85.00, 184.00)	126.00 (87.00, 190.00)	121.00 (83.00, 180.00)	124.00 (85.00, 185.00)	122.00 (84.00, 182.00)
Lipid Panel Values Out of Range	6.40	6.55	6.96	7.24	5.87
BNP (pg/mL)	215.00 (62.00, 613.00)	208.00 (62.00, 605.00)	219.00 (60.00, 647.00)	216.00 (60.00, 621.00)	214.00 (63.00, 623.00)
NT-proBNP (pg/mL)	1291.00 (258.00, 4739.00)	1243.00 (266.00, 4800.00)	1045.00 (211.00, 3970.00)	1086.00 (220.00, 4249.50)	1316.50 (270.00, 4762.00)

*Categorical variables are presented as percentages

**Continuous variables are presentes as Median (Q1, Q3)

Table 5: Selected Hospital Characteristics

Hospital Characteristic	
ALL	270
Total beds:	1200 (700, 2031)
Hospital Bed Size	
0-258	83
259-389	72
390-572	64
573-2000	51
Annual Number of PCIs	
0-357	90
358-675	73
676-1129	62
1130-4722	45
Annual Number of Cardiac Caths	
0-850	87
851-1499	79
1500-2562	55
2563-13500	47
Percentage of Medicare Patients	
0-42%	62
43-52%	73
53-60%	48
61-100%	87
Hospital Type	
Government	5
Community	236
University	29
Public/Private	
Public	156
Private	114
Region	
Northeast	16
Midwest	83
South	133
West	38
Teaching status	
Non-Teaching	154
Teaching	116
Community Location	
Rural	43
Urban	147
Suburban	80

*Category sums may not equal the total hospital number due to unknowns values

**Categorical variables are presented as percentages

***Continuous variables are presentes as Median (Q1, Q3)