



# **Medicare Hospital Quality Chartbook 2011**

**Performance Report on Readmission Measures for  
Acute Myocardial Infarction,  
Heart Failure, and Pneumonia**

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**Prepared by  
Yale New Haven Health System Corporation  
Center for Outcomes Research and Evaluation**



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# Executive Summary

## **Background:**

The 2011 edition of the Centers for Medicare and Medicaid Services (CMS) Hospital Quality Chartbook presents analyses that provide insights into hospital performance on the publicly reported readmission measures for patients with acute myocardial infarction (AMI), heart failure, and pneumonia. Within this chartbook, we provide information about recent trends in hospital performance and variation in outcomes by several key hospital characteristics, including geographic location and patient population. We also describe the relationship among the three readmission measures.

## **Updates to the report:**

Given the increasing national attention on readmissions as an arena for quality improvement **we have focused the 2011 edition on hospital achievement as measured by 30-day risk-standardized readmission rates (RSRRs)**, which convey information about the quality and efficiency of care at the nation's hospitals.

There have been several changes to the 2011 edition when compared with the 2010 edition:

- Updated years of data include 2007-2009 data (except for Section Two: Regional Variation analyses which use July 2007- June 2010 publicly-reported data)
- For the first time, **Veterans Health Administration (VA) hospitals are included in selected analyses** examining annual trends, performance variation, and geographic variation in RSRRs. (Figures 1.1 – 1.3 and 2.1)
- New analyses provide additional insight into hospital performance:
  - Correlation between condition-specific publicly reported RSRRs
  - RSRRs by hospitals' proportion of Medicaid patients served
  - RSRRs by hospitals' rural status

Additional minor methodology changes can be found in Appendix A.

## **Highlights of the report:**

### **National Trends and Distributions**

- Annual trends in RSRRs remain stable in the years leading up to initial public reporting (2009).
- RSRRs over the past 3 years were nearly 20% for AMI, almost 25% for HF, and just over 18% for pneumonia.
- For all measures, substantial variation in hospital performance remains.

### **Regional Variation**

- There exists significant geographic variation in hospital performance measured by RSRRs after hospitalization for AMI, heart failure, and pneumonia.
- The western mountain region appears to perform consistently better than the national rate, while areas in the Northeast and Central South East perform consistently worse.

### **Disparities**

- Hospital performance on RSRRs is not strongly associated with race, income, or Medicaid status of their patients.
- Hospitals serving a high proportion of vulnerable patients have a wide range of performance.
- However, the small subgroup of hospitals caring for particularly high proportions of vulnerable patients has a modestly higher median RSRR, suggesting the need for greater understanding of how to translate the successes of high performing hospitals to their peer hospitals.

### **Hospital Characteristics**

- Safety net hospitals have a similar range of performance as non-safety net hospitals despite caring for a large number of vulnerable patients.
- Teaching hospitals have a similar range of performance as non-teaching hospitals despite providing educational services to inexperienced physicians in-training.
- Hospitals have a similar range of performance across urban and rural locations despite patients at more remote hospitals confronting challenges in access to care and greater distance to providers.

### **Readmissions across Conditions**

- Among the three condition-specific publicly reported readmission measures, the RSRRs are moderately correlated, suggesting a common signal of quality.
- However, no RSRR is sufficiently correlated with another to obviate the need for each measure.

# What are Risk-Standardized Readmission Rates (RSRRs)?

## Measuring Key Hospital Outcomes

This report focuses on 30-day Risk-Standardized Readmission Rates (RSRRs) for Medicare fee-for-service (FFS) patients admitted to the hospital for heart attack (acute myocardial infarction or AMI), heart failure, or pneumonia as measures of hospital outcomes of care. These readmission measures were endorsed by the National Quality Forum and are publicly reported by CMS on the Web site [Hospital Compare](#). This box provides a brief overview of how the rates are calculated.<sup>1-3</sup> A full description of the measures is available on the [QualityNet](#) Web site (see [Readmission Measures](#)).

## Patients Included in the Measures

The measures include Medicare VA beneficiaries aged ≥65 discharged after admission at acute care hospitals, including Department of Veterans Health Administration (VA) hospitals, with a principal discharge diagnosis of AMI, heart failure, or pneumonia and with a complete claims history for the 12 months before the date of admission. The measures exclude certain admissions for patients, including those who were discharged against medical advice. The detailed inclusion and exclusion criteria for each measure are in Appendix B.

## Measured Outcomes

The readmission rates assess readmissions for any reason within 30 days of discharge from a hospital stay. Readmissions are counted regardless of whether patients are readmitted to the same hospital or to a different acute care facility. The AMI measure, however, does not count admissions for certain procedures that may be part of planned follow-up care as a readmission.

## Risk-Adjustment

To level the playing field across hospitals, the measures adjust for key differences in patient risk factors that are clinically relevant and have strong relationships with the outcome (e.g. demographic factors, patient comorbidities).

For each patient, covariates are obtained from Medicare claims extending 12 months prior and including the index admission. The models seek to adjust for case differences based on the clinical status of the patient at the time of admission. Accordingly, only comorbidities that convey information about the

patient at that time or in the 12 months prior, and not complications that arise during the course of the hospitalization, are included in the risk-adjustment.

## Calculating the RSRRs

The readmission measures use hierarchical logistic regression to create RSRRs at the hospital level. The RSRRs are calculated as the ratio of the number of “predicted” to the number of “expected” readmissions, multiplied by the national unadjusted readmission rate. For each hospital, the “numerator” of the ratio is the number of readmissions within 30 days predicted on the basis of the hospital’s performance with its observed case mix, and the “denominator” is the number of readmissions expected on the basis of the nation’s performance with that hospital’s case mix.

This approach is analogous to a ratio of “observed” to “expected” used in other types of statistical analyses. It conceptually allows for a comparison of a particular hospital’s performance given its case-mix to an average hospital’s performance with the same case-mix. Thus, a lower ratio indicates lower-than-expected readmission and *better quality*; a higher ratio indicates higher-than-expected readmission and *worse quality*.

All of the publicly reported measures have been validated through comparison with measures developed in medical records and found to profile hospitals similarly.

In Section One Trends and Distributions, the national RSRR is a weighted average of the hospital-specific RSRRs.

1. Keenan PS, Normand S-LT, Lin Z, et al. An Administrative Claims Measure Suitable for Profiling Hospital Performance on the Basis of 30-Day All-Cause Readmission Rates Among Patients With Heart Failure / CLINICAL PERSPECTIVE. *Circulation: Cardiovascular Quality and Outcomes*. September 1, 2008 2008;1(1):29-37.
2. Krumholz HM, Lin Z, Drye EE, et al. An Administrative Claims Measure Suitable for Profiling Hospital Performance Based on 30-Day All-Cause Readmission Rates Among Patients With Acute Myocardial Infarction. *Circulation: Cardiovascular Quality and Outcomes*. March 1, 2011 2011;4(2):243-252.
3. Lindenauer PK, Normand S-LT, Drye EE, et al. Development, validation, and results of a measure of 30-day readmission following hospitalization for pneumonia. *Journal of Hospital Medicine*. 2011;6(3):142-150.



## SECTION ONE

### Trends and Distributions

#### *Background*

Thirty-day Risk-Standardized Readmission Rates (RSRRs) provide an estimate of hospital quality and efficiency for Medicare FFS and VA patients discharged after admission to the hospital for AMI, heart failure, or pneumonia.

This section of analyses provides an overview of trends from 2007 to 2009 in hospital performance using RSRRs, including trends in RSRRs for all three conditions to provide insight into whether hospital performance is improving. We also show distributions of RSRRs over a three-year period to provide insight into whether hospitals vary substantially in performance.

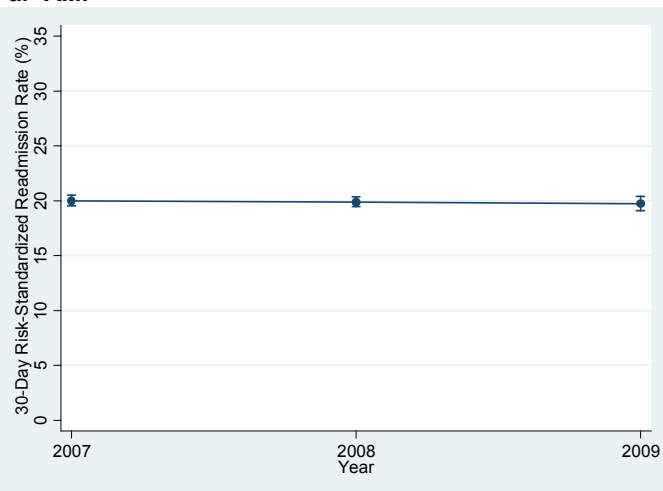
The distribution for unadjusted readmission rates is provided in Appendix C for comparison.

## Annual Trends in Readmission Rates Remain Stable

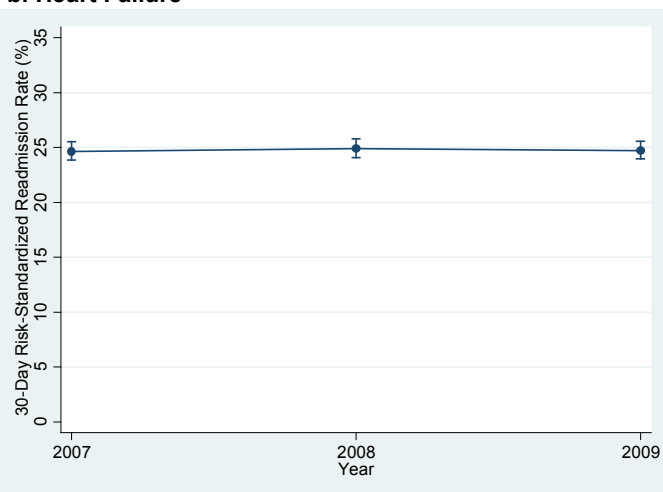
**Figure 1.1 Trend in Median Hospital RSRRs, 2007-2009**

Medicare FFS beneficiaries and VA beneficiaries aged ≥65 years

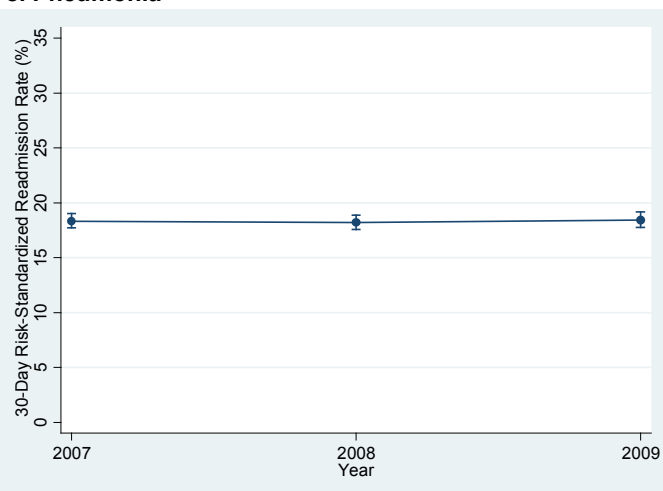
**a. AMI**



**b. Heart Failure**



**c. Pneumonia**



These figures and Table 1.1 below display national trends in annual hospital-level 30-day RSRRs after admission for AMI, heart failure, and pneumonia from 2007 to 2009. For the first time, these data contain results for both non-federal and VA hospitals combined.

Monitoring annual trends in RSRRs provides insight into the quality of care provided by U.S. hospitals. RSRRs for all three conditions were relatively stable and remained high from 2007 to 2009, with similar distributions from year to year. The median RSRR after admission for AMI in 2009 for U.S. hospitals was 19.7%, 24.7% after admission for heart failure, and 18.4% after admission for pneumonia.

While AMI RSRRs improved slightly and pneumonia RSRRs worsened slightly, there were no significant changes in RSRR for any condition between 2007 and 2009. However, the impact of publicly reporting RSRRs, which began in 2009, will be captured in future analyses.

**Table 1.1 Trend in Median Hospital RSRRs (%)**

Condition	2007		2008		2009	
	Median	Range	Median	Range	Median	Range
<b>AMI</b>	20.0	16.8-23.9	19.9	16.9-24.1	19.7	15.8-26.2
<b>Heart Failure</b>	24.7	18.6-31.3	24.9	20.2-32.5	24.7	20.1-31.4
<b>Pneumonia</b>	18.3	14.7-24.2	18.2	14.1-23.5	18.4	14.4-24.0

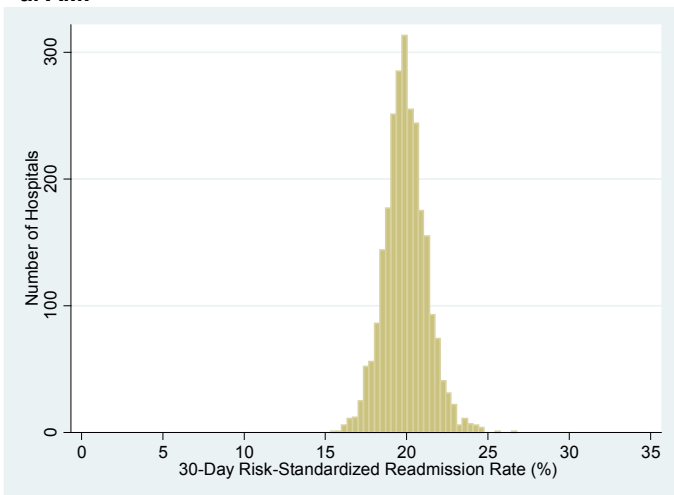
**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (Appendix B.I).

**Notes:** 1) Veterans Health Administration (VA) hospitals are included in this analysis. 2) The results of hospitals with fewer than 10 cases of the condition in each year are not shown; however these hospitals have been included in RSRR calculations. 3) For AMI, the total number of hospitals was 2,484 in 2007, 2,447 in 2008, and 2,316 in 2009. 4) For HF, the total number of hospitals was 4,238 in 2007, 4,183 in 2008, and 4,128 in 2009. 5) For pneumonia, the total number of hospitals was 4,474 in 2007, 4,474 in 2008, and 4,413 in 2009. 6) The unadjusted readmission rates for each condition can be found in Appendix C

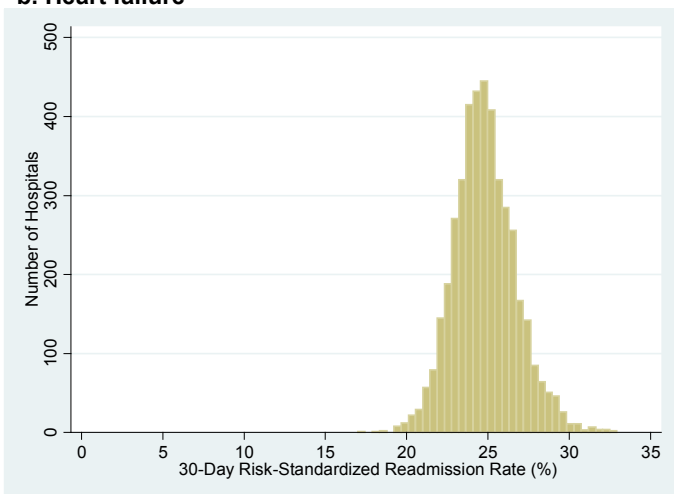
## Variation in Readmission Rates among U.S. Hospitals Continues

**Figure 1.2 Distribution of Hospital RSRRs, 2007-2009**  
 Medicare FFS beneficiaries and VA beneficiaries aged ≥65 years

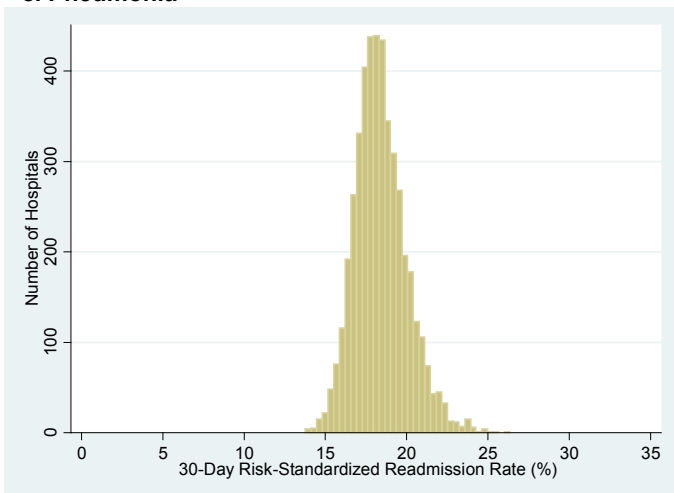
**a. AMI**



**b. Heart failure**



**c. Pneumonia**



These figures and Table 1.2 below display distributions of RSRRs after admission for AMI, heart failure, and pneumonia among U.S. hospitals (including VA hospitals).

Variation in RSRRs reflects differences in performance among U.S. hospitals, with wider distributions suggesting more variation and narrower distributions suggesting less variation.

Hospital RSRRs for AMI, heart failure, and pneumonia were similarly distributed. While the majority of hospitals performed close to the national median, the range of risk-standardized rates for all conditions remains wide, suggesting substantial opportunity for improvement.

**Table 1.2 Distribution of Hospital RSRRs, 2007-2009 (%)**

	AMI	Heart failure	Pneumonia
<b>Maximum</b>	26.8	33.0	26.4
<b>90%</b>	21.5	27.3	20.5
<b>75%</b>	20.7	26.0	19.4
<b>Median (50%)</b>	19.9	24.7	18.3
<b>25%</b>	19.1	23.6	17.3
<b>10%</b>	18.4	22.6	16.5
<b>Minimum</b>	15.3	17.0	13.8

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (Appendix B.I).

**Notes:** 1) Veterans Health Administration (VA) hospitals are included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for: AMI =2,546; HF =4,319; and pneumonia =4,568.

## SECTION ONE

### Trends and Distributions

#### *Summary*

- VA hospitals are now part of public reporting.
- RSRRs after hospitalization for AMI, heart failure and pneumonia remain high and have not changed from 2007 to 2009.
- While a majority of hospitals perform close to the national median, broad variation in RSRRs remains, signaling a continuing opportunity for improvement.
- If every hospital performing below the level of the 25<sup>th</sup> percentile were able to improve performance on these measures and reach the same level, 4,481 readmissions after hospitalizations for AMI, 20,665 readmissions after hospitalizations for heart failure, and 16,691 readmissions after hospitalizations for pneumonia would be avoided.
- As public reporting of these measures began in July 2009, the impact of public reporting may only become apparent in subsequent years of analysis.

## SECTION TWO

### Regional Variation

#### *Background*

This section of analyses provides information on regional variation in hospital performance using RSRRs for all three conditions to provide insight into patterns of care across Hospital Referral Regions (HRRs) in the United States.

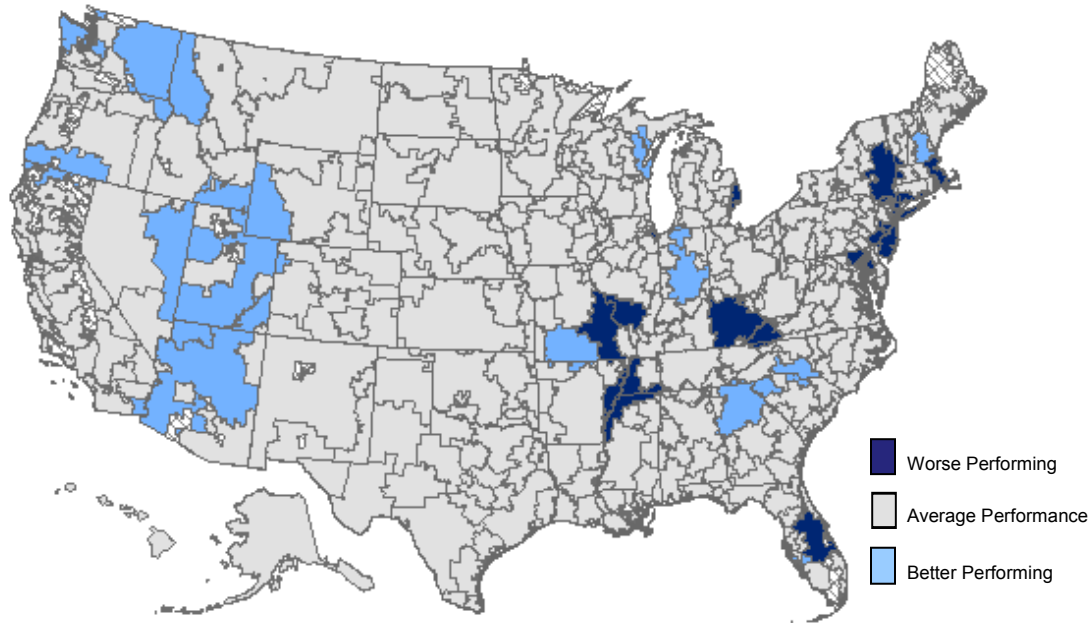
#### **Definition of Hospital Referral Region**

HRRs represent regional health care markets for tertiary medical care that generally requires the services of a major referral center. HRRs were defined in the Dartmouth Atlas of Health Care 1999, by documenting where patients were referred for major cardiovascular surgical procedures and for neurosurgery.<sup>1</sup> Each HRR contains at least one city where both major cardiovascular procedures and neurosurgery are performed. The HRR ranking methodology is presented in Appendix D. <sup>1</sup>The Quality of Medical Care in the United States: A Report on the Medicare Program. The Dartmouth Atlas of Health Care 1999. Available at <http://www.dartmouthatlas.org/downloads/atlas/99Atlas.pdf> (Accessed August 23, 2011)

## AMI RSRRs Vary by Region

**Figure 2.1a Classification of HRRs by RSRRs for AMI, 2007-2009**

Medicare FFS beneficiaries and VA beneficiaries aged ≥65 years



**Source Data and Population:** AMI RSRR Measure Cohort— July 2007-June 2010—publicly reported RSRRs

**Notes:** 1) Veterans Health Administration (VA) hospitals are included in this analysis. 2) The HRR ranking methodology can be found in Appendix D.

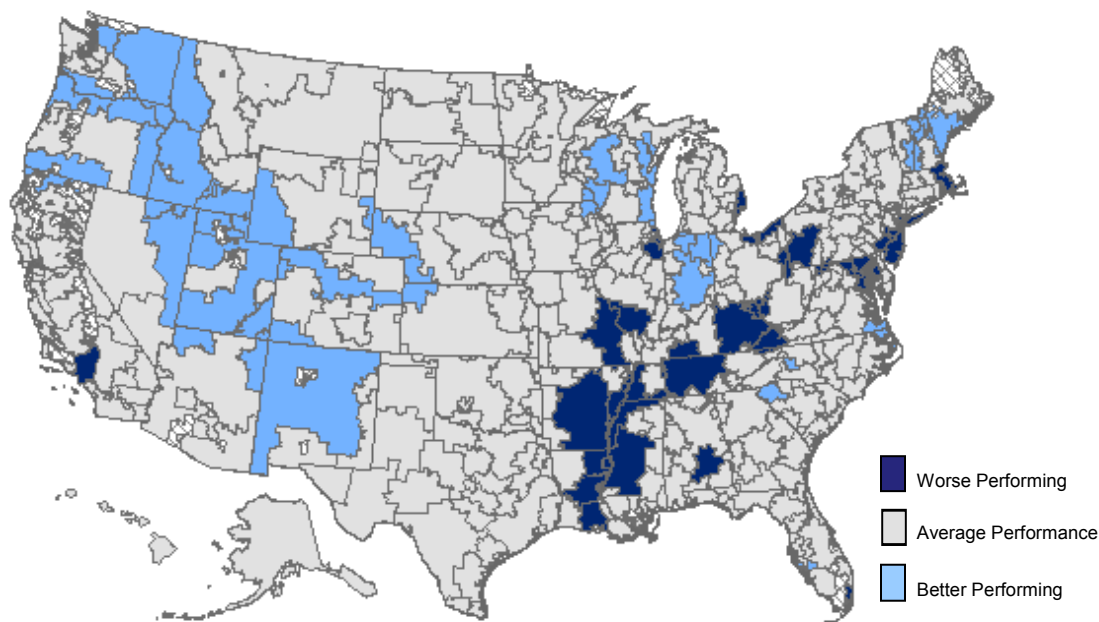
This figure displays the geographic variation in RSRRs after admission for AMI. Areas are divided by HRR and include data for both non-federal and VA hospitals. The dark blue areas represent HRRs with RSRRs significantly worse than the national rate, while the light blue areas represent those HRRs performing significantly better than the national rate. The majority of HRRs perform similarly to the national rate, as represented by the grey areas. Table 2.1a below displays those HRRs performing better (left-hand column) and worse (right-hand column) than the national rate.

**Table 2.1a Performance Status Compared to the National Rate for AMI RSRRs**

Better Performing HRRs		Worse Performing HRRs	
Atlanta, GA	South Bend, IN	Albany, NY	Lexington, KY
Charlotte, NC	Spokane, WA	Baltimore, MD	Manhattan, NY
Green Bay, WI	Springfield, MO	Blue Island, IL	Memphis, TN
Greenville, SC		Boston, MA	Munster, IN
Indianapolis, IN		Bronx, NY	New Brunswick, NJ
Manchester, NH		Camden, NJ	New Haven, CT
Medford, OR		Chicago, IL	Newark, NJ
Phoenix, AZ		Detroit, MI	Orlando, FL
Salt Lake City, UT		East Long Island, NY	Philadelphia, PA
Sarasota, FL		Hackensack, NJ	St. Louis, MO
Seattle, WA		Kingsport, TN	White Plains, NY

## Heart Failure RSRRs Vary by Region

**Figure 2.1b Classification of HRRs by RSRRs for Heart Failure, 2007-2009**  
Medicare FFS beneficiaries and VA beneficiaries aged ≥65 years



**Source Data and Population:** Heart failure RSRR Measure Cohort— July 2007-June 2010—publicly reported RSRRs  
**Notes:** 1) Veterans Health Administration (VA) hospitals are included in this analysis. 2) The HRR ranking methodology can be found in Appendix D.

This figure displays the geographic variation in RSRRs after admission for heart failure. Again, regions are divided by HRR. The figure includes data for both non-federal and VA hospitals, and shows poor performing HRRs in dark blue and superiorly performing HRRs in light blue. Grey areas show HRRs performing similarly to the national rate. Table 2.1b displays those HRRs performing better (left-hand column) and worse (right-hand column) than the national rate.

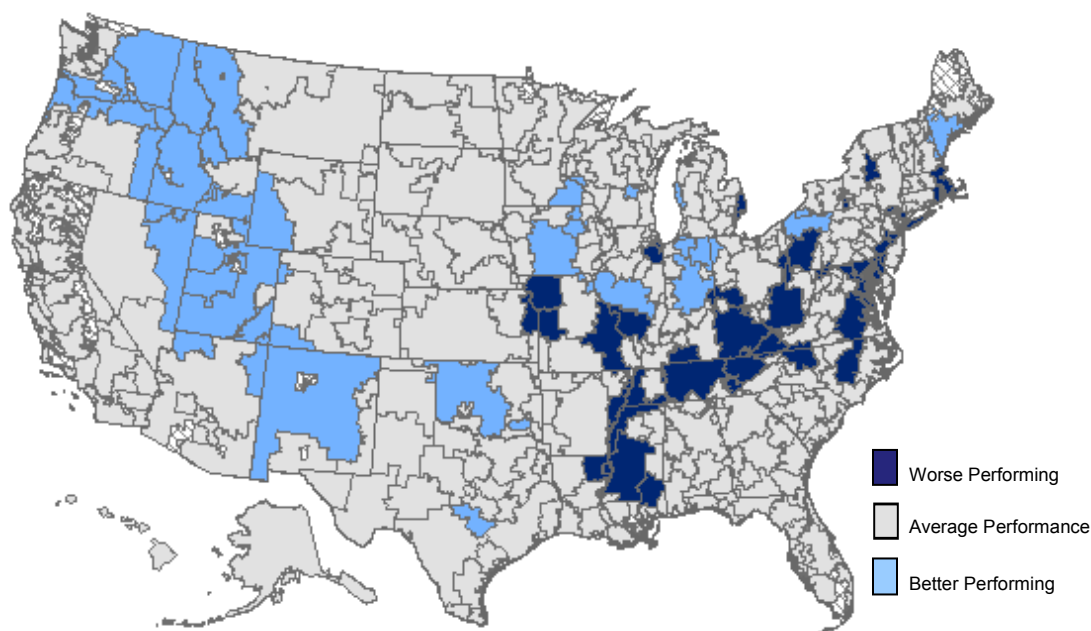
**Table 2.1b Performance Status Compared to the National Rate for Heart Failure RSRRs**

Better Performing HRRs		Worse Performing HRRs		
Albuquerque, NM	Marshfield, WI	Alexandria, LA	Hackensack, NJ	Miami, FL
Boise, ID	Medford, OR	Baltimore, MD	Huntington, WV	Monroe, LA
Denver, CO	Milwaukee, WI	Blue Island, IL	Jackson, MS	Montgomery, AL
Everett, WA	Norfolk, VA	Boston, MA	Joliet, IL	Nashville, TN
Fort Wayne, IN	Ogden, UT	Bronx, NY	Kingsport, TN	New Brunswick, NJ
Green Bay, WI	Portland, ME	Camden, NJ	Lafayette, LA	Newark, NJ
Greenville, SC	Portland, OR	Chicago, IL	Lexington, KY	Philadelphia, PA
Hickory, NC	Salt Lake City, UT	Cleveland, OH	Little Rock, AR	Pittsburgh, PA
Indianapolis, IN	Sarasota, FL	Detroit, MI	Los Angeles, CA	St. Louis, MO
La Crosse, WI	South Bend, IN	East Long Island, NY	Manhattan, NY	Takoma Park, MD
Lebanon, NH	Spokane, WA	Evanston, IL	Memphis, TN	Washington, DC

## Pneumonia RSRRs Vary by Region

**Figure 2.1c Classification of HRRs by RSRRs for Pneumonia, 2007-2009**

Medicare FFS beneficiaries and VA beneficiaries aged ≥65 years



**Source Data and Population:** Pneumonia RSRR Measure Cohort— July 2007-June 2010—publicly reported RSRRs

**Notes:** 1) Veterans Health Administration (VA) hospitals are included in this analysis. 2) The HRR ranking methodology can be found in Appendix D.

This figure displays the geographic variation in RSRRs after admission for pneumonia. Regions are divided by HRR. The figure includes data for both non-federal and VA hospitals, and shows poor performing HRRs in dark blue and superiorly performing HRRs in light blue. Grey areas show HRRs performing similarly to the national rate. Table 2.1c displays those HRRs performing better (left-hand column) and worse (right-hand column) than the national rate.

**Table 2.1c Performance Status Compared to the National Rate for Pneumonia RSRRs**

Better Performing HRRs		Worse Performing HRRs		
Albuquerque, NM	Portland, OR	Baltimore, MD	Jackson, MS	Philadelphia, PA
Austin, TX	Provo, UT	Blue Island, IL	Joliet, IL	Pittsburgh, PA
Boise, ID	Rochester, MN	Boston, MA	Kansas City, MO	Providence, RI
Des Moines, IA	Salt Lake City, UT	Bronx, NY	Kingsport, TN	Raleigh, NC
Erie, PA	South Bend, IN	Charleston, WV	Knoxville, TN	Richmond, VA
Fort Wayne, IN	Spokane, WA	Chicago, IL	Lexington, KY	St. Louis, MO
Indianapolis, IN	Springfield, IL	Cincinnati, OH	Manhattan, NY	Takoma Park, MD
Missoula, MT	Waterloo, IA	Dearborn, MI	Memphis, TN	Washington, DC
Muskegon, MI	Yakima, WA	Detroit, MI	Monroe, LA	White Plains, NY
Neenah, WI		East Long Island, NY	Nashville, TN	Wilmington, DE
Oklahoma City, OK		Elmira, NY	New Brunswick, NJ	Winston-Salem, NC
Portland, ME		Hattiesburg, MS	Newark, NJ	



## SECTION TWO

### Regional Variation

#### *Summary*

- There exists significant geographic variation in hospital performance measured by RSRRs after hospitalization for AMI, heart failure and pneumonia.
- Fewer HRRs perform significantly better or worse than the national rate on the AMI readmission measure as compared to the heart failure and pneumonia measures.
- While the U.S. maps of RSRR performance among HRRs presented on the previous pages are not identical, there are consistent regions of high performance in the western mountain region as well as lower performance in the Northeast and Central South East.



## SECTION THREE

### Disparities and Performance

#### *Background*

This section of analyses provides several examinations into the existence of disparities in hospital performance using RSRR estimates as a measure of quality of care.

Many observers have voiced concern that hospitals caring for relatively higher portions of vulnerable populations, for whom disparities in care have previously been documented, will be systematically disadvantaged when their performance is estimated, even after risk-standardization for important patient characteristics related to age and comorbid disease. Therefore, we carefully examined the association between the patient population cared for by hospitals and RSRRs.

The following section looks at disparities in performance in three ways. We examine the relationships between RSRR and the hospital's population measured by the proportion of African-American patients (Figure 3.1), patient median income (Figure 3.2), and proportion of Medicaid patients (Figure 3.3), respectively. Due to data limitations, VA hospitals were excluded and analyses examining minority race were limited to African-American patients.

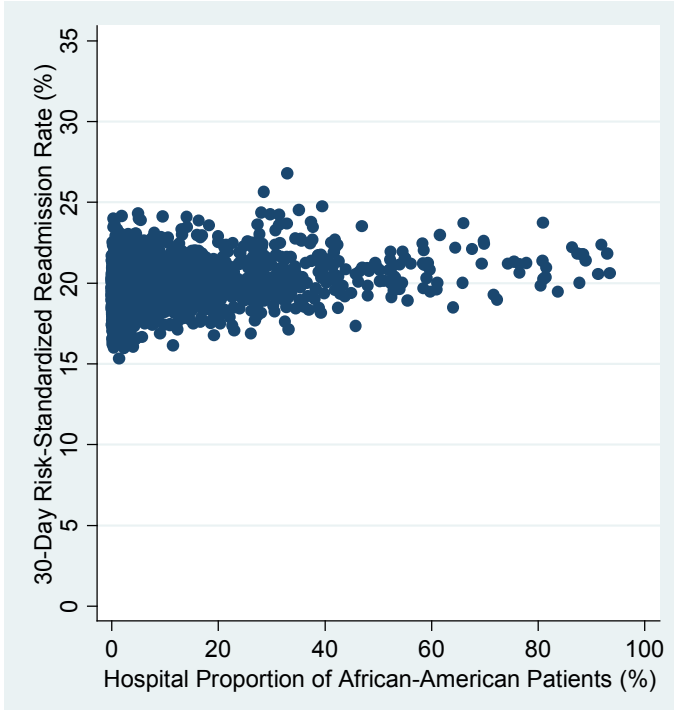
**SECTION 3.1**

**Hospitals' Performance by Their Patients' Race**

## How Do Hospitals with Varying Proportions of African-American Patients Perform on AMI RSRRs?

**Figure 3.1a AMI RSRR by Proportion of African-American Patients in the Hospital, 2007-2009**  
 Medicare FFS beneficiaries aged ≥65 years

a.i.

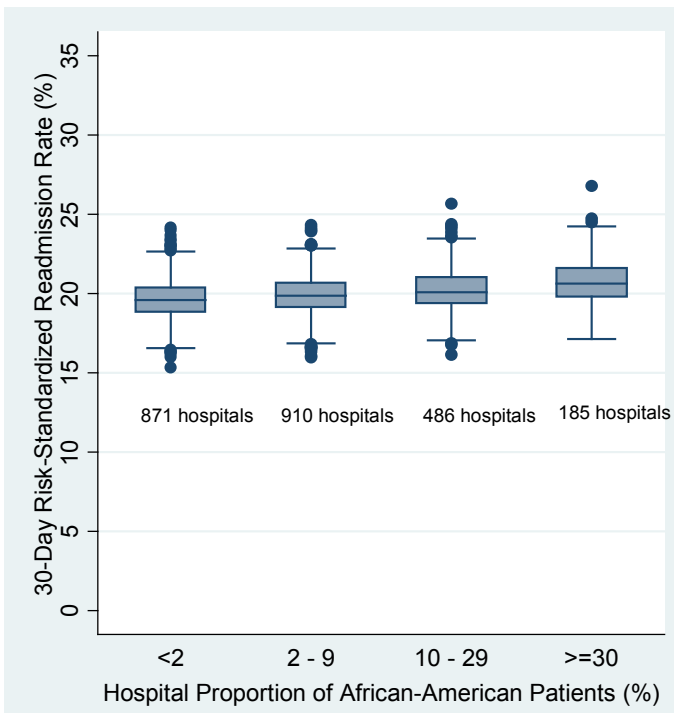


These figures and Table 3.1a below display RSRRs after admission for AMI among U.S. hospitals categorized by the proportion of African-American patients cared for by the facility.

The scatterplot demonstrates that the vast majority of hospitals are caring for low proportions of African-American patients. Among the limited number of hospitals caring for a relatively higher proportion of African-American patients, performance varies widely, with both high and low performing hospitals (box-and-whiskers plot).

However, as shown in the box-and-whiskers plot and Table 3.1a, hospitals caring for 30% or more African-American patients have a median RSRR after AMI 1% higher than those caring for <2% African-American patients.

a.ii.



**Table 3.1a AMI RSRR by Proportion of African-American Patients in the Hospital, 2007-2009 (%)**

% AA Patients	N	Median	Range
<2%	871	19.6	15.3 - 24.2
2%-9%	910	19.9	16.0 - 24.3
10%-29%	486	20.1	16.2 - 25.7
≥30%	185	20.6	17.2 - 26.8

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); 2009 Inpatient Admissions from Medicare Database (Proportion of African-American patients) (Appendix B.II).

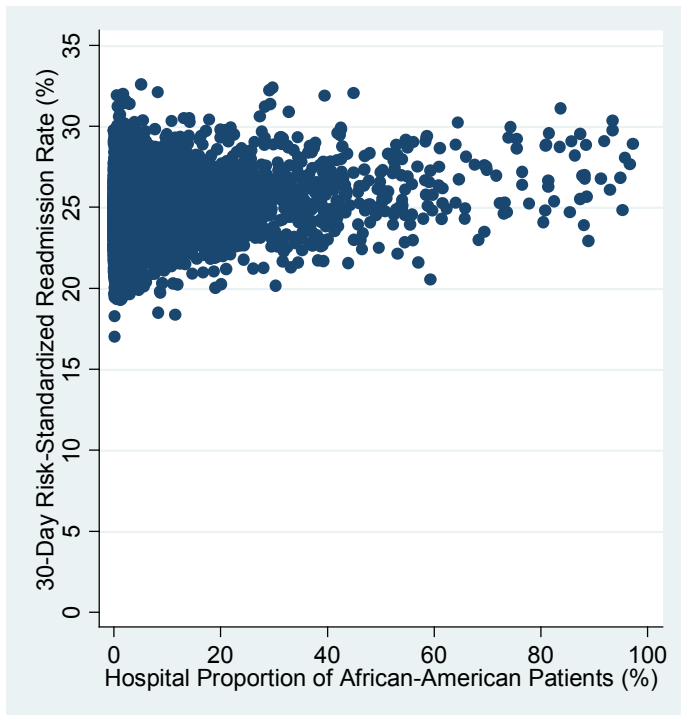
**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for: AMI = 2,546. 4) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

# How Do Hospitals with Varying Proportions of African-American Patients Perform on Heart Failure RSRRs?

**Figure 3.1b Heart Failure RSRR by Proportion of African-American Patients in the Hospital, 2007-2009**  
Medicare FFS beneficiaries aged ≥65 years

DISPARITIES AND PERFORMANCE

b.i.

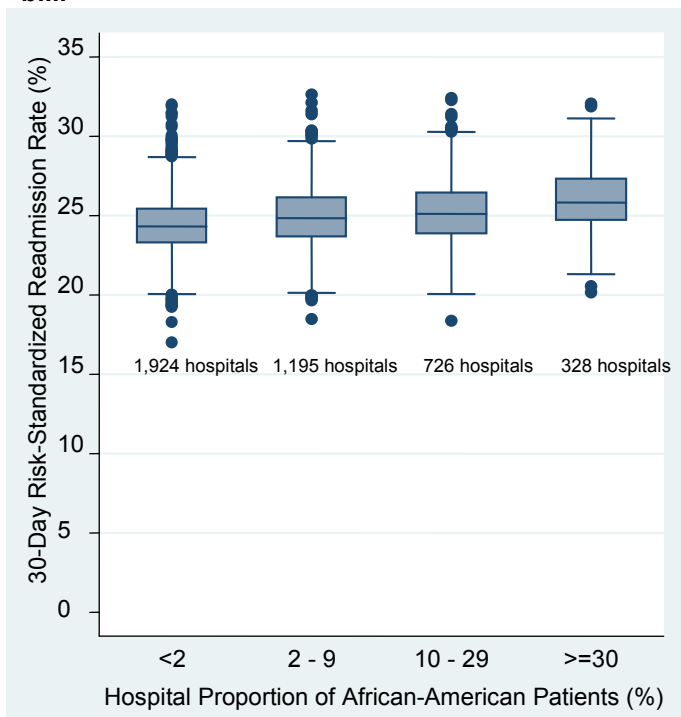


These figures and Table 3.1b below display RSRRs after admission for heart failure among U.S. hospitals categorized by the proportion of African-American patients cared for by the facility.

The scatterplot demonstrates that the vast majority of hospitals are caring for low proportions of African-American patients. Among the limited number of hospitals caring for a relatively higher proportion of African-American patients, performance varies widely, with both high and low performing hospitals (box-and-whiskers plot).

However, as shown in the box-and-whiskers plot and Table 3.1b, hospitals caring for 30% or more African-American patients have a median RSRR after heart failure 1.5% higher than those caring for <2% African-American patients.

b.ii.



**Table 3.1b Heart Failure RSRR by Proportion of African-American Patients in the Hospital, 2007-2009 (%)**

% AA Patients	N	Median	Range
<2%	1,924	24.3	17.0 - 32.0
2%-9%	1,195	24.9	18.5 - 32.6
10%-29%	726	25.1	18.4 - 32.4
≥30%	328	25.8	20.2 - 32.1

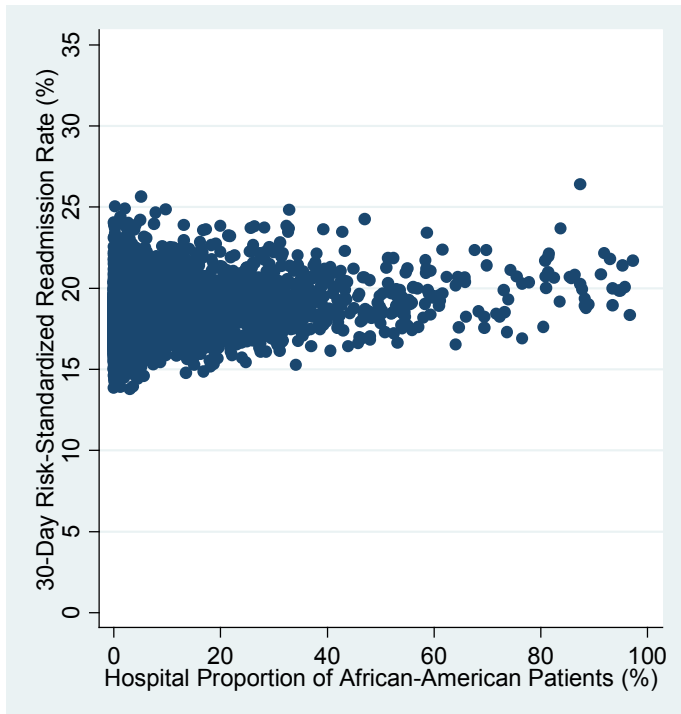
**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); 2009 Inpatient Admissions from Medicare Database (Proportion of African-American patients) (Appendix B.II).

**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for HF = 4,319. 4) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

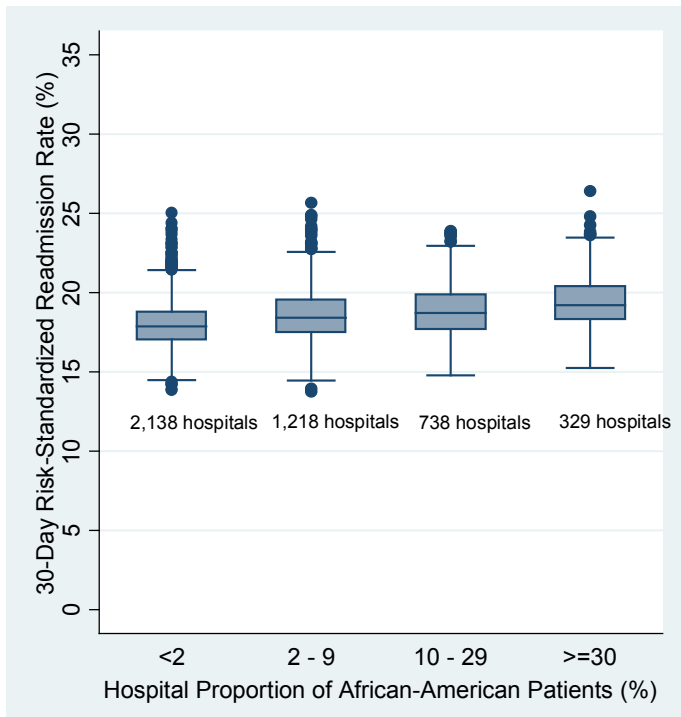
# How Do Hospitals with Varying Proportions of African-American Patients Perform on Pneumonia RSRRs?

**Figure 3.1c Pneumonia RSRR by Proportion of African-American Patients in the Hospital, 2007-2009**  
Medicare FFS beneficiaries aged ≥65 years

c.i.



c.ii.



These figures and Table 3.1c below display RSRRs after admission for pneumonia among U.S. hospitals categorized by the proportion of African-American patients cared for by the facility.

As with the AMI and heart failure measures, the scatterplot demonstrates that the vast majority of hospitals are caring for low proportions of African-American patients. Among the limited number of hospitals caring for a relatively higher proportion of African-American patients, performance varies widely, with both high and low performing hospitals (box-and-whiskers plot).

Again, as shown in the box-and-whiskers plot and Table 3.1c, hospitals caring for 30% or more African-American patients have a median RSRR after pneumonia 1.3% higher than those caring for <2% African-American patients.

**Table 3.1c Pneumonia RSRR by Proportion of African-American Patients in the Hospital, 2007-2009 (%)**

% AA Patients	N	Median	Range
<2%	2,138	17.9	13.9 - 25.0
2%-9%	1,218	18.4	13.8 - 25.7
10%-29%	738	18.7	14.8 - 23.9
≥30%	329	19.2	15.3 - 26.4

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); 2009 Inpatient Admissions from Medicare Database (Proportion of African-American patients) (Appendix B.II).  
**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for pneumonia =4,568. 4) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

DISPARITIES AND PERFORMANCE

**SECTION 3.2**

**Hospitals' Performance by Their Patients' Income**

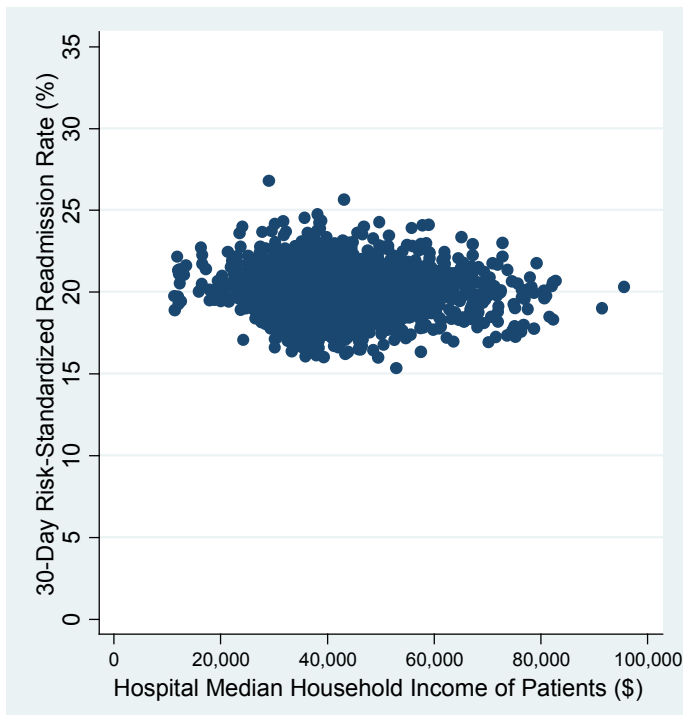


# How Do Hospitals' Performance on AMI RSRRs Vary by Patient Median Household Income?

**Figure 3.2a AMI RSRR by Patient Population Median Income, 2007-2009 (%)**

Medicare FFS beneficiaries aged ≥65 years

a.i.

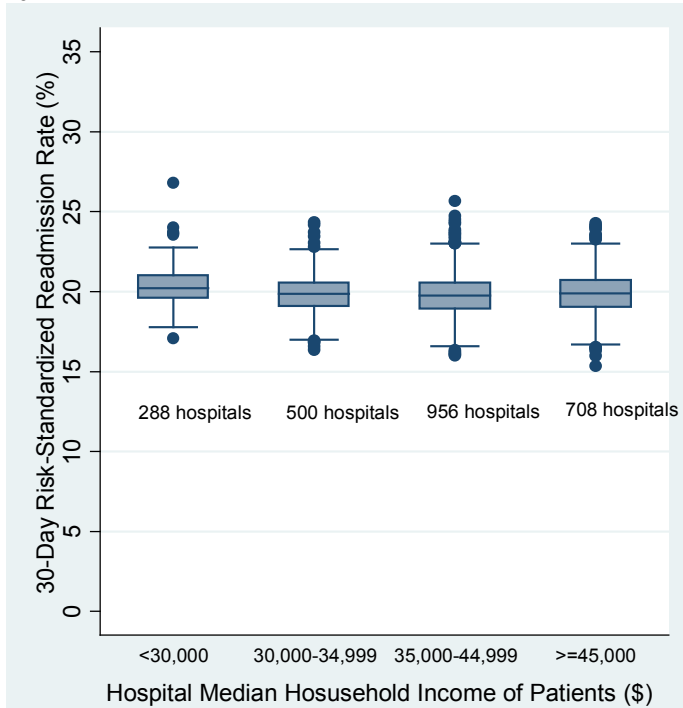


These figures and Table 3.2a below display RSRRs after admission for AMI among U.S. hospitals categorized by the patient population median income, derived from U.S. Census data.

The scatterplot demonstrates that hospitals' patient population median incomes vary widely, with no clear association between AMI RSRR and income.

The box-and-whiskers plot similarly demonstrates that AMI RSRRs range widely and similarly across U.S. hospitals, regardless of patients' median income.

a.ii.



**Table 3.2a AMI RSRR by Hospital Patient Population Median Income, 2007-2009 (%)**

Median Income	N	Median	Range
<\$30,000	288	20.2	17.1-26.8
\$30,000-\$34,999	500	19.9	16.4-24.3
\$35,000-\$44,999	956	19.8	16.0-25.7
≥ \$45,000	708	19.9	15.3-24.3

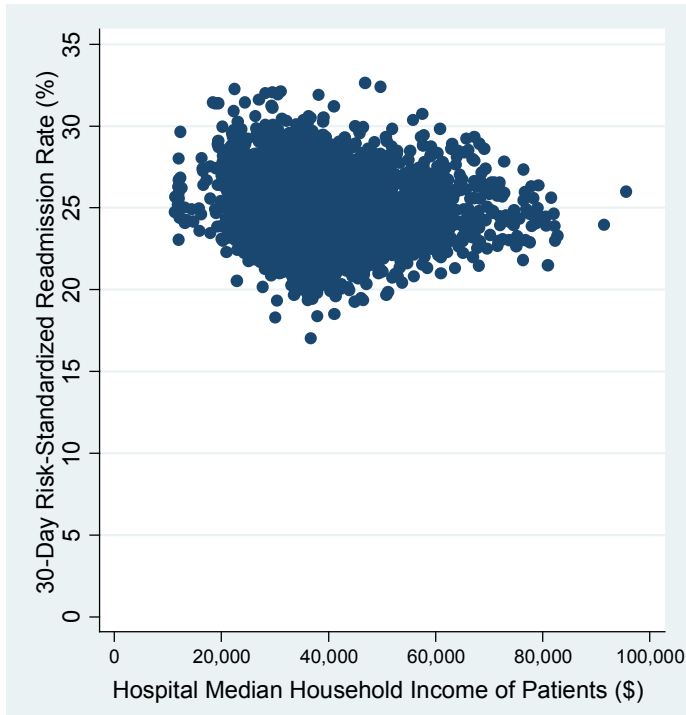
**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); 2008 Inpatient Admissions from Medicare Database (Appendix B.II) and Census 2000 data (Appendix B.III.i).

**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Income categories are estimated using median income level of patients' zip codes based on 2000 Census data. 4) Total number of hospitals included in the analysis for AMI = 2,452. 5) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

## How Do Hospitals' Performance on Heart Failure RSRRs Vary by Patient Median Household Income?

**Figure 3.2b Heart Failure RSRR by Hospital Patient Population Median Income, 2007-2009 (%)**  
Medicare FFS beneficiaries aged ≥65 years

b.i.

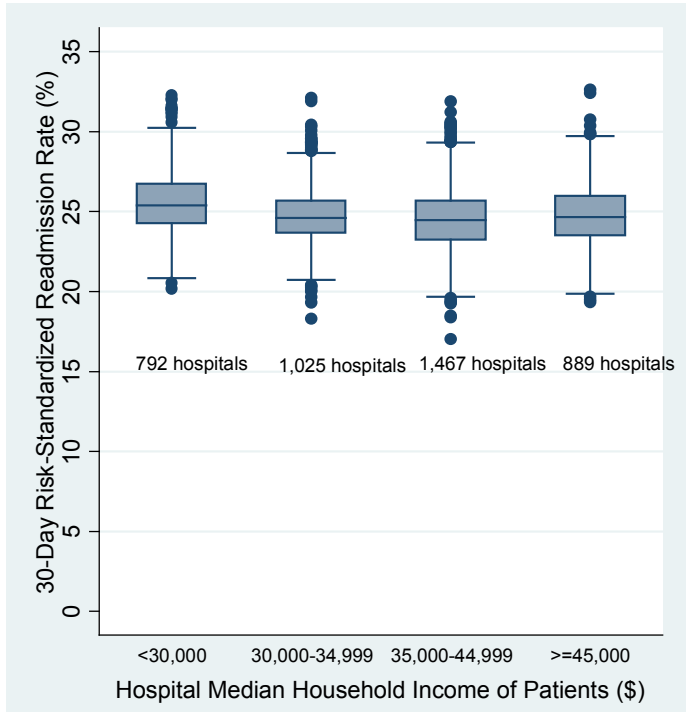


These figures and Table 3.2b below display RSRRs after admission for heart failure among U.S. hospitals categorized by the patient population median income, derived from U.S. Census data.

Again, the scatterplot demonstrates that hospitals' patient population median incomes vary widely, with no clear association between heart failure RSRR and income.

The box-and-whiskers plot similarly demonstrates that heart failure RSRRs range widely among U.S. hospitals, regardless of patients' median income. Hospitals caring for the patients of lowest income have a median RSRR that is less than 1% higher than those with the highest income patient group.

b.ii.



**Table 3.2b Heart Failure RSRR by Hospital Patients Population Median Income, 2007-2009 (%)**

Median Income	N	Median	Range
<\$30,000	792	25.4	20.2-32.3
\$30,000-\$34,999	1,025	24.6	18.3-32.1
\$35,000-\$44,999	1,467	24.5	17.0-31.9
≥\$ 45,000	889	24.7	19.4-32.6

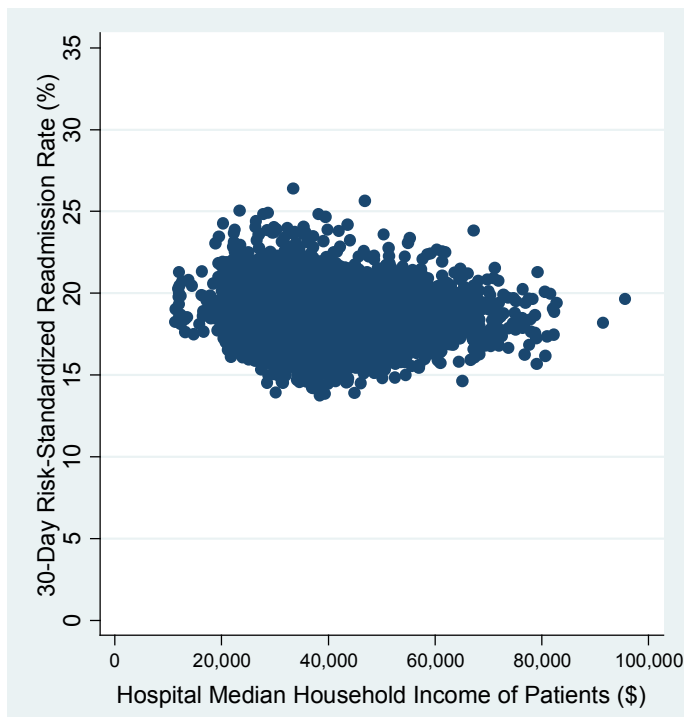
**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); 2008 Inpatient Admissions from Medicare Database (Appendix B.II) and Census 2000 data (Appendix B.III.i).

**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Income categories are estimated using median income level of patients' zip codes based on 2000 Census data. 4) Total number of hospitals included in the analysis for HF = 4,173. 5) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

## How Do Hospitals' Performance on Pneumonia RSRRs Vary by Patient Median Household Income?

**Figure 3.2c Pneumonia RSRR by Hospital Patient Population Median Income, 2007-2009 (%)**  
Medicare FFS beneficiaries aged ≥65 years

c.i.

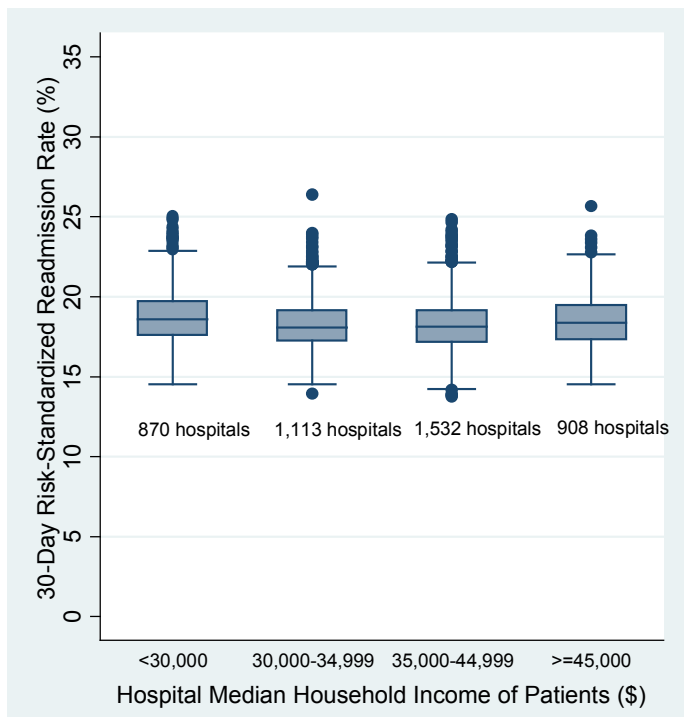


These figures and Table 3.2c below display RSRRs after admission for pneumonia among U.S. hospitals categorized by the patient population median income, derived from U.S. Census data.

Consistent with both the AMI and heart failure readmission measures, the scatterplot demonstrates that hospital patient populations' median incomes vary widely, with no clear association between pneumonia RSRR and income.

The box-and-whiskers plot similarly demonstrates that pneumonia RSRRs are widely distributed and consistent across U.S. hospitals, regardless of patients' median income.

c.ii.



**Table 3.2c Pneumonia RSRR by Hospital Patient Population Median Income, 2007-2009 (%)**

Median Income	N	Median	Range
<\$30,000	870	18.6	14.5-25.0
\$30,000-\$34,999	1,113	18.1	13.9-26.4
\$35,000-\$44,999	1,532	18.1	13.8-24.8
≥ \$45,000	908	18.4	14.5-25.7

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); 2008 Inpatient Admissions from Medicare Database (Appendix B.II) and Census 2000 data (Appendix B.III.i).

**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Income categories are estimated using median income level of patients' zip codes based on 2000 Census data. 4) Total number of hospitals included in the analysis for pneumonia = 4,423. 5) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

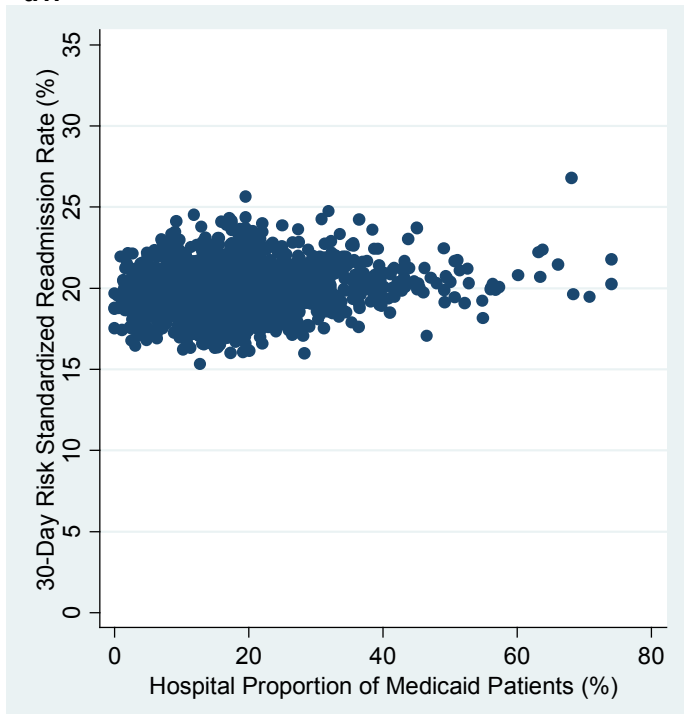
**SECTION 3.3**

**Hospitals' Performance by Their Patients' Medicaid Status**

# How Do Hospitals' Performance on AMI RSRRs Vary by Proportion of Patients Enrolled in Medicaid?

**Figure 3.3a AMI RSRR by Hospital Proportion of Medicaid Patients, 2007-2009**  
 Medicare FFS beneficiaries aged ≥65 years

a1.

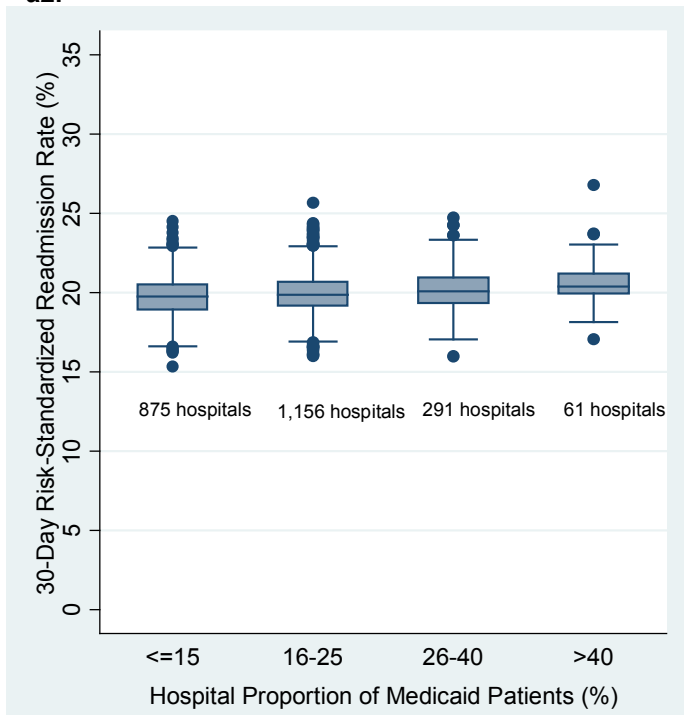


These figures and Table 3.3a below display RSRRs after admission for AMI among U.S. hospitals categorized by the proportion of Medicaid patients cared for by the facility as defined by American Hospital Association (AHA) data.

The scatterplot demonstrates that a limited number of hospitals have 40% or more Medicaid patients, and their performance varies widely, with both high and low performing hospitals.

The box-and-whiskers plot demonstrates that the range of RSRRs is wide and similar across U.S. hospitals, regardless of hospitals' proportion of Medicaid patients. However, hospitals caring for 40% or more Medicaid patients have a marginally higher median RSRR after AMI.

a2.



**Table 3.3a AMI RSRR by Hospital Proportion of Medicaid Patients, 2007-2009 (%)**

% Medicaid	N	Median	Range
≤15%	875	19.8	15.3-24.5
16-25%	1,156	19.9	16.0-25.7
26-40%	291	20.1	16.0-24.8
>40%	61	20.4	17.1-26.8

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); American Hospital Association (AHA) data to derive Medicaid eligibility rate (Appendix B.III.ii).

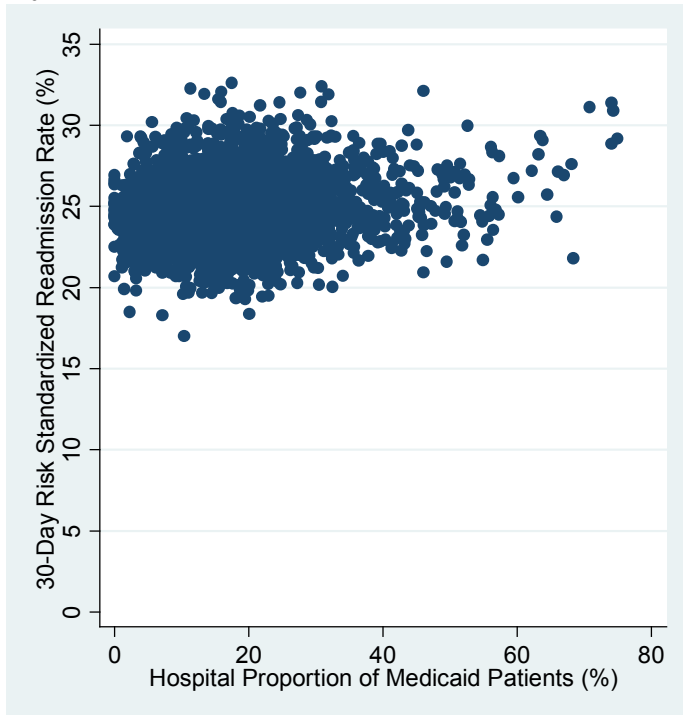
**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for AMI = 2,383. 4) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

## How Do Hospitals' Performance on Heart Failure RSRRs Vary by Proportion of Patients Enrolled in Medicaid?

**Figure 3.3b Heart Failure RSRR by Hospital Proportion of Medicaid Patients, 2007-2009\***

Medicare FFS beneficiaries aged ≥65 years

b.i.

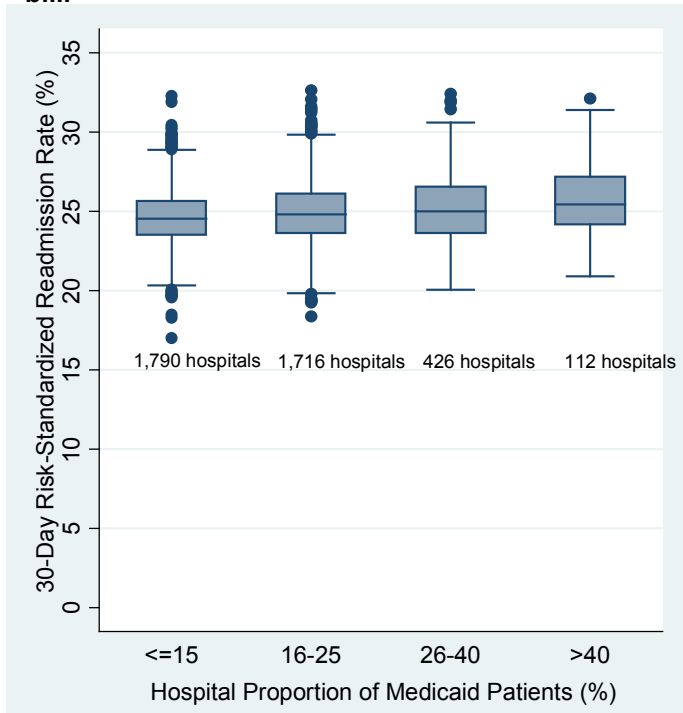


These figures and Table 3.3b below display RSRRs after admission for heart failure among U.S. hospitals categorized by the proportion of Medicaid patients cared for by the facility as defined by AHA data.

The scatterplot demonstrates that a limited number of hospitals have 40% or more Medicaid patients, and their performance varies widely, with both high and low performing hospitals.

The box-and-whiskers plot demonstrates that RSRRs are wide and similar across U.S. hospitals, regardless of hospitals' proportion of Medicaid patients. However, hospitals caring for 40% or more Medicaid patients have a marginally higher median RSRR after heart failure.

b.ii.



**Table 3.3b Heart Failure RSRR by Hospital Proportion of Medicaid Patients, 2007-2009 (%)**

% Medicaid	N	Median	Range
≤15%	1,790	24.6	17.0-32.3
16-25%	1,716	24.8	18.4-32.6
26-40%	426	25.0	20.1-32.4
>40%	112	25.4	20.9-32.1

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); American Hospital Association data to derive Medicaid eligibility rate (Appendix B.III.ii).

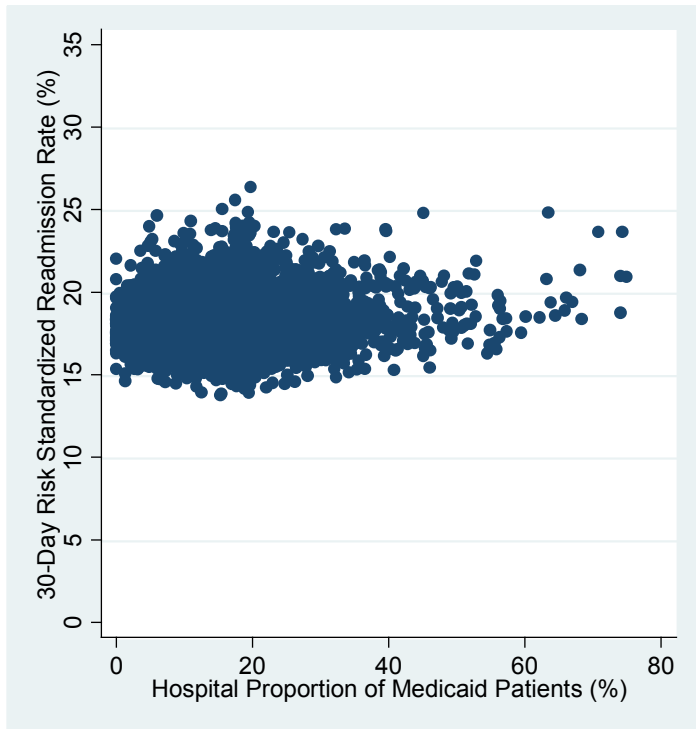
**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for HF = 4,044. 4) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

## How Do Hospitals' Performance on Pneumonia RSRRs Vary by Proportion of Patients Enrolled in Medicaid?

**Figure 3.3c Pneumonia RSRR by Hospital Proportion of Medicaid Patients, 2007-2009**

Medicare FFS beneficiaries aged ≥65 years

c1.

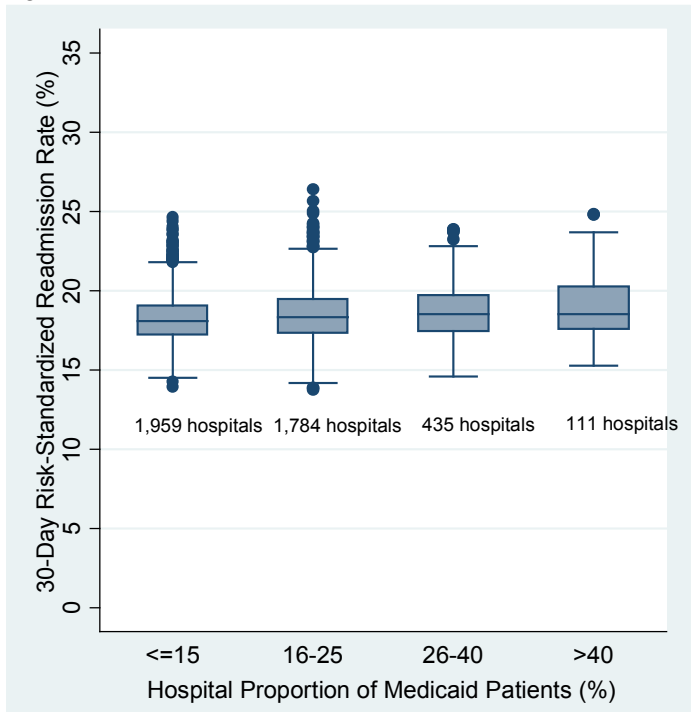


These figures and Table 3.3c below display RSRRs after admission for pneumonia among U.S. hospitals categorized by the proportion of Medicaid patients cared for by the facility as defined by AHA data.

The scatterplot demonstrates that a limited number of hospitals have 40% or more Medicaid patients, and their performance varies widely, with both high and low performing hospitals.

The box-and-whiskers plot demonstrates that RSRRs are wide and similar across U.S. hospitals, regardless of hospitals' proportion of Medicaid patients. However, hospitals caring for 40% or more Medicaid patients have a marginally higher median RSRR after pneumonia.

c2.



**Table 3.3c Pneumonia RSRR by Hospital Proportion of Medicaid Patients, 2007-2009 (%)**

% Medicaid	N	Median	Range
≤15%	1,959	18.1	13.9-24.7
16-25%	1,784	18.3	13.8-26.4
26-40%	435	18.5	14.6-23.9
>40%	111	18.5	15.3-24.8

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); American Hospital Association (AHA) data to derive Medicaid eligibility rate (Appendix B.III.ii).

**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for pneumonia= 4,289. 4) Interpretation of box-and-whisker plot and scatterplot is discussed in Appendix E.

## SECTION THREE

# Disparities and Performance

### *Summary*

#### **Overall**

- Hospitals serving more vulnerable populations, such as those with a high proportion of African-American patients, low patient median income, and high proportion of Medicaid patients, have a wide range of performance.
- However, hospitals with the highest percentages of African-American patients and, to a lesser extent, those hospitals with higher proportions of Medicaid patients, had higher RSRRs, even as there was substantial overlap across all hospitals.
- There are high performing hospitals serving vulnerable populations and examining these hospitals more closely may provide valuable insights into how to translate their successes to peer hospitals to reduce disparities.

#### **Hospitals' Performance by their Patients' Race**

- African-American patients make up fewer than 10% of hospitals' patient populations for a large majority of hospitals.
- RSRRs for all conditions vary widely regardless of hospitals' proportion of African-American patients, with examples of both high and low performing hospitals among those with high proportions of African-American patients.
- Median RSRRs among hospitals serving the highest proportions of African-American patients (30% or greater) are 1.0% to 1.5% higher than the median values among hospitals serving fewer than 2% African-American patients.

#### **Hospitals' Performance by their Patients' Income**

- Median income levels for the patient populations hospitals serve, as defined by U.S. Census data, are relatively evenly distributed among hospitals.
- RSRRs for all three conditions vary widely by a hospitals' patient population median income, with examples of both high and low performing hospitals among those with low median incomes.
- Median RSRRs among hospitals serving the lowest income patients are only 0.3% (or less) higher than the median values among hospitals serving the wealthiest areas.

#### **Hospitals' Performance by their Patients' Medicaid Status**

- Medicaid patients make up fewer than 40% of hospitals' patient populations for the vast majority of hospitals in all readmission measures.
- RSRRs for all three conditions vary widely by a hospitals' proportion of Medicaid patients, with examples of high and low performing hospitals among those with a high proportion of Medicaid patients
- There are no clear relationships between the proportion of a hospital's patients that are in Medicaid and RSRR for the three readmission measures.
- Median RSRRs among hospitals serving over 40% Medicaid patients are less than 1% higher than the median values among hospitals serving less than 15% Medicaid patients.



## SECTION FOUR

# Hospital Characteristics

### *Background*

This section of analyses provides several examinations into hospital performance estimated using RSRRs as a measure of quality of care by key hospital characteristics.

Certain types of hospitals are generally expected to have better performance, including those with greater financial and clinical resources. Therefore, we carefully examined the association between certain hospital characteristics and RSRRs.

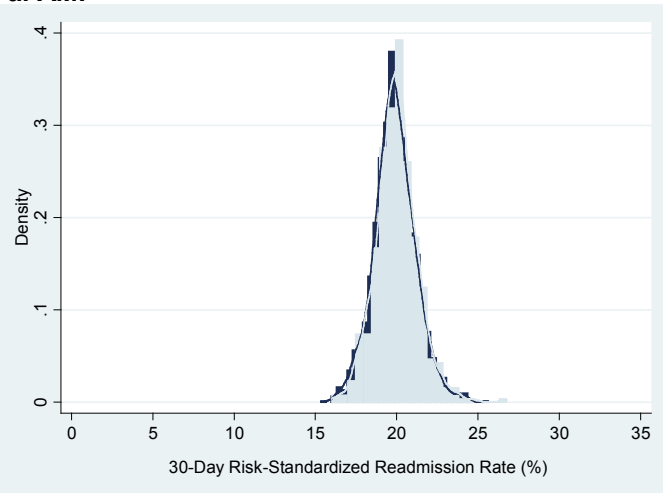
In the following section, we examine RSRRs among safety net and non-safety net hospitals (Figure 4.1), teaching and non-teaching hospitals (Figure 4.2), and urban, large rural, small rural, and remote rural hospitals (Figure 4.3), respectively. Due to data limitations, VA hospitals were excluded from these analyses.

# Is Hospital Performance Related to Safety Net Status?

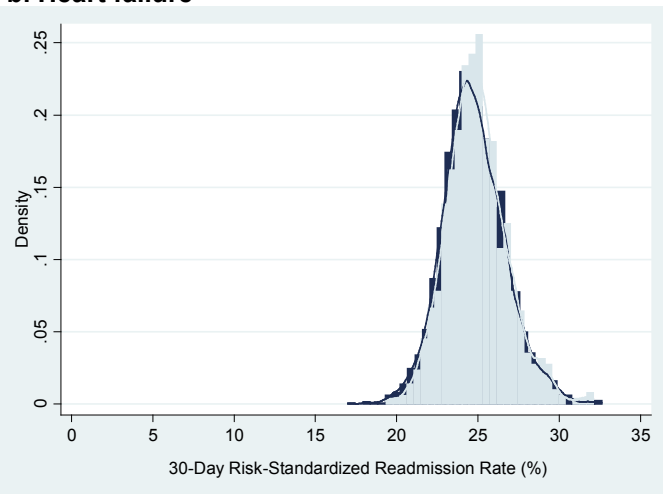
**Figure 4.1 RSRR by Hospital Safety Net Status, 2007-2009\***

Medicare FFS beneficiaries aged ≥65 years

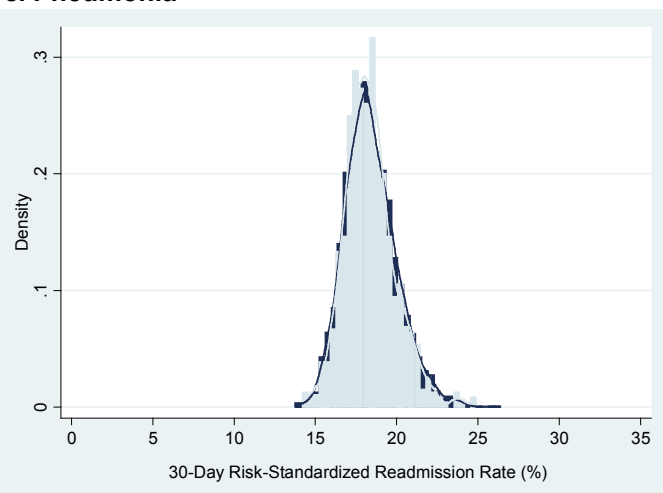
**a. AMI**



**b. Heart failure**



**c. Pneumonia**



■ Safety net ■ Non-Safety net

These figures and Table 4.1 below display distributions of hospital RSRRs after admission for AMI, heart failure, and pneumonia among safety net (pale blue) and non-safety net (dark blue) hospitals. Safety net hospitals are defined as those committed to caring for populations without stable access to care, specifically public hospitals or private hospitals with a Medicaid caseload greater than one standard deviation above their respective state's mean private hospital Medicaid caseload [AHA data].

There is a substantial overlap in distributions of hospital RSRRs among safety net and non-safety net hospitals for all three conditions and minimal differences in performance.

**Table 4.1 RSRR by Hospital Safety Net Status, 2007-2009 (%)**

Condition	N	Safety Net		Non-Safety Net		
		Median	Range	N	Median	Range
AMI	524	20.0	16.0 – 26.8	1,859	19.8	15.3 – 25.7
Heart failure	1206	24.8	19.4 – 32.1	2,838	24.7	17.0 – 32.6
Pneumonia	1345	18.2	14.2 – 24.9	2,944	18.3	13.8 – 26.4

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007–December 2009 (RSRR) (Appendix B. I); American Hospital Association 2008 Annual Survey data (Safety-net status) (Appendix B.III.ii).

**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Safety net hospitals are defined as those committed to caring for populations without stable access to care, specifically public hospitals or private hospitals with a Medicaid caseload greater than one standard deviation above their respective state's mean private hospital Medicaid caseload. 4) This analysis compares RSRRs by safety net status only among urban hospitals to allow for better comparison of the safety net and non-safety net hospitals. 5) Total number of hospitals included in the analysis for: AMI = 2,383; heart failure = 4,044; and pneumonia = 4,289. 6) Interpretation of overlapping histogram is discussed in Appendix E.

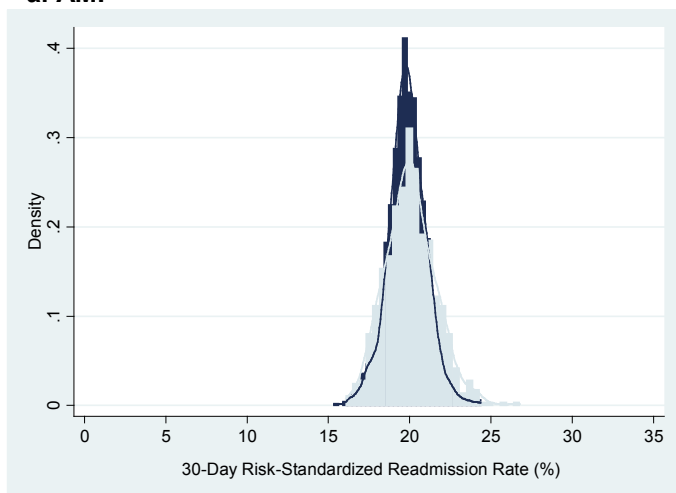
\* The y-axis represents density instead of number of hospitals to facilitate comparison between the two types of hospitals with different sample sizes.

# Is Hospital Performance Related to Teaching Status?

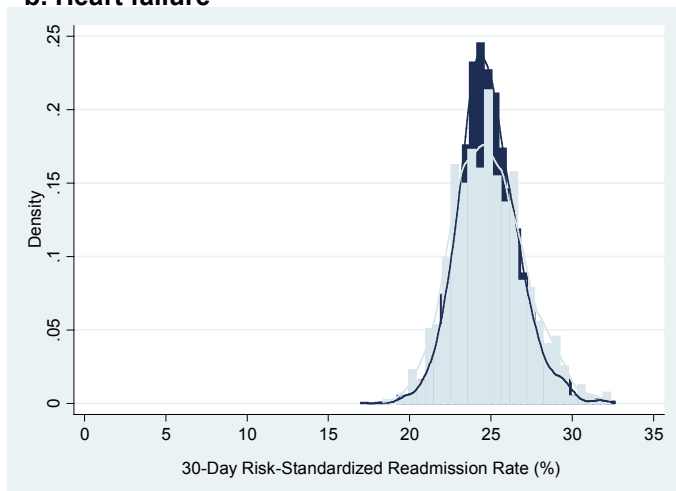
**Figure 4.2 RSRR by Hospital Teaching Status, 2007-2009\***

Medicare FFS beneficiaries aged ≥65 years

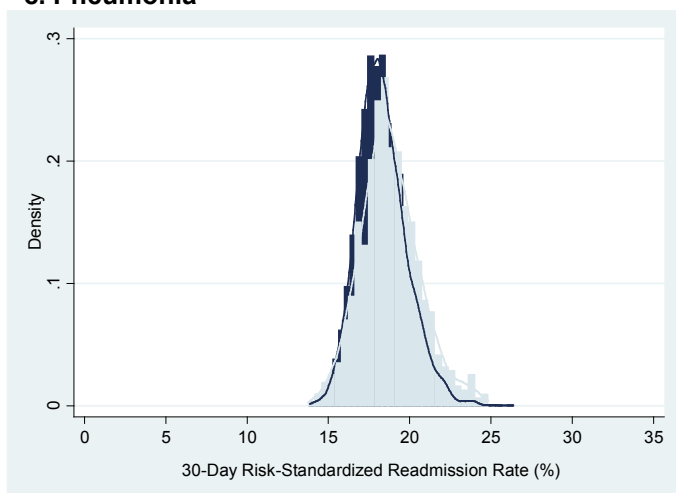
**a. AMI**



**b. Heart failure**



**c. Pneumonia**



Teaching Non-Teaching

These figures and Table 4.2 below display distributions of hospital RSRRs after admission for AMI, heart failure, and pneumonia among teaching (pale blue) and non-teaching (dark blue) hospitals, as defined by AHA data. Teaching hospitals provide post-graduate education for physicians completing residency and fellowship.

RSRRs after admission for pneumonia are slightly higher among teaching hospitals, but no different after admission for heart failure or AMI.

There is a substantial overlap in distributions of hospital RSRRs among teaching and non-teaching hospitals for all three conditions and minimal differences in performance.

HOSPITAL CHARACTERISTICS

**Table 4.2 RSRR by Hospital Teaching Status, 2007-2009 (%)**

Condition	Teaching			Non-Teaching		
	N	Median	Range	N	Median	Range
AMI	695	20.0	16.1 – 26.8	1,688	19.8	15.3 – 24.4
Heart failure	757	24.8	18.4 – 32.4	3,287	24.7	17.0 – 32.6
Pneumonia	763	18.6	13.8 – 24.8	3,526	18.2	13.9 – 26.4

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.i); American Hospital Association 2008 Annual Survey data (Teaching status) (Appendix B.iii.ii).  
**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for: AMI = 2383; heart failure = 4,044; and pneumonia = 4,289. 4) Interpretation of overlapping histogram is discussed in Appendix E.

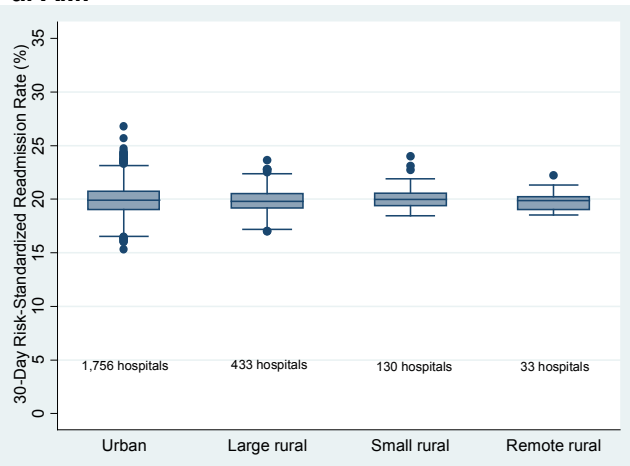
\* The y-axis represents density instead of number of hospitals to facilitate comparison between the two types of hospitals with different sample sizes.

## Is Hospital Performance Related to the Rural Status of a Hospital?

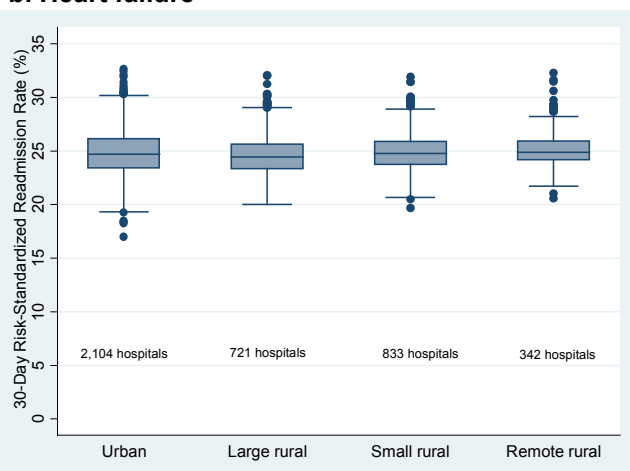
**Figure 4.3 RSRR by Hospital Location, 2007-2009**

Medicare FFS beneficiaries aged ≥65 years

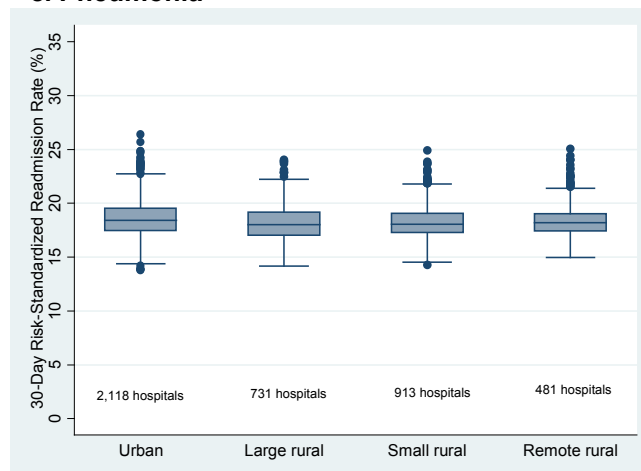
### a. AMI



### b. Heart failure



### c. Pneumonia



These figures and Table 4.3 below display box-and-whisker distributions of hospital RSRRs after admission for AMI, heart failure, and pneumonia among hospitals located in urban, large rural, small rural and remote rural areas, as defined by Department of Agriculture data.

RSRRs are similar across U.S. hospitals, regardless of geographic location with no notable differences except for slightly higher RSRRs after admission for pneumonia among urban hospitals and a narrow distribution among the remote rural hospitals for AMI RSRR.

**Table 4.3 RSRR by Hospital Location, 2007- 2009 (%)**

Condition	Urban		Large Rural		Small Rural		Remote Rural	
	Median	Range	Median	Range	Median	Range	Median	Range
<b>AMI</b>	19.9	15.3 – 26.8	19.8	17.0 – 23.7	20.0	18.5 – 24.0	19.9	18.5 – 22.2
<b>Heart failure</b>	24.7	17.0 – 32.6	24.4	20.0 – 32.1	24.8	19.7 – 31.9	24.9	20.6 – 32.3
<b>Pneumonia</b>	18.4	13.8 – 26.4	18.0	14.2 – 24.0	18.1	14.3 – 24.9	18.2	15.0 – 25.0

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (RSRR) (Appendix B.I); The United States Department of Agriculture 2000 Rural-Urban Commuting Area (Appendix B.III.ii).

**Notes:** 1) Veterans Health Administration (VA) hospitals are NOT included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for: AMI = 2,352; HF = 4,000; and pneumonia = 4,243. 4) Interpretation of box-and-whisker plot is discussed in Appendix E.

## SECTION FOUR

### Hospital Characteristics

#### *Summary*

#### **Overall**

- There is a substantial overlap in distributions of RSRRs among hospitals regardless of their greater financial or clinical resources, including minimal differences in performance among safety net and non-safety net hospitals, teaching and non-teaching hospitals, and urban, large rural, small rural, and remote rural hospitals.

#### **Safety Net Status**

- Safety net hospitals have a similar range of performance as non-safety net hospitals when measured using RSRRs despite caring for a larger number of vulnerable patients.
- Median RSRRs are 0.2% higher among safety net hospitals after admission for AMI compared to non-safety net hospitals, but equivalent after admission for heart failure and pneumonia.

#### **Teaching Status**

- Teaching hospitals have a similar range of performance as non-teaching hospitals when measured using RSRRs despite providing educational services to inexperienced physicians in-training.
- Median RSRRs are 0.4% higher among teaching hospitals after admission for pneumonia compared to non-teaching status hospitals, but less than or equal to 0.2% higher after admission for AMI and heart failure.

#### **Rural Status**

- Hospitals have a similar range of performance across geographic locations despite patients at more remote hospitals confronting challenges in access to care and greater distance to providers.



## SECTION FIVE

### Readmission across Conditions

#### *Background*

This section provides insight into how to maximize efforts to reduce hospital readmission.

We examined the correlation among RSRRs for each of the three conditions to provide insight into whether a hospital's performance on one measure correlates with its performance on another. This analysis addresses the question of how consistent hospital quality, as measured by RSRRs, is across conditions.

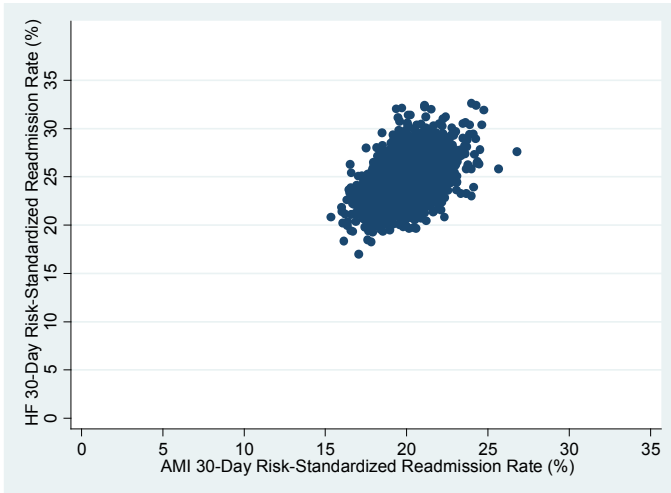
This analysis incorporates data from VA hospitals.

## Are RSRRs Correlated among Different Conditions?

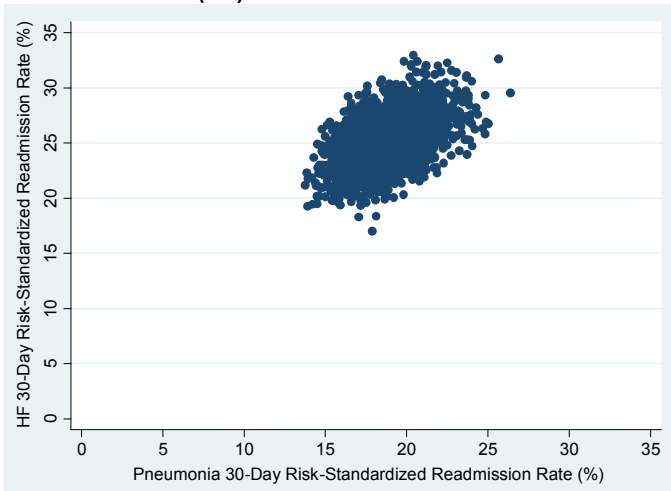
**Figure 5.1 Correlation of RSRRs across Conditions, 2007-2009**

Medicare FFS beneficiaries and VA beneficiaries aged ≥65 years

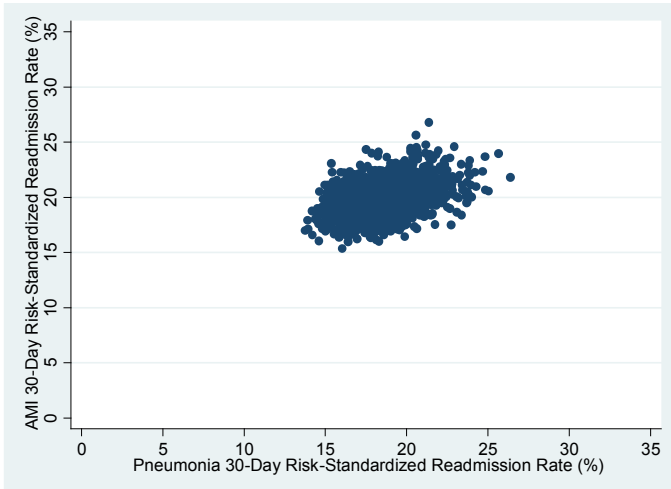
### a. Heart Failure (HF) and AMI



### b. Heart Failure (HF) and Pneumonia



### c. AMI and Pneumonia



These figures and Table 5.1 below display correlations of RSRRs after admission for AMI, heart failure, and pneumonia among U.S. hospitals, including VA hospitals.

Because RSRRs are designed to measure certain components of hospitals' quality of care, we expect that hospitals' RSRRs after admissions for the three different medical conditions would be at least moderately correlated.

No pair of RSRRs was so strongly correlated that one could be predicted by another.

Nevertheless, each pair of RSRRs was moderately correlated. Correlations between the RSRRs for heart failure and both AMI and pneumonia were of the largest magnitude, such that heart failure RSRR explained a substantial proportion of the variation in AMI and pneumonia RSRRs.

However, no RSRR was sufficiently correlated with another to obviate the need for reporting condition-specific RSRRs.

**Table 5.1 Correlation of RSRRs across Conditions, 2007-2009 (%)**

	AMI	Heart Failure	Pneumonia
AMI	1.00	0.53 ( $<.0001$ )	0.42 ( $<.0001$ )
Heart Failure	...	1.00	0.54 ( $<.0001$ )
Pneumonia	...	...	1.00

**Source Data and Population:** Condition-specific RSRR Measure Cohorts—January 2007-December 2009 (Appendix B.I).

**Notes:** 1) Veterans Health Administration (VA) hospitals are included in this analysis. 2) The results of hospitals with fewer than 25 cases of the condition over the three-year period are not shown; however these hospitals have been included in RSRR calculations. 3) Total number of hospitals included in the analysis for: heart failure and AMI = 2,545; pneumonia and heart failure = 4,284; and AMI and pneumonia = 2,536. 4) Interpretation of scatterplot is discussed in Appendix E.



## SECTION FIVE

### Readmission across Conditions

#### *Summary*

Hospitals' RSRRs after admissions for three different medical conditions were moderately correlated, suggesting that condition-specific RSRRs reflect a signal of both overall hospital quality and condition-specific quality.

No RSRR was sufficiently correlated with another to obviate the need for the other RSRRs.

# Appendix A – Changes in Analyses from 2010 Chartbook

A number of analyses were modified somewhat to provide more refined insight into hospital performance:

- Annual RSRR trend analyses used hospital exclusion criteria of less than 10 condition-specific discharges per year, as opposed to less than 25, to include more hospitals.
- Hospital characteristics based on patient populations, such as the proportion of Medicaid patients, were estimated from the complete hospital patient population, as opposed to the condition-specific population.

# Appendix B – Chartbook Cohorts

## I. *Condition-specific RSRR Measure Cohort – January 2007-December 2009*

### Cohort Definition<sup>2</sup>

The cohort includes admissions for Medicare fee-for-service (FFS) beneficiaries and Veterans Health Administration (VA) patients aged >65 years discharged from non-federal acute care hospitals or VA hospitals with a principal discharge diagnosis of AMI, heart failure, or pneumonia, respectively, and with a complete claims history for 12 months prior to admission date (This requirement is dropped for patients with an index admission within a VA hospital.). The data set includes hospitalizations with discharge dates between January 1, 2007 and December 31, 2009 (except for Section Two Regional Variation which includes hospitalizations with discharge dates between July 1, 2007 and June 30, 2010).

Note: VA patients are not included in the cohort for the Section Three Hospital Characteristics analyses or Section Four Readmission across Conditions analyses.

### ICD-9 codes defining AMI, heart failure, and pneumonia

#### i. *Acute Myocardial Infarction (AMI)*

410.00	AMI (anterolateral wall) – episode of care unspecified
410.01	AMI (anterolateral wall) – initial episode of care
410.10	AMI (other anterior wall) – episode of care unspecified
410.11	AMI (other anterior wall) – initial episode of care
410.20	AMI (inferolateral wall) – episode of care unspecified
410.21	AMI (inferolateral wall) – initial episode of care
410.30	AMI (inferoposterior wall) – episode of care unspecified
410.31	AMI (inferoposterior wall) – initial episode of care
410.40	AMI (other inferior wall) – episode of care unspecified
410.41	AMI (other inferior wall) – initial episode of care
410.50	AMI (other lateral wall) – episode of care unspecified
410.51	AMI (other lateral wall) – initial episode of care

410.60	AMI (true posterior wall) – episode of care unspecified
410.61	AMI (true posterior wall) – initial episode of care
410.70	AMI (subendocardial) – episode of care unspecified
410.71	AMI (subendocardial) – initial episode of care
410.80	AMI (other specified site) – episode of care unspecified
410.81	AMI (other specified site) – initial episode of care
410.90	AMI (unspecified site) – episode of care unspecified
410.91	AMI (unspecified site) – initial episode of care

ii. *Heart Failure*

402.01	Hypertensive heart disease, malignant, with heart failure
402.11	Hypertensive heart disease, benign, with heart failure
402.91	Hypertensive heart disease, unspecified, with heart failure
404.01	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.03	Hypertensive heart and chronic kidney disease, malignant, with heart failure and with chronic kidney disease stage V or end stage renal disease
404.11	Hypertensive heart and chronic kidney disease, benign, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.13	Hypertensive heart and chronic kidney disease, benign, with heart failure and chronic kidney disease stage V or end stage renal disease
404.91	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and with chronic kidney disease stage I through stage IV, or unspecified
404.93	Hypertensive heart and chronic kidney disease, unspecified, with heart failure and chronic kidney disease stage V or end stage renal disease
428.0	Congestive heart failure, unspecified
428.1	Left heart failure
428.20	Unspecified systolic heart failure
428.21	Acute systolic heart failure
428.22	Chronic systolic heart failure
428.23	Acute on chronic systolic heart failure
428.30	Unspecified diastolic heart failure
428.31	Acute diastolic heart failure
428.32	Chronic diastolic heart failure
428.33	Acute or chronic diastolic heart failure
428.40	Unspecified combined systolic and diastolic heart failure
428.41	Acute combined systolic and diastolic heart failure
428.42	Chronic combined systolic and diastolic heart failure
428.43	Acute on chronic combined systolic and diastolic heart failure

428.9	Heart failure, unspecified
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iii. *Pneumonia*

480.0	Pneumonia due to adenovirus
480.1	Pneumonia due to respiratory syncytial virus
480.2	Pneumonia due to parainfluenza virus
480.3	Pneumonia due to SARS associated coronavirus
480.8	Viral pneumonia: pneumonia due to other virus not elsewhere classified
480.9	Viral pneumonia unspecified
481	Pneumococcal pneumonia [streptococcus pneumoniae pneumonia]
482.0	Pneumonia due to klebsiella pneumoniae
482.1	Pneumonia due to pseudomonas
482.2	Pneumonia due to hemophilus influenzae (h. influenzae)
482.30	Pneumonia due to streptococcus unspecified
482.31	Pneumonia due to streptococcus group a
482.32	Pneumonia due to streptococcus group b
482.39	Pneumonia due to other streptococcus
482.40	Pneumonia due to staphylococcus unspecified
482.41	Methicillin susceptible pneumonia due to staphylococcus aureus
482.42	Methicillin resistant pneumonia due to staphylococcus aureus
482.49	Other staphylococcus pneumonia
482.81	Pneumonia due to anaerobes
482.82	Pneumonia due to escherichia coli [e.coli]
482.83	Pneumonia due to other gram negative bacteria
482.84	Pneumonia due to legionnaires' disease
482.89	Pneumonia due to other specified bacteria
482.9	Bacterial pneumonia unspecified
483.0	Pneumonia due to mycoplasma pneumoniae
483.1	Pneumonia due to chlamydia
483.8	Pneumonia due to other specified organism
485	Bronchopneumonia organism unspecified
486	Pneumonia organism unspecified
487.0	Influenza with pneumonia
488.11	Influenza due to identified novel H1N1 influenza virus with pneumonia

## Exclusion Criteria

The measures exclude admissions for patients:

- With an in-hospital death (because they are not eligible for readmission).
- Without at least 30 days post-discharge enrollment in FFS Medicare (because the 30-day readmission outcome cannot be assessed in this group). This exclusion applies only to patients who have index admissions in non-VA hospitals.
- Who were transferred to another acute care facility as described below (because we are focusing on discharges to non-acute care settings).
- Who were discharged against medical advice (AMA) (because providers did not have the opportunity to deliver full care and prepare the patient for discharge).

Full details of the development of the risk-standardization model for the readmission measures are available at: [2010 Measures Maintenance Technical Report: Acute Myocardial Infarction, Heart Failure, and Pneumonia 30-Day Risk-Standardized Readmission Measures](#).

## **II. Condition-specific Inpatient Admissions from Medicare Database Cohort**

### Cohort Definition

The cohort includes admissions for Medicare FFS beneficiaries with enrollment status at the time of admission aged  $\geq 65$  years discharged from non-federal acute care hospitals. The data set is derived from linking Part A inpatient claims data from the Medicare Provider Analysis and Review (MedPAR) File with the Medicare Denominator File for each year. We obtain the FFS status for the admissions from the Medicare Denominator File. The ICD-9 codes defining AMI, heart failure, and pneumonia are listed under the RSRR Measure Cohort.

## **III. Other Data Sources**

- i. Census 2000 data<sup>3</sup>
  - Five digit zip code level data was downloaded.
  - This data was used to estimate proportion of patients from zip code with median household income  $< 35,000$ .
- ii. American Hospital Association (AHA) Annual Survey Database Fiscal Year 2008<sup>4</sup>
  - This data was used to determine teaching status, safety net status, proportion of Medicaid patients in the hospital, and census regions of hospitals.
- iii. The United States Department of Agriculture 2000 Rural-Urban Commuting Area Codes<sup>5</sup>
  - This data was used to determine hospital location.

<sup>3</sup> [http://factfinder.census.gov/home/saff/main.html?\\_lang=en](http://factfinder.census.gov/home/saff/main.html?_lang=en)

<sup>4</sup> <http://www.ahadata.com/ahadata/html/AHASurvey.html>

<sup>5</sup> <http://www.ers.usda.gov/briefing/Rurality/RuralUrbanCommuntingAreas/>

## Appendix C – Unadjusted Readmission Rates

Distribution of Unadjusted Hospital Readmission Rates, 2009 (%)

	AMI	Heart failure	Pneumonia
Maximum Rate	66.7	70.0	53.3
75 <sup>th</sup> Percentile	25.0	28.4	21.7
Median (50 <sup>th</sup> Percentile)	20.0	23.9	17.6
25 <sup>th</sup> Percentile	15.4	19.8	13.6
Minimum Rate	0.0	0.0	0.0

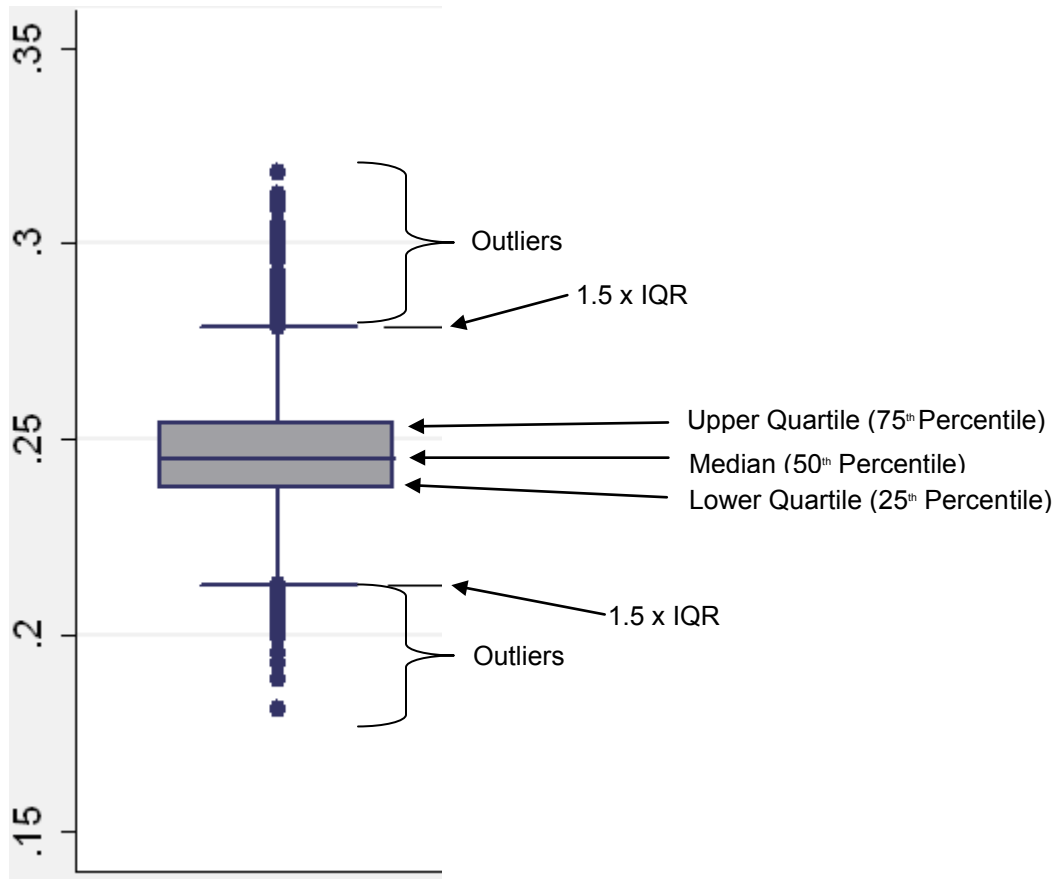
## Appendix D – HRR Ranking Methodology

### Hospital Referral Region (HRR) Ranking Methodology

For ranking HRRs based on outcomes, hospital-level risk-standardized readmission rates (RSRRs) are aggregated to the HRR level. The variances of hospital estimated rates are calculated from the results of a bootstrapping simulation. The inverse of the variance is used to weight the hospital level results before averaging them at the HRR level. Hospitals with larger sample sizes, which usually have small variances of the estimated rates and therefore more precise estimates, lend more weight to the average. For assigning whether an HRR is significantly different than the national rate, we used a 2-level (hospital and HRR) hierarchical linear regression model with hospital RSRR as the dependent variable and an HRR-level random intercept in the model.

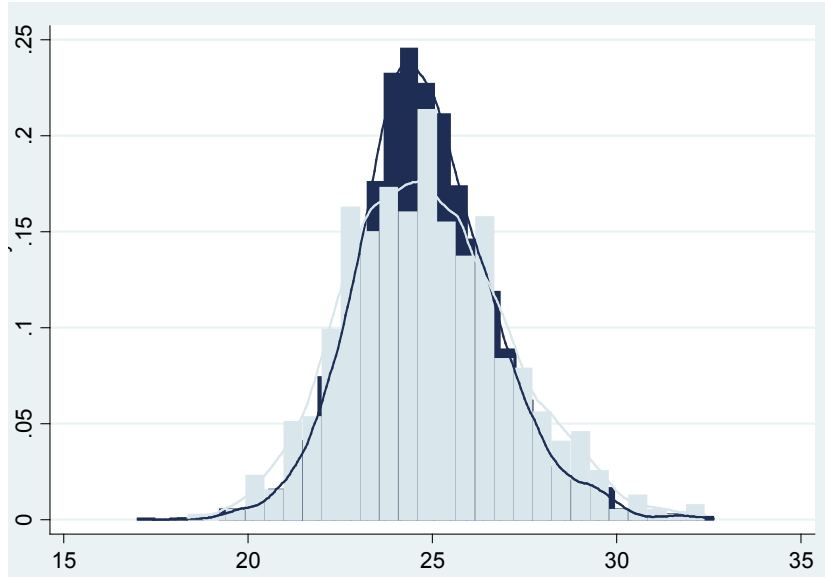
## Appendix E – Figure Explanations

### I. *Box and Whisker Plots*



A box-and-whisker plot graphically displays the distribution of a variable. The line in the shaded box represents the median value. The shaded box, bounded by the upper (75<sup>th</sup>) and lower (25<sup>th</sup>) quartiles, represents the interquartile range (IQR). The lines, or “whiskers”, extending from either end of the box are equal to 1.5 times the IQR (the 75<sup>th</sup> percentile minus the 25<sup>th</sup> percentile). All data points beyond the whiskers are considered outliers. These outliers are represented by individual dots.

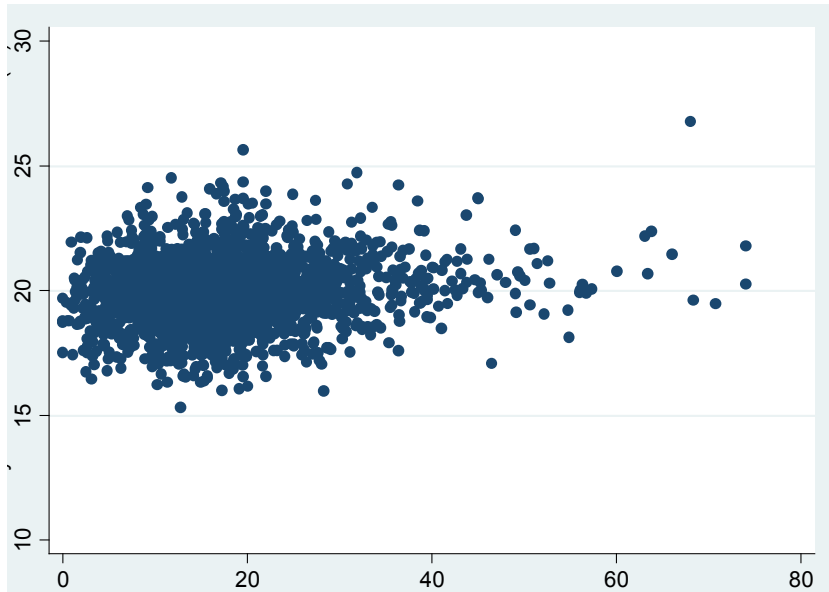
## II. Overlapping Histograms



An overlapping histogram graphically displays the distribution of a variable among two categories of observations. Because of differences in the sample size between the two categories of observations (i.e., one category may have many more observations than the other), the graph is plotted along a y-axis defined as density, a measure of the relative number of observations to the total number of observations which sums to 1 for the entire sample of observations. The vertical bars represent the density of observations for each value of the variable, using two shades for the bars to represent the two categories of observations. The lines represent a LOESS smoothing curve for the distribution of the variable.



### III. Scatterplots



A scatterplot graphically displays the distribution of a variable. Each observation is represented by an individual dot. Areas of clustering, where there are many similar observations, often render the individual dots indistinguishable.