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Hospital Performance And Market Share: Implications For Patient Choice, Value-Based Care, And Health Equity

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Hospital Performance and Market Share: Implications for Patient Choice, Value-Based Care, and Health Equity

A Thesis Submitted to the Yale University School of Medicine In Partial Fulfillment of the Requirements for the Degree Doctor of Medicine

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Abstract

There is substantial hospital-level variation in the quality of healthcare delivered in the United States. Although patients now have greater access to public reporting of hospital quality than ever before, many individual, geographic, and structural factors limit patient choice. The degree to which hospital quality aligns with hospital market share is largely unknown.

Using public performance measure score and volume data from CMS's Hospital Care Compare, we assessed the association between publicly reported hospital performance scores and hospital market share for elective, semi-elective, and non-elective procedures.

Using logistic regression, we found a significant association between hospitals' risk-adjusted complication rate and their market share with a modest effect size for hip/knee replacement complication (-4.2; 95% CI: -6.56, -1.88; p<.001) and acute myocardial infarction (AMI) readmission (-1.7; 95% CI: -3.10, -0.25; p=0.02). We did not find a significant association for AMI mortality or coronary artery bypass graft (CABG) readmission or mortality.

These findings highlight a continued need to better align where patients receive care and the quality of care they receive for non-elective and semi-elective conditions/procedures. They support efforts to increase transparency and usability of hospital quality reporting, reduce constraints on patient choice, and increase the capacity and geographic distribution of high-quality hospitals.

Value-based payment and healthcare delivery models are essential to efforts to advance the alignment of hospital quality and market share given their incentives around clinical outcomes. Expanding the implementation of these models could improve access to high-quality care. However, early evidence suggests that the structure of many of these programs may disincentivize providers from caring for more complex patients and worsen existing racial and socioeconomic health disparities, indicating an urgent need for refinement and optimization.

Publication

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1.0 Introduction

Twenty years after the publication of "Crossing the Quality Chasm: A New Health System for the 21st Century," there remains substantial hospital-level variation in the quality of healthcare delivered in the United States[1,2]. A 2016 study found a massive 1.7 to 32-fold difference over 24 AHRQ outcome measures between hospital service areas and counties in the top and bottom 10%[1]. Regional variation in outcomes does not appear to be associated with healthcare spending or utilization[3,4].

Studies have consistently shown that hospital and physician quality of care is important to patients[5,6]. A 2005 study of 16 heterogenous focus groups across four cities found patients to be highly interested in hospital quality and would consider switching hospitals based on quality information[5]. Other studies have further demonstrated patient willingness to switch hospitals based on surgical mortality data[7]. Of the various dimensions of healthcare quality, technical quality of the physician appears to be particularly important to patients, although interpersonal and experience-based skills are valued as well[8].

There are many public tools available to help patients make informed decisions about where to seek care[9]. For example, the Center for Medicare and Medicaid Services (CMS) developed the Hospital Care Compare online tool (previously known as Hospital Compare) to enable people with Medicare to "make more informed decisions about where [to] get [their] health care"[10]. The site lists hospital-level risk-adjusted readmission, mortality, and complication performance measure scores for a number of conditions and procedures, including acute myocardial infarction (AMI), coronary artery

bypass graft (CABG), and hip/knee replacement (Image 1). Categorical rating classifications are also presented for each performance measure, indicating whether the score is no different than the national average, above the national average, or below the national average.

There are also numerous other national-level online rating tools for patients to access including the US News & World Report, Healthgrades, Consumer Reports, Consumer Checkbook, and ProPublica[9]. Healthgrades is the most-accessed overall site with 8.9 million unique visitors in September 2015[9]. CMS's Hospital Compare and Physician Compare is the most-accessed public site with 3.7 and 5.3 million unique views respectively in 2015[9]. Private hospital rating sites often incorporate CMS's public hospital rating data.

Individual, Geographic, and Structural Factors Limiting Quality-based Choices

Studies have demonstrated that the degree to which the public can access, understand, and act on hospital quality information can be limited and uneven. One 2015 survey found that only 17% of respondents had seen any information comparing hospital quality and only 4% had used what they found[11]. Even with adequate access, hospital quality data can be challenging for consumers to understand[12]. Research has revealed some best practices for how to present the information with particular focus on message route and tone as well as how best to improve the comprehension of those with low numeracy skills[13,14]. Even still, differences in consumers' decision-making strategies lead to substantial variation in the effect of publicly reported performance measures at the individual level[15].

Even with adequate access and understanding of comparative information, patient choice may be restricted by geographic, socioeconomic, and structural factors. These factors may be best illustrated in rural contexts where research has shown a tendency for patients to bypass nearby rural hospitals to receive care at larger urban centers[16]. However, this tendency is unevenly distributed. One study of rural areas in Colorado found that patients with Medicare and Medicaid were 43.6% and 20.9% less likely to bypass rural hospitals than patients with commercial insurance[17]. Furthermore, rural white female patients were found to go to urban hospitals 5.76 times more than nonwhite female patients[17]. Another study of a sample of 1,702 rural Medicare hospitalizations found that white race and high education status were associated with choosing an urban hospital over a rural hospital[18]. Studies applicable to the non-rural areas of the United States have confirmed these observations. Within select condition types and procedures, privately insured patients and those in HMO's have been found to be more responsive to hospital quality measures, relative to Medicaid, Medicare, and non-HMO commercially insured patients[19,20].

The hospital network of individual insurance plans has a large impact on patients' ability to choose where to receive care as well. The McKinsey Center for U.S. Health System Reform found that roughly 40% of marketplace hospital networks were considered "narrow" in 2014, 2015, and 2016—"narrow" was defined as having less than 70% of hospitals in a given area participating[21]. The Kaiser Family Foundation estimated that in 2015 one-third of Medicare Advantage enrollees were in plans with narrow physician networks, defined as covering less than 30% of physicians in the county[22]. Furthermore, 20% of Medicare Advantage plans were found to include fewer than five cardiothoracic surgeons and 36% of plans had fewer than 10% of psychiatrists in their county in 2015[22].

Narrow network insurance plans do offer some advantages to consumers. One study estimated that plans with narrow physician and hospital networks were approximately 16 percent cheaper relative to plans with broader networks[23]. In addition, narrow networks could help steer patients towards high-value providers[24]. However, they also carry risks by limiting provider choice and increasing financial liability to patients should they need to seek care from an out-of-network specialist. It is also often difficult for patients to assess whether a narrow network includes high-quality providers and is adequate for their needs[24].

The fact that some groups of patients have more choice than others has important social ramifications. Many racial and socioeconomic disparities in clinical process measures and health outcomes have been linked to greater use of poorer performing hospitals by minority or marginalized populations. One large national study of Medicare patients found that between 2006 and 2008 black patients were more likely to be readmitted after hospitalization for AMI, CHF, and pneumonia and that that gap was partially explained by site of care[25]. A single market study of very preterm infants in New York City hospitals found that hospital of birth accounted for approximately 40% of the disparity between black and white patients in morbidity and mortality and for approximately 30% of the disparity between Hispanic and white patients[26]. Notably, research also suggests that the differences in site of care between black and white patients is primarily driven by non-geographic factors (e.g. socioeconomic status, provider bias, hospital access) than by distance alone[27]. One study found that such non-geographic factors accounted for a greater degree of the difference in use of high-quality hospitals for AMI and CABG by black and white patients than geographic factors[27].

The Gap in the Assessment of the Alignment between Hospital Quality and Market Share

As previously detailed, there are many forces within healthcare in the United States that either promote or constrain patients' ability to choose to receive care from high quality hospitals. However, a robust, multi-condition, nation-wide assessment of the aggregate effect of these forces is missing from the literature.

For some conditions and procedures, substantial research efforts have explored the relationship between surgeon and institution volume and outcomes[28,29]. However, these studies are designed to assess how greater operator experience could be associated with better outcomes. They are not designed to assess market dynamics or the overall utilization of higher-quality hospitals by patients.

One study in 2003 did examine whether public mortality scores impacted hospital market share and found that higher mortality in a number of conditions did not adversely impact market share[30]. However, this study was limited to 30 hospitals within one healthcare market in Ohio and used data that is now over twenty years old[30].

Furthermore, a robust assessment of the geographic distribution of high-quality hospitals in United States and the degree to which patients have meaningful condition-specific choices within their markets is also missing from the literature.

A 2017 study examined degree of clustering of high-quality health service centers in US healthcare markets using the Dartmouth Atlas's hospital referral region (HRR) definition of healthcare markets and CMS's five star rating system[31]. The study found that healthcare markets rarely had high quality performance in all of the four healthcare sectors of hospitals, nursing homes, home health agencies, and dialysis centers. It also

demonstrated that HRRs that did have 3 or 4 top-ranked health sectors had a higher median income, lower percent of the population living below the poverty line, and lower percent of the population that was Black relative to HRR's without any top-ranked health sectors[31]. This study was limited by its use of CMS's overall five-star rating system as it precludes conclusions about the condition-specific choices that are made at the patient level. A 2016 National Bureau of Economic Research working paper found little correlation across quality measures within hospitals, underscoring the need to use condition-specific quality measures when assessing patient choice[32].

2.0 Statement of Purpose

It is in this context that this study aims to investigate the relationship between publicly reported hospital performance scores and hospital market share using publicly available fee-for-service Medicare hospital volume and quality data.

By using quality data that is accessible by patients online through CMS's Hospital Care Compare tool, this study hopes to shed light on the relative degree to which patients are able to choose to receive care from high quality providers for elective, semi-elective, and non-elective conditions and procedures.

This study also aims to present preliminary data regarding the number and market-level distribution of condition-specific, high-performing hospitals to explore the practicality of the market-level choices that consumers are presented with from CMS's Hospital Care Compare website.

Results from this study could support efforts to promote patient choice within healthcare in the United States, improve the utility of existing methods to assess and report hospital quality to the public, increase the performance of low-quality hospitals, and expand the implementation of value-based models of care.

Specific Aims

Specific Aim 1: This study aimed to assess the association between publicly reported hospital performance scores and hospital market share for elective (Hip/Knee Replacement), semi-elective (CABG), and non-elective (AMI) conditions/procedures in Hospital Care Compare.

Hypothesis 1: Given the structural barriers that inhibit patient choice, it was hypothesized that this study would not find an association between publicly reported hospital performance scores and hospital market share.

Specific Aim 2: This study aimed to assess the number of healthcare markets (HRRs) that have hospitals that are rated as "above the national average" by CMS for elective (Hip/Knee Replacement), semi-elective (CABG), and non-elective (AMI) conditions/procedures in Hospital Care Compare.

Hypothesis 2: It was hypothesized that this study would find that very few markets have hospitals that are rated as "above the national average" for elective (Hip/Knee Replacement), semi-elective (CABG), and non-elective (AMI) conditions/procedures in Hospital Care Compare.

3.0 Methods

3.1 Student Contribution & Ethics Statement

The author August Oddleifson was primarily responsible for and completed all stages of the research design and implementation process, including research design, data analysis, and manuscript drafting. Other co-authors of the Oddleifson et. al. 2021 paper in JAMA Network Open contributed to various aspects including study concept and design, interpretation of data, data analysis, and manuscript editing and feedback.

This research was exempt from institutional review board approval because it did not meet the NIH's definition of human subject research outlined in 45 CFR part 46.

Animals were not used at part of this study.

3.2 Methods Description

Temporal Structure

This study was cross-sectional and conducted at the hospital-level. It used three conditions/procedures that were chosen to exemplify non-elective, semi-elective, and elective conditions/procedures: acute myocardial infarction (AMI), coronary artery bypass graft (CABG), and hip/knee replacement, respectively. The 30-day mortality rate and the 30-day readmission rate were used for AMI and CABG and the 90-day complication rate was used for hip/knee replacement. All performance scores and volume measurements were obtained from CMS's Hospital Care Compare database. Hospital condition/procedure-specific volume was obtained from the 2020 report year, corresponding to the period of July 1, 2016 to June 30, 2019. Hospital

condition/procedure-specific performance scores were obtained from the 2019 report year, corresponding to the period of July 1, 2015 to June 30, 2018. The market share was computed at the hospital referral region (HRR) level by dividing hospitals' condition/procedure-specific volume by the sum of their condition/procedure-specific volume in their HRR.

Covariates

The hospital characteristics of geographical region, ownership, type, and critical access designation were obtained from the Hospital Care Compare database. The hospital characteristics of teaching status, bed size, and healthcare referral region (HRR) were obtained from the Dartmouth Atlas. All hospital characteristics correspond to calendar year 2016.

The American Community Survey 2012-2016 5-year estimate was the source for ZIP Code Tabulation Area (ZCTA) demographic characteristics which were aggregated to the HRR level. These demographic characteristics included population size, percent non-white, percent population in a rural area, percent population with less than a high school education, and percent of population below the federal poverty level.

All continuous covariates were included as categorical terciles in each regression model.

Market concentration was calculated by condition/procedure for each HRR by the Herfindahl-Hirschman Index (HHI) method[33].

A ZCTA to zip code crosswalk was required to link each ZCTA to an HRR. The crosswalk used was from the American Academy of Family Physicians' Uniform Data System Mapper website[34].

Exclusion Criteria

Prior to the application of the exclusion criteria, there were 4,930 hospitals for each of the five performance measures. The hospital type criteria excluded 96 Children's or Veteran's Association hospitals. The state exclusion criteria excluded 59 hospitals in Puerto Rico, Guam, American Samoa, Virgin Islands, and the Northern Mariana Islands. 2,689 hospitals did not have a volume or score available for the AMI Readmission measure. 2,527 hospitals did not have a volume or score available for the AMI Mortality measure. 3,804 hospitals did not have a volume or score available for the CABG Readmission measure. 3,795 hospitals did not have a volume or score available for the CABG Mortality measure. 2,115 hospitals did not have a volume or score available for the Hip and/or Knee Complication measure. An additional 259 hospitals were missing at least one covariate.

Performance Measures

The performances measures in this study included fee-for-service Medicare beneficiaries 65 or older who had been enrolled for 12 months or more before their date of admission. The readmission measures also required the patients to be enrolled for at least 30 days after their discharge for inclusion. The mortality measures included deaths for any reason either during or after the hospital admission. The CABG measure only included patients who underwent isolated CABG without concomitant valve replacement or any other major vascular or cardiac procedure. Complications that were included in the hip and/or knee replacement measure included any of the following: pneumonia, acute myocardial infarction, or sepsis/septicemia/shock during the index admission or within 7 days of admission; pulmonary embolism, surgical site bleeding, or death during the index

admission or within 30 days; or mechanical complications or periprosthetic joint infection/wound infection during the admission or within the following 90 days. All performance measure underwent risk adjustment by CMS to account for various patient characteristics including age and past medical history[35].

CMS calculated the performance score categorical ratings by comparing the national rate with the hospital's 95% interval estimate[36]. If the 95% interval estimate included the national rate than the hospital was labeled as "no different than the national rate." If the 95% interval estimate was higher than the national rate than the hospital was labeled as "worse than the national rate." If the 95% interval estimate was lower than the national rate than the hospital was labeled as "better than the national rate."

These five performance measures were chosen by this study because they are used widely by healthcare policy researchers and are readily accessible for access by patients on the CMS Hospital Care Compare website.

The performance score was centered at the sample mean for this study.

A Note on the Choice of Use of HRRs over HSAs

Markets are difficult to define. However, prior research has shown that for 45% of HSAs, fewer than half of the patients were admitted to hospitals located within the HSA[37]. In contrast, on average, 88% of patients were admitted to hospitals located in their HRR[37]. Therefore, conceptually we believe using HRR will allow us to better understand patients' choice of hospitals and examine changes in a hospital's market share.

3.3 Statistical Methods

The statistical test used to model hospital market share was a fractional regression via generalized linear models with binomial family and logit link. A separate model was used for each of the five performance measures. The response variable was hospital market share and the primary predictor variable was performance measure score. Covariates included the hospital characteristics of number of beds tercile, ownership, and teaching status; the market non-demographic characteristics of HRR concentration and geographic region; and the market demographic characteristics of population size tercile, percentage non-white tercile, percentage rural tercile, percentage less than high school degree tercile, and percentage below federal poverty line tercile. The lowest tercile served as the reference level for all tercile variables. All model estimates were reported as marginal effects. Estimates included the 95% confidence interval. Significance was determined by a $P<.05$. All analysis was completed in RStudio, version 1.2 by August Oddleifson.

A Note on the Choice of Fractional Regression over Simple Linear Regression

We explored the use of a simple linear model early in our research. It produced a substantial number of market share predictions outside of 0 to 1, which is inappropriate for a proportional-based response variable. Table 1 and Figure 1 summarizes the large percentage of predictions that fell below 0. Based on this evaluation, we considered fractional regression to be more appropriate for our analysis and chose not to report results from a simple linear model.

4.0 Results

Characteristics of Hospitals

Table 1 in Oddleifson et. al. (2021) shows the diverse characteristics of hospital in the sample[38]. In total, 1,989 and 2,165 hospitals were included for AMI readmission and mortality respectively, 966 and 975 for CABG readmission and mortality, and 2,660 for hip and knee complication[38].

Table 1 in Oddleifson et. al. (2021) shows that hospitals represented in the hip and knee complication measure tended to have a lower market share compared to AMI and CABG. Specifically, the average market share for hip and knee complication was 5.2% whereas it was 7.3% and 6.8% for AMI readmission and mortality respectively and 21.2% and 20.9% for CABG readmission and mortality respectively[38]. Moreover, the CABG measures had many hospitals with market shares above 75% while the hip and knee measure had relatively few.

The unweighted mean of the performance measure score was 15.7% with a standard deviation of 1.0% for AMI readmission, 12.8% with a standard deviation of 1.1% for AMI mortality, 12.8% for CABG readmission with a standard deviation of 1.3%, 3.1% for CABG mortality with a standard deviation of 0.9%, and 2.6% for hip/knee complications with a standard deviation of .6%.

Performance Score and Market Share Regression Result

Table 2 in Oddleifson et. al. (2021) summarizes the adjusted and unadjusted results of the multivariable regression assessing the association between hospital-level performance

score and market share. Table 2 in this thesis includes the adjusted marginal effect results of the covariates. The hip and knee complication model showed that every percentage point increase in risk-adjusted 30-day complication rate was associated with a 4.2 percentage point decrease in market share (95% CI, −6.56 to −1.88 percentage points; standardized coefficient: −0.25; $P < .001$)[38]. The AMI readmission model showed that every percentage point increase in a hospital's risk-adjusted complication rate was associated with a 1.7 percentage point decrease in its market share (95% CI, −3.10 to −0.25; standardized coefficient, −0.16; $P = .02$)[38]. There was no significant association between a hospital's performance score and market share for AMI mortality (−0.85; 95% CI, −2.07 to 0.38; standardized coefficient, −0.09; $P = .17$), CABG readmission (−0.49; 95% CI, −2.49 to 1.52; standardized coefficient, −0.04; $P = .63$), and CABG mortality (−1.24; 95% CI, −4.40 to 1.93; standardized coefficient, −0.06; $P = .44$)[38].

Number and Market-Level Distribution of Above-Average Hospitals

Table 3 in this thesis shows that the vast majority of markets did not have a hospital rated as 'better than the national average.' Eighty-five percent of markets did not have a hospital that was 'better than the national average' for the AMI Readmission measure, 86% for the AMI Mortality measure, 70.8% for the CABG Readmission measure, 69.2% for the CABG Mortality measure, and 80.1% for the Hip and Knee Complication measure.

Similarly, the vast majority of hospitals were contained within markets that do not have a hospital listed as 'better than the national average.' Ninety-two percent of hospitals were within a market that did not have a hospital listed as 'better than the national average' for the AMI Readmission measure, 82.9% for the AMI Mortality measure, 89.7% for the

CABG Readmission measure, 82.9% for the CABG Mortality measure, and 73.9% for the Hip and Knee Complication measure.

Furthermore, the vast majority of patient volume was contained within markets that do not have do not have a hospital listed as ‘better than the national average.’ Ninety-one percent of patient volume occurred within a market that did not have a hospital listed as ‘better than the national average’ for the AMI Readmission measure, 81.8% for the AMI Mortality measure, 87.2% for the CABG Readmission measure, 79.3% for the CABG Mortality measure, and 67.8% for the Hip and Knee Complication measure.

Table 4 in this thesis shows that the vast majority of markets for all five measures only contain average-rated hospitals. Eighty-three percent of markets only contained average rated hospitals for the AMI Readmission measure, 80.7% for the AMI Mortality measure, 66.9% for the CABG Readmission measure, 66.2% for the CABG mortality measure, and 69.0% for the Hip and Knee Complication measure.

Figures 2-6 show how large contiguous areas of the United States consist of markets without ‘better than the national average” hospitals for all five performance measures.

5.0 Discussion

5.1 Looking Back: Understanding the Results

Better hospital performance score was associated with a larger market share for hip-knee replacement complication rate and AMI readmission rate but not for AMI mortality, CABG readmission, or CABG mortality. The effect sizes for the significant associations were modest. The greater effect size for the elective procedure suggests that patients may be more able to choose their place of care for elective procedures relative to semi-elective and non-elective procedures.

There are four major factors that can contribute to an explanation of the differences observed in these results: elective vs non-elective procedure type, geographical accessibility, consolidation of hip/knee replacement procedures into high-volume centers, and the surgical quality-volume relationship.

Elective vs Non-Elective Procedure Type

The clearest explanation for these findings is that hip and knee replacement is an elective procedure that allows patients more time and opportunity to choose the site of care relative to the semi-elective CABG or the emergent AMI. Patients who value quality could more easily chose higher quality hospitals.

If patients can more readily chose site of care for elective procedures, one could assume that the competition for patients could drive providers to improve the quality of care. Interestingly, this assumption was found to be unsupported in a 2016 National Bureau of Economic Research study that showed no association between a measure of market-level

competition and quality for elective hip and knee replacement[32]. Like this study, the authors proposed several explanations including low use of publicly reported quality measures and reliance on primary care physician referral by patients[32].

Geographic Accessibility

For CABG, the lack of association may suggest that consumers are less able to choose their site of care based on public reporting of hospital quality due to the fewer number of CABG facilities. There is a substantial difference in the number of centers providing hip and knee replacement (~2630) vs CABG (~970) in the United States. This may mean that CABG centers are more geographic dispersed than hip and knee replacement centers.

Several studies provide preliminary evidence that patients may have greater geographic proximity to high-quality hip and knee replacement centers than high-quality CABG centers. A 2016 study found that 82% of the US population lived within 50 miles of a high-volume center for hip and knee replacement[39]. A 2017 study found that more than 40% of older adults lived greater than 50 miles from a hospital with a STS-CABG ranking better than their closest hospital, indicating a substantial travel distance in pursuit of better quality[40]. Notably, for CABG, increased driving time to a cardiac care center has been shown to independently worsen 30-day outcomes from cardiac operations[41].

The Consolidation of Hip/Knee Procedures into High-Volume Centers

Our data showed that the mean complication rate for the hip/knee replacement measure (2.6%) was much lower than the mean readmission and mortality rates for AMI (15.7% and 12.8% respectively) and the readmission rate for CABG (12.8%).

This low complication rate for hip and knee replacement is consistent with national efforts to improve procedural outcomes and reduce the variation between centers. Central to the success of this effort has been the reduction in the use of low-volume centers. Between 2000 and 2012, the proportion of arthroplasties performed in low-volume centers decreased from 17.4% to 5.4%[39]. As described in the next section, high-volume centers tend to perform better due to the hypothesized relationship between operator volume and outcomes in hip/knee replacement. The alignment observed in our study may be partly explained by these national trends in volume consolidation.

It is important to note that the beneficial impact of this alignment between volume and quality in hip/knee replacement is distributed unevenly among patient populations. Research has demonstrated that minority populations have lower hip/knee replacement utilization rates and higher incidence of adverse events[42]. Part of these differences may be explained by greater utilization of low-volume hospitals by minorities. A 2008 study found Black, Hispanic and Asian race/ethnicity and Medicaid insurance to be predictors of utilization of low-volume hospitals for total knee replacement[43]. A 2011 study found Hispanic ethnicity, and black and Asian race to be predictors of low-volume hospital use for total hip replacement[44].

The Quality-Volume Relationship

There is extensive literature exploring a possible causal relationship between surgical volume and quality[28,29,45]. The mechanism is that surgeons and surgical centers that perform more surgeries have accumulated more individual and institutional experience that benefits patients through better outcomes. The effect is not uniform across surgical procedures[46]. For hip and knee replacement, surgeon and hospital volume has been

shown to be associated with lower mortality and readmission, though process standardization has also been shown to be independently associated with better outcomes[47,48]. In contrast, for coronary artery bypass graft (CABG), volume has been shown to be a poor overall predictor of mortality[49-51]. And for acute myocardial infarction (AMI), higher volume centers are associated with better adherence to process of care measures but not with better outcomes[52,53].

5.2 Looking Forward: Patient Choice, Value-Based Care, and Health Equity

While the observed significant associations between performance score and market share for AMI readmission rate and hip and knee replacement were encouraging, the small effect size highlights a continued need to increase the number of patients being treated at high-quality hospitals. This thesis proposes that there are two principal means to pursue this goal: (a) improve patients' awareness of and ability to use and act on hospital quality ratings and (b) increase the number, capacity, or geographic accessibility of high-quality hospitals.

This section will explore specific unmet needs in these two areas and discuss how best to refine and optimize existing policy interventions.

Improving Public Reporting of Quality to Promote Patient Choice at both the Hospital and Health Plan Level

This study identified a major limitation in CMS's Hospital Care Compare data set and public website. For the five performance measures we examined, CMS Hospital Care Compare does not present most consumers with meaningful choices within their markets. When a consumer in most healthcare markets in the United States visits the Hospital Care Compare website to find information about the quality of the hospitals in their area for a specific condition or procedure, they learn that all the hospitals are of similar quality—no different than the national average. Without doubt, discerning differences in quality between hospitals is a challenging science. However, this research demonstrates a need to improve existing evaluation methodologies or create new approaches that enable the

presentation of more meaningful differences to consumers at the market level in an effort to better inform their choices.

Improving hospital quality reporting at the health plan level is also an urgent need. A substantial degree of hospital choice takes place during health plan selection[54]. Initiatives to improve the transparency of hospital quality reporting must be accompanied by renewed efforts to report network-wide quality at the point of consumer plan decision in the healthcare exchange marketplaces. Selecting health insurance is a notoriously difficult process, especially for consumers with low health literacy or impaired decision making[55]. Lack of understanding of concepts, poor skill with numbers, information overload, misinformation, time constraints, and language barriers are a few of the challenges consumers face when selecting a plan[56-58]. Studies have shown that health insurance literacy is lower among vulnerable populations, such as those with low income or low education[56,59,60]. It is therefore imperative to find intuitive, meaningful, and accurate ways to represent aggregate health insurance network quality information within health insurance marketplace exchanges.

An excellent case example of the challenges associated with health plan rating systems is Medicare Advantage. Medicare Advantage is a managed-care Medicare program offered through various private insurers. It has a 5-point star rating system that incorporates more than 50 measures around clinical effectiveness, accessibility, patient experience, and health outcomes[61]. Much like Hospital Compare, these ratings are available through an online platform, along with each plan's premiums, deductibles, copays, and drug costs[61]. However, few eligible consumers know about the star rating system and many find the website hard to use[62]. While studies have shown that consumer choice of Medicare

Advantage plans is associated with quality and cost, brand recognition and market share continue to exert a strong influence[63,64]. Efforts within the Medicare Advantage program to provide transparent quality reporting are laudable but additional work is needed to finetune the approach to truly enable consumers to drive quality improvement.

Using Public Reporting to Incentivize Improvements in Hospital Quality & Health Outcomes

Many studies have explored the role of public reporting of hospital quality data in incentivizing hospital care quality improvement. A meta-analysis in 2016 found that the introduction of public reporting of hospital quality data was associated with a reduction in mortality rates[65]. Research has also demonstrated steady improvement in patient satisfaction nationally after the introduction of the Hospital Consumer Assessment of Healthcare Providers and System (HCAHPS) survey measuring patient satisfaction[66]. Qualitative narrative analysis in Rhode Island has also shown that public reporting of patient satisfaction can accelerate quality improvements at hospitals[67].

There are several mechanisms that have been proposed to explain the positive impact of public reporting of hospital quality data on patient satisfaction and health outcomes. Berwick et. al. (2003) proposed two pathways: the selection pathway and the change pathway[68]. The selection pathway represents how providers may be motivated to improve their services with the knowledge that consumers are actively selecting providers based on the publicly available information. This pathway aligns with the concept of a free market—where providers are incentivized to meet the needs of consumers or risk losing market share to competitors. The change pathway represents how providers may be inherently motivated to improve if deficits in their processes are made known to them.

Hibbard et. al. (2005) proposed a third mechanism wherein providers identified as poor performers would be motivated to improve to protect their reputation[69].

A risk inherent in the use of public reporting of hospital quality data is intentional patient selection bias. Hospitals could be motivated to avoid more challenging or high-risk patients to achieve quality benchmarks[70,71]. A survey conducted in 2005 of interventional cardiologists found that 79% agreed that public reporting of mortality data had influenced their decision whether or not to conduct angioplasty on individual patients[72]. A 2005 study comparing utilization of PCI in higher-risk patients found lower utilization in New York, a state with public PCI outcomes reporting, and Michigan, a state without public PCI outcomes reporting[73]. It is important to note that more is not always better—perhaps public reporting leads interventionalists to be more likely to defer a case when the complexity exceeds their capability[71].

Refining Innovative Value-Based Payment and Healthcare Delivery Models: Opportunities for Alignment and Risks for Health Equity

Innovative healthcare delivery models that promote high-value care are essential to efforts to further align hospital quality and hospital market share because their incentive structures are explicitly oriented around clinical outcomes. Greater adoption of value-based care models would likely increase accessibility to high-quality care.

However, there is a risk that these models will disincentivize providers from treating more medically or socially complex patients, which could worsen access and outcome disparities. In implementing these programs, care must be taken to adequately mitigate this risk.

This section will explore several promising innovative models—bundled payments, value-based purchasing, Medicare Advantage, and value-based insurance design—and offer a review of the current evidence for their effectiveness in improving care value, health outcomes, and health equity.

Bundled Payments

Bundled payment reimbursement models provide a single payment for the entirety of a clinical episode. CMS has conducted several large scale trials of bundled payments, including Bundled Payments for Care Improvement (BPCI), BPCI Advanced, and the Comprehensive Care for Joint Replacement Model (CJR)[74].

Research has shown that bundled payments can achieve similar or better outcomes compared to fee-for-service with modestly lower cost for lower extremity joint replacement but not for other conditions or procedures[75-77]. Specifically regarding CABG and PCI, a recent study demonstrated participation in BPCI was not associated with a meaningful differences in length of stay, clinical outcomes, or payments for either procedure[78].

Unfortunately, the benefit of CJR for hip and knee replacement was not evenly distributed. A recent study of over four million Medicare beneficiaries between 2013 and 2017 found that the implementation of the CJR model for hip and knee replacement was associated with a modest increase in utilization disparities in total knee replacement but not total hip replacement[79].

The difference in the performance of joint replacement and PCI under bundled payments may be due to the fact that post-acute care costs, with higher variation in joint

replacement, may be more easily optimized than readmission costs, which have higher variation in acute myocardial infarction[78,80]. Additionally, Agarwal et. al. 2020 notes that the difference in impact of bundled payments on joint replacement versus medical conditions may be partly explained by the elective nature of joint replacement and the younger, less medically complex patient population[77].

In the context of the results of this thesis, it appears that bundled payments may play a role in improving quality of hip and knee replacement and thus could increase geographic access to high quality providers. However, the observed modest worsening of utilization disparities is concerning. More rigorous risk stratification of patients could enable to more appropriate compensation and reduce the incentive for a selection bias[77,81,82].

The BPCI Advanced model is ongoing and will provide more data on the impact of bundled payments on quality and cost[83].

Medicare Advantage

Most private insurers that provide Medicare Advantage health insurance plans receive risk-adjusted capitated payments from the federal government for each plan enrollee, providing a clear incentive for insurers to facilitate high-value care and reduce cost[84]. Other notable characteristics of Medicare Advantage include how they limit out-of-pocket spending, provide prescription-drug coverage, and often offer additional services such as health rewards programs and targeted services for at-risk patients[84].

However, despite the clear incentive structure, results are mixed as to whether Medicare Advantage is superior to Traditional Medicare in value of care and outcomes measures. One recent study using Medical Expenditure Panel Survey data from 2006 to 2015 found

that the prevalence of low-value care use was similar between Medicare Advantage and Traditional Medicare[85]. Furthermore, another study found that risk-adjusted 30-day readmission rates for acute myocardial infarction, congestive heart failure, and pneumonia were higher for Medicare Advantage enrollees compared to those with Traditional Medicare[86]. However, several studies have shown overall healthcare utilization to be lower for Medicare Advantage enrollees compared to Traditional Medicare without impacting health status or patient satisfaction[87,88]. More research is needed to resolve this conflicting picture. The heterogeneity of the services and benefits offered by Medicare Advantage plans is a clear challenge that studies need to actively mitigate in their design.

Some evidence suggests that the incentive structure inherent in Medicare Advantage plans enrollees may not be appropriate optimized and may be contributing to worsening health disparities. Three recent studies revealed that there are greater racial disparities in hospital readmission, avoidable hospitalizations, and behavioral health process measures within Medicare Advantage enrollees relative to Traditional Medicare enrollees[89-91]. Furthermore, another study found that Medicare Advantage plans with higher star ratings had larger disparities in quality[92]. While it is well documented that minority patients are more likely to receive lower quality hospital care and less likely to have access to high-quality primary care, the mechanisms at play for why specific outcomes disparities are worse for Medicare Advantage enrollees relative to Traditional Medicare enrollees is still unclear[89]. However, their existence supports adoption of standardized plan-level reporting of outcome measures stratified by race and ethnicity[91]. There may also be value

in refining the risk-adjustment methodology of the Medicare Advantage star ratings in order to lessen incentives for insurers to avoid more challenging patient populations[93].

Another important structural component of Medicare Advantage plans is that they specify a defined network of hospitals and providers for enrollees to use and are sold on marketplace exchanges[84]. This essentially requires patients to choose their providers at the time of health plan selection. Unfortunately, current evidence does not indicate that this increases the overall likelihood that patients will receive care at high-quality hospitals relative to Traditional Medicare[94]. As detailed in the above section "Improving Public Reporting of Quality to Promote Patient Choice," quality reporting at the health plan level needs optimization to improve transparency and facilitate more informed choices by patients.

One additional area of opportunity is Medicare Advantage plans that are offered by healthcare service organizations directly. Referred to as "vertical integrated", these plans tend to have higher patient satisfaction and perform better on provider process measures[95,96]. Yet, the vast majority of Medicare Advantage enrollees are not enrolled in vertically integrated plans—only 22.0 percent of contracts were vertically integrated in 2015[95].

Value-Based Purchasing Programs

Value-based purchasing (VBP) programs adjust fee-for-service payments to acute care hospitals based on clinical performance[97]. Pay-for-performance VBP is a relatively low-risk introductory value-based care model that allows providers and organizations to build competence in key areas such as performance measurement, payment incentives, and risk management[98]. CMS's VBP program, Hospital Value-Based Purchasing Program

(HVBP), began in 2013 and adjusts payments based on clinical outcomes, person and community engagement, safety, efficiency, and cost reduction[97]. Numerous other VBP programs exist, implemented by both state and commercial payers[98].

Unfortunately, the most recent meta-analysis of CMS's HVBP showed no impact on patient outcomes or quality of care[99]. However, this analysis only included seven academic papers, indicating that the impact of this program may not be adequately explored in the literature. More specifically, research in this area is limited by short study periods[98]. There is also limited understanding of exactly how providers and hospitals respond to the value-based incentive structures and the levers they use to improve care quality[98].

A meta-analysis of 28 studies showed that safety-net hospitals tended to perform worse on the outcome measures that underline the payment adjustment calculations, indicating a possible disproportionate negative impact on safety-net hospitals[99]. This finding supports efforts to more rigorously adjust for patient population-level risk factors to ensure that safety-net hospitals are not unfairly punished and that non-safety-net hospitals are not further disincentivized from caring for more socially complex patients[99].

Value-based purchasing programs likely have an important role to play in aligning hospital quality and hospital market share. However, additional research is needed to understand more precisely how the incentives interact with the underlying hospital-level mechanisms and how patient-level social and medical complexity can be adequately adjusted for to avoid detrimental selection incentives.

Value-Based Insurance Design

Value-based insurance design (VBID) adjusts cost-sharing with consumers based on the value of the provided service. Out-of-pocket spending is higher for low-value care than for high-value care[100]. VBID has been implemented by both private and public insurers, including the states of Connecticut and North Carolina[101,102]. Medication adherence is a particular focus of these programs due to VBID's capacity to reduce the out-of-pocket cost of medications for diabetes, hypertension, and cholesterol that have the potential to prevent disease or significantly impact disease trajectory[100].

The most recent meta-analysis of experimental studies assessing the impact of VBID on medication adherence, clinical outcomes, and total health care spending showed that VBID was associated with increased medication adherence without increased total health care spending[100]. The meta-analysis cited limited evidence for the evaluation of outcomes and a need for further research in this area[100].

Preliminary evidence exists that VBID may positively impact racial and ethnic disparities in medication adherence and health outcomes[103]. One experimental study of VBID's impact on medication adherence following AMI found that full coverage without cost sharing of β-blockers and statins for nonwhite participants was associated with a 35% lower risk of readmission and a 70% decrease in healthcare spending[103]. Remarkably, full coverage without cost sharing eliminated disparities in rates of adverse coronary events between white and nonwhite participants[104].

Clearly, VBID has an important role to play in facilitating utilization of high-value care by patients and reducing access and outcomes disparities caused by differential ability to pay. Early success in medication adherence may be transferable to devices, procedures, and clinical services[103]. It is possible that VBID could be used to incentivize patients to

select high-quality hospitals. However, sole focus on patient-level factors is likely insufficient for broad system-level alignment around quality. As such, VBID should be pursued in conjunction with other innovative payment and healthcare delivery strategies.

5.3 Key Study Limitations

Although the cross-sectional nature of this study precluded inference regarding the directionality of the observed association, it provided helpful initial information about the potential to use public reporting to channel patients to higher quality providers.

Other study limitations included hospital-level instead of patient-level analysis, the use of a discrete set of performance measures for fee-for-service Medicare beneficiaries only, and low or uneven use of performance scores by patients. Further research using data at the patient level, additional performance measures (e.g. patient satisfaction), and younger patient populations would provide additional insights.

6.0 Conclusion

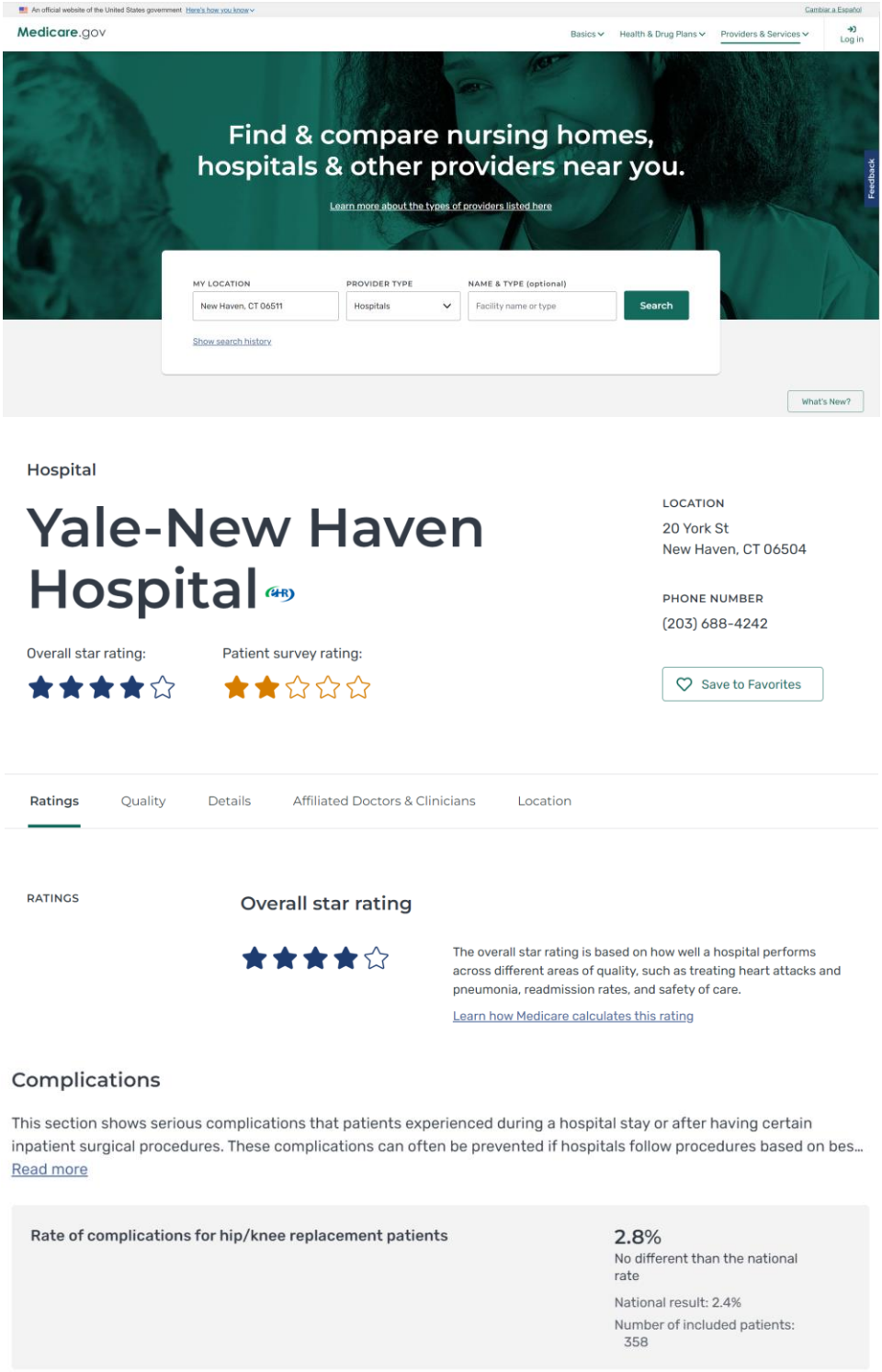
In conclusion, the results of this study demonstrated a statistically significant association with a modest effect size between performance score and market share for hip and knee replacement and AMI mortality. These results support efforts to (a) improve patients' ability to choose where they receive their care and (b) improve the capacity or geographic accessibility of high-quality facilities.

Value-based payment and healthcare delivery models are essential efforts to advance the alignment of hospital quality and market share given their incentives around clinical outcomes. However, a renewed focus on health equity must be central to these efforts as early evidence suggests that some innovative value-based healthcare delivery and payment models may disincentivize care for complex patient and worsen health access and outcome disparities.

7.0 Images, Tables, and Figures

In order of appearance

Image 1: Screenshots from Hospital Care Compare



Source: Hospital Care Compare 2022[105]

Table 1: Predicted market share <0% when using a simple linear model

	# of Hospitals	% of Hospitals
Hip & Knee Complication	324	12.20%
AMI Mortality	316	14.60%
CABG Mortality	39	4%
AMI Readmission	294	14.80%
CABG Readmission	38	3.90%

Note: None of the hospitals had predicted market share >100%.

Figure 1: Market share predictions, when using a simple linear model

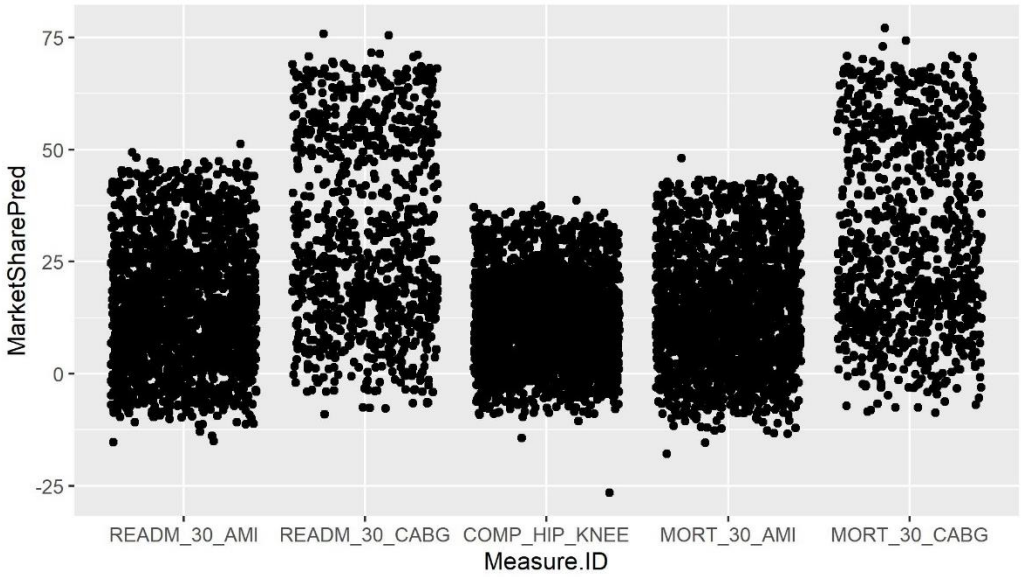


Table 2: Full regression results with covariates, adjusted

	AMI Readmission	AMI Mortality	CABG Readmission	CABG Mortality	Hip/Knee Complication
Score	-1.68 (-3.1 to -0.25; P=0.02)	-0.85 (-2.07 to 0.38; P=0.17)	-0.49 (-2.49 to 1.52; P=0.63)	-1.24 (-4.4 to 1.93; P=0.44)	-4.22 (-6.56 to -1.88; P<.001)
Beds – Second Tercile (ref: first tercile)	0.09 (0.06 to 0.13; P<.001)	0.09 (0.06 to 0.12; P<.001)	0.05 (-0.01 to 0.11; P=0.13)	0.05 (-0.01 to 0.12; P=0.1)	0.03 (0 to 0.06; P=0.03)
Beds – Third Tercile (ref: first tercile)	0.18 (0.14 to 0.22; P<.001)	0.18 (0.14 to 0.21; P<.001)	0.14 (0.07 to 0.22; P<.001)	0.14 (0.07 to 0.22; P<.001)	0.1 (0.07 to 0.13; P<.001)
Market Concentration Binomial – Unconcentrated (ref: Concentrated)	-0.07 (-0.12 to -0.02; P=0.01)	-0.07 (-0.12 to -0.02; P=0)	-0.14 (-0.24 to -0.04; P=0.01)	-0.12 (-0.22 to -0.02; P=0.02)	-0.05 (-0.09 to -0.01; P=0.01)
Hospital Type - Critical Access (ref: acute care)	-0.1 (-0.26 to 0.06; P=0.22)	-0.1 (-0.19 to 0; P=0.04)			-0.07 (-0.1 to -0.03; P<.001)
Hospital Ownership – Physician Ownership (ref: government)	0 (-0.06 to 0.06; P=0.96)	0 (-0.06 to 0.05; P=0.85)	-0.03 (-0.14 to 0.08; P=0.56)	-0.03 (-0.14 to 0.07; P=0.54)	0.01 (-0.03 to 0.06; P=0.53)
Hospital Ownership – Voluntary non-profit	0 (-0.04 to 0.05; P=0.92)	0.01 (-0.04 to 0.05; P=0.74)	-0.01 (-0.1 to 0.08; P=0.78)	-0.01 (-0.1 to 0.08; P=0.82)	0.01 (-0.02 to 0.05; P=0.43)
Teaching Status – Any Teaching (ref: no teaching)	0.01 (-0.04 to 0.06; P=0.63)	0 (-0.05 to 0.04; P=0.96)	0.01 (-0.07 to 0.1; P=0.76)	0.01 (-0.07 to 0.09; P=0.84)	0.01 (-0.04 to 0.05; P=0.77)
Hospital Region – Midwest (ref: northeast)	-0.01 (-0.05 to 0.04; P=0.79)	0.01 (-0.03 to 0.05; P=0.62)	-0.08 (-0.17 to 0.01; P=0.09)	-0.07 (-0.16 to 0.02; P=0.12)	0 (-0.04 to 0.03; P=0.86)
Hospital Region – South (ref: northeast)	-0.01 (-0.06 to 0.04; P=0.79)	0.01 (-0.03 to 0.06; P=0.66)	-0.05 (-0.15 to 0.05; P=0.34)	-0.04 (-0.14 to 0.06; P=0.43)	0 (-0.04 to 0.04; P=0.92)
Hospital Region – West (ref: northeast)	0.02 (-0.03 to 0.07; P=0.47)	0.05 (0 to 0.1; P=0.05)	0.03 (-0.07 to 0.13; P=0.57)	0.03 (-0.07 to 0.13; P=0.51)	0.02 (-0.03 to 0.06; P=0.49)
HRR Population – Second Tercile (ref: first tercile)	-0.14 (-0.2 to -0.09; P<.001)	-0.12 (-0.17 to -0.07; P<.001)	-0.32 (-0.4 to -0.24; P<.001)	-0.32 (-0.4 to -0.24; P<.001)	-0.11 (-0.16 to -0.07; P<.001)
HRR Population – Third Tercile (ref: first tercile)	-0.19 (-0.25 to -0.12; P<.001)	-0.16 (-0.23 to -0.1; P<.001)	-0.42 (-0.51 to -0.32; P<.001)	-0.42 (-0.52 to -0.32; P<.001)	-0.15 (-0.2 to -0.1; P<.001)

HRR Percent Non-White – Second Tercile (ref: first tercile)	0.01 (-0.03 to 0.05; P=0.61)	0.01 (-0.02 to 0.05; P=0.5)	0 (-0.07 to 0.07; P=0.98)	0 (-0.07 to 0.07; P=0.95)	0.02 (-0.01 to 0.05; P=0.2)
HRR Percent Non-White – Third Tercile (ref: first tercile)	0 (-0.05 to 0.04; P=0.84)	0 (-0.04 to 0.04; P=0.91)	0.03 (-0.05 to 0.11; P=0.46)	0.03 (-0.05 to 0.11; P=0.53)	0.02 (-0.01 to 0.06; P=0.24)
HRR Percent Rural – Second Tercile (ref: first tercile)	0.02 (-0.02 to 0.06; P=0.29)	0.02 (-0.02 to 0.06; P=0.25)	0.02 (-0.05 to 0.09; P=0.6)	0.02 (-0.05 to 0.1; P=0.54)	0.01 (-0.03 to 0.04; P=0.71)
HRR Percent Rural – Third Tercile (ref: first tercile)	0.04 (0 to 0.09; P=0.04)	0.05 (0.01 to 0.09; P=0.02)	0.05 (-0.03 to 0.13; P=0.25)	0.05 (-0.03 to 0.13; P=0.25)	0.02 (-0.02 to 0.05; P=0.39)
HRR Percent Less than HS Education – Second Tercile (ref: first tercile)	-0.01 (-0.05 to 0.03; P=0.6)	-0.01 (-0.05 to 0.03; P=0.54)	-0.03 (-0.11 to 0.04; P=0.41)	-0.03 (-0.1 to 0.04; P=0.42)	0 (-0.04 to 0.03; P=0.78)
HRR Percent Less than HS Education – Third Tercile (ref: first tercile)	0 (-0.05 to 0.05; P=0.93)	0 (-0.05 to 0.04; P=0.87)	-0.05 (-0.14 to 0.04; P=0.32)	-0.05 (-0.14 to 0.04; P=0.3)	0 (-0.04 to 0.05; P=0.82)
HRR Percent Below Federal Poverty Line – Second Tercile (ref: first tercile)	-0.01 (-0.06 to 0.03; P=0.5)	-0.01 (-0.05 to 0.03; P=0.58)	-0.04 (-0.12 to 0.03; P=0.24)	-0.05 (-0.12 to 0.03; P=0.21)	-0.02 (-0.05 to 0.01; P=0.26)
HRR Percent Below Federal Poverty Line – Third Tercile (ref: first tercile)	-0.01 (-0.06 to 0.03; P=0.58)	-0.01 (-0.06 to 0.03; P=0.51)	-0.03 (-0.11 to 0.05; P=0.45)	-0.03 (-0.11 to 0.05; P=0.44)	-0.01 (-0.05 to 0.02; P=0.5)

Notes: Marginal effect, % (95% CI)

Table 3: Markets, hospitals, and volume by presence of at least 1 “Better than national average” hospital within a market

Measure	Better than National Average Hospital within HRR?	HRR Count (%)	Hospital Count (%)	Volume Total (%)
30-Day AMI Readmission Rate	Single Hospital HRR	28 (9.15%, n=306)	28 (1.39%, n=2009)	11398 (2.52%, n=453064)
	No	261 (85.29%, n=306)	1850 (92.09%, n=2009)	410129 (90.52%, n=453064)
	Yes	17 (5.56%, n=306)	131 (6.52%, n=2009)	31537 (6.96%, n=453064)
30-Day AMI Mortality Rate	Single Hospital HRR	20 (6.54%, n=306)	20 (0.91%, n=2186)	7466 (1.69%, n=441318)
	No	263 (85.95%, n=306)	1812 (82.89%, n=2186)	361012 (81.8%, n=441318)
	Yes	23 (7.52%, n=306)	354 (16.19%, n=2186)	72840 (16.51%, n=441318)
30-Day CABG Readmission Rate	Single Hospital HRR	84 (27.54%, n=305)	84 (8.59%, n=978)	13043 (10.12%, n=128898)
	No	216 (70.82%, n=305)	877 (89.67%, n=978)	112342 (87.16%, n=128898)
	Yes	5 (1.64%, n=305)	17 (1.74%, n=978)	3513 (2.73%, n=128898)
30-Day CABG Mortality Rate	Single Hospital HRR	83 (27.21%, n=305)	83 (8.41%, n=987)	13408 (10.1%, n=132696)
	No	211 (69.18%, n=305)	818 (82.88%, n=987)	105242 (79.31%, n=132696)
	Yes	11 (3.61%, n=305)	86 (8.71%, n=987)	14046 (10.59%, n=132696)
Hip and Knee Complication Rate	Single Hospital HRR	6 (1.96%, n=306)	6 (0.22%, n=2682)	4498 (0.48%, n=943537)
	No	245 (80.07%, n=306)	1981 (73.86%, n=2682)	639554 (67.78%, n=943537)
	Yes	55 (17.97%, n=306)	695 (25.91%, n=2682)	299485 (31.74%, n=943537)

Table 4: Markets, hospitals, and volume by HRR hospital rating composition category

Measure	HRR Hospital Rating Composition Category	HRR Count (%)	Hospital Count (%)	Volume Total (%)
30-Day AMI Readmission Rate	Single Hospital	28 (9.15%, n=306)	28 (1.39%, n=2009)	11398 (2.52%, n=453064)
	Only Average	255 (83.33%, n=306)	1732 (86.21%, n=2009)	388191 (85.68%, n=453064)
	Average & Worse	6 (1.96%, n=306)	118 (5.87%, n=2009)	21938 (4.84%, n=453064)
	Average & Better	16 (5.23%, n=306)	114 (5.67%, n=2009)	27869 (6.15%, n=453064)
	Worse, Average, & Better	1 (0.33%, n=306)	17 (0.85%, n=2009)	3668 (0.81%, n=453064)
30-Day AMI Mortality Rate	Single Hospital	20 (6.54%, n=306)	20 (0.91%, n=2186)	7466 (1.69%, n=441318)
	Only Average	247 (80.72%, n=306)	1650 (75.48%, n=2186)	328947 (74.54%, n=441318)
	Average & Worse	16 (5.23%, n=306)	162 (7.41%, n=2186)	32065 (7.27%, n=441318)
	Average & Better	23 (7.52%, n=306)	354 (16.19%, n=2186)	72840 (16.51%, n=441318)
30-Day CABG Readmission Rate	Single Hospital	84 (27.54%, n=305)	84 (8.59%, n=978)	13043 (10.12%, n=128898)
	Only Average	204 (66.89%, n=305)	775 (79.24%, n=978)	98703 (76.57%, n=128898)
	Average & Worse	12 (3.93%, n=305)	102 (10.43%, n=978)	13639 (10.58%, n=128898)
	Average & Better	5 (1.64%, n=305)	17 (1.74%, n=978)	3513 (2.73%, n=128898)
30-Day CABG Mortality Rate	Single Hosptial	83 (27.21%, n=305)	83 (8.41%, n=987)	13408 (10.1%, n=132696)
	Only Average	202 (66.23%, n=305)	777 (78.72%, n=987)	98702 (74.38%, n=132696)
	Only Worse	1 (0.33%, n=305)	2 (0.2%, n=987)	245 (0.18%, n=132696)
	Average & Worse	8 (2.62%, n=305)	39 (3.95%, n=987)	6295 (4.74%, n=132696)
	Average & Better	10 (3.28%, n=305)	81 (8.21%, n=987)	12392 (9.34%, n=132696)
	Worse, Average, & Better	1 (0.33%, n=305)	5 (0.51%, n=987)	1654 (1.25%, n=132696)
Hip and Knee Complication Rate	Single Hospital	6 (1.96%, n=306)	6 (0.22%, n=2682)	4498 (0.48%, n=943537)
	Only Average	211 (68.95%, n=306)	1498 (55.85%, n=2682)	478909 (50.76%, n=943537)
	Average & Worse	34 (11.11%, n=306)	483 (18.01%, n=2682)	160645 (17.03%, n=943537)
	Average & Better	47 (15.36%, n=306)	496 (18.49%, n=2682)	221998 (23.53%, n=943537)
	Worse, Average, & Better	8 (2.61%, n=306)	199 (7.42%, n=2682)	77487 (8.21%, n=943537)

8.0 Maps

Figure 2: HRR Facility Rating Variation: Mortality AMI

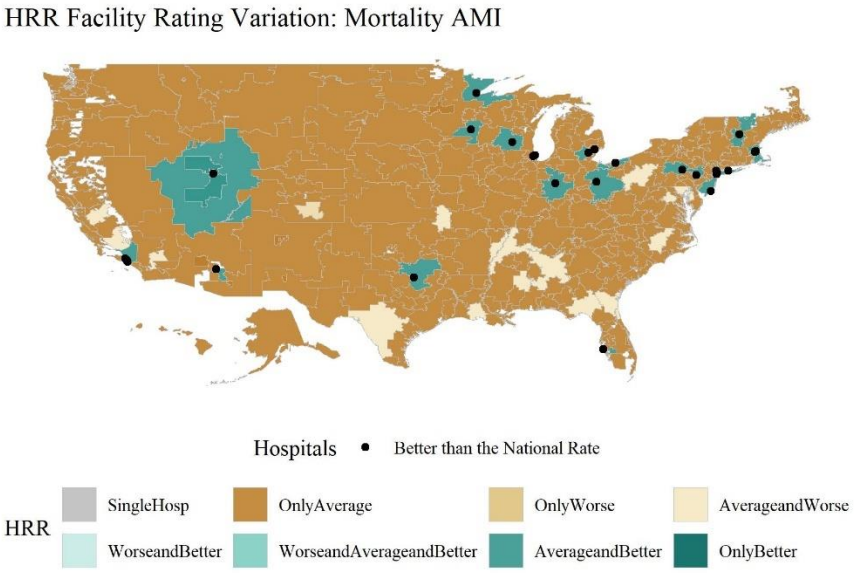


Figure 3: HRR Facility Rating Variation: Readmission AMI

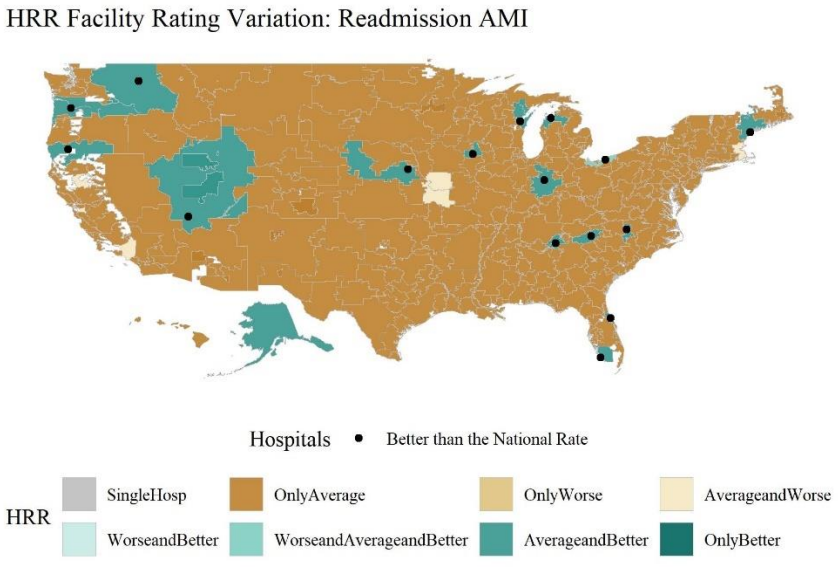


Figure 4: HRR Facility Rating Variation: CABG Mortality

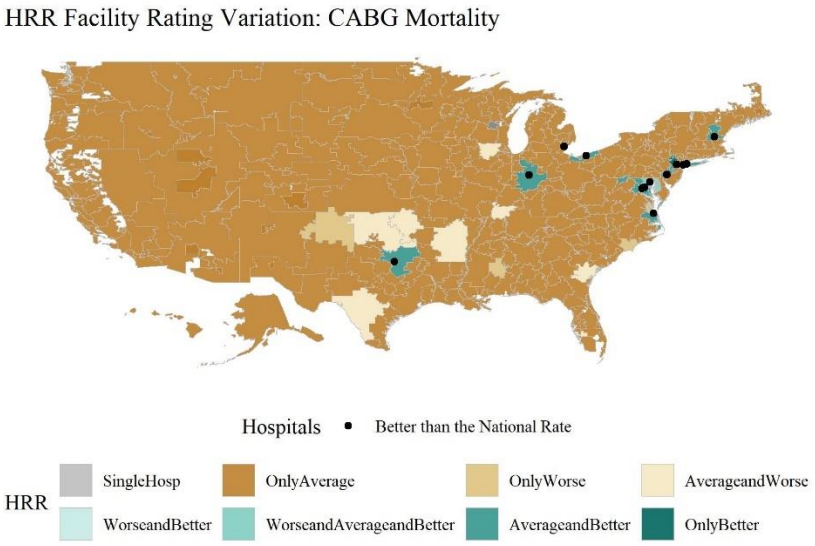


Figure 5: HRR Facility Rating Variation: CABG Readmission

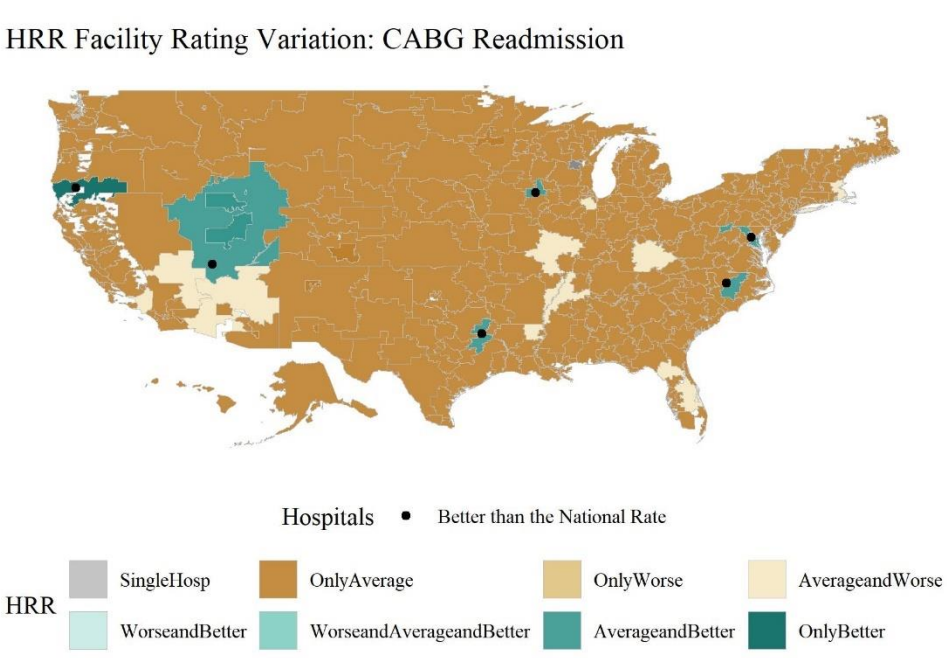
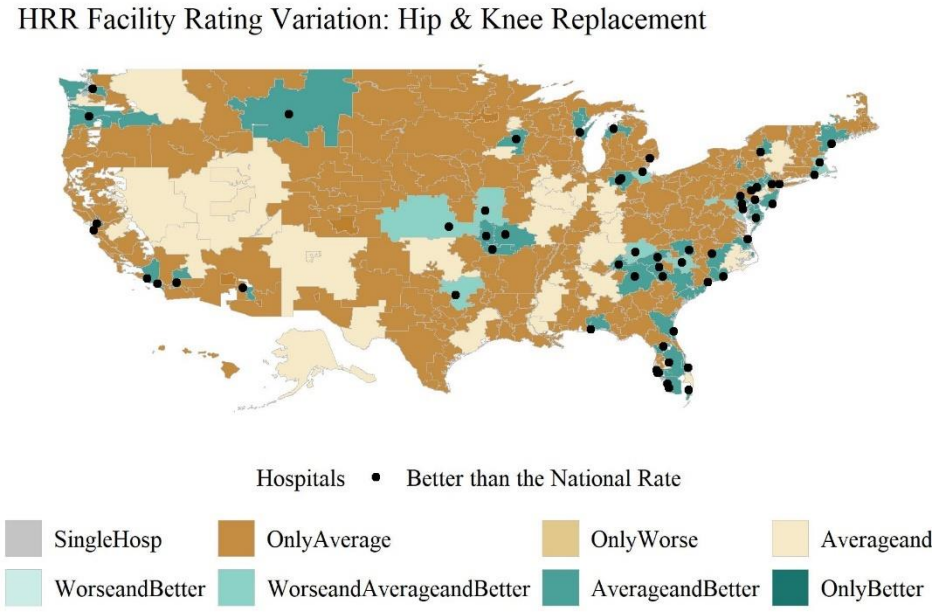


Figure 6: HRR Facility Rating Variation: Hip & Knee Replacement



9.0 References

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