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A Managerial Ecosystem for Excellence in Hospital Administration

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Abstract

Major healthcare systems and hospital organizations face a myriad of challenges in today's business environment, having to provide very complex and more comprehensive medical care with fewer resources. In this study, we investigate determinants of hospital performance in critical dimensions and propose an information infrastructure intended to promote excellence in clinical performance while sustaining a solid financial footing.

Senior executives must be knowledgeable in both business and clinical aspects of hospital administration because their decisions ultimately affect patient care and clinical outcomes. Key performance indicators (KPI) are necessary on both dimensions to inform their decisions. Financial and operational aspects of hospital performance are tied to physical resources, staffing and services provided, development projects and growth of the institution. Clinical aspects pertain to the care provided to patients and are represented by metrics such as death rates, infection rates, readmission rates, and patient-satisfaction surveys. These measures are affected by patient characteristics as well as services rendered. A thorough understanding of KPIs and their potential roles in effecting change for excellence in organizational performance is vital for hospital administrators.

We build multivariate statistical models to assess hospital performance considering institutional characteristics and the populations they serve. Deviations from "adjusted norms" derived from these models reveal areas where an institution's performance exceeds or falls below expectation or national standards. In addition, it allows for true inter-hospital comparisons.

Upper Echelons Theory states that, “organizational outcomes – strategic choices and performance levels – are partially predicted by managerial background characteristics.” To assess extant evidence of this, we identify high and low performing hospitals with our proposed metrics and investigate whether there is a difference between these groups with respect to the training of senior management and the composition of the executive suite.

Using our proposed metrics, we are unable to conclude that the training of senior management or the composition of the executive suite affects hospital performance. To guide strategic initiatives and improve control, we develop an ecosystem using KPIs that align with spheres of managerial responsibility for hospitals and propose them as an alternative to published “hospital star ratings” reported by third parties.

Keywords: hospital performance, key performance indicator, ecosystem, leadership, physicians

List of Exhibits

List of Tables

Table of Contents

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Glossary

AHD	American Hospital Directory
AHRQ	Agency for Healthcare Research and Quality
AI	Artificial intelligence
ASC	Ambulatory Surgical Center
ASCQR	Ambulatory Surgical Center Quality Reporting
AMI	Acute Myocardial Infarction
AVG	Average
BSC	Balanced Score Card
CABG	Coronary Artery Bypass Graft
CAUTI	Catheter-Associated Urinary Tract Infections
CDC	Centers for Disease Control and Prevention
CDI	*Clostridium Difficile* Infection
CEBP	Clinical Episode Based Purchasing
CEO	Chief Executive Officer
CLABSI	Central Line-Associated Bloodstream Infections
CEO	Chief Executive Officer
CMO	Chief Medical Officer
CMS	Centers for Medicare and Medicaid Services
COMP	Complications
COPD	Chronic Obstructive Pulmonary Disease
ED	Emergency Department
EDAC	Excess Days in Acute Care
EBITDAR	Earnings before interest, taxes, depreciation, amortization and rents
EHR	Electronic Health Record
FFS	Fee-For-Service
HACRP	Hospital-Acquired Conditions Reduction Program
HAI	Healthcare-Associated Infections
HCAHPS	Hospital Consumer Assessment of Healthcare Providers and Systems
HCC	Hierarchical Condition Category
HCRIS	Healthcare Provider Cost Reporting Information System
HF	Heart Failure
HIT	Health Information Technology
HOPD	Hospital Outpatient Department
HRRP	Hospital Readmissions Reduction Program
HVBP	Hospital Value-Based Purchasing
ICD-10-CM	International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM)
IPBS	Institutional Provider and Beneficiary Summary
IMG	Imaging
IMM	Immunization
IQR	Inpatient Quality Reporting
KPI	Key performance indicators

LOS	Length of Stay
MBA	Master's in business administration
MD	Medical Doctor
MORT	Mortality
MRSA	Methicillin-Resistant *Staphylococcus aureus*
MSPB	Medicare Spending per Beneficiary (also referred to as SPP for Spending Per Patient)
MSA	Metropolitan Statistical Area
MSR	Measure
MPV	Medicare Payment and Volume
NQF	National Quality Forum
OAS CAHPS	Outpatient and Ambulatory Surgical Center Consumer Assessment of Healthcare Providers and Systems
OCM	Oncology Care Measures
OIE	Outpatient Imaging Efficiency
OM	Operating Margin
OP	Outpatient
OQR	Outpatient Quality Reporting
PN	Pneumonia
PPP	Pay-for-Performance
PRO	Patient Reported Outcomes
PSI	Patient Safety Indicators
PUF	Public Use File
READM	Readmissions
ROA	Return on Assets
RSCR	Risk-Standardized Complication Rate
SEP	Sepsis
SIR	Standardized Infection Ratio
SM	Structural Measures
STK	Stroke
TEL	Theory of Expert Leadership
THA/TKA	Total Hip/Knee Arthroplasty
TJC	The Joint Commission
VBC	Value-Based-Care

Chapter 1. Introduction

The shift from pay-for-performance (PPP) to value-based-care (VBC) in the healthcare industry means the emphasis has changed from *volume* of services performed to *quality* of services performed. Payments are partly based on better clinical outcomes such as decreases in readmission rates, infection rates, complication rates and death rates. Financial penalties are incurred for suboptimal care in the form of reduced payment for services provided. Understanding the drivers of clinical performance is essential for hospital administrators. As a result, over the past two decades, the role of physicians as leaders has grown increasingly important within the hospital system (Angood & Birk, 2014; Gibeau et al., 2020; Kaiser et al., 2020).

Physician leaders need to be mature clinicians with the appropriate mindset and desire to help improve healthcare delivery, coupled with an understanding of how best to utilize physical resources and personnel in the process. Administrative leaders need to be effective in providing the medical infrastructure in a financially sustainable manner, but with an understanding and appreciation of the clinical impacts of their decisions. The assumption that successful clinicians can easily transition to senior managerial roles is ill-founded and simply not true (Desaiet al., 2009). In order to gain insight on how to develop chief executive officer (CEO) skills, one study looked at six hospital presidents/CEOs who were medical doctors (MD) and found that leadership skills and business acumen were the most important factors in choosing a CEO (Kaplan, 2006). In the study by Kaplan (2006), lack of operations experience was the missing ingredient why physician executives did not break the “caducean ceiling” and why only about five percent of hospitals nationwide are physician-led.

In the value-based payment model currently used, (increased) payment is based on (good) clinical outcomes. The hospital CEO, as the final arbiter, makes major decisions that affect resources and services. This means that today's non-physician healthcare leaders are increasingly making administrative decisions that ultimately impact clinical care and patient outcomes. As such, they must have a deep understanding of the clinical performance and the factors that influence them.

1.1. Hospital Rankings and Leadership

In a special white paper report, Angood & Birk (2014) noted, "…physician leadership will be essential for health care to continue moving toward higher quality, consistent safety, streamlined efficiency and becoming value based" (p. 6). As shown in Exhibit 1.1, they noted that the *US News and World Report* rankings (2013) "honor roll" listed 18 institutions – of which the top five were physician-led. From this list, it can also be seen that more than half of the hospitals on the list were physician-led.

Exhibit 1.1

Physicians as Hospital Leaders for 2013

Rank	Organization	State	Name of CEO/President	Physician?
1	Johns Hopkins Hospital	MD	Paul B. Rothman	Yes
2	Massachusetts General Hospital	MA	Peter Slavin	Yes
3	Mayo Clinic	MN	John H. Noseworthy	Yes
4	Cleveland Clinic	OH	Delos M. Cosgrove	Yes
5	UCLA Medical Center	CA	David T. Feinberg	Yes
6	Northwestern Memorial Hospital	IL	Dean M. Harrison	No
7	New York-Presbyterian University Hospital of Columbia and Cornell	NY	Steven J. Corwin	Yes
8	UCSF Medical Center	CA	Mark R. Laret	No
9	Brigham and Women's Hospital	MA	Elizabeth G. Nabel	Yes
10	UPMC-University of Pittsburgh Medical Center	PA	Jeffrey A. Romoff	No
11	Hospital of the University of Pennsylvania	PA	Ralph W. Muller	No
12	Duke University Medical Center	NC	Victor J. Dzau	Yes
13	Cedars-Sinai Medical Center	CA	Thomas M. Priselac	No
14	NYU Langone Medical Center	NY	Robert I. Grossman	Yes
15	Barnes-Jewish Hospital/Washington University	MO	Richard Liekweg	No
16	IU Health Academic Center	IN	Dan Evans	No
17	Thomas Jefferson University Hospital	PA	Stephen K. Klasko	Yes
18	University Hospitals Case Medical Center	OH	Thomas F. Zenty III	No

Note. With permission from Angood & Birk, 2014.

Allegedly, within hospitals, physician leaders bridge the divide between medicine and management. Sarto and Veronesi (2016) conducted a review of clinical leadership and hospital performance and found a mostly positive impact of clinical leadership on outcome measures, but that there was a negative impact on financial and social performance. However, their study sample was small at 19 hospitals and its generalizability was limited.

There is growing evidence that physician-led hospitals have lower mortality rates and higher patient satisfaction scores compared with their non-physician counterparts (Tasi et al., 2019). Exhibit 1.2 shows a more recent list from *US News and World Report* rankings (2020) and, again, the top six institutions are physician-led. Most US hospitals, however, are managed by administrative leaders (Tasi et al., 2019).

Exhibit 1.2

Rankings of US hospitals, 2020

1. Mayo Clinic, Rochester, Minnesota
2. Cleveland Clinic
3. Johns Hopkins Hospital, Baltimore
4 (tie). New York-Presbyterian Hospital-Columbia and Cornell, New York
4 (tie). UCLA Medical Center, Los Angeles
6. Massachusetts General Hospital, Boston
7. Cedars-Sinai Medical Center, Los Angeles
8. UCSF Medical Center, San Francisco
9. NYU Langone Hospitals, New York
10. Northwestern Memorial Hospital, Chicago
11. University of Michigan Hospitals-Michigan Medicine, Ann Arbor
12. Brigham and Women's Hospital, Boston
13. Stanford Health Care-Stanford Hospital, Stanford, California
14. Mount Sinai Hospital, New York
15. Hospitals of the University of Pennsylvania-Penn Presbyterian, Philadelphia
16. Mayo Clinic-Phoenix
17. Rush University Medical Center, Chicago
18 (tie). Barnes-Jewish Hospital, St. Louis
18 (tie). Keck Hospital of USC, Los Angeles
20. Houston Methodist Hospital

Note. With permission from US News and World Report, 2020.

The balanced scorecard (BSC) is a performance measurement tool that was developed by Kaplan & Norton (1996). Used in organizations to help business managers link short-term activities to long-term organization objectives, the BSC is an indication of what the organization is trying to achieve – its vision. The BSC has been applied in healthcare since the 1990's and its relevance to healthcare remains strong. The BSC takes into consideration key performance indicators (KPIs) in financial measures as well as performance measures in customer relationships, internal processes and learning and growth which are reflective of clinical outcomes. While the BSC has been used in healthcare since the 1990's, frequent adaptations from the original BSC framework within the healthcare context result in only about 20% adherence to the original BSC framework; patients are minimally included in development teams.

Medicine, as practiced within highly complex organizations, involves both the operational and business aspect as well as clinical performance. Leadership requires both clinical acumen and operations expertise. The positive impact of clinical leadership on outcome measures (decreased mortality rates) and the growing evidence that physician-led hospitals have higher patient satisfaction scores compared with their non-physician counterpart, point to physicians-as-leaders being an important factor affecting organization performance. The optimal hospital leadership structure on hospital performance, however, has not yet been established.

The Centers for Medicare and Medicaid Services (CMS) has a star rating of hospitals to reflect clinical quality of care at these institutions. The start ratings considers five domains of hospital performance that pertain to patients' experiences and include: (1) mortality, (2) safety of care, (3) readmissions, (4) patient experience and (5) timely and effective care. The 48 measures or KPIs that constitute these five domain groups along with their component number of measures are shown in the Exhibit 1.3 below. The complete CMS list of measure names and their descriptions are shown in Appendix B.

Exhibit 1.3

Number of Measures for each Safety Domain Group

Group	Number of Measures (N=48)
Mortality	7
Safety of Care	8
Readmission	11
Patient Experience	8
Timely & Effective Care	14

The star rating is generated based on the overall summary scores using a statistical process of k-means clustering to group hospitals with scores of one-to-five-star ratings.

Hospitals represented with a particular star rating in one cohort group (e.g., large university-affiliated teaching hospitals) may perform quite differently from hospitals with the same star rating in another group (e.g., regional hospitals outside major cities). This is because not all hospitals provide the same types of services, nor do they all report the same information for each dimension of performance. Details about how data are collected and assembled to produce the star ratings are not generally understood by hospital administrators and clinicians which can lead to misinterpretation and misuse of the star ratings.

1.2. Research Objectives

The CMS star ratings summarize ratings of performance that affect patients on various dimensions, and present them as rankings from 1(lowest performing) to 5 (highest performing). Large differences in rank can sometimes involve immaterial differences in levels of performance. Further, in consolidating metrics for the dimensions of performance, the components of a score, which are attributable to healthcare practices that fall under different spheres of managerial control, become unavailable for analysis. As a result, their value to the leadership teams responsible for making decisions to improve hospital clinical performance is diminished. Using KPIs that represent hospital performance at a more granular level while establishing norms that reflect an institution's structural characteristics, mission and range of services rendered would better help identify the areas within the hospital where clinical care needs improvement. Placing such information in the hands of clinical leaders and managers responsible for performance in the respective dimensions would support an ecosystem for fostering superior performance and effecting the change necessary to achieve it.

With this aim, we: (1) discuss the shortcomings of the CMS star ratings for hospital administration, (2) develop an alternative set of KPIs more suited for hospital administration, (3) produce statistical models for setting norms of performance considering the hospital's characteristics and characteristics of its patients, and (4) identify high-performing and low-performing hospitals using deviations from adjusted norms of performance, and for a sample of hospitals from these two groups. We will collect information about the executive leadership team and determine if there is evidence that medical training of the chief executive or presence of a chief medical officer (CMO) as a member of the hospital executive leadership team contributes to superior institutional performance.

Finally, we propose an ecosystem that would use deviations from adjusted norms of performance to identify hospital areas needing improvement. In this last phase, we employ tools for the proposed ecosystem to identify hospitals that have achieved superior performance on critical dimensions and hospitals with performance that falls below expectations to help inform the decisions by the parties responsible for effecting the changes for the necessary improvement.

Chapter 2. Literature review

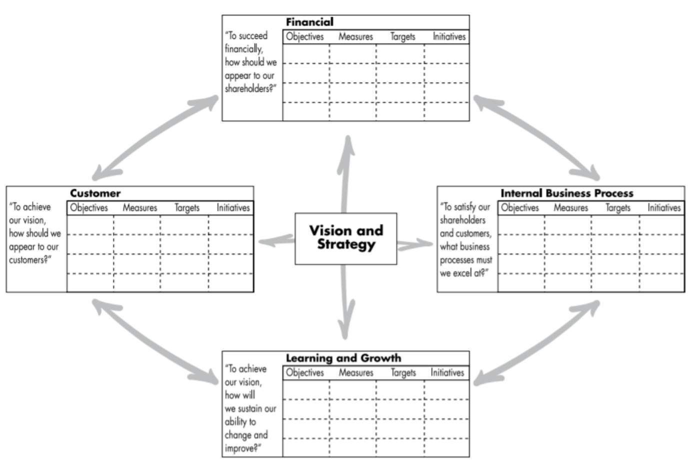
Hospital performance encompasses clinical performance as well as financial and operational performance. High performance in both dimensions depends on the business model, but is also expected to be dependent on leadership capabilities. In this chapter, we review literature pertaining to the use of balanced scorecards for hospital performance, leadership theory, and rating of hospital performance in comparison with peer institutions.

2.1. Balanced Scorecard

The BSC was developed by Kaplan & Norton (1996) to help business managers link short-term activities to the organization's vision and strategy. It takes into consideration financial perspectives as well as performance measures in three non-financial areas: customer relationships, internal processes and learning and growth. The interactions of these perspectives are depicted pictorially in Exhibit 2.1 below.

Exhibit 2.1

Translating Vision and Strategy: Four Perspectives

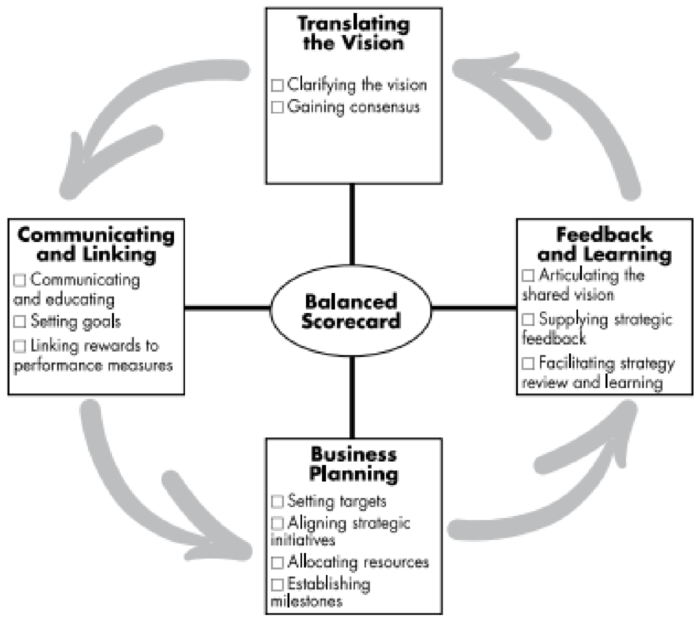


Note. With permission from Kaplan & Norton, 1996.

On the path to achieving a BSC, the process steps involved are shown in Exhibit 2.2.

Exhibit 2.2

Strategy for Balance Scorecard: Four Processes



Note. With permission from Kaplan & Norton, 1996.

Translating the vision ensures that managers will agree on the metrics to operationalize organizational goals, thereby clarifying the organization's visions. *Communication and linking* allows for the BSC to be accessible to everyone in the organization and can be subsequently applied to smaller units within the organization. Performance can be measured at a more local level and incentives and rewards can be linked to improved performance measures. *Business planning* involves the integration of operations and financial plans: it removes the disconnect between strategic planning and resource allocation and budgeting. Thus, the BSC ensures that budgetary constraints support organizational strategy and vision. The fourth process, depicted as *feedback and learning*, looks at whether budgeted financial goals have been met. It is within this fourth process that organizations can look at short-term goals and metrics from the non-financial perspective which affords for further strategic learning. Strategic learning consists of not only making necessary adjustments based on data and feedback, but also testing the hypothesis that the strategy was initially based on. It is referred to as a double-loop feedback and is a process involving introspection by leaders. This is necessary to help examine assumptions relating to the cause and effect relationships of business practices (Argyris, 1991).

The BSC has been applied in healthcare since the 1990’s and its relevance to healthcare remains strong (Behrouzi & Ma'Aram, 2019; Chow et al., 1998; Inamdar et al., 2002; Walker & Dunn, 2006; Zelmanet al., 2003). IBM Watson Health 100 Top Hospitals is based on a proprietary BSC approach to rank hospitals based on five hospital groups: major teaching, teaching, large community, medium community, and small community hospitals (IBM 2021). The Malcolm Baldridge National Quality Improvement Act was signed into law in 1987 to improve quality and productivity in the USA by establishing guidelines and criteria that organizations can utilize to improve their internal quality improvements. The Malcolm Baldridge National Quality Award (MBNQA) was established in 1988 and is given by US presidents to businesses that apply for the award within the sectors of manufacturing, service, education and healthcare. To receive the MBNQA award, the organization has to apply for the award and must be outstanding in the areas of leadership, strategic planning, customer focused, knowledge management, human resource focused, process management and results (Foster et al., 2007), components all similar to the BSC framework. In 2020, two of the five awards were given to organizations within the healthcare industry (Boutin, 2020).

In a recent review of BSCs in healthcare, Bohm et al. (2021) found that frequent adaptations from the original BSC framework occurred within the healthcare context such that only about 20% of BSCs used identical formatting to the original BSC framework. In addition, they found that the customers, i.e., patients, were included in development teams only three percent of the time. They concluded that due to the heterogeneity in the approach to using BSCs in healthcare, methodological guidance is needed for a more uniform approach to using the BSC framework in healthcare. Trotta et al. (2013) proposed a framework for teaching hospitals wherein the stakeholders were not only patients, but also included medical students, residents and researchers, further illustrating the heterogeneity in the approach to using BSCs in healthcare.

Balanced scorecards have also been applied at the system level for hospital systems (Amer et al., 2022; Yap, Siu et al., 2005). Yap et al. (2005) studied the adoption of a system-level scorecard into institution-specific scorecards in acute and non-acute hospitals and found that teaching hospitals used the system-level scorecard significantly more than community hospitals and that larger teaching and community hospitals were more likely to use a system-level scorecard to report performance data than smaller hospitals. In a recent review, Amer et al. (2022) looked at the impact of BSC in health care organizations, specifically to assess the impact on patient satisfaction, Health Care Workers' (HCW) satisfaction and financial performance. They found that BSC adoption showed positive outcomes for patient satisfaction and financial performance, but was only mildly impactful on HCW satisfaction. Their review was limited, however, by a high rate of bias in the studies they reviewed as well as the heterogeneity of data collection methods in those studies.

2.2. Leadership Theories

Leadership in administration, similar to medicine, requires training and development. As a result, in the past decade, there has been a rise of dual MD and masters of business administration (MBA) degrees offered by medical schools to the point where one in five medical schools offers a combined MD/MBA degree (Lemon, 2018).

One study of physician-leaders as CEOs examined quality scores at the top 100 US hospitals in three specialty fields – cancer, heart surgery and digestive disorders – and found that the average hospital quality score was higher in institutions with physician CEOs (Goodall, 2011). While intriguing, this cross-sectional analysis was too narrow to draw firm conclusions regarding leadership. This extent to which CEO leadership training influences hospital performance needs to be studied.

2.2.1. Upper Echelons Theory

Organizational performance, based on Upper Echelons Theory, states that "organizational outcomes – strategic choices and performance levels – are partially predicted by managerial background characteristics" (Hambrick & Mason, 1984). Refinements in Upper Echelons Theory introduced two moderators: managerial discretion and executive job demands (Hambrick, 2007). According to Hambrick (2007 p. 200), "Discretion exists when there is an absence of constraint and when there is a great deal of means-ends ambiguity," and "if… discretion is lacking, executive characteristics do not much matter." In other words, under heavy workloads, executives may regress to making important decisions based on intuition or prior experience, reflecting their background characteristics. This is especially true in the hospital organizations where administrative decisions can directly impact patients' lives. Managerial training and relevant experience of senior hospital executives are thus seen as important characteristics that will potentially affect organizational performance.

2.2.2. Theory of Expert Leadership

A framework for the Theory of Expert Leadership (TEL) was developed in a study examining university leadership and performance (Goodall, 2009b). Goodall (2009b) argued that world-class scholars made the best leaders of research universities, not administrators. This was a longitudinal study in the UK and demonstrated that a vice-chancellor's prior scholarly success is indicative of the number of top grades a university is likely to attain. This study maintained that scholarship is not a proxy for management skills; the university president must have additional skills other than academic research. This study also revealed that firms behave differently from universities: corporate commitment is less for academicians who are devoted to their discipline and peers; university revenue does not necessarily reflect scholarly performance. In US hospitals, however, revenue generation is a critical aspect of performance.

In addressing how much core knowledge the leader of an organization must possess, TEL suggests that organizations perform better when leaders have a deep understanding of the core business (Goodall, 2009a). TEL is a function of inherent knowledge (attained through education and high ability in the business core activity), industry experience and leadership capabilities (includes management and leadership training and experience). Within medicine, TEL proposes that medical leaders, as opposed to business CEOs, improve organizational performance through four channels: (1) the accomplished medical leader influences strategy, (2) the intimate knowledge of the work environment, values and culture better positions the leader to evaluate performance and set realistic goals, (3) ability to attract more outstanding core professionals: like attracts like and (4) the medical leader's credibility and influence among core workers signal organizational priorities to stakeholders – patients and the board members alike. Within TEL, the physician leader must possess additional managerial capabilities aside from core medical knowledge.

Personalities and behaviors of senior managers are also seen as important determinants of organizational performance. CEO humility and its effect on firm outcomes using upper echelon, power and paradox theories was also recently studied (Ou et al., 2018). These researchers found that humble CEOs were more likely to work well with others, seek out information from others when they were uninformed and were more likely to adopt an ambidextrous strategic orientation, thereby leading to better firm outcomes.

2.2.3. Dyadic Leadership

According to Lemon (2018), MBA-trained physicians make better-qualified co-leaders as a part of a leadership dyad, such that, when paired with a professional administrator, they may effectively oversee a clinical service line such as pediatrics or oncology. The dyad model at the leadership level is intended to draw on medical expertise to better ensure clinical quality and innovation, present a more patient-centric approach to care and engender physician loyalty. Simultaneously, the non-physician leader's expertise in, for example, operations and revenue management, supply chain and support systems is intended to complement the physician leader's skills in a dyadic model. A recent review based on scientific papers, published in English in international journals and conference proceedings, studied whether there was better hospital performance with MD leadership (Sarto & Veronesi, 2016). This review showed a positive impact on clinical outcomes, but a negative impact on financial and social performance with MD leadership.

Dyadic leadership at the CEO level, comprised of a physician leader and a non-physician leader would offer complementary leadership skills. A seasoned medical practitioner along with an experienced business executive with management training would seem to offer the best of both worlds – an effect that is expected to be magnified if both leaders had additional training in their complementary realms. This dyad would foster collaboration and encourage the leaders to seek each other's advice, fulfilling the requirements of effective management as seen in paradox theory since it would lead to a more ambidextrous orientation for addressing tensions between clinical performance and financial performance. Co-leadership as seen in this dyad model would appear to be supported by the findings of humble leadership and its increase in firm performance (Ou et al., 2018). Dyadic leadership at the CEO level in hospitals, however, has not been widely adopted. This may be due to the structure of the organization (where one person reports to the board of trustees) or due to financial restraints (salaries of two top leaders).

Saxena (2020) looked at the challenges for dyadic leadership and found that there are important areas requiring attention for a successful partnership. He found that mindset, competencies, interpersonal relationships, support, communication and collaboration are the most important dimensions in the partnership relationship. As such, collaboration at the CEO level within the executive suite may be an important factor affecting organization performance. A proximate surrogate for this pure model therefore needs to be studied.

Ambidextrous orientation can be inferred from known exploitation or exploration measures used in the past. In hospitals, the exploration-exploitation equivalent will be assessed as tensions of clinical performance and financial performance where clinical performance is centered around patient care. Ambidextrous orientation, assessed using both clinical and financial data, can be used to examine whether it can be linked to leadership structure. Ambidextrous orientation of the organization is seen when organizations show simultaneous improvement in *both* patient clinical outcomes and financial measures, which is further accompanied by improved hospital rating (Buhlman & Lee, 2019).

Pluralistic organizations are organizations that have multiple institutional demands or logics and diverse goal; hospitals, which have to deal with the dichotomy of patient care and managerial logics, are pluralistic organizations (Gibeau et al., 2020). This diversity of goals or multiple logics have a profound influence on organizational life. In hospitals, co-leadership of a physician and a nurse-administrator is used as a strategy to deal with these tensions at the service line or senior management level, below the CEO level. An example of this was shown in the study by Kim et al. (2014) using a leadership dyad model to effect change on an inpatient ward. Six US hospitals using a physician-director and nurse-manager dyad collaboration showed improved patient outcomes, aligning with the mission of the organization to continually assess and improve measures such as quality, safety, efficiency and patient satisfaction (Kim et al., 2014). CEO leadership training and structure may be a surrogate for the dyadic model.

2.3. Third Party Hospital Rankings

Austin et al. (2015) looked at four national organizations providing hospital ratings and found that no single hospital was rated as a top performing hospital by all four entities, most likely due to the divergent measures of performance. A more recent article looked at the discrepancies between hospital rating systems in an attempt to develop a composite rank score for easier use by patients (Hota et al., 2020). This study compared the ratings from US News Best Hospitals, Vizient Quality and Accountability Study, CMS Star Rating, Leapfrog Hospital Safety Grade and Truven (now IBM Watson Health) Top 100 Hospitals Ratings. Using Spearman correlations, the highest correlation was found between Leapfrog Hospital Safety Grade and CMS Star Rating. While *mortality rates, effectiveness, efficiency, safety and patient centeredness* were common domains among CMS, Vizient and Truven, *structure* accounted for 30% weight or more for US News and Leapfrog ratings. Structure was dropped from CMS star ratings for 2021 because of measurement issues. Also, US News had “Reputation” as a domain that accounted for a 27% weight in their ranking. This illustrates the complexity involved in ranking systems.

Vizient is a repository of clinical data from over 1200 hospitals and comprises over 95% of the nation’s academic medical centers. This is a comparative database where members upload data to through a consolidated patient data feed and most of the data come from administrative billing records. The Vizient clinical database includes CMS data and contains discharge and line-item, patient-level detail data from Vizient-member hospitals. Vizient generates value-added metrics including clinical flags, Agency for Healthcare Research and Quality (AHRQ) safety and quality indicators, National Healthcare Safety Network (NHSN) Indicators, Core Measures data, and Vizient risk-adjusted values. Vizient's dashboards allow hospitals to compare their performance with other 'like' hospitals, i.e., academic-based hospital or community-based hospitals.

American Hospital Directory (AHD) is another 'private' data repository that is based on data from CMS including Medicare claims data and hospital cost reports. AHD requires a paid subscription to access their portal. It provides financial data as well as statistics and outcomes analytics for more than 7,000 hospitals nationwide using CMS data in a user-friendly manner. These clinical and financial data can be cross referenced with CMS data and validity confirmed. AHD also includes information about the members of the executive suite including CEOs and CMOs.

The discrepancies between hospital rating systems is well acknowledged (Hota et al., 2020). Different rating systems may not have the same level of information based on billing information that CMS possesses so they may not be able to capture the necessary data needed for certain measures. For example, unless a patient is readmitted to the same hospital where the initial treatment was done, readmission data may not be captured in Vizient – even among hospitals within the same hospital systems. The chart shown below in Exhibit 2.3 illustrates the alignment (or lack of) between Vizient and CMS. Here, for example under HAI (*Safety of Care*) domain, Vizient, though aligned with CMS, lacks MRSA bacteremia that CMS reports as HAI_5_SIR.

Exhibit 2.3

Measure Information for each Safety Domain for Vizient and CMS

Vizient and CMS Star Ratings Crosswalk

Domain/Measure	Vizient	CMS Star Ratings	Alignment
Mortality	Inpatient only All payor Most clinical conditions Proprietary Risk Model	30-day Traditional Medicare only Limited to AMI, CHF, PN, COPD, CABG, and STK CC/MCC Risk Model	
Readmissions	Index Hospital only All payor Most clinical conditions No risk adjustment	30-day Traditional Medicare only Limited to AMI, CHF, PN, COPD, CABG, and THK CC/MCC Risk Model	
HCAHPS	All Composites Top Box Score Limited Patient Mix adjustment	All Composites Linear Mean Score (all responses count) Full patient mix adjustment	
HAIs	Includes CAUTI, CLABSI, SSIs (Colon and Hyst.) and C diff.	Includes same measures as Vizient but also includes MRSA	
PSI-90	All payor	Traditional Medicare Only	
Timely and Effective Care	Includes lab-based quality metrics	Includes outpatient, sepsis, and perinatal care process metrics	
Composite Methodology	Ranks hospitals in 4 distinct peer groups based on size and scope	Ranks hospitals in 3 distinct peer groups based on the # of measures that meet volume criteria	

Legend		
Near Exact Match	Conceptual Match	Not Aligned

Within the T*imely and Effective Care* and *Composite Methodology* domains, Vizient has no direct alignment with CMS. Some other major differences include: (1) CMS only uses TM claims data whereas Vizient uses claims data from all payors, (2) readmissions in Vizient look at the index hospital only with most clinical conditions, (3) CMS uses 30-day readmission for all Medicare claims data for all hospitals and focuses on AMI, HF, COPD, CABG and THA/TKA.

Medical institutions are highly complex, dynamic systems. Seemingly inconsequential problems can balloon into major problems – resulting in severe injury or death. Risk-adjusted mortality scores are widely used to evaluate hospital performance, but can be problematic since it is doesn't account for case volumes and requires a confidence interval for interpretation (Pitocco & Sexton, 2017). To overcome this, Pitocco and Sexton (2017) used an upper-tail probability to screen for hospitals performing poorly and a lower-tail probability to screen for hospitals performing well; their methodology was sensitive to case numbers. This further underscores the complexity in evaluating hospital performance.

The CMS *Overall Star Ratings* of hospital quality was introduced in 2016 and was designed to allow for hospital comparisons in order to help patients and consumers make more informed choices in selecting a hospital (CMS.gov, 2022). When launched in 2016, the CMS *Overall Hospital Quality Star Ratings* met with controversy due to lack of transparency in their methodology and data sharing (Bilimoria & Barnard, 2016). In 2021, CMS *Overall Hospital Quality Star Ratings* was revised and re-released, making it simpler, more transparent and predictable (Bilimoria & Barnard, 2021).

To qualify for a CMS star rating, hospitals must have: (1) reported clinical measures in either mortality or safety domain and (2) reported clinical measures in at least three domains. Hospitals are then assigned to a peer group based on the number of domains reported: 5-domain cohort, 4-domain cohort or 3-domain cohort. Each measure is analyzed across all hospitals *within their peer-group domain cohort* and a weighted measure score is generated which is aggregated into a measure group score. The measure domains contribute a fixed weight to the overall hospital summary score, e.g., mortality, safety of care, readmissions, and patient experience each account for 22% of the hospital summary score while timely and effective care accounts for 12% of the hospital summary score. These measure group scores for the domains are added to calculate an overall summary score for each hospital within their peer groups. The hospital star rating is then generated based on the overall summary scores by using a statistical process of k-means clustering to group hospitals in scores of one through five stars based on the summary scores.

Not all hospitals provide information for each dimension of performance. If a hospital fails to report information needed to generate a score on one of the dimensions, the fixed weight is redistributed among the others. For example, for 5-domain cohort groups, if information for *efficiency care*, which accounts for 12% of the hospital summary score, is missing, this number is eliminated such that the other four measure domain group are now worth 25% instead of the original 22%.

Ratings from rating agencies exhibit low correlations possibly because of either limited variance in the metrics used or significant differences in the nature of the institutions and the populations they serve. Nevertheless, CMS data appear to be the most comprehensive and are utilized to a great extent by all the various rating agencies. Therefore, CMS data will be the sole source of clinical and financial information used in this study.

2.4. Assessing Quality of Care

A conceptual framework for assessing quality of care proposed by Donabedian (1988) included the following categories: structure, process and outcome. Structure relates to the environment in which care is provided and includes material and human resources as well as organizational structure. He contends that structural measures, while they may facilitate better performance, are not a good indicator of quality. Thus, he favored the use of either *process* measures or *outcome* measures to assess quality.

Process measures include interventions intended to prevent manifestation of disease. For example, screening colonoscopies or mammograms are used for early detection and treatment of colon and breast cancers respectively, and is a direct measure of the quality of healthcare (Mant, 2001). Process measures require an assumption that a difference in the process is linked to an important difference in health outcomes (Eddy, 1998). Porporato et al. (2017) looked at the cause-effect relationship for “best patient experience process” (using process measures such as hand hygiene performance and wait times) and “best patient experience outcome” (using outcome measures such as infection rates and mortality) in a community hospital within a BSC framework. The implication of their study was that unless attention is paid to how process measures are obtained and collected, distortions are introduced into composite measures and, furthermore, process-outcome relationships should be tested and not assumed.

Outcome measures denote the effects of an intervention on the health of a patient – it tracks results that are of immediate importance to consumers, especially those that reflect risk of mortality (Van Matre & Koch, 2009). Mant (2001), in his review of performance indicators, noted that differences in outcome may be due to four factors: case mix, data collection methodology, chance occurrences and quality of care. Further, he stated that process measures are more sensitive to differences in the quality of care and are, therefore, direct measures of quality. Additionally, if standardized data collection methods are used and validated case mix adjustments are applied with large sample sizes, significant variations in health outcomes may provide accurate indicators of real differences in quality.

Performance outcome measures gauge the hospital’s ability to achieve targeted goals and often reflect how underlying processes are aligned with best practices. Key performance indicators, from a BSC framework, can be clinical, financial or customer focused. Clinical KPIs are compiled by numerous agencies including the Centers for Medicare and Medicaid Services (CMS), Agency for Healthcare Research and Quality (AHRQ) and the Joint Commission (TJC).

Key performance indicators using a BSC model to evaluate hospital performance were recently studied (Rahimi et al., 2017). The researchers considered over 200 indicators from a review of the literature and selected 77 after an internal expert panel review; this list was further narrowed to include 22 KPIs. The results of that study are shown in Exhibit 2.4 below.

Exhibit 2.4

KPIs of Hospital Performance from a BSC Perspective

BSC perspectives	Indicators		Indicators	
Finance (F)	F1	Ratio of total revenue to total costs	F8	the cost of drugs and materials
	F2	% Deductions of hospital	F9	%Personnel costs of total costs
	F5	Average expenditures per bed per day		
Internal Process (P)	P1	average Length of stay	P8	Discharge with Personal satisfaction
	P3	Bed occupancy	P9	Hospital infection rate
	P4	bed turnover	P10	Clinical errors
	P5	Mortality rate	P26	Mean Length of stay in emergency department
	P6	Cancelled operations	P27	Emergency Room (ER) waiting time
Learning and Growth (G)	G1	Staff satisfaction rate	G3	Training expenditures per capita
	G2	Staff turnover	G8	Employee absenteeism rate
Customer (C)	C1	The facilities for families and visitors	C3	Rate of Patient complaints
	C2	Patients satisfaction percentage		

Note. With permission from Rahimi et al., 2017.

This study illustrates the variation in the selection of KPIs which are often selected based on their importance to the parent institutions. For example, cancelled surgical operations was probably identified as a KPI because of the high rate of operations cancelled at that institution. While this is an important metric to track, the reason as to why they are cancelled, i.e., the process, is not being studied. For instance, the lack of a preoperative clinic might be the process that is lacking which is leading to inadequate preparation of patients and their eventual cancellations on the day of surgery. This study supports the use of performance metrics, as relevant from a BSC perspective, where these measures can be analyzed, and overall performance assigned to the hospital. It underscores, however, the variability of KPIs and the challenges faced in comparing performance data among many hospitals.

With big data afforded by electronic health records (EHR), attempts to use artificial intelligence (AI) analytical methods are increasingly being used to predict patient outcomes. Downing et al. (2017) developed an AI algorithm using a semi-supervised machine learning approach for characterizing hospital performance using CMS data. While their study revealed nuanced differences in performance often obscured in existing hospital rating systems, their AI algorithm was best suited for complete datasets and only 1,614 US hospitals, mostly urban, were included in their study, thereby limiting the generalizability of their findings.

2.5. Performance Measurement

Hospital performance needs to be objectively quantified. Performance measures include KPIs that are either clinical, financial, operational or customer focused. They are developed to measure the results of the organization’s practices and procedures with the end-goal of improving patient care and satisfaction while generating revenue. Since KPIs are often chosen based on their importance to the parent institution, their selection is influenced by many institutional factors including location, patient mix, payor mix, tax status and profit margins.

CMS is the governing body that maintains patients’ clinical outcomes data. Their Public Use Files (PUF) are composed from provider (hospital) claims submittal and contain demographic, clinical and financial data. Medicare-certified institutional providers are required to submit annual cost reports which contain provider information such as facility characteristics, utilization data, cost and charges by cost center (both in total and for Medicare), Medicare settlement data and financial statement data. CMS maintains the cost report data in the Healthcare Provider Cost Reporting Information System (HCRIS). Financial data include providers' submitted charges, the allowed payment from Medicare, the amount paid to providers and the amount owed by patients. These CMS data contain hospital descriptive data which include the hospital state and zip code, ownership (nonprofit, private, etc.), emergency services, and the criteria for interoperability of electronic health records (EHR). Hospital clinical performance data are also reported and include the overall star rating, mortality measures, safety measures, readmission measures, efficiency measures and patient experience measures. It also indicates whether the hospital is better, worse or no different from the national average for these aforementioned measures.

The star ratings initially considered over 150 measures from over 4000 Medicare-certified hospitals using Medicare claims data based on The International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) codes over a yearly period. Generally, the database includes Medicare patients who are 65 years or older with an index admission (for a specific condition such as heart failure), enrolled in Medicare fee-for-service (FFS) part A and part B for 12 months prior to the index admission and 30 days post-discharge and part A during the index admission. They had to have been discharged alive after the index admission, and not transferred to another acute healthcare facility. Excluded cases from this cohort are patients not having 30 days of post-discharge Medicare FFS and those discharged against medical advice.

Based on simplified methodology and greater emphasis on the more predictable measures, the latest version of CMS star ratings (2021) considers 48 measures. The documentation of the methodology used by CMS to calculate hospital star ratings is replicated from their website and provided in Appendix A. The CMS hospital star ratings as re-released in 2021 not only provide more transparency and predictability, they allow for longitudinal comparisons among hospitals (Bilimoria & Barnard, 2021). Because not all hospitals provide information for each dimension of performance, hospitals are divided by the number of domains for which they provide information and are divided into 3, 4, or 5 domain groups, making inter-hospital comparisons difficult to perform.

The ideal number of KPIs can be elusive, yet they represent the key drivers critical for the success of the hospital. Clinical, financial, operational or customer-focused KPIs are all interrelated as suboptimal clinical care can lead to poor clinical outcomes with subsequent impact on both financial performance and customer (i.e., patient) satisfaction. CMS has developed quality metric standards for hospitals which help quantify healthcare processes and patient outcomes. Within a value-based payment model, these performance metrics are linked to provider reimbursement rates. Higher payment is awarded for above average ratings whereas a penalty (decreased payment) is incurred for below average performance. The next subchapter elaborates on the metrics used for evaluating performance in hospitals.

2.5.1. Financial and Operations Performance Metrics

Financial and operational KPIs are divided into inpatient flow and revenue cycle and are represented in Table 2.1 below.

Table 2.1

Factors Affecting Inpatient Flow and Revenue Cycle

Inpatient flow	Revenue cycle
Number of beds	Average cost per discharge
Bed turnover	Total operating margin
Occupancy rate	Personnel expense as % net revenue
Average length of stay	Supply expense as % net revenue
Admission rate	Total A/R days outstanding
Readmission rate	EBITDAR
	Bad debt

Hospital that provide service to Medicare patients are required to provide financial information to CMS including asset information.

Inpatient flow deals with hospital bed capacity and its effects on patient admissions and discharges from the hospital. The *number of beds* shows the capacity of the facility or how many patients can be treated as inpatients. It can be subdivided into, for example, medical, surgical and intensive care unit beds, to address the needs of the institution. Inpatient bed capacity is dependent not only the physical plant space, but also on the availability of employees to provide care at the beside. *Bed turnover* rates illustrate the efficiency of inpatient care – how fast a patient is admitted and subsequently discharged from that facility; this may also impact patient satisfaction. *Occupancy* rate refers to the number of hospital beds in use at a given time (or the number of admitted patients) to the total bed capacity. It is important to know the difference between the number of available beds and the number of patients needing inpatient care in order to address the need for further capacity at that facility. Lower occupancy rates can lead to the hospital losing money due to over-staffing and plant maintenance costs whereas if the occupancy rate remains too high, under-staffing could be an issue, patients may experience increased wait-times before admission or simply be transferred to another institution, all of which could all lead to lower clinical care and poor patient, decreased patient satisfaction outcomes as well as decreased patient revenue.

The patient's *length of stay* (LOS) measures the period, in days, from the time of admission to the time of discharge from the hospital. This can impact hospital financial performance since the longer a patient remains admitted in the hospital, the higher the cost for their care. CMS, in an effort to encourage shorter inpatient stays when feasible, offers financial incentives to hospitals for reducing inpatient times for an episode of care. *Admission* rates show how many patients are being taken care of as inpatients after either an emergency department (ED) visit, transfer from another institution or after a surgical procedure. Admission rates, occupancy rates and LOS numbers can help with investment in capital expenditure and hiring decisions. The original episode of care for which a patient is first admitted is called the index admission. *Readmission* rates track the percentage of patients that return to the hospital with the same problem within 30 days after being discharged from the hospital for the index admission. This is a measure of the clinical quality of care given to inpatients. Lower hospital readmission rates indicate strong quality of care – there is no need to return to the hospital after being treated and discharged. Conversely, high readmission rates indicate that proper care may not have been delivered to patients or they were prematurely discharged from the hospital and is of great clinical concern. High readmission rates could also be detrimental to the hospital’s financial performance since hospitals with higher readmission rates may not receive full Medicare reimbursement payments as a financial penalty.

Revenue cycle deals with hospital finances which are important for keeping the facility operational. The *cost per discharge* is a dynamic measure that shows the cost of inpatient care and is dependent on the hospital's specific case-mix. These data can also be used to assess the cost of treatment in relation to reimbursement received and help with identifying departments within the hospital that are overspending and departments that are profitable. High cost-of-care coupled with low profits negatively impact financial performance which ultimately results in the diminution of services available at that hospital. *Total operating margin (OM)* is the *ratio* of facility revenue after operating costs are deducted (wages, rents, supplies etc.) to total facility revenue. This metric also provides data on how much a hospital makes on each dollar of sales generated. A strong margin is important since it allows hospitals to pay fixed costs without accruing debt.

Personnel expense as a percent of net revenue reflects labor costs and is reflective of the number of employees and how they are paid. Lower personnel costs may decrease employee satisfaction due to decreased overall worker compensation and lower staffing ratios (e.g., number of nurses to number of patients) which results in a higher work burden. Conversely, higher personnel costs, reflective of higher compensation and increased staffing ratios, can increase employee satisfaction, but can decrease hospital profitability. *Supply expense* as percent of net revenue reflects medicine, equipment and maintenance costs. These costs can adversely affect the profitability of a department since a high supply cost to provide care coupled with low profits (i.e., reimbursement) negatively impact financial performance which could result in the diminution of services available at that hospital.

Bad debt is the loss of revenue associated with the difference in patients hospital bills and the actual (lesser) payments received from patients for delivered care. High bad debt ratios (the average bad debt to net patient revenue ratio) can impact the level of charity care at a hospital, negatively impacts hospital revenue which could further lead to decreased services at that hospital. Additionally, collection practices used by hospitals may not be consistent and, therefore bad debt ratios may not be a good measure to evaluate hospital performance.

Total accounts receivable (A/R) days outstanding reflects the days that revenue has been billed but not collected and is reflective of the efficiency of the billing/collections department or related to patient demographics. Earnings before interest, taxes, depreciation, amortization and rents (*EBITDAR*) is a measure of a hospital's operations performance. EBITDAR margin is the ratio of EBITDAR to total annual revenue; higher margins mean decreased operating expenses and, thus, a more profitable operation. EBITDAR and A/R information is not reported to CMS, but Medicare costs are provided at the hospital level for the other components of inpatient flow and revenue cycle in the Table 2.1 above.

These financial data can be used to produce financial and operations metrics such as percent return on asset (pctROA), percent OM (pctOM), average LOS (avgLOS) and income per bed (incomeperbed).

2.5.2. Clinical Metrics

Clinical quality measures are generally classified as either *process* measures or *outcome* measures. They gauge the hospital's ability to achieve its targeted goals and often reflect how underlying processes are aligned with best practices. *Outcome* measures track results that are of immediate importance to consumers, especially those that deal with complications such as death. *Process* measures are predicated on the fact that different pathways can be linked to important differences in health outcomes.

Both the initial presentation and prior diagnoses can impact the patient's eventual outcome. The prior diagnoses account for the comorbidities or associated health conditions they have upon presentation. For the patient who presents with multiple severe comorbidities or is moribund, a poor outcome is expected. As such, if observed, the resulting poor outcome is not counted against the hospital. For example, if a patient who comes into the hospital with a gunshot wound to the heart, is unstable upon presentation and eventually dies, this is considered to be an *expected* death. Similarly, an older patient with multiple major comorbidities (i.e., high blood pressure, emphysema, diabetes and end-stage renal disease on hemodialysis) who presents with severe sepsis (infection found in the blood) and ends up dying because of septicemia, would be considered an expected death. In both of these scenarios, the observed to expected ratio (O/E) for dying is one. Alternatively, a healthy patient (i.e., no comorbidities) who presents to the hospital for treatment of gallstones and ends up dying, is considered to be an unexpected death; the O/E ratio is greater than one.

Risk-adjusted standardization considers patient characteristics (such as age, comorbidities and other indicators such as frailty) as well as hospital characteristics (rural, critical access hospital, not-for-profit, etc.) to help with parity in comparing clinical outcomes. Silber et al. (1992) studied two common surgery procedures and showed that the death rate was associated with both patient and hospital characteristics whereas the adverse occurrence rate was primarily associated with patient characteristics. The predicted outcome at any hospital can be compared to a nationalized, case-mix adjusted average. The risk-standardized complication rate (RSCR) is then expressed in terms of the national rate (NR):

$$\text{RSCR} = \frac{(\#\ of\ outcomes\ predicted\ based\ on\ \boldsymbol{hospital's\ observed}\ casemix)}{(\#of\ outcomes\ predicted\ based\ on\ \boldsymbol{national\ performance}\ with\ hospital's\ casemix)}(NR)$$

Risk-standardized complication rate allows for comparisons of complication rates between hospitals for patients with similar comorbid conditions. It indicates whether a patient has a better/worse chance of having a complication when presenting to Hospital A compared with Hospital B. Lower RSCR rates are better since they reflect better care at that specific hospital compared with the national average or standardized hospital.

The CMS *Overall Star Ratings* of hospital quality, designed in 2016 to allow for comparisons of hospitals, was re-released in 2021 utilizing 48 measures using RSCRs. The Overall Star Ratings reflect five domains of hospital performance or grouped measures pertaining to patients' experiences: (1) mortality, (2) safety, (3) readmissions, (4) patient experience and (5) timely and effective care. To receive a star rating, hospitals must report on at least three domains, one of which has to be either mortality or safety. Based on 2021 revision methodology, the measures for each domain group is shown in Exhibit 2.5 below.

Exhibit 2.5

Measure Information for each Performance Domain

Mortality	Effectiveness	Efficiency	Safety	Patient Centeredness
MORT-30-AMI	EDAC-30-AMI	IMM-3	COMP-HIP-KNEE	H-COMP-1
MORT-30-CABG	EDAC-30-HF	OP-22	HAI-1	H-COMP-2
MORT-30-COPD	EDAC-30-PN	OP-23	HAI-	H-COMP-3
MORT-30-HF	READM-30-CABG	OP-29	HAI-3	H-COMP-5
MORT-30-PN	READM-30-COPD	OP-33	HAI-4: SSI	H-COMP-6
MORT-30-STK	READM-30-Hip-Knee	PC-01	HAI-5: MRSA	H-COMP-7
PSI-4-SURG-COMP	READM-30-HOSP-WIDE	1-Sep	HAI-6: C.diff	H-HSP-RATING
	OP-32	ED-2b	PSI-90 Composite	H-CLEAN-HSP
	OP-35 ADM	OP-3b		
	OP-35 ED	OP-30		
	OP-36	OP-8		
		OP-10		
		OP-13		

The *Mortality* domain consists of 7 measures and includes deaths within 30 days of patients admitted due to acute myocardial infarctions (AMI) or heart attacks, coronary artery bypass graft (CABG) surgeries, chronic obstructive pulmonary disease (COPD), heart failure (HF), pneumonia (PN) and stroke (STK). Patient Safety Indicators (PSIs) are measures of serious complications for patients that are obtained from AHRQ (CDC.gov). The most serious complication from a treatable post-operative complication is death and is represented as PSI_04 in the Mortality domain.

The index admission is the initial encounter when the patient is first admitted to the hospital for treatment. Exhibit 2.5 shows the E*ffectiveness* domain which accounts for readmissions within 30 days after discharge from an index admission. This domain pertains to unplanned hospital visits in three different scenarios: (1) excess days in acute care (EDAC) after AMI, HF and PN, (2) unplanned readmission after CABG surgery, COPD, THA/TKA patients and overall readmission after discharge from hospital and (3) unplanned admission after outpatient interventions such as colonoscopy, chemotherapy, outpatient surgery or ED visit after outpatient chemotherapy. EDAC measures look *at the total number of days* the patient spends in acute care (includes ED visits and observation admissions) with the primary discharge diagnosis of AMI, HF or PN within a 30-day period *after discharge*. EDAC is the difference between the *predicted* days in acute care and the *actual* days in acute care per 100 discharges. It is a risk-standardized complication measure since the *predicted* days are hospital days after adjusting for the patient's risk factors. The number of predicted days is based on national data which reflect the average number of days patients would spend in acute care if they had been admitted and discharged from an average-performing hospital with similar comorbidities. Similarly, unplanned readmission after CABG surgery, COPD, THA/TKA patients and overall readmission after discharge from hospital are risk-standardized hospital rates. OP_32 is the RSCR admission rate within 7 days after low-risk, outpatient colonoscopies per 1000 cases at ambulatory surgical centers (ASCs) within hospital outpatient departments (HOPDs). It reflects complications such as bowel perforation or bleeding after having a colonoscopy that subsequently require hospital admission. Hospital visits after outpatient surgery, or OP_36, provides patient outcomes following surgery at HOPDs. The measure result is a facility-specific risk-standardized hospital visit ratio within 7 days of hospital outpatient surgery by comparing it against a reference value of one. The hospital admissions (OP_35_ADM) and ED visits (OP_35_ED) after outpatient chemotherapy provide information (per 100 chemotherapy patients) on the quality of care delivered to these patients. They measure inpatient admissions or ED visits due to anemia, dehydration, diarrhea, emesis, nausea, neutropenia, pain, pneumonia, fever, or sepsis within 30 days after receiving chemotherapy treatment.

Timely and effective patient care is reflected in the *Efficiency* domain shown in Exhibit 2.5 and contains 14 measures. This domain contains a process measure IMM_3 which is the percent of healthcare workers who have been influenza-vaccinated; it deals with preventive care. The other measures are outcome measurements reflecting how quickly care was administered (in minutes) or the percentage of patients who got treatments for certain ailments. Measures ED_2b (time spent in ED before transfer to floor once the decision to admit was made), OP_18b (time spent in ED) and OP_3b (time to transfer patients for acute coronary intervention) deal with duration of time (minutes) and are objective measurements obtained from medical records. Lower numbers represent more expeditious care which could lead to better patient satisfaction, increased throughput and potentially increased revenue.

The remaining 10 measures for the *efficiency* domain deal with percentage of patients who: left without being seen (OP_22), stroke patients receiving timely brain scan (OP_23), appropriate care for severe sepsis and septic shock (SEP_1), radiation therapy for bony metastases (OP_33), preventive care such as appropriate follow-up for normal (OP_29) or abnormal (OP_30) colonoscopies, scheduling of deliveries too early (PC_01), appropriate use of MRI for back pain (OP_8), appropriate testing of abdomen using CT scans (OP_10) and appropriate imaging stress test for low risk surgical procedures (OP_13). For OP_22, PC_01, OP_8, OP_10 and OP_13, lower percentages represent better care an is representative of better hospital performance.

As shown in Exhibit 2.5, the *Safety* domain consists of complications and other healthcare-associated infections (HAI) and includes 8 measures: (1) rates of complications for hip and knee replacement patients (COMP-HIP-KNEE), (2) HAI-1or central-line associated bloodstream infections (CLABSI), (3) HAI-2 or catheter-associated urinary tract infections (CAUTI), (4) HAI-3 or surgical site infections from colon surgery, (5) HAI-4: SSI or surgical site infections from abdominal hysterectomy, (6) HAI-5: MRSA or methicillin-resistant staphylococcus aureus (MRSA) blood infections, (7) HAI-6: C.diff or clostridium difficile (or C.diff.) intestinal infections and (8) PSI-90 Composite or patient safety and adverse events composite score. Since all hospitals are required to report data about certain infections to the Centers for Disease Control and Prevention (CDC) via the National Healthcare Safety Network, **HAI measures apply to all patients** treated in acute care hospitals and include adult, pediatric, neonatal, Medicare, and non-Medicare patients. The CDC calculates a Standardized Infection Ratio (SIR) which considers factors such as the type of patient-care location, number of patients with existing infections, laboratory analysis, hospital affiliation (e.g., with a medical school), hospital size (beds), patient age and patients' comorbidities (CDC.gov) which can be expressed as:

$$\text{SIR} = \frac{(\#\ of\ \boldsymbol{Observed\ HAI})}{(\#\ of\ \boldsymbol{Predicted\ HAI}\ based\ on\ national\ aggregrate\ data\ adjusted\ for\ hospital\ factors\ )}$$

HAIs are reported as SIRs such that a hospital score <1 represents a better performing hospital since the observed cases are less than the predicted cases.

PSI-90 is a composite measure of serious complications and is one of the 11 measures as shown in Exhibit 2.5. PSI-90 is the weighted average of its component indicators and is intended to gauge the frequency of potentially preventable complications during hospital admissions – either surgical or medical. It is risk-adjusted to account for differences in hospital patients' characteristics and can be broken down into its component values: PSI_03, PSI_06, PSI_08, PSI_09, PSI_10, PSI_11, PSI_12, PSI_13, PSI_14, and PSI_15. These PSI along with their descriptions are shown below in Exhibit 2.6 below.

Exhibit 2.6

Components of PSI_90

- PSI 03 Pressure Ulcer Rate
- PSI 06 Iatrogenic Pneumothorax Rate
- PSI 08 In-Hospital Fall With Hip Fracture Rate
- PSI 09 Perioperative Hemorrhage or Hematoma Rate
- PSI 10 Postoperative Acute Kidney Injury Requiring Dialysis Rate
- PSI 11 Postoperative Respiratory Failure Rate
- PSI 12 Perioperative Pulmonary Embolism (PE) or Deep Vein Thrombosis (DVT) Rate
- PSI 13 Postoperative Sepsis Rate
- PSI 14 Postoperative Wound Dehiscence Rate
- PSI 15 Abdominopelvic Accidental Puncture or Laceration Rate

PSI-90 is based on the volume of the adverse event and the harm associated with the adverse event. The volume weights were calculated based on the number of safety-related events for each component indicators in the Medicare population. The harm weights were obtained using linked claims data for two years of Medicare FFS beneficiaries and is calculated by multiplying estimates of the probability of excess harms associated with each adverse patient safety event by the corresponding utility weights (1–disutility). Here, disutility measures the severity of the adverse events associated with each of the harms (i.e., the least preferred outcome from a patient's perspective). Because PSI-90 cannot be easily replicated due to its nature, it is included for completeness, but its component measures will be used instead during further analyses.

The hospital consumer assessment of healthcare providers and systems (HCAHPS) patient survey captures a random sample of patients' experiences post-discharge. *Patient Centeredness* seen in Exhibit 2.5 is another group measure or domain that includes 8 measures obtained from these surveys. This domain pertains to patients' communication: with nurses (H-COMP-1), with doctors (H-COMP-2), about medicines (H-COMP-5) and discharge information (H-COMP-6). It also deals with patients' perception of responsiveness of hospital staff (H-COMP-3), cleanliness of the hospital (H-CLEAN-HSP), care transition from the acute hospital setting (H-COMP-7) and patients' overall hospital rating (H-HSP-RATING). At least 100 HCAHPS surveys need to be completed *over a four-quarter period* in order to receive HCAHPS star rating. A list of questions used for HCAHPS survey is replicated in Appendix C.

The HCAHPS surveys are scored linearly using a measurement scale to obtain a numeric score for each survey. CMS then applies patient-mix adjustments to help account for group tendencies to respond either more negatively or positively to surveys. These adjustments are also based on patient sub-groups and include factors such as age, health, educational level, language spoken at home among others. The linear adjusted HCAHPS scores are then transformed into a linear-scaled score (range 0-100) using a conversion factor involving the hospital-level measure mean and the lowest/highest possible response to the measure. A weighted average of HCAHPS linear-scaled scores over four quarters is performed based on the quarter's eligible patient discharges and rounded to a whole integer (hachpsonline.org).

In general, hospitals providing complex, tertiary or quaternary care report on all 5 domains and being held to a “different” standard, generally result in lower scores and a lower star rating. Thus, the star rating measure domain group scores may not be uniform across hospitals within the same star rank.

The preceding discussion illustrates the complexity involved in evaluating hospital performance. This could, perhaps, account for the discordance seen among the various rating agencies. Identifying top performing hospitals based on ratings remains elusive. It is confusing to the consumer because of the differences in ratings for a given hospital by the various rating organizations. Thus, a more comprehensive, equitable, user-friendly rating system would be of considerable value to help hospital administrators identify low performing clinical areas and then effect change to improve clinical performance once those areas are identified.

Chapter 3. Research Methods

In this study, we examine hospital outcomes from CMS data and devise a rating system whereby hospitals can leverage this information to improve clinical outcomes. This study also identifies the milieu in which these outcomes are measured and explores the concept of an ecosystem for clinical excellence. We shall consider patients' needs and characteristics and organizational characteristics such as facilities, staff and processes that affect hospital performance. In studying these factors that impact hospital performance, we construct a clinical rating system whereby hospital leadership and hospital managers can readily identify areas of clinical performance that need improvement. Additionally, since more comprehensive services are provided at large hospitals, direct hospital comparisons in large hospitals can be easily performed based on this rating system.

The dyadic model of medical leadership, seen as a professional administrator paired with a clinician, does not seem to occur frequently in the executive suite. As we consider CEO leadership characteristics, we shall therefore examine more generally the effects of managerial and leadership training on hospital performance – both clinical and financial. We shall study the influence of advanced education in management and medicine for the CEO and the presence of a CMO in the executive suite on hospital performance.

This study is designed to be a staged, mixed-method approach. The first part of this study shall be exploratory and will consist of research using secondary data from CMS to develop a true rating system. This rating system will then be used to evaluate the relationship between hospital leadership and hospital performance. To evaluate institution performance, publicly reported patient outcomes and financial data from CMS will be used. Online searches will be performed to obtain educational attributes of CEOs and the presence of CMOs at those institutions to ascertain leaders characteristics' influence on performance. The first stage of this study does not require IRB approval since these data are publicly available and will be examined at the hospital level. The first stage of this study is to be used as the dissertation requirement for this DBA program.

The second part of this study (to be left for further research after this dissertation) will be qualitative and will include interviews of top executives (CEO, COO and CMO), to ascertain personal characteristics and leadership style for qualitative analysis. These interview data will be examined and links to organization performance established. The second stage of this study will require IRB approval. This second stage of this study will be future research, separate from this dissertation.

3.1. Research Model

In the first phase of this study, using CMS clinical metrics as revised for 2021, we examine hospital performance considering operational and financial performance indicators in addition to clinical performance outcomes. This study will, however, examine CMS data collected before COVID-19 in order to minimize pandemic noise in our calculations. We will examine how the performance measures are related to key hospital structural characteristics in terms of resources and structure and include the various factors shown in Table 3.1 below.

Table 3.1

Key Hospital Characteristics Impacting Hospital Performance

Hospital size	Short-term facility
For-profit-hospital	Long-term facility
Non-profit-hospital	Specialty facility
Gov't hospital	Other facility
Emergency service provided	Acute care
Electronic health records	Children's hospital
Psychiatric hospital	Critical access hospital

Market and local area characteristics represent factors external to the hospital that can affect the primary population served by hospitals, for example, critical access hospitals (CAH). Patients' characteristics effects on organizational performance will also be examined. A hospital's aggregate patients' characteristics represents factors that might indicate unmeasured individual patient risk or factors that directly affect hospital resources, for example, coexisting disease or disproportionate share status of the uninsured. These patient characteristics are included in Table 3.2.

Table 3.2

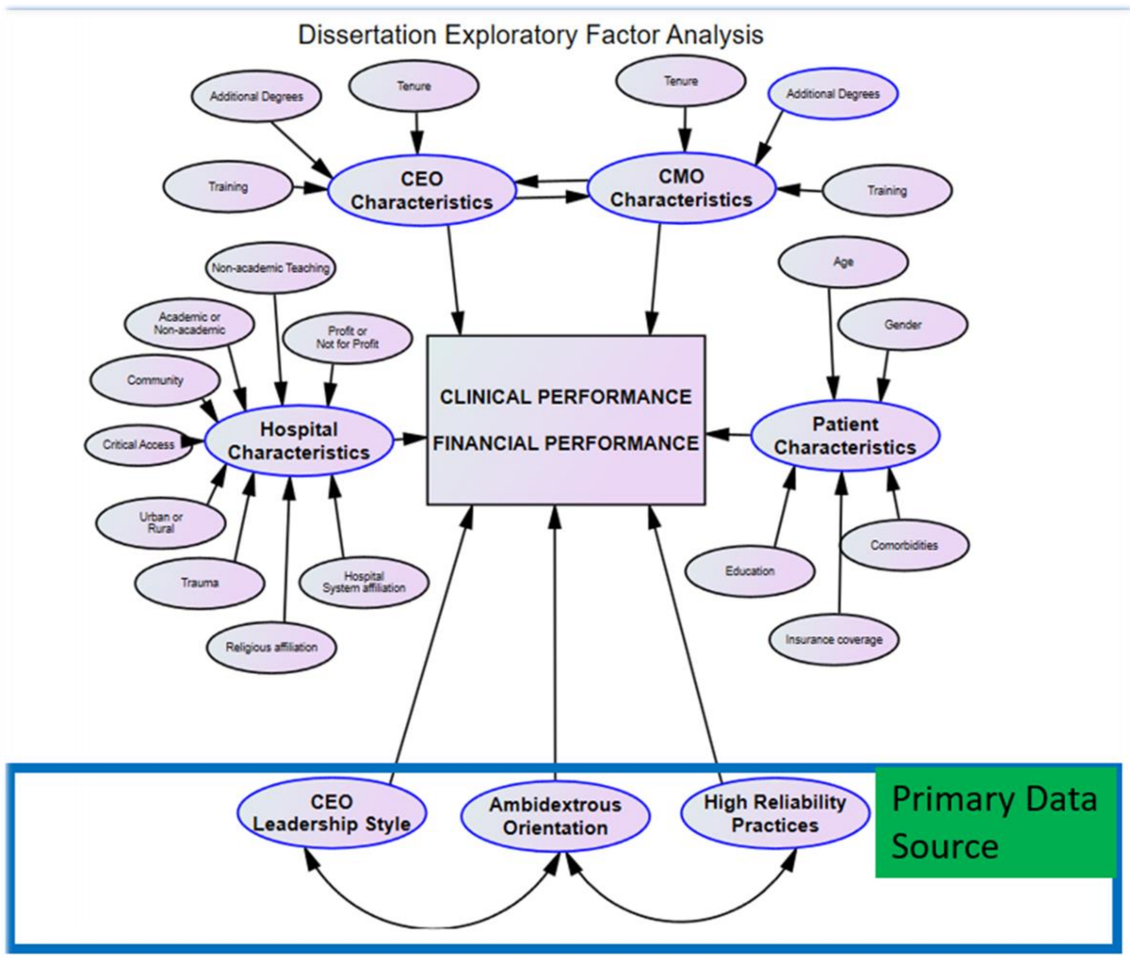
Key Patient Characteristics Impacting Hospital Performance

Demographics: age, gender, race
Education level
Employment status
Insurance coverage or income level
Comorbidities

Other factors affecting hospital performance include CEO leadership education, training and experience, as well as CMO leadership; ancillary degrees, training and tenure are also included. The representation of the proposed factors that affect hospital performance to be used in this study is shown below in Exhibit 3.1.

Exhibit 3.1

Exploratory Analysis of Factors that Affect Hospital Performance



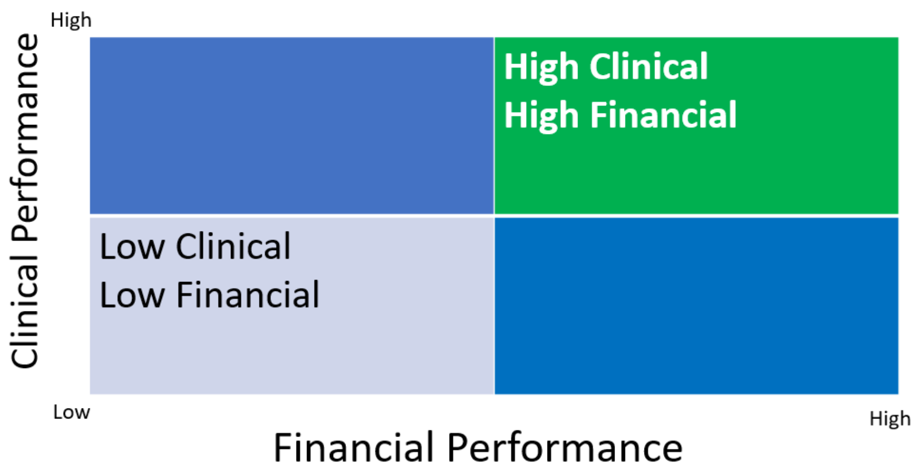
In this dissertation, we consider all these attributes **except** those within the solid box in Exhibit 3.1 since they require intensive primary data collection and are planned to be included in a future study.

The clinical and financial performance dimensions for each hospital will be examined based on the characteristics of the hospital and the characteristics of the patients. The extent to which the characteristics of the CEO and CMO jointly explain the variation in performance will then be explored for KPIs judged to be particularly relevant to superior clinical care as reported by CMS.

Based on the analysis of these clinical data, statistical models will be derived for KPIs that are particularly relevant to superior clinical care and financial performance. Using these models, we will assess performance of large hospital organizations in both clinical and financial aspects and categorize them using the performance grid shown below in Exhibit 3.2.

Exhibit 3.2

Performance Grid for Hospitals



If performance is materially affected by training and experience of senior executives, we would expect the effects to be revealed in comparisons of highest-performing institutions with lowest-performing institutions. Concentrating on hospitals in these groups makes data collection of executive characteristics tractable – reducing the sample of institutions from approximately 7,000 to fewer than 100 for our exploratory examination of the effects of leadership characteristics.

CEO and CMO credentials are a matter of public record. Professional degree type will be obtained from internet websites and AHD which will be used to examine whether professional training affects organization performance. Leadership structure at the CEO level will be assessed by noting the composition of the executive suite. Specifically, whether the presence of a CMO in the executive suite could be indicative that an administrative CEO taps into the expertise of the CMO to improve organization performance. Ambidextrous orientation, by extension, would include hospitals that are high performing in clinical and high performing in financial performance as illustrated in our performance grid shown earlier in Exhibit 3.2.

Hospital operations and financial performance can be assessed using the list previously shown in Table 2.1. Operating margin (OM), for example, is a commonly used financial measure and speaks to the profitability of a company (Burkhardt & Wheeler, 2013; Kaiser et al., 2020). OM is expressed as:

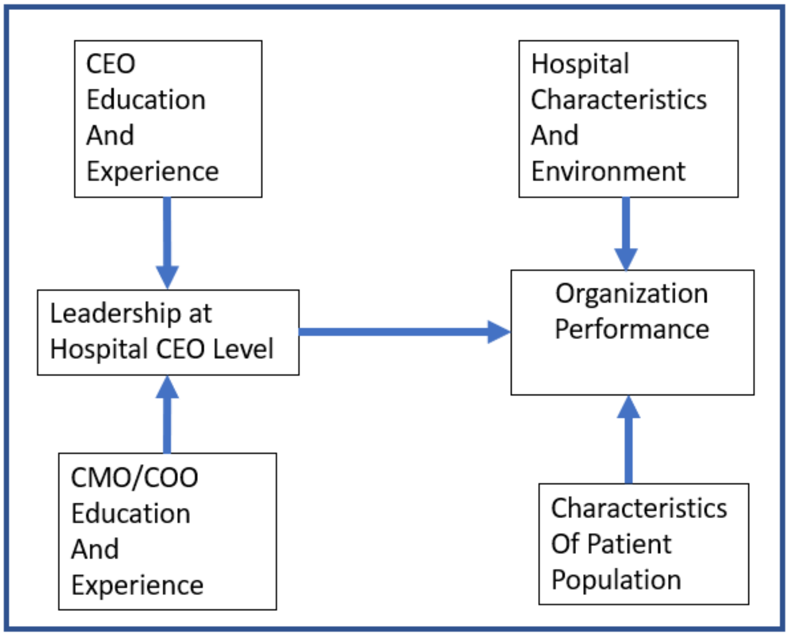
$$OM = \frac{Net\ Income}{Operating + Nonoperating\ Revenue}$$

The financial metrics listed in Table 2.1 that are available through CMS will be calculated for the different hospitals considering the characteristics of the hospital as well as patient characteristics and profitability thereby assessed. Hospitals identified as high financial performing will then be examined for links to leadership structure.

Objective clinical outcomes based on clinical performance from hospital KPIs (mortality and complication rates, acute myocardial infarction rates, readmission rates, etc.) found in CMS data as previously shown in Exhibit 2.5 will be obtained. To allow for meaningful comparisons among hospitals, performance measures need to be normalized before analysis. This normalization procedure can be defined as the difference between the mean of all hospital scores and the individual hospital score divided by the standard deviation score for all hospitals. In this calculation, the normal deviation (*normdev*) from the mean score for all hospitals is zero and the hospital scores can be evaluated against this *normdev*, or any other target deviation (such as top 5^{th} percentile). By accounting for the different hospital characteristics (such as academic or community-based hospital, etc.) as well as patient characteristics (education, gender, etc.), hospital ratings can be obtained based on target deviations. The top ratings of hospitals calculated from these clinical group domains will be examined for links to leadership structure. These data from secondary sources such as AHD and CMS will be analyzed to study the effect of training and leadership structure of CEO leadership and CMO leadership at US hospitals and its impact on the combination of clinical and financial performance will be evaluated. Multivariate regression will be used to study the effects of hospital characteristics as well as characteristics of the patients served by that hospital on overall hospital performance. Additionally, leadership structure on hospital performance will examined with statistical adjustments for patient and hospital characteristics. This analysis will be used to support to a model as shown in Exhibit 3.3.

Exhibit 3.3

Model Based on Secondary Data Sources



In this model, education refers to the professional degrees and advanced degree training the leader has acquired. Leadership training in the different fields of medicine and business would help to provide insight into ambidextrous decision making. Ambidextrous orientation, as viewed from a clinical performance or financial performance perspective, would lead to increased organization performance. Also, the leadership structure, in terms of the presence of a CMO at the executive level, on hospital performance will be studied.

In sum, we shall review commonly used hospital measures, or KPIs, to assess clinical quality and how these measures are used to generate hospital quality ratings. These hospital quality ratings will be critically assessed, and the limitations and shortcomings identified. KPIs and their measure scores will be obtained from CMS.

Performance as measured in the governmental data from CMS will be related to factors expected to influence measures of hospital performance, including leadership structure and the characteristics of the leaders themselves.

Overall performance measures for each hospital will be derived based on two dimensions: the operation and financial outcome on one hand and clinical performance based on KPIs deemed particularly important on the other hand. This study will identify hospitals with high performance in both dimensions and hospitals with low performance in both dimensions considering: their mission, business environment, resources and patient population.

From a hospital managerial perspective, these outcome measures will be examined in more granular detail with the goal of proposing what could be seen as an ideal ecosystem: a set of organizational arrangements and processes to achieve hospital excellence. Using the same clinical metrics and financial data from CMS, we intend to explore the elemental metrics, their character, domains of applicability and individuals responsible for the represented dimensions of performance. Interrelationships in responsibilities inferred from these data will be discussed and organizational processes for ideal engagement of managers in pursuit of excellence shall be proposed.

Filling gaps in the literature regarding the effects of leadership structure at the CEO level is expected to have value within and outside the medical industry. The first part of this study will initially address the general question of how hospital performance is affected by hospital characteristics as well as patient characteristics. Additionally, the extent to which the characteristics of the CEO and the CMO jointly explain variation in performance for the high and low performance hospitals will be examined from the context of leadership training and structure, while accounting for the characteristics of the hospital and the patients they serve.

If we find, for example, that MD leadership at the CEO level is associated with more complex and comprehensive care delivered with fewer resources and superior performance (both clinical and financial), more institutions might consider structuring themselves accordingly. Strategic vision would place patients at the center of all decision-making and better patient outcomes would be the primary goal of hospital systems while financial performance would be maximized. This stream of research would have implications for hospital organizations and could be instrumental for attaining clinical excellence. Our findings may also be relevant to other settings where both business acumen and core scientific knowledge are critical for superior organizational performance.

3.2. Data Sources

The unit of analysis is the hospital. The sources for our data on hospital performance and hospital characteristics are CMS and AHD. CMS is the premier data source for Medicare patients. In addition, AHD lists the CEO and CMO presence and the hospital's system affiliation.

Patient demographic data will be obtained from US census-tract data. Census-tract geographical boundaries are determined by the US Census Bureau once every ten years. Each county is comprised of a certain number of tracts based on population density. The Climate and Economic Justice Screening Tool is a federal initiative to help identify disadvantaged communities including those that are marginalized, underserved and overly affected by pollution. The tool uses publicly available census-tract datasets to provide socioeconomic, environmental and climate information. A census tract is identified as disadvantaged if it meets particular thresholds for socioeconomic indicators. It provides the percent of a census tract population where household income is at or below 200% of the federal poverty level and the percent of households that are both (1) earning less than 80% Housing & Urban Development Area Median Family income by county and (2) are spending over 30% of their income on housing costs. As an indicator of education, the Climate and Economic Justice Screening Tool provides higher education non-enrollment in school as a percentage of people age15 and older who are not enrolled in school and those over 25 years old without a high school diploma . This tool also provides health information for asthma, diabetes, heart disease and life expectancy; all used to identify communities that may be disadvantaged due to health burdens (90^{th} percentile for the aforementioned diseases) as well as socioeconomically (65^{th} percentile for low income) and educationally (80% or more of people 15 years and older not enrolled in higher education). Patient characteristics data obtained from this tool include comorbidities, educational level, median household as well as disadvantaged communities. Locations of hospital by county can be cross-referenced using these data as well as CMS data to explore these patient characteristics on hospital performance.

CMS also has the Institutional Provider and Beneficiary Summary (IPBS) PUFs which provides information on institutional providers from CMS chronic conditions warehouse and contains 100 percent of Medicare claims for beneficiaries who are enrolled in the fee-for-service (FFS) program as well as enrollment and eligibility data for 2010. These data include gender, ethnicity, comorbidities (such hypertension, diabetes, heart disease, stroke, Alzheimer, dementia, etc.) and deathrates of Medicare beneficiaries. It also provides an overall average severity score among Medicare beneficiaries utilizing the services of the hospital at any point during the service year based on their medical comorbidities. IPBS also contains a surrogate for income and wealth by identifying Medicare beneficiaries who are also simultaneously receiving Medicaid benefits.

CEO and CMO hospital affiliation, training and tenure are publicly available information. These data could be found from AHD and from internet sites such as Doximity and LinkedIn and from professional organizations such as American Hospital Association and state hospital associations. System affiliation can also be obtained from AHD and state hospital associations. These data will be used to help identify relationships between leadership characteristics and organizational performance after accounting for hospital and patient characteristics.

Chapter 4. Results and Analysis of Key Performance Indicators

This chapter is divided into four sections. The first section deals with analysis of the clinical data from CMS. These data are recategorized and aggregated into measures with similar groupings that focus on key aspects of clinical activity for managerial review. The second section deals with the CMS financial data used in analysis to identify top performing hospitals based on hospital characteristics. The third section deals with census-tract data as well as CMS data to help study the effect of patients' characteristics on hospital performance. The fourth section examines hospital performance when accounting for hospital and patient characteristics.

4.1. Clinical Performance Indicators Rearranged

The CMS public-use-files (PUFs) were downloaded (Home | Provider Data Catalog (cms.gov)) for Medicare provider data. These online data are comprised of Comma Separated Value (*csv*) files along with the Portable Document Format (*pdf*) data dictionary file that gave the definitions and methodology CMS used in calculating the star ratings. We converted them to *SAS 9.4* analytic software format for our analysis. It is important to emphasize that *all* Medicare-certified hospitals are being used in our initial analyses. The CMS Group domains with measure names were shown earlier in Exhibit 2.5Exhibit 2.5. PSI-90 is the weighted average of its component indicators intended to gauge the frequency of potentially preventable complications during hospital admissions and is based on the concept of volume of the adverse event and the harms associated with the adverse event using linked Medicare FFS beneficiary data. Since replication of PSI_90 was not feasible, we chose to treat PSI_90 separately, but included all its component indicators since these are readily available and are reflective of the type of care received at a particular hospital.

The measures in the initial five domains from were rearranged into areas of clinical commonality. For example, the *Mortality* domain now includes complication events (initially in *Safety* domain) and consists of 19 measures. The *Effectiveness* domain reflect readmission data and consists of 11 measures; the *Efficiency* domain reflects timeliness metrics and includes 13 measures; *Safety* domain is reduced to 6 measures and *Patient Centeredness* domain remains at 10 measures as shown in Exhibit 4.1 below.

Exhibit 4.1

Clinical Domains Rearranged Based on Clinical Commonality

Mortality	Effectiveness	Efficiency	Safety	Patient Centeredness
COMP_HIP_KNEE	EDAC_30_AMI	EDV	HAI_1_SIR	H_CLEAN_LINEAR_SCORE
MORT_30_AMI	EDAC_30_HF	ED_1b	HAI_2_SIR	H_COMP_1_LINEAR_SCORE
MORT_30_CABG	EDAC_30_PN	ED_2b	HAI_3_SIR	H_COMP_2_LINEAR_SCORE
MORT_30_COPD	READM_30_AMI	IMM_2	HAI_4_SIR	H_COMP_3_LINEAR_SCORE
MORT_30_HF	READM_30_CABG	IMM_3	HAI_5_SIR	H_COMP_5_LINEAR_SCORE
MORT_30_PN	READM_30_COPD	OP_18b	HAI_6_SIR	H_COMP_6_LINEAR_SCORE
MORT_30_STK	READM_30_HIP_KNEE	OP_18c		H_COMP_7_LINEAR_SCORE
PSI_10_POST_KIDNEY	READM_30_HOSP_WIDE	OP_2		H_HSP_RATING_LINEAR_S
PSI_11_POST_RESP	READM_30_HF	OP_22		H_QUIET_LINEAR_SCORE
PSI_12_POSTOP_PULMEMB_DVT	READM_30_PN	OP_23		H_RECMND_LINEAR_SCORE
PSI_13_POST_SEPSIS	OP_32	OP_29		
PSI_14_POSTOP_DEHIS	OP_35_ADM	OP_30		
PSI_15_ACC_LAC	OP_35_ED	OP_31		
PSI_3_ULCER	OP_36	OP_33		
PSI_4_SURG_COMP		OP_3b		
PSI_6_IAT_PTX		OP_5		
PSI_8_POST_HIP		PC_01		
PSI_90_SAFETY		SEP_1		
PSI_9_POST_HEM		VTE_6		
		OP_8		
		OP_10		
		OP_13		

To allow for differences among hospitals, patients' characteristics (age, comorbidities, etc.) complication rates are risk-adjusted using Medicare claims data for the 12 months prior to the index admission. The risk-standardized complication rate (RSCR) for death is expressed as below in terms of national death rate (NDR):

RSCR

$$= \frac{(\#of\ deaths\ predicted\ based\ on\ the\ \boldsymbol{hospital's\ observed}\ casemix)}{(\#\ of\ deaths\ predicted\ based\ on\ the\ \boldsymbol{national\ performance}\ with\ hospital's\ casemix)}(NDR)$$

These death rates are shown in Exhibit 4.2 below. Note that in this table, the number of hospital facilities that reported on the numerous measures are shown along with the range of values as well as the mean, median and standard deviation (SD); also included are the best (1^{st} percentile) and worst (99^{th}) percentiles. The lowest number of reporting facilities is 1003 for CABG mortalities. This may be explained by the fact that not many community hospitals perform these types of operations, most likely due to the increased resources necessary to have a successful program. The max number of reported facilities shown is 4137 for MORT_30_PN or mortality due to pneumonia. This is illustrative of the fact that many more hospitals manage patients with pneumonia and that in these hospitals, patients diagnosed with pneumonia, can die.

Exhibit 4.2

Simple Statistics for Mortality Domain

Measurement Name	Number of Facilities	Minimum Value	1st Percentile	5th Percentile	Median Value	Mean Value	95th Percentile	99th Percentile	Maximum Value	Standard Dev
COMP_HIP_KNEE	2741	1.30	1.60	1.80	2.500	2.587	3.50	4.10	11.00	0.5432
MORT_30_AMI	2356	8.80	10.30	11.10	12.800	12.811	14.70	15.60	17.20	1.1098
MORT_30_CABG	1003	1.20	1.80	2.10	3.000	3.134	4.90	6.10	7.30	0.8562
MORT_30_COPD	3534	4.90	6.10	6.90	8.400	8.536	10.50	11.60	14.30	1.1079
MORT_30_HF	3614	5.50	7.50	8.80	11.500	11.563	14.50	15.90	18.80	1.7171
MORT_30_PN	4137	8.10	10.90	12.50	15.600	15.695	19.20	21.50	25.80	2.1017
MORT_30_STK	2508	8.90	10.60	11.60	13.700	13.841	16.50	18.00	21.40	1.4799
PSI_10_POST_KIDNEY	2761	0.25	0.74	0.96	1.310	1.341	1.82	2.43	3.14	0.2758
PSI_11_POST_RESP	2736	1.37	2.79	3.96	6.925	7.518	12.66	16.24	28.46	2.7115
PSI_12_POSTOP_PULMEMB_DVT	2966	1.44	2.07	2.50	3.650	3.793	5.53	6.85	9.93	0.9556
PSI_13_POST_SEPSIS	2741	1.66	2.94	3.62	4.910	5.075	7.07	8.55	11.57	1.0424
PSI_14_POSTOP_DEHIS	2740	0.51	0.66	0.77	0.920	0.954	1.24	1.51	2.10	0.1588
PSI_15_ACC_LAC	2939	0.36	0.74	0.90	1.240	1.292	1.86	2.31	3.16	0.3024
PSI_3_ULCER	3156	0.03	0.06	0.11	0.380	0.489	1.27	2.28	11.02	0.4857
PSI_4_SURG_COMP	1783	91.71	117.04	133.42	162.070	162.955	196.61	214.97	242.87	19.3867
PSI_6_IAT_PTX	3177	0.12	0.17	0.20	0.260	0.271	0.37	0.46	0.59	0.0517
PSI_8_POST_HIP	3173	0.07	0.08	0.09	0.110	0.110	0.14	0.15	0.21	0.0139
PSI_90_SAFETY	3202	0.43	0.68	0.77	0.970	0.993	1.33	1.58	3.81	0.1846
PSI_9_POST_HEM	2961	1.33	1.83	2.04	2.470	2.510	3.12	3.71	4.84	0.3326

Specifically, for MORT_30_AMI (30-day deathrate after having an AMI), the number of hospitals reporting was 2356; the mean and median mortality rate values were similar at 12.8% and the SD was 1.11. Here, we see the better (i.e., lowest deathrate) performing hospital was at 10.3% vs the worst (i.e., highest deathrate) performing hospital was at 15.6%. The clinical performance summaries for the other 4 domains are shown in Appendix D. Because they use different units for measurement, we restate and normalize these data before analyzing their interrelationships.

This normalization procedure was carried out for mortality and complications where *normdev* can be calculated as the difference between the *meanscore* and *Score* divided by the standard deviation score (*stddevscore*); the results are shown below in Exhibit 4.3. Here, N refers to the number of data values read (54228 observations) from the numerous facilities that were shown in Exhibit 4.2 earlier.

Exhibit 4.3

Performance Statistics for Mortality Domain to Obtain Normdev

Variable	Label	N	N Miss	Minimum	Mean	Maximum	Std Dev
Score		54228	37642	0.0300000	10.5438666	242.8700000	28.8122352
numfac	number of nonmissing values, Score	91870	0	1003.00	2852.96	4137.00	658.3829049
meanscore	the mean, Score	91870	0	0.1096155	13.4143014	162.9547448	35.4257680
stddevscore	the standard deviation, Score	91870	0	0.0138713	1.8277457	19.3866907	4.1808613
nummiss	number of missing values, Score	91870	0	792.0000000	1983.14	3926.00	669.8654715
maxscore	the largest value, Score	91870	0	0.2100000	22.9716502	242.8700000	52.2320066
p99score	the 99th percentile, Score	91870	0	0.1500000	18.5776171	214.9700000	46.5394980
p95score	the 95th percentile, Score	91870	0	0.1400000	16.6348486	196.6100000	42.6408360
p75score	the upper quartile, Score	91870	0	0.1100000	14.4242713	174.4300000	37.9093667
p50score	the median, Score	91870	0	0.1100000	13.2699138	162.0700000	35.2500827
p25score	the lower quartile, Score	91870	0	0.1000000	12.2336634	150.1200000	32.6642967
p5score	the 5th percentile, Score	91870	0	0.0900000	10.7195078	133.4200000	29.0700764
p1score	the 1st percentile, Score	91870	0	0.0600000	9.3795700	117.0400000	25.5200325
minscore	the smallest value, Score	91870	0	0.0300000	7.2475319	91.7100000	20.0407306
normdev	Std dev from meanscore	54228	37642	-21.6831355	1.562387E-14	3.9551181	0.9998340
targetdev	Std dev from p5score	54228	37642	-22.4634665	-1.3687935	2.5744646	1.0171045

Note. *normscore*=mean score and *targetscore*=p5score or top 5th percentile score.

In normalizing these data, the *meanscore* is 13.4143 and the *stddevscore* is 1.8277; the mean for *normdev* reverts to zero and the target deviation (*targetdev*) can then be calculated as the difference of the Score from the target score (p5score) divided by the stddevscore. For example, for the Mortality and Complications measures, the mean top 5th percentile (p5score) is 10.7195 as shown in Exhibit 4.3, the *normdev* is shown at zero and the mean *targetdev* (mean deviation from p5 score) is -1.36879. This tells us that to be in the top 5th percentile for Mortality, the hospital has to be 1.37 SD below the *normdev* score. The *meanscore*, *normdev* and *targetdev* for the other 4 domains are also shown in Appendix D. While these scores allow for comparison among hospitals, the categories remain very broad and are too generalized for meaningful use with regards to managerial decision-making.

To help simplify and refine our analysis, these 5 clinical domains were further rearranged to accommodate for CMS 2021 methodology changes. To decrease any COVID-19-noise, however, 2019 CMS data were used. Looking specifically at the

Mortality domain as rearranged in Exhibit 4.1 above, the 19 measures can be broken into 6 subgroups that are representative of measures for surgical mortality, medical mortality, surgical complications, combined complications and aggregated surgical complications. Specifically, measures for surgical mortality which includes two measures (CABG and PSI_04 mortalities) and is renamed KPI 101_SURG_MORT. Measures for medical mortality, renamed as KPI 102_MED_MORT, includes 5 measures for deaths due to AMI, COPD, HF, PN, STK. Measures for surgical complications includes 8 measures and is renamed as KPI 103_SURG_COMPL; three measures constitute the renamed KPI 104_COMBINED_COMPL which includes both surgical and medical patients' complications such as pressure ulcers, iatrogenic pneumothorax, and hip fractures after falls. KPI 191_AGGR_SURG_COMPL is the renamed aggregated PSI_90 measure and remains separate. These subgroups are shown below in Table 4.1 and *Mortality* domain is renamed as *KPI Group 1*.

Table 4.1

Mortality Measures Renamed into new KPI Group 1

Measure_ID	KPI renamed
MORT_30_CABG	KPI_101:SURG_MORT
PSI_4_SURG_COMP	KPI_101:SURG_MORT
MORT_30_AMI	KPI_102:MED_MORT
MORT_30_COPD	KPI_102:MED_MORT
MORT_30_HF	KPI_102:MED_MORT
MORT_30_PN	KPI_102:MED_MORT
MORT_30_STK	KPI_102:MED_MORT
COMP_HIP_KNEE	KPI_103:SURG_COMPL
PSI_10_POST_KIDNEY	KPI_103:SURG_COMPL
PSI_11_POST_RESP	KPI_103:SURG_COMPL
PSI_12_POSTOP_PULMEMB_DVT	KPI_103:SURG_COMPL
PSI_13_POST_SEPSIS	KPI_103:SURG_COMPL
PSI_14_POSTOP_DEHIS	KPI_103:SURG_COMPL
PSI_15_ACC_LAC	KPI_103:SURG_COMPL
PSI_9_POST_HEM	KPI_103:SURG_COMPL
PSI_3_ULCER	KPI_104:COMBINED_COMPL
PSI_6_IAT_PTX	KPI_104:COMBINED_COMPL
PSI_8_POST_HIP	KPI_104:COMBINED_COMPL
PSI_90_SAFETY	KPI_191:AGGR_SURG_COMPL

Note. Four new variables created: KPI_101 – KPI_104.

Some of the measures used in 2019 were retired in 2021 due to methodological changes from CMS revisions. All measures from Exhibit 4.1 were regrouped by commonality and renamed based on the management focus similar to the procedure as shown above in Table 4.1. The results are summarized and shown in Exhibit 4.4 below.

Exhibit 4.4

KPI Group 1- KPI Group 6 Formed from Rearranged Management Focus Areas and Based on Key Performance Indicator Groupings

KPI Group	Management Focus	Number of Measures for Focus	Key Perfomance Indicator	Number of Measures for Indicator
1	Mortality and Complications	19	101_SURG_MORT	2
1	Mortality and Complications	19	102_MED_MORT	5
1	Mortality and Complications	19	103_SURG_COMPL	8
1	Mortality and Complications	19	104_COMBINED_COMPL	3
1	Mortality and Complications	19	191_AGGR_SURG_COMPL	1
2	Unplanned Readmissions	14	201_EDAC_CAR_PULM	3
2	Unplanned Readmissions	14	201_RETIRED	3
2	Unplanned Readmissions	14	202_READMIT_POST_DC	4
2	Unplanned Readmissions	14	203_OP_PROC_ADMIT	4
3	Infections	6	301_DEVICE_INFECT	2
3	Infections	6	302_SURG_INFECT	2
3	Infections	6	303_ID_INFECT	2
4	Timeliness of Care	13	400_RETIRED	9
4	Timeliness of Care	13	401_ED_RM_WAIT_TIME	1
4	Timeliness of Care	13	402_ED_LEFT_UNSEEN	1
4	Timeliness of Care	13	403_ED_TIMELY_TX	1
4	Timeliness of Care	13	404_ED_AMI_XFER_TIME	1
5	Patient Ratings	10	501_ENVIRON_SCORE	2
5	Patient Ratings	10	502_COMM_SCORE	6
5	Patient Ratings	10	503_HOSP_RATING	1
5	Patient Ratings	10	504_HOSP_RECOMMEND	1
6	Practice Protocols	9	601_WORKER_FLU_VACC	1
6	Practice Protocols	9	602_BONE_EXT_RT_TX	1
6	Practice Protocols	9	603_OB_DELIVER_EARLY	1
6	Practice Protocols	9	604_OP_TIMELY_COLON_TX	2
6	Practice Protocols	9	605_APPROP_SEPSIS_CARE	1
6	Practice Protocols	9	606_INAPP_OP_TX	3

Note. List includes 2019 measures that were retired in 2021.

Exhibit 4.4 shows *KPI Group 1* for the *Mortality and Complications* management focus domain and has 5 aggregated performance indicators: 101_SURG_MORT (containing 2 measures), 102_MED_MORT (containing 5 measures), 103_SURG_COMPL (containing 8 measures), 104_COMBINED_COMPL (containing 3 measures) and

191_AGGR_SURG_COMPL (containing one aggregated measure). Similarly, from Exhibit 4.4, *KPI Group 2* for *Unplanned Readmissions*, has 3 aggregated performance indicators: 201_ EDAC_CAR_PULM which is the excess days in acute care spent in hospital after AMI, HF and PN; 202_READMIT_POST_DC which is the readmissions within 30 days for CABG, COPD, TKA/THA and hospital-wide readmissions; 203_OP_PROC_ADMIT which is indicative of unplanned admissions after outpatient colonoscopies. Retired measures totaled three: both admission and ED visits after receiving outpatient chemotherapy and outpatient surgery. The summary of all aggregated compositions of KPI Group 1 - KPI Group 6 (*Mortality and Complications, Unplanned Readmissions, Infections, Timeliness of Care, Patient Ratings and Practice Protocols*) are shown in Appendix E.

Summary statistics from CMS data for the KPI Group 1as listed in Exhibit 4.4 are provided in Exhibit 4.5.

Exhibit 4.5

The Mean and Standard Deviation Values for the Components of KPI Group 1

Variable	N	N Miss	Minimum	Mean	Maximum	Std Dev
KPI101_SURG_MORT_dev	1227	1582	-3.5097973	-0.0191005	2.4323256	0.8229056
KPI101_SURG_MORT_N	2809	0	0	0.6810253	2.0000000	0.8401852
KPI101_SURG_MORT_NX	2809	0	0	1.3189747	2.0000000	0.8401852
KPI102_MED_MORT_dev	2762	47	-3.1679766	-0.0474077	2.5405424	0.6846940
KPI102_MED_MORT_N	2809	0	0	3.9238163	5.0000000	1.3673149
KPI102_MED_MORT_NX	2809	0	0	1.0761837	5.0000000	1.3673149
KPI103_SURG_COMPL_dev	2173	636	-2.7020100	-0.0086649	1.4886334	0.4653276
KPI103_SURG_COMPL_N	2809	0	0	5.3481666	8.0000000	3.4935580
KPI103_SURG_COMPL_NX	2809	0	0	2.6518334	8.0000000	3.4935580
KPI104_COMBINED_COMPL_dev	2082	727	-5.7520975	0.0021299	1.6173649	0.6067131
KPI104_COMBINED_COMPL_N	2809	0	0	2.2232111	3.0000000	1.3141037
KPI104_COMBINED_COMPL_NX	2809	0	0	0.7767889	3.0000000	1.3141037
KPI191_AGGR_SURG_COMPL_dev	2082	727	-11.5186339	-0.0069371	3.0504610	0.9864912
KPI191_AGGR_SURG_COMPL_N	2809	0	0	0.7411890	1.0000000	0.4380595
KPI191_AGGR_SURG_COMPL_NX	2809	0	0	0.2588110	1.0000000	0.4380595

Note. Hospitals screened for (1) number of beds > 19, (2) net income > -$10,000,000, (3) |percent ROA| ≤ 100 and (4) |income per bed| ≤ $200,000.

In alignment with CMS methodology, simple averages are calculated for these KPI groups based on the number of indicator measures. For example, for *KPI Group 1*, performance indicator 101_SURG_MORT is the average of two measure indicators and the normdev can be again calculated as the difference between the normscore and score divided by the standard deviation score. The mean of KPI101_SURG_MORT_dev is listed as -0.0191 in Exhibit 4.5 above. Similarly, the KPI102_MED_MORT_dev is listed as -0.0474 as shown in Exhibit 4.5 and reflects the average of 5 measure indicators. The other performance indicators that constitute the average deviations for *KPI Group 1* (KPI103_SURG_COMPL_dev, KPI104_COMBINED_COMPL_dev and KPI191_AGGR_SURG_COMPL_dev) are the averages based on the number of measure indicators (as listed previously in Exhibit 4.4) and are shown in Exhibit 4.5.

In Exhibit 4.5, the CMS data were screened for extreme outliers by imposing the condition that the number of hospital beds had to be greater than 19. The financial screen to exclude extreme outliers was applied at this time and included conditions where: (1) net income > -$10,000,000, (2) |%ROA| ≤ 100 and (3) |income per bed| ≤ $200,000. This decreased the number of hospitals from 4,100 to around 2,800 hospitals. The performance indicator variable KPI101_SURG_MORT_N (mortality for CABG and PSI_04 or surgical complication deaths) had a total of 2809 hospitals with a mean of 0.68103 (min score = 0; max score = 2). KPI101_SURG_MORT_dev can be calculated, and the mean value is -0.0191. Notice the number of hospitals used in this calculation that had meaningful values was 1227, the lowest of all the other mortality and complications measures listed. Similar statistics care for KPI102_MED_MORT, KPI103_SURG_COMPL, KPI104_COMBINED_COMPL and

KPI191_AGGR_SURG_COMPL are shown in Exhibit 4.5. The simple statistics for all the groups (*KPI Group 1 - KPI Group 6*) are shown Appendix F. These statistics at this granular level can be examined by managers at hospitals to help in decision-making and this shall be further explored in Chapter 6.

The number of variables shown in Appendix F are too numerous for concise, meaningful analysis of across hospitals. In a similar manner to CMS, 6 new variables can be derived from the KPI Groups: *G1_mortcompdev, G2_readmissionsdev, G3_safetydev, G4_timelindev, G5_ptexpdev* and *G6_opcaredev*. The definitions for these new variables are listed below, and are the mean values of the components of *KPI Group1-6*:

G1_mortcompdev=mean(KPI101_SURG_MORT_dev, KPI102_MED_MORT_dev, KPI103_SURG_COMPL_dev, KPI104_COMBINED_COMPL_dev)

G2_readmissionsdev = mean(KPI201_EDAC_CAR_PULM_dev, KPI202_READMIT_POST_DC_dev, KPI203_OP_PROC_ADMIT_dev)

G3_safetydev=mean(KPI301_DEVICE_INFECT_dev, KPI302_SURG_INFECT_dev, KPI303_ID_INFECT_dev)

G4_timelindev=mean(KPI401_ED_RM_WAIT_TIME_dev, KPI402_ED_LEFT_UNSEEN_dev, KPI403_ED_TIMELY_TX_dev, KPI404_ED_AMI_XFER_TIME_dev)

G5_ptexpdev=mean(KPI501_ENVIRON_SCORE_dev, KPI502_COMM_SCORE_dev, KPI503_HOSP_RATING_dev, KPI504_HOSP_RECOMMEND_dev)

G6_opcaredev=mean(KPI601_WORKER_FLU_VACC_dev, KPI602_BONE_EXT_RT_TX_dev, KPI603_OB_DELIVER_EARLY_dev, I604_OP_TIMELY_COLON_TX_dev, PI605_APPROP_SEPSIS_CARE_dev)

Note that the aggregated KPI191_AGGR_SURG_COMPL is **not** included in these new variables because the data used in calculating these values were at the patient-identified level which requires IRB approval for use and, therefore, is beyond the scope of this study. The KPI104_COMBINED_COMPL_dev is included, however, since it represents complication rates. These new G1-G6 deviation variables (*G2_readmissionsdev*, *G3_safetydev*, *G4_timelindev*, *G5_ptexpdev* and *G6_opcaredev*) shall be used in our regression analyses onwards in this chapter. Using CMS data, we can calculate values for the G1-G6 deviation variables by performing the above calculations and the results of the simple statistics for these variables are shown in Exhibit 4.6 below.

Exhibit 4.6

Simple Statistics for G1-G6 Deviation Variables

Simple Statistics						
Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
G1_mortcompdev	2894	-0.03736	0.44958	-108.11764	-4.25187	1.42452
G2_readmissionsdev	2528	0.01161	0.46619	29.34562	-2.08110	2.88812
G3_safetydev	1837	0.24378	1.04635	447.82157	-10.53029	1.67451
G4_timelindev	2501	0.05195	0.74604	129.91849	-6.54703	1.43605
G5_ptexpdev	1972	0.01045	0.80447	20.60946	-4.37788	2.29833
G6_opcaredev	2419	-0.03791	0.78945	-91.70660	-8.50503	1.57683

Note. Hospitals screened for (1) number of beds > 19, (2) net income > -$10,000,000, (3) |percent ROA| ≤ 100 and (4) |income per bed| ≤ $200,000.

In this table, we see that G1 for *mortality and complications (G1_mortcompdev)* has the highest number of hospitals at 2,894 hospitals with a mean value of -0.03736. The G1 and G2 variables for *mortality and complications* and *readmission* have the lowest standard deviations at 0.44958 and 0.46619 respectively, indicating a small variation among hospitals for the *mortality and complications* and *readmission* indicators. The other G3-G6 variables show standard deviations 1.5-2.3 times higher, meaning these indicators have a higher variation among hospitals.

CMS data provide a hospital's categorical rating of 'better than' based on comparisons of hospital's score with national scores for the domains of care as shown below as *betteron* ratings in Exhibit 4.7. Based on these simple statistics for 2,800 hospitals, the mean value of 0.0975 for *betteronmortality* shows that approximately 10% of hospitals were better than the national average for *mortality* compared with 30% for *safety*, *readmissions*, *patient experience* and *timely care* as shown below. This is consistent with the importance CMS places on mortality in their CMS ratings.

Exhibit 4.7

CMS Hospitals with "better on" Ratings

Variable	N	N Miss	Minimum	Mean	Maximum	Std Dev
betteronmortality	2809	0	0	0.0975436	1.0000000	0.2967494
betteronsafecare	2809	0	0	0.2894268	1.0000000	0.4535771
betteronreadmissions	2809	0	0	0.3688145	1.0000000	0.4825694
betteronpatientexper	2809	0	0	0.2627269	1.0000000	0.4401937
betteroneffcare	2809	0	0	0.0370239	1.0000000	0.1888539
betterontimelycare	2809	0	0	0.3065148	1.0000000	0.4611281
betteronimaging	2809	0	0	0.1067996	1.0000000	0.3089133

Note. Hospitals screened for (1) number of beds > 19, (2) net income > -$10,000,000, (3) |percent ROA| ≤ 100 and (4) |income per bed| ≤ $200,000.

These categorical values will be retained in our analysis later in this chapter and will complement the normalized deviations in selecting top and bottom performing hospitals.

To select the top performing and low performing hospitals *G1_mortcompdev* or *G2_readmissionsdev* must be included; additional clinical criteria used are:

<u>High Performers</u>: More than three G1 – G6 standard deviations > 0.25 **or** number of national ratings (*betteron* ratings) > 3

<u>Low Performers</u>: More than four G1 – G6 standard deviations < - 0.25 **or** number of national ratings (*betteron* ratings) = 0

Notice that in keeping with CMS, the importance of either of mortality or readmissions criteria have been retained as a requirement for all hospitals. In addition, they must also report on either 2 other G-deviations (3 total) with superior performance or have CMS hospital “better on” ratings in 3 categories. Similarly, if four (total) G-deviations meet a poor threshold or there are no CMS hospital “better on” ratings, the hospital is a low performing hospital.

4.2. Hospital Characteristics and Operations and Financial Performance

CMS non-clinical data pertain to the financial assets as well as some hospital characteristics. Hospital characteristics include ownership or type of control, the provide type, location and facility type. The type of control or the auspices under which a hospital operates is important since it determines its tax status. Table 4.2 shows the 13 types of control and their frequencies for the 6,000 US hospital from CMS data.

Table 4.2

Hospital Type of Control

Type of Control	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Voluntary NFP, Relig	601	9.94	601	9.94
Gov, State	229	3.79	830	13.73
Gov, Hosp District	346	5.72	1176	19.45
Gov, City	67	1.11	1243	20.56
Gov, Other	72	1.19	1315	21.75
Voluntary NFP, Other	2392	39.57	3707	61.32
Prop, Individual	22	0.36	3729	61.69
Prop, Corporation	1460	24.15	5189	85.84
Prop, Partnership	219	3.62	5408	89.46
Prop, Other	110	1.82	5518	91.28
Gov, Fed	42	0.69	5560	91.98
Gov, City-County	87	1.44	5647	93.42
Gov, County	398	6.58	6045	100.00

Note. NFP=Not-for-Profit; Prop=proprietary; Fed=Federal; Relig=Religious.

Note that almost 40% of US hospitals are voluntary, not-for-profit hospitals and the next largest group are the proprietary, corporate hospitals at 24%.

The type of facility is shown in Table 4.3. Other types not shown in this table are Religious, non-medical institutions, Children's hospitals and Alcohol and Drug facilities.

Table 4.3

Hospital Facility Type

Facility Type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
General, Short Term	2615	43.26	2615	43.26
General, Long Term	2189	36.21	4804	79.47
Cancer	55	0.91	4859	80.38
Psychiatric	37	0.61	4896	80.99
Rehab	1149	19.01	6045	100.00

Hospitals are classified as acute care and can be either short term or long-term hospitals. Any inpatient care, either in a hospital or skilled nursing facility, for 60 consecutive days is considered long-term care. This applies whether you are in an acute care hospital or a LTCHs which are certified as acute-care hospitals, but they focus on patient stays more than 25 days.

CMS also classifies hospitals according to the type of hospital, as shown in Table 4.4, where CCN facility type refers to CMS certification number for hospitals.

Table 4.4

Hospital Type by CCN

CCN Facility Type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Critical Access Hosp	1353	22.38	1353	22.38
Children Hosp	7	1.60	1450	23.99
Long Term care	377	6.24	1827	30.22
ORD	9	0.15	1836	30.37
Psych Hospital	595	9.84	2431	40.22
Rehab Hosp	289	4.78	2720	45.00
Research, Non-Medical	14	0.23	2734	45.23
Short Term Hosp	3311	54.77	6045	100.00

Note. CCN= CMS Certification Number; ORD=Outpatient Rehab and Drug facility.

Notice that according to the CCN facility type, almost 55% of US hospitals are Short-term acute care hospitals and Critical Access hospitals (CAH) are the next largest subset at 22%. CAH tend to be rural hospitals and often serve as triage and transfer centers to hospitals where more complex care is available. The facility type is also classified by rural or urban locations within CMS data. Table 4.5 shows that almost 60% of US hospitals are urban, or near a major city while about 39% are considered rural.

Table 4.5

Hospital Facility Type by Location: Rural vs Urban

Facility Type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
Not Known	76	1.26	76	1.26
Rural	2349	38.86	2425	40.12
Urban	3620	59.88	6045	100.00

Considering the fact that most physicians prefer to work in an urban setting, it is not surprising that rural hospitals, which comprise nearly 39% of US hospitals, may face a paucity of physician coverage and may be a key ingredient in the health care disparities that exist.

CMS data contain information on full-time employees (FTE), Medicare and Medicaid mix, bed and occupancy rates, assets and other financial measures and hospital characteristics; the complete list is shown in Appendix G.

Exhibit 4.8 shows the pertinent list of variables used from the complete CMS dataset with simple statistics. Notice that the variables from *elechealthrecords* to *IP_use_checklist* in Exhibit 4.8 are categorical variables. A value of one means the characteristic is present. The mean value of a binary variable (zero or one) indicates the proportion of hospitals having that characteristic.

Exhibit 4.8

Hospital Variables from CMS Data with Simple Statistics

Variable	Name	N	N Missing	Minimum	Mean	Maximum	Std Dev
elechealthrecords	Electronic Health Record	4041	0	0.00	0.53	1.00	0.50
shorttermfacility	Short term Facility	4041	0	0.00	0.76	1.00	0.43
longtermfacility	Long term facility	4041	0	0.00	0.08	1.00	0.27
specialtyfacility	Specialty facility	4041	0	0.00	0.10	1.00	0.30
otherfacility	Other facility	4041	0	0.00	0.07	1.00	0.25
acutecare	Acute care hospital	4041	0	0.00	0.46	1.00	0.50
childrenshospital	Children's hospital	4041	0	0.00	0.01	1.00	0.07
criticalaccesshospital	Critical Access hospital	4041	0	0.00	0.19	1.00	0.39
psychhospital	Psychiatric hospital	4041	0	0.00	0.07	1.00	0.26
forprofithospital	For-profit-hospital	4041	0	0.00	0.34	1.00	0.47
govthospital	Government hospital	4041	0	0.00	0.16	1.00	0.37
nonprofithospital	Not-for-profit hospital	4041	0	0.00	0.50	1.00	0.50
emergencyservice	Emergency service provided	4041	0	0.00	0.63	1.00	0.48
rural	rural	4041	0	0.00	0.39	1.00	0.49
lab_result_elec	Electronic lab result	2632	1409	0.00	0.74	1.00	0.44
lab_result_track	Electronic lab result track	2632	1409	0.00	0.72	1.00	0.45
op_surg_chklist	Operating surgical checklist	2632	1409	0.00	0.77	1.00	0.42
pnt_safety_cult	Patient safety culture	2632	1409	0.00	0.63	1.00	0.48
IP_use_checklist	Inpatient checklist use	2632	1409	0.00	0.75	1.00	0.43
FTEemployees	FTE employees	4019	22	1.00	778.48	26491.16	1352.92
numinternsandresidents	Numinterns and residents	798	3243	0.01	81.49	1610.73	155.63
pcthospdaysmedicaid	% hospital days for medicaid	3458	583	0.01	4.94	98.83	7.40
pcthospdaysmedicare	% hospital days for medicare	4022	19	0.01	20.88	83.67	13.59
acutecarebeddays	Number acute care bed days	4037	4	17.00	29444.04	699630.00	45412.01
acutebeddaysavailable	Number acute bed days available	4040	1	1104.00	47715.72	1004845.00	60359.81
acutecareoccupancyrate	Acute care occupancy rate	4036	5	0.19	51.25	112.03	22.95
acutecarebeds	Acute care beds	4041	0	20.00	134.07	2753.00	167.80
totalbedsallservices	Total beds al lservices	4041	0	20.00	151.79	2826.00	183.63
totalbeddaysavailallserv	Total bed days avail all serv	4040	1	1104.00	54056.06	1031490.00	66116.37
totalbeddaysallservices	Total bed days all services	4041	0	35.00	42632.80	816698.00	53981.19
allservicessoccupancyrate	All services occupancy rate	4040	1	0.35	104.57	1519.04	131.44
avgMedicareLOS	Avg Medicare LOS	4019	22	0.37	6.94	86.05	7.22
equippctoftotalassets	Equip % of total assets	3832	209	-2262.25	150.12	34513.34	728.79
pctcarecostuncompensated	% care cost uncompensated	3075	966	-0.33	2.42	140.00	3.72

The formulas used to calculate the variables to be used in our analysis are listed below using the identical CMS fields:

Percent Medicare occupancy rates:
pcthospdaysmedicare=100*total_days_title_XVIII/
total_bed_daysavailable
Percent Medicaid occupancy rates:
pcthospdaysmedicaid=100*total_days_title_XIX/
total_bed_days_available

Hospital occupancy :
acutecarebeddays=Total_Days__V___XVIII___XIX___Un
acutebeddaysavailable=total_bed_days_available
acutecareoccupancyrate=100* acutecarebeddays/
acutebeddaysavailable
acutecarebeds=number_of_beds
totalbedsallservices=Number_of_Beds_____Total_for_all_S
totalbeddaysavailallserv=Total_Bed_Days_Available___Total
totalbeddaysallservices=var31
allservicessoccupancyrate=100*totalbeddaysallservices/
totalbeddaysavailallserv
avgMedicareLOS=Hospital_Total_Days_Title_XVIII/
Total_Discharges_Title_XVIII

Asset mix and percent ROA:
equippctoftotalassets=100*(fixed_equipment+major_movable_equipment+minor_equipment_depreciable+
health_information_technology de)/total_fixed_assets
pctcarecostuncompensated=100*(cost_of_charity_care+cost_of_uncompensated_care)/Combined_Outpatient___Inpatient
pctROA=100*Net_Income/Total_Assets
pctROBeds=100*Net_Income_from_Service_to_Patie/
Number_of_Beds

Financial measures in percentage:
pctoperatingmargin=100*Net_Income/Gross_Revenue
pctptmargin=100*Net_Income_from_Service_to_Patie/
Net_Patient_Revenue
pctsalarytorevenue=100*Salaries__Wages__and_Fees_Payab/
Net_Income

The calculated values for these variables are easily obtained, but upon further examination of these results, it becomes apparent there are very extreme values because of the nature of the data reported to CMS. These calculated data were therefore screened to include institutions for which: (1) number of beds > 19, (2) net income > -$10,000,000, (3) |percent ROA| ≤ 100 and (4) |income per bed| ≤ $200,000. Exhibit 4.9 shows the number of hospitals remaining after these criteria are applied is around 2,800 hospitals. It also shows that the constraint of income per bed of ±$200,000 overrides the constraint of percent ROA within ±100% and the wide range of percent OM seen from -37% to 28%. The number of hospitals is 2,800 which provides a sample that is large enough for meaningful analysis.

Exhibit 4.9

Number of Hospitals after Screening Conditions Imposed

Variable	N	N Miss	Minimum	Mean	Maximum	Std Dev
pctROA	2803	6	-96.5348024	3.6585375	84.2215982	13.7201633
incomeperbed	2809	0	-199115.84	-2700.69	199904.78	89559.88
pctoperatingmargin	2806	3	-37.0784439	1.1490282	27.5437782	3.4062728

Note. Hospitals screened for (1) number of beds > 19, (2) net income > -$10,000,000, (3) |percent ROA| ≤ 100 and (4) |income per bed| ≤ $200,000.

These data can be used to select the top performing and low performing hospitals. The financial criteria used in selecting these are:

<u>High Performers</u>: pctROA ≥ 5 **and** incomeperbed ≥ 350 **and** pctoperatingmargin ≥ 1.5

<u>Low Performers</u>: pctROA ≤ -10 **or** incomeperbed ≤ 0 **or** pctoperatingmargin ≤ - 10

Notice the conditional statements are different for the high and low performers: the high performers have to meet **all** the conditions for pctROA, incomeperbed and pctoperatingmargin whereas the low performers only had to meet one of the conditions.

If all these conditions were required for the low performers, then number of hospitals would be too few for meaningful analysis, even if the conditions were relaxed, hence the '**or**' operative in the condition statement above.

4.3. Patient Characteristics

Patient characteristics including demographics such as age, gender, race, marital status, etc. and chronic conditions are only available at the patient identifier level from the CMS Chronic Conditions Warehouse (CCW) within CMS data (ccwdata.org). This data source will not be used because these are patient-identifiable datafiles, and our unit of analysis is the hospital. CMS does provide *CMS 2010 Institutional Provider and Beneficiary Summary* (IPBS) PUF that contain some demographic and chronic conditions data which are obtained from CMS CCW which is aggregated at the institutional provider level Home | Provider Data Catalog (cms.gov).

The patient data from the IPBS PUF, aggregated at the hospital level, indicate the percent of each gender and race cared for each hospital. These percentages are shown in Exhibit 4.10 along with other simple statistics.

Exhibit 4.10

Patient Demographic at Hospital Level Data from IPBS PUF

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
pctdualeligible	2715	27.31766	13.68191	74167	0.83699	94.48491
avgriskscore	2716	1.34504	0.23962	3653	0.79000	3.44000
pctmales	2716	40.93335	3.53833	111175	2.19512	67.66917
pctnonwhite	2707	16.36335	19.07522	44296	0.60713	99.40606
mortalityrate	2707	5.88721	1.57606	15937	0.93151	17.05831

The chronic conditions listed in the IPBS PUFs include major comorbidities such as asthma, COPD, diabetes, AMI, atrial fibrillation, stroke and chronic kidney disease. It also includes other conditions such as hyperlipidemia, hypothyroidism, depression, Alzheimer's disease (with and without associated dementia), anemia, cataracts, glaucoma, cancers (breast, endometrial, lung, prostate, and colorectal), prostatic hyperplasia, rheumatoid arthritis and osteoporosis. Since the early 2000s, the value-based system, where risk is moved from payors to patients and physicians, has been ongoing; health care providers are not paid for the volume of work they do, but based on the quality and value of the services they deliver. As a result, CMS introduced the Hierarchical Condition Category (HCC) in 2003 which is a set of codes that are designed to accurately reflect patient "acuity" – or the severity of illnesses – and CMS uses these codes to determine reimbursements to Medicare Advantage plans. These chronic conditions are used to calculate an average HCC risk score among Medicare beneficiaries and is represented as *avgriskscore* with mean =1.345 as show in Exhibit 4.10. Also shown is the mean mortality rate at ~6%.

The IPBS PUFs also contain information on patients who receive dual benefits of Medicare and Medicaid which is indicative of income status since only low-income beneficiaries are eligible for both benefits. The mean percent dual eligible (*pctdualeligible*) shown in Exhibit 4.10 for over 2,700 hospitals is ~27%. These data will be used later on in our analysis.

Census tracts are defined by the US Census Bureau and are small, relatively permanent subdivisions of a county, comprised of 1,200 to 8,000 people (average population size of 4,000 people). US census-tract data can be obtained from the *Climate and Economic Justice Screening Tool* which is based on the American Community Survey from 2015-2019 (https://screeningtool.geoplatform.gov/en/methodology). This tool was developed to help improve the geographic targeting of certain Federal programs and to better address the challenges of certain communities (pollution, disinvestment or disadvantaged status).

These data were collected at the census-tract level which can be aggregated to the county level. They provide information on income, education, housing value, life expectancy and health conditions such as asthma, diabetes and heart disease. The health conditions are based on a weighted percent of people who answered positively to both being told by a health professional they had the stated condition, and they still have the ongoing condition. A list of these health conditions along with their descriptions are shown in Exhibit 4.11 below.

Exhibit 4.11

Patient Demographic Data and Descriptions Based on Census-Tract Data

Dataset	Description
Low income	Percent of a census tract's population of households where household income is at or below 200% of the Federal poverty level
Higher education non-enrollment	Percent of people 15 or older who are not currently enrolled in college, university, or graduate school
Low median Income	Median income of the census tract calculated as a percent of the area's median income
Median home value	Median home value of owner-occupied housing units in the census tract
Energy burden	Average annual energy cost per household ($) divided by average household income
Wastewater discharge	Risk-Screening Environmental Indicators (RSEI) modeled toxic concentrations at stream segments within 500 meters, divided by distance in kilometers
Asthma	Weighted percent of people who answer "yes" to both of the following questions: "Have you ever been told by a health professional that you have asthma?" and "Do you still have asthma?"
Diabetes	Weighted percent of people ages 18 years and older who report being told by a health professional that they have diabetes other than diabetes during pregnancy
Heart disease	Weighted percent of people ages 18 years and older who report being told by a health professional that they had angina or coronary heart disease
Low life expectancy	Average number of years of life a person who has attained a given age can expect to live
Unemployment	Number of unemployed people as a percentage of the civilian labor force
Poverty	Percent of a census tract's population in households where the household income is at or below 100% of the Federal poverty level
High school degree non-attainment	Percent of people age 25 years or older in a census tract whose education level is less than a high school diploma

Low income refers to the percentage of homes that meet the threshold for 200% below the federal poverty line and low education is the percentage of homes with adults $\geq$ 25-year-old who lack a high school diploma as defined in Exhibit 4.11. Disadvantaged tracts must meet the requirement of an environmental or climate indicator (e.g., pollution) and either of two related socioeconomic indicators such as income or education. A census tract must meet the thresholds for both indicators to be considered disadvantaged (*disadvtract*). Each indicator has a cutoff value as a threshold, so a tract satisfies an indicator if it exceeds the indicator's cutoff value. For example, to meet the socioeconomic indicator for poverty, the census tract must have more households living at or below 200% of the Federal poverty level than 65% of all census tracts in the county; for education, a census tract must have 80% or more of individuals $\geq$15 years old who are currently unenrolled in higher education in that census tract. Similarly, for pollution thresholds, a tract must be closer to hazardous waste, Risk Management Plan facilities or Superfund sites than 90% of all other census tracts in the county.

Hospital county information can be coupled with data from census-tract at the county level and patient demographics can then be linked back to the hospitals. Exhibit 4.12 shows the simple statistics for these variables.

Exhibit 4.12

Patient Demographic Data Based on Census-Tract Data

Variable	N	Mean	Std Dev	Sum	Minimum	Maximum
disadvtract	2565	0.30354	0.26897	778.59076	0	1.00000
medianhousingval	2565	177566	102067	455457821	43100	995645
lowincloweduc	2565	0.33795	0.27577	866.84119	0	1.00000
pctasthmatic	2517	25.45532	8.14185	64071	8.57452	75.44204
pctdiabetic	2517	30.22255	11.89537	76070	9.12027	106.65295
pctheartdisease	2517	18.29661	8.11339	46053	4.43259	73.77049
life_expectancy	2464	77.87058	2.27981	191873	69.42354	87.00000

Note. Distract=disadvantaged tract; pctasthmatic=% asthmatic; pctdiabetic=% diabetic pctheartdisease=% heart disease; *lowincloweduc*=low income and low education. Here, N indicates the number of hospitals in the US, based on county codes, that meet the criteria of the listed variables and is around 2,500.

The combined patient demographic data obtained from both census-tract data and IPBS PUF will used in our analysis. They will be used along with the data from the clinical and financial data presented earlier in this chapter in our analyses in the next sections of this chapter.

4.4. Correlates of Hospital Performance considering Hospital Characteristics and Patient Characteristics

In the clinical metrics section show previously, 6 new G-variables were derived from the clinical measures: *G1_mortcompdev, G2_readmissionsdev, G3_safetydev, G4_timelindev, G5_ptexpdev* and *G6_opcaredev*. With the variables we have discussed previously, there are over 60 variables for consideration in regression analysis which are shown in the Table 4.6 below along with their definitions:

Table 4.6

List of Variables used in Regression Analysis

Variable	**Definition**
acutecarebeds	Total number of acute beds available in the hospital
acutebeddaysavailable	Acute beds available for the year (#acutecarebeds*365)
acutecarebeddays	Acute beds available for the year (#acutecarebeds*365)
acutecareoccupancyrate	Total number of acute beds with patients/total number of beds days available
allservicessoccupancyrate	Total number of all beds with patients/total number of beds days available
avgMedicareLOS	Average Medicare length of stay
avgriskscore	Average risk score from CMS
betteroneffcare	Better on efficient care from CMS
betteronimaging	Better on imaging care from CMS
betteronmortality	Better on mortality from CMS
betteronpatientexper	Better on patient experience from CMS
betteronreadmissions	Better on readmissions from CMS
betteronsafecare	Better on timely care from CMS
betterontimelycare	Better on imaging care from CMS
childrenshospital	Children’s hospital
criticalaccesshospital	Critical access hospital
disadvtract	Disadvantaged tract from census-tract data
elechealthrecords	Electronic health records
emergencyservice	Emergency services
equippctoftotalassets	Equipment as percentage of total assets
forprofithospital	For profit hospital
FTEemployees	Full-time employees
G1_mortcompdev	G1 mortality and complications deviation
G2_readmissionsdev	G2 readmissions deviation
G3_safetydev	G3 mortality and complications deviation

Table 4.6 (continued).

G4_timelindev	G4 timeliness of care deviation
G5_ptexpdev	G5 patients' experience deviation
G6_opcaredev	G5 outpatient care deviation
govthospital	Government hospital
highperformer	High performing hospital
incomeperbed	Income per bed
IP_use_checklist	Inpatient checklist use
lab_result_elec	Lab results electronically posted
lab_result_track	Lab results electronically tracked
largehosp	Lager hospital
life_expectancy	Life expectancy in years
longtermfacility	Long term healthcare facility
lowincloweduc	Low income, low education from census-tract survey
lowperformer	Low performing hospital
medianhousingval	Median Housing value
mediumhosp	Medium size hospital
mortalityrate	Mortality rate
nonprofithospital	Non-profit hospital
numinternsandresidents	Number of interns and residents
numKPIsbetter	Number of G-variables better
numKPISworse	Number of G-variables worse
numratingsbetter	Number of *betteron* ratings better
op_surg_chklist	Operative surgical checklist used
otherfacility	Other types of facility
pctasthmatic	Percentage asthmatic
pctcarecostuncompensated	Percentage of non-compensated care
pctdiabetic	Percentage of diabetic patients
pctdualeligible	Percentage of patients eligible for Medicare and Medicaid
pctheartdisease	Percentage of heart disease patients
pcthospdaysmedicaid	Percentage of hospital days billed as Medicaid
pcthospdaysmedicare	Percentage of hospital days billed as Medicare
pctmales	Percentage of male patients
pctnonwhite	Percentage of non-white patients
pctROA	Percentage of return on assets
pnt_safety_cult	Patient safety culture
psychhospital	Psychiatric hospital
rural	Rural hospital
smallhosp	Small size hospital
specialtyfacility	Specialty Hospital
totalbeddaysallservices	Total hospital beds*365
totalbeddaysavailallserv	Total beds staffed*365
totalbedsallservices	Total hospital beds

First, we examine simple correlations among the G-variables, then we observe how the targeted performance measures are correlated, and identify explanatory variables most highly correlated with targeted performance measures. A Pearson correlation table for the G1-G6 variables is listed below in Exhibit 4.13. There are between 2,107 and 2,809 hospital values used in these correlations as shown.

Exhibit 4.13

Pearson Correlation Table for G1-G6 Variables

	G1_mortcompdev	G2_readmissionsdev	G3_safetydev	G4_timelindev	G5_ptexpdev	G6_opcaredev
G1_mortcompdev	1.00000 2809	0.01994 0.2909 2809	0.07152 0.0010 2107	0.06954 0.0003 2738	0.02801 0.1822 2269	0.05970 0.0020 2671
G2_readmissionsdev	0.01994 0.2909 2809	1.00000 2809	0.01387 0.5246 2107	0.22066 <.0001 2738	0.29363 <.0001 2269	0.11398 <.0001 2671
G3_safetydev	0.07152 0.0010 2107	0.01387 0.5246 2107	1.00000 2107	0.05885 0.0071 2095	0.02991 0.1776 2033	0.04135 0.0582 2099
G4_timelindev	0.06954 0.0003 2738	0.22066 <.0001 2738	0.05885 0.0071 2095	1.00000 2738	0.35048 <.0001 2249	0.22959 <.0001 2631
G5_ptexpdev	0.02801 0.1822 2269	0.29363 <.0001 2269	0.02991 0.1776 2033	0.35048 <.0001 2249	1.00000 2269	0.12909 <.0001 2240
G6_opcaredev	0.05970 0.0020 2671	0.11398 <.0001 2671	0.04135 0.0582 2099	0.22959 <.0001 2631	0.12909 <.0001 2240	1.00000 2671

Note. Hospitals screened for (1) number of beds > 19, (2) net income > -$10,000,000, (3) |percent ROA| ≤ 100 and (4) |income per bed| ≤ $200,000.

From Exhibit 4.13 we see that there are no large correlations among these 6 variables, the highest being 0.35048 between G4 and G5 and the next highest at 0.2963 between G2 and G5, so co-linearity is not an issue among these variables. While the correlations are not high, however, there are some are understandingly statistically significant relationships, albeit with a high degree of residual variation. Constructing a correlation with these many variables would not be legible if condensed, or would be confusing when presented on multiple pages. Correlation between the individual key target variables and all other variables are presented in a series of Exhibits that follow.

Exhibit 4.14

Pearson Correlation Table for G1_mortcompdev and All Other Variables

Obs	Correlated Variable	G1_mortcompdev	Sample Size	P-value
1	numKPISworse	-0.35067	2,809	<.0001
2	numKPIsbetter	0.30573	2,809	<.0001
3	betteronmortality	0.28407	2,809	<.0001
4	betteronsafecare	0.20532	2,809	<.0001
5	numratingsbetter	0.18244	2,809	<.0001
6	medianhousingval	0.16424	2,758	<.0001
7	avgriskscore	0.12646	2,716	<.0001
8	op_surg_chklist	0.12091	2,809	<.0001
9	lowperformer	-0.12051	2,809	<.0001
10	life_expectancy	0.11749	2,668	<.0001
11	pnt_safety_cult	0.11630	2,809	<.0001
12	IP_use_checklist	0.11448	2,809	<.0001
13	Incomeperbed	0.10842	2,809	<.0001
14	pctheartdisease	-0.10497	2,713	<.0001
15	rural	-0.09946	2,809	<.0001
16	pctasthmatic	-0.09333	2,713	<.0001
17	avgMedicareLOS	-0.08951	2,808	<.0001
18	lab_result_elec	0.08612	2,809	<.0001
19	govthospital	-0.08482	2,809	<.0001
20	pctdiabetic	-0.08472	2,713	<.0001
21	pcthospdaysmedicaid	-0.08394	2,649	<.0001
22	highperformer	0.08260	2,809	<.0001
23	criticalaccesshospital	-0.08095	2,809	<.0001
24	pctcarecostuncompensated	-0.08021	2,797	<.0001
25	mortalityrate	-0.07603	2,707	<.0001
26	lab_result_track	0.07476	2,809	<.0001
27	G3_safetydev	0.07152	2,107	0.0010
28	G4_timelindev	0.06954	2,738	0.0003
29	smallhosp	-0.06290	2,809	0.0009
30	pctdualeligible	0.06116	2,715	0.0014
31	G6_opcaredev	0.05970	2,671	0.0020
32	pctnonwhite	0.05762	2,707	0.0027
33	betteronpatientexper	0.05732	2,809	0.0024
34	allservicessoccupancyrate	-0.05562	2,809	0.0032
35	mediumhosp	0.05436	2,809	0.0040
36	pctmales	-0.05205	2,716	0.0067
37	emergencyservice	-0.05013	2,809	0.0079
38	pcthospdaysmedicare	0.04541	2,809	0.0161
39	acutecareoccupancyrate	0.04238	2,809	0.0247
40	forprofithospital	0.04234	2,809	0.0248
41	FTEemployees	0.03972	2,801	0.0355
42	betteroneffcare	0.03792	2,809	0.0445
43	pctROA	0.03751	2,803	0.0471
44	acutecarebeds	0.03547	2,809	0.0601
45	nonprofithospital	0.03468	2,809	0.0661
46	acutebeddaysavailable	0.03263	2,809	0.0838
47	lowincloweduc	-0.03163	2,758	0.0967
48	totalbedsallservices	0.03116	2,809	0.0987
49	numinternsandresidents	0.02841	712	0.4490
50	totalbeddaysavailallserv	0.02805	2,809	0.1372
51	G5_ptexpdev	0.02801	2,269	0.1822
52	acutecarebeddays	0.02681	2,809	0.1554
53	otherfacility	0.02580	2,809	0.1716
54	betteronreadmissions	0.02378	2,809	0.2078
55	betteronimaging	-0.02285	2,809	0.2260
56	G2_readmissionsdev	0.01994	2,809	0.2909
57	equippctoftotalassets	-0.01907	2,658	0.3257
58	largehosp	0.01276	2,809	0.4992
59	betterontimelycare	-0.01194	2,809	0.5270
60	totalbeddaysallservices	0.00811	2,809	0.6675
61	elechealthrecords	0.00693	2,809	0.7135
62	disadvtract	-0.00591	2,758	0.7565

The highest (absolute) correlation seen is with *numKPIsworse* at 0.35067. This is not unexpected since the *numKPIsworse* variable is concerned with issues on mortality and complications; similarly, the correlations are close to 0.3 for *numKPIsbetter* and *betteronmortality* measures because they deal with issues on mortality and complications. We see that there are highly statistically significant relationships for the first 43 variables with significant correlations for the first 30 variables, ranging from -0.35 for *NumKPISworse* to 0.06 for *pctdualeligible*.

This can be done for all other variables and the results are shown in the correlation pdf files attached in Appendix H. The ten highest correlations for G1-G6 variables are shown in Exhibit 4.15. In this table, the highest correlation is 0.62353, seen between G5 (patient experience) and *betteronpatientexper* measures which are essentially measuring the same metric. All other correlations in Exhibit 4.15 are below 0.45. Again, there are statistically significant relationships between these variables with significant residual values. We see that the G4-variable (timeliness) is correlated with G2 (readmissions), G5 (patient experience) and G6 (outpatient care). Intuitively, these relationships appears to make sense since timely care leads to a better experience and potentially decreases readmissions.

Exhibit 4.15

Variables with Highest Correlation Values for G1-G6 Performance Indicators

Obs	Correlated Variable	G1_mortcompdev	Sample Size	P-value
1	numKPISworse	-0.35067	2,809	<.0001
2	numKPIsbetter	0.30573	2,809	<.0001
3	betteronmortality	0.28407	2,809	<.0001
4	betteronsafecare	0.20532	2,809	<.0001
5	numratingsbetter	0.18244	2,809	<.0001
6	medianhousingval	0.16424	2,758	<.0001
7	avgriskscore	0.12646	2,716	<.0001
8	op_surg_chklist	0.12091	2,809	<.0001
9	lowperformer	-0.12051	2,809	<.0001
10	life_expectancy	0.11749	2,668	<.0001

Obs	Correlated Variable	G2_readmissionsdev	Sample Size	P-value
1	numKPIsbetter	0.39904	2,809	<.0001
2	avgriskscore	-0.30773	2,716	<.0001
3	numKPISworse	-0.30355	2,809	<.0001
4	G5_ptexpdev	0.29363	2,269	<.0001
5	avgMedicareLOS	-0.24668	2,808	<.0001
6	pctnonwhite	-0.23704	2,707	<.0001
7	betteronreadmissions	0.23277	2,809	<.0001
8	smallhosp	0.22397	2,809	<.0001
9	G4_timelindev	0.22066	2,738	<.0001
10	criticalaccesshospital	0.20351	2,809	<.0001

Obs	Correlated Variable	G3_safetydev	Sample Size	P-value
1	numKPISworse	-0.27470	2,107	<.0001
2	numKPIsbetter	0.26441	2,107	<.0001
3	IP_use_checklist	0.10387	2,107	<.0001
4	criticalaccesshospital	-0.10107	2,107	<.0001
5	allservicesoccupancyrate	-0.09794	2,107	<.0001
6	op_surg_chklist	0.09726	2,107	<.0001
7	pcthospdaysmedicare	-0.08699	2,107	<.0001
8	G1_mortcompdev	0.07152	2,107	0.0010
9	avgMedicareLOS	-0.06356	2,106	0.0035
10	lab_result_elec	0.06291	2,107	0.0039

Obs	Correlated Variable	G4_timelindev	Sample Size	P-value
1	pctnonwhite	-0.45225	2,639	<.0001
2	avgriskscore	-0.40745	2,647	<.0001
3	betterontimelycare	0.39735	2,738	<.0001
4	avgMedicareLOS	-0.38999	2,737	<.0001
5	numKPIsbetter	0.38674	2,738	<.0001
6	acutecareoccupancyrate	-0.38577	2,738	<.0001
7	acutecarebeddays	-0.37130	2,738	<.0001
8	acutebeddaysavailable	-0.36079	2,738	<.0001
9	acutecarebeds	-0.36020	2,738	<.0001
10	smallhosp	0.35968	2,738	<.0001

Obs	Correlated Variable	G5_ptexpdev	Sample Size	P-value
1	betteronpatientexper	0.62353	2,269	<.0001
2	numKPIsbetter	0.48157	2,269	<.0001
3	avgriskscore	-0.47579	2,199	<.0001
4	numKPISworse	-0.45829	2,269	<.0001
5	smallhosp	0.40916	2,269	<.0001
6	mortalityrate	-0.37012	2,193	<.0001
7	pctnonwhite	-0.36441	2,197	<.0001
8	criticalaccesshospital	0.35689	2,269	<.0001
9	G4_timelindev	0.35048	2,249	<.0001
10	avgMedicareLOS	-0.34654	2,268	<.0001

Obs	Correlated Variable	G6_opcaredev	Sample Size	P-value
1	numKPISworse	-0.42168	2,671	<.0001
2	numKPIsbetter	0.36800	2,671	<.0001
3	G4_timelindev	0.22959	2,631	<.0001
4	pctnonwhite	-0.19662	2,579	<.0001
5	disadvtract	-0.19031	2,627	<.0001
6	lowincloweduc	-0.18280	2,627	<.0001
7	numratingsbetter	0.17801	2,671	<.0001
8	lowperformer	-0.17471	2,671	<.0001
9	pnt_safety_cult	0.16269	2,671	<.0001
10	life_expectancy	0.15557	2,542	<.0001

Pearson correlations are also shown for the other significant variables that we will use in our regression analysis and are shown in Exhibit 4.16. These variables are related to LOS, occupancy rates, % ROA, income per bed, number of G-variables better than a chosen standard (labeled as *numKPIsbetter*) or G-variables worse than a chosen standard (labeled as *numKPIsworse*), number of CMS ratings *better on* than the national standard (*numratingsbetter*), high performer and low performer hospitals. Again, there are highly statistically significant correlations observed among variables as seen by p values <0.0001, with significant unexplained residual variations. We see that *avgMedicareLOS* is negatively related to small hospitals and *G4_timelindev*. One possible explanation is that small hospitals do not offer the same services as larger hospitals, so treatment is delayed, leading to higher LOS. Concomitantly, this results in a negative relationship with *G4_timelindev* which is reflective of timeliness of care. Looking at *acutecareoccupancyrate, pctROA* and *incomeperbed,* small hospitals have a statistically significant negative relationship with correlation coefficients of -0.574, -0.190 and -0.284 respectively. One possible explanation is, again, the services being offered may not be as comprehensive as at larger hospitals so less patient seek elective care at the smaller hospitals, resulting on decreased occupancy rates which leads to decreased % ROA and income per bed. Looking at *numKPIsbetter* (obtained from G-variables) and *numratingsbetter* (from CMS), patient experience and timeliness of care are common to both metrics. For high performing hospitals (*highperformer* variable), *G5_ptexpdev* and *G_2redmissionsdev* were the G-variables seen with correlations that were highly statistically significant. Low performing hospitals (*lowperformer*) are hospitals without surgical (*op_surg_cklist*) or inpatient (*IP_use_checklist*) checklists or electronic lab results (*Lab_result_elec*) as seen in Exhibit 4.16.

Exhibit 4.16

Variables with Highest Correlation Values for Other Significant Performance Indicators

Obs	Correlated Variable	avgMedicareLOS	Sample Size	P-value
1	acutecareoccupancyrate	0.46872	2,808	<.0001
2	avgriskscore	0.45834	2,715	<.0001
3	smallhosp	-0.43925	2,808	<.0001
4	acutecarebeddays	0.41903	2,808	<.0001
5	totalbeddaysavailallserv	0.41446	2,808	<.0001
6	totalbedsallservices	0.41441	2,808	<.0001
7	acutebeddaysavailable	0.40820	2,808	<.0001
8	acutecarebeds	0.40779	2,808	<.0001
9	G4_timelindev	-0.38999	2,737	<.0001
10	pctnonwhite	0.38975	2,706	<.0001

Obs	Correlated Variable	acutecareoccupancyrate	Sample Size	P-value
1	pcthospdaysmedicare	0.63456	2,809	<.0001
2	acutecarebeddays	0.62437	2,809	<.0001
3	smallhosp	-0.57389	2,809	<.0001
4	acutecarebeds	0.55986	2,809	<.0001
5	totalbeddaysallservices	0.55954	2,809	<.0001
6	acutebeddaysavailable	0.55792	2,809	<.0001
7	FTEemployees	0.55755	2,801	<.0001
8	totalbedsallservices	0.55063	2,809	<.0001
9	totalbeddaysavailallserv	0.54889	2,809	<.0001
10	largehosp	0.49678	2,809	<.0001

Obs	Correlated Variable	pctROA	Sample Size	P-value
1	incomeperbed	0.48112	2,803	<.0001
2	acutecareoccupancyrate	0.23227	2,803	<.0001
3	lowperformer	-0.22051	2,803	<.0001
4	smallhosp	-0.19022	2,803	<.0001
5	acutebeddaysavailable	0.16244	2,803	<.0001
6	acutecarebeds	0.16061	2,803	<.0001
7	acutecarebeddays	0.15911	2,803	<.0001
8	totalbeddaysavailallserv	0.15509	2,803	<.0001
9	rural	-0.15366	2,803	<.0001
10	totalbedsallservices	0.15288	2,803	<.0001

Obs	Correlated Variable	incomeperbed	Sample Size	P-value
1	pctROA	0.48112	2,803	<.0001
2	lowperformer	-0.33451	2,809	<.0001
3	smallhosp	-0.28428	2,809	<.0001
4	acutecareoccupancyrate	0.27006	2,809	<.0001
5	pnt_safety_cult	0.25981	2,809	<.0001
6	govthospital	-0.24723	2,809	<.0001
7	IP_use_checklist	0.24158	2,809	<.0001
8	numratingsbetter	0.23159	2,809	<.0001
9	op_surg_chklist	0.23079	2,809	<.0001
10	criticalaccesshospital	-0.23054	2,809	<.0001

Obs	Correlated Variable	numKPIsbetter	Sample Size	P-value
1	numKPIsbetter	1.00000	2,809	_
2	numKPIsworse	-0.56049	2,809	<.0001
3	G5_ptexpdev	0.48157	2,269	<.0001
4	G2_readmissionsdev	0.39904	2,809	<.0001
5	betteronpatientexper	0.39767	2,809	<.0001
6	numratingsbetter	0.39010	2,809	<.0001
7	G4_timelindev	0.38674	2,738	<.0001
8	G6_opcaredev	0.36800	2,671	<.0001
9	G1_mortcompdev	0.30573	2,809	<.0001
10	betterontimelycare	0.27309	2,809	<.0001

Obs	Correlated Variable	numKPIsworse	Sample Size	P-value
1	numKPIsworse	1.00000	2,809	_
2	numKPIsbetter	-0.56049	2,809	<.0001
3	numratingsbetter	-0.46340	2,809	<.0001
4	G5_ptexpdev	-0.45829	2,269	<.0001
5	G6_opcaredev	-0.42168	2,671	<.0001
6	lowperformer	0.38921	2,809	<.0001
7	G4_timelindev	-0.35356	2,738	<.0001
8	G1_mortcompdev	-0.35067	2,809	<.0001
9	betteronpatientexper	-0.34536	2,809	<.0001
10	op_surg_chklist	-0.33824	2,809	<.0001

Obs	Correlated Variable	numratingsbetter	Sample Size	P-value
1	betteronreadmissions	0.56006	2,809	<.0001
2	betteronsafecare	0.55507	2,809	<.0001
3	lowperformer	-0.53615	2,809	<.0001
4	betteronpatientexper	0.51690	2,809	<.0001
5	numKPIsworse	-0.46340	2,809	<.0001
6	numKPIsbetter	0.39010	2,809	<.0001
7	betteronimaging	0.33488	2,809	<.0001
8	betterontimelycare	0.32895	2,809	<.0001
9	G5_ptexpdev	0.32563	2,269	<.0001
10	op_surg_chklist	0.29355	2,809	<.0001

Obs	Correlated Variable	highperformer	Sample Size	P-value
1	numKPIsbetter	0.26108	2,809	<.0001
2	numratingsbetter	0.21795	2,809	<.0001
3	incomeperbed	0.21789	2,809	<.0001
4	betteronpatientexper	0.17984	2,809	<.0001
5	numKPIsworse	-0.16607	2,809	<.0001
6	G5_ptexpdev	0.15407	2,269	<.0001
7	pctROA	0.12458	2,803	<.0001
8	G2_readmissionsdev	0.11451	2,809	<.0001
9	betteronsafecare	0.09838	2,809	<.0001
10	betteronreadmissions	0.08647	2,809	<.0001

Obs	Correlated Variable	lowperformer	Sample Size	P-value
1	numratingsbetter	-0.53615	2,809	<.0001
2	numKPIsworse	0.38921	2,809	<.0001
3	incomeperbed	-0.33451	2,809	<.0001
4	betteronreadmissions	-0.31622	2,809	<.0001
5	op_surg_chklist	-0.30475	2,809	<.0001
6	IP_use_checklist	-0.30163	2,809	<.0001
7	lab_result_track	-0.27406	2,809	<.0001
8	lab_result_elec	-0.27404	2,809	<.0001
9	betteronsafecare	-0.27270	2,809	<.0001
10	betterontimelycare	-0.26762	2,809	<.0001

Note. Significant Variables are avgMedicareLOS, acurecareoccupancyrate, pctROA, incomeperbed, numKPIsbetter, numKPIsworse, numratingsbetter, numratingsworse, highperformer and lowperformer.

Pearson correlations can also be obtained for different hospital sizes (large, medium and small); Exhibit 4.17 to Exhibit 4.19 show these correlations for G1-G6 for large, medium and small hospitals, respectively.

Exhibit 4.17

Pearson Correlation Table for G1-G6 Variables in Large Hospitals

	G1_mortcompdev	G2_readmissionsdev	G3_safetydev	G4_timelindev	G5_ptexpdev	G6_opcaredev
G1_mortcompdev	1.00000 570	0.07351 0.0795 570	0.11330 0.0070 566	0.13282 0.0015 569	0.14204 0.0007 564	0.11384 0.0066 569
G2_readmissionsdev	0.07351 0.0795 570	1.00000 570	0.05473 0.1936 566	0.14980 0.0003 569	0.25873 <.0001 564	0.20804 <.0001 569
G3_safetydev	0.11330 0.0070 566	0.05473 0.1936 566	1.00000 566	0.16318 <.0001 565	0.14398 0.0006 563	0.04922 0.2423 566
G4_timelindev	0.13282 0.0015 569	0.14980 0.0003 569	0.16318 <.0001 565	1.00000 569	0.13681 0.0011 563	0.22870 <.0001 568
G5_ptexpdev	0.14204 0.0007 564	0.25873 <.0001 564	0.14398 0.0006 563	0.13681 0.0011 563	1.00000 564	0.18489 <.0001 564
G6_opcaredev	0.11384 0.0066 569	0.20804 <.0001 569	0.04922 0.2423 566	0.22870 <.0001 568	0.18489 <.0001 564	1.00000 569

Exhibit 4.18

Pearson Correlation table for G1-G6 Variables in Medium Hospitals

	G1_mortcompdev	G2_readmissionsdev	G3_safetydev	G4_timelindev	G5_ptexpdev	G6_opcaredev
G1_mortcompdev	1.00000 1009	0.05494 0.0811 1009	0.13224 <.0001 992	0.21672 <.0001 1005	0.03817 0.2340 974	0.15994 <.0001 1004
G2_readmissionsdev	0.05494 0.0811 1009	1.00000 1009	0.04459 0.1605 992	0.23022 <.0001 1005	0.27685 <.0001 974	0.18811 <.0001 1004
G3_safetydev	0.13224 <.0001 992	0.04459 0.1605 992	1.00000 992	0.11776 0.0002 992	0.05921 0.0648 973	0.04488 0.1578 992
G4_timelindev	0.21672 <.0001 1005	0.23022 <.0001 1005	0.11776 0.0002 992	1.00000 1005	0.37618 <.0001 974	0.43892 <.0001 1003
G5_ptexpdev	0.03817 0.2340 974	0.27685 <.0001 974	0.05921 0.0648 973	0.37618 <.0001 974	1.00000 974	0.27338 <.0001 974
G6_opcaredev	0.15994 <.0001 1004	0.18811 <.0001 1004	0.04488 0.1578 992	0.43892 <.0001 1003	0.27338 <.0001 974	1.00000 1004

Exhibit 4.19

Pearson Correlation Table for G1-G6 Variables in Small Hospitals

	G1_mortcompdev	G2_readmissionsdev	G3_safetydev	G4_timelindev	G5_ptexpdev	G6_opcaredev
G1_mortcompdev	1.00000 1230	0.00247 0.9309 1230	0.01934 0.6512 549	-0.03456 0.2387 1164	0.02087 0.5732 731	-0.00695 0.8181 1098
G2_readmissionsdev	0.00247 0.9309 1230	1.00000 1230	0.00066 0.9876 549	0.07082 0.0157 1164	0.16179 <.0001 731	0.09201 0.0023 1098
G3_safetydev	0.01934 0.6512 549	0.00066 0.9876 549	1.00000 549	0.00070 0.9870 538	0.02766 0.5384 497	0.03462 0.4216 541
G4_timelindev	-0.03456 0.2387 1164	0.07082 0.0157 1164	0.00070 0.9870 538	1.00000 1164	0.22539 <.0001 712	0.19883 <.0001 1060
G5_ptexpdev	0.02087 0.5732 731	0.16179 <.0001 731	0.02766 0.5384 497	0.22539 <.0001 712	1.00000 731	0.07141 0.0586 702
G6_opcaredev	-0.00695 0.8181 1098	0.09201 0.0023 1098	0.03462 0.4216 541	0.19883 <.0001 1060	0.07141 0.0586 702	1.00000 1098

The sample size for the hospitals decreases as hospital size increases: there are up to 1230 hospitals used in the correlation for small hospitals, 1009 hospitals used in the correlation for medium hospitals and 570 hospitals used in the correlation for large hospitals for G1 variable or *G1_mortcompdev*. In each hospital-size group, there are some statistically significant correlations among these variables, but the Pearson correlations are small such that these variables do not appear to be redundant. For example, in large hospitals in exhibit 4.17, for *G_2readmissionsdev,* there is not a statistically significant relationship with *G1_mortcompdev and G3_safetydev,* but for timeliness (*G4_timelindev*), patient experience (*G5_ptexpdev*) and outpatient care delivery (*G6_opcaredev*), the correlation coefficients are 0.14980, 0.25873 and 0.20804 and are highly statistically significant. These relationships remain true for medium and small hospitals as seen in these Exhibits 4.18 and 4.19.

The next step in our study is performing regression analysis to ascertain relationships between hospital performance and the independent variables. The regression analysis in *SAS-9* uses many different regression models, but we have used PROC REG because of the capability to provide for interactive changes both in the model and the data used to fit the model. Using a backward elimination process, all variables are initially included in the model and are sequentially deleted until the regression model does not improve by removing any additional variables. Regression analysis will be performed for the G1-G6 variables, pctROA, incomeperbed, pctoperatingmargin and avgmedicareLOS variables.

When the hospital can be classified as rural or urban, for each of these variables, regression analyses will be run separately for both the average of the standard deviations and the adjusted deviations. The adjusted deviations were performed by eliminating any variables that may overly (positively) influence the performance of the hospital such as: lab_result_elec, lab_result_track, op_surg_chklist, pnt_safety_cult, IP_use_checklist, elechealthrecords as well as the size of the hospital. The SAS-9 programs written in order to perform these analyses are listed in Appendix I.

For the G1-variable (*G1_mortcompdev)*, the first step (Step 0) of the regression model for the average standard deviations with all variables included is displayed in Exhibit 4.20. This table shows the initial parameter estimates, the standard error as well as the F-values and probability values (Pr>F).

Exhibit 4.20

Regression Analysis, Step 0, for Average Standard Deviations for G1_mortcompdev *with All Variables*

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-4.84113	1.25267	2.17427	14.94	0.0001
rural	0.09467	0.04178	0.74759	5.14	0.0238
lab_result_elec	-0.26544	0.14931	0.46007	3.16	0.0760
lab_result_track	-0.04874	0.11070	0.02823	0.19	0.6599
op_surg_chklist	0.17014	0.25912	0.06276	0.43	0.5117
pnt_safety_cult	0.08198	0.05758	0.29509	2.03	0.1551
IP_use_checklist	0.20231	0.23438	0.10846	0.75	0.3884
elechealthrecords	0.17452	0.05970	1.24430	8.55	0.0036
smallhosp	0.16883	0.10796	0.35602	2.45	0.1184
mediumhosp	0.06567	0.04267	0.34481	2.37	0.1244
forprofithospital	0.00014832	0.04850	0.00000136	0.00	0.9976
govthospital	-0.14950	0.05723	0.99362	6.83	0.0092
emergencyservice	-0.05639	0.09330	0.05319	0.37	0.5458
criticalaccesshospital	0.29756	0.23671	0.23004	1.58	0.2093
FTEemployees	0.00004132	0.00002129	0.54822	3.77	0.0528
numinternsandresidents	-0.00014589	0.00016224	0.11772	0.81	0.3689
pcthospdaysmedicaid	-0.01189	0.00337	1.81425	12.46	0.0004
pcthospdaysmedicare	0.00460	0.00265	0.43919	3.02	0.0830
equippctoftotalassets	-0.00064549	0.00023269	1.12021	7.69	0.0057
pctcarecostuncompensated	0.01749	0.00917	0.52989	3.64	0.0569
acutecarebeddays	-0.00000135	0.00000144	0.12727	0.87	0.3502
acutebeddaysavailable	0.00000197	0.00000552	0.01859	0.13	0.7209
acutecarebeds	-0.00028407	0.00192	0.00319	0.02	0.8823
totalbedsallservices	0.00018305	0.00174	0.00162	0.01	0.9160
totalbeddaysallservices	7.669361E-7	6.447571E-7	0.20598	1.41	0.2348
totalbeddaysavailallserv	-0.00000216	0.00000497	0.02756	0.19	0.6637
allservicessoccupancyrate	-0.00067299	0.00032976	0.60633	4.17	0.0417
disadvtract	0.20421	0.30135	0.06685	0.46	0.4983
medianhousingval	2.35086E-7	1.601862E-7	0.31354	2.15	0.1428
lowincloweduc	0.08522	0.31433	0.01070	0.07	0.7864
PCTASTHMATIC	0.00276	0.00565	0.03468	0.24	0.6257
pctdiabetic	0.00771	0.00766	0.14738	1.01	0.3148
pctheartdisease	-0.01412	0.01190	0.20475	1.41	0.2361
life_expectancy	0.04969	0.01505	1.58589	10.89	0.0010
pctdualeligible	-0.00795	0.00200	2.31066	15.87	<.0001
avgriskscore	1.16923	0.15085	8.74532	60.07	<.0001
pctmales	-0.00773	0.00486	0.36875	2.53	0.1121
pctnonwhite	-0.00207	0.00180	0.19297	1.33	0.2501
mortalityrate	-0.09279	0.01631	4.70899	32.35	<.0001

With backward elimination, the variable with the least contribution to the model are sequentially eliminated. For *G1_mortcompdev*, after 23 backward elimination steps, the remaining variables that contribute to *G1_mortcompdev*, or the regression model, is shown in Exhibit 4.21. Statistics for *G1_mortcompdev* show a mean of -0.00027 using 593 hospitals.

Exhibit 4.21

Regression Analysis Results for Average Standard Deviations for G1_mortcompdev

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-4.57232	0.78886	33.59	<.0001
rural	0.07757	0.03991	3.78	0.0524
lab_result_elec	-0.26953	0.10740	6.30	0.0124
elechealthrecords	0.16353	0.05849	7.82	0.0054
govthospital	-0.15248	0.05486	7.73	0.0056
FTEemployees	0.00003350	0.00001474	5.16	0.0234
pcthospdaysmedicaid	-0.01371	0.00308	19.76	<.0001
pcthospdaysmedicare	0.00488	0.00236	4.27	0.0391
equippctoftotalassets	-0.00059780	0.00022270	7.21	0.0075
pctcarecostuncompensated	0.01613	0.00865	3.48	0.0626
totalbeddaysavailallserv	-0.00000103	3.345218E-7	9.46	0.0022
allservicessoccupancyrate	-0.00051333	0.00021812	5.54	0.0189
disadvtract	0.31406	0.12291	6.53	0.0109
life_expectancy	0.05451	0.00961	32.19	<.0001
pctdualeligible	-0.00835	0.00173	23.40	<.0001
avgriskscore	1.10754	0.12586	77.43	<.0001
pctmales	-0.00886	0.00458	3.75	0.0534
mortalityrate	-0.09484	0.01466	41.85	<.0001

Note. Mean = -0.00027 using 593 hospitals; R^2 = 0.28; RMSE = 0.3805.

The variables having the greatest marginal influence on *G1_mortcompdev* are *pcthospdaysmedicaid*, *life_expectancy*, *pctdualeligible*, *avgriskscore* and *mortalityrate*. The variables having positive influence are *life_expectancy* and *avgriskscore*. This seems intuitive since patients who live longer lives may have multiple comorbidities and higher risk scores leading to higher mortality and complication rates. The variables having the greatest negative influence are *pcthospdaysmedicaid*, *pctdualeligible* and *mortalityrate*. While these variables' effects on *G1_mortcompdev* seem less intuitive, these characteristics must be considered when assessing performance.

The variables over which the hospital has control or those which may influence the performance of the hospital, either positively or negatively, need to be considered. These are variables such as electronic lab results (*lab_result_elec*), tracking lab results electronically (*lab_result_track*), surgery checklists (*op_surg_chklist*), inpatient checklists (*IP_use_checklist*), patient safety culture (*pnt_safety_cult*), EHR (*elechealthrecords*) as well as the size of the hospital and mortality rate are removed from the model. The first step (Step 0) of the regression model for the adjusted standard deviations for *G1_mortcompdev* with all significant variables are shown in Exhibit 4.22.

Exhibit 4.22

Regression Analysis Variables, Step 0, for Adjusted Deviations for G1_mortcompdev

Variable	Parameter Estimate	Standard Error	Type II SS	F Value	Pr > F
Intercept	-6.83992	1.90639	2.44899	12.87	0.0004
rural	0.14184	0.06552	0.89170	4.69	0.0311
forprofithospital	-0.06700	0.08306	0.12377	0.65	0.4205
govthospital	-0.11210	0.07854	0.38754	2.04	0.1545
emergencyservice	0.07892	0.23261	0.02190	0.12	0.7346
FTEemployees	0.00003991	0.00002767	0.39577	2.08	0.1502
numinternsandresidents	0.00011299	0.00024980	0.03892	0.20	0.6514
pcthospdaysmedicaid	-0.01492	0.00468	1.93639	10.18	0.0016
pcthospdaysmedicare	0.00678	0.00476	0.38492	2.02	0.1559
pctcarecostuncompensated	-0.03214	0.02266	0.38251	2.01	0.1572
acutecarebeddays	-0.00000208	0.00000188	0.23385	1.23	0.2684
acutebeddaysavailable	-0.00000795	0.00000946	0.13448	0.71	0.4011
acutecarebeds	0.00325	0.00343	0.17067	0.90	0.3443
totalbedsallservices	-0.00344	0.00331	0.20568	1.08	0.2992
totalbeddaysallservices	0.00000109	0.00000193	0.06000	0.32	0.5748
totalbeddaysavailallserv	0.00000819	0.00000903	0.15623	0.82	0.3655
allservicesoccupancyrate	-0.00189	0.00317	0.06759	0.36	0.5516
disadvtract	0.24803	0.50492	0.04591	0.24	0.6236
medianhousingval	1.862185E-7	2.454574E-7	0.10950	0.58	0.4486
lowincloweduc	0.43053	0.52723	0.12686	0.67	0.4148
PCTASTHMATIC	0.00828	0.00937	0.14860	0.78	0.3775
pctdiabetic	0.00570	0.01254	0.03928	0.21	0.6499
pctheartdisease	-0.02238	0.02008	0.23615	1.24	0.2661
life_expectancy	0.08269	0.02276	2.51153	13.20	0.0003
pctdualeligible	-0.01432	0.00320	3.80200	19.99	<.0001
avgriskscore	0.60451	0.17853	2.18116	11.47	0.0008
pctmales	-0.01018	0.00873	0.25862	1.36	0.2445
pctnonwhite	0.00206	0.00286	0.09870	0.52	0.4719

After 19 elimination steps, the regression model for the adjusted deviations for *G1_mortcompdev* is shown in Exhibit 4.23 and has a mean value of -0.00457 using 623 hospitals.

Exhibit 4.23

Regression Analysis Results for Adjusted Standard Deviations for G1_mortcompdev

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-4.01224	1.10743	13.13	0.0003
rural	0.07700	0.04211	3.34	0.0679
govthospital	-0.12932	0.05486	5.56	0.0187
FTEemployees	0.00005009	0.00001770	8.01	0.0048
pcthospdaysmedicaid	-0.01577	0.00318	24.61	<.0001
acutecarebeddays	-0.00000174	5.659961E-7	9.43	0.0022
allservicessoccupancyrate	-0.00040141	0.00022522	3.18	0.0752
disadvtract	0.43377	0.12960	11.20	0.0009
medianhousingval	2.609685E-7	1.530762E-7	2.91	0.0887
PCTASTHMATIC	0.00954	0.00479	3.97	0.0468
pctheartdisease	-0.01440	0.00681	4.47	0.0348
life_expectancy	0.04361	0.01381	9.97	0.0017
pctdualeligible	-0.00744	0.00169	19.46	<.0001
avgriskscore	0.51370	0.10037	26.19	<.0001

Note. Mean = -0.00457 using 623 hospitals; R^2 = 0.20; RMSE = 0.4043.

The variables having the greatest marginal influence on the adjusted standard deviations for *G1_mortcompdev* are *pcthospdaysmedicaid, pctdualeligible* and *avgriskscore*. The only variable having positive influence is *avgriskscore*.

The regression model for the adjusted standard deviations for *G1_mortcompdev* in *large hospitals* is shown in Exhibit 4.24. Again, the variables that may overly influence the performance of the hospital such *as lab_result_elec, lab_result_track, op_surg_chklist, pnt_safety_cult, IP_use_checklist, elechealthrecords* as well as the size of the hospital and mortality rate, are removed from the model so the variables are the same as those shown previously in Exhibit 4.22.

Exhibit 4.24

Regression Analysis Results for Adjusted Standard Deviations for G1_ mortcompdev in Large Hospitals

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-9.10084	1.53013	35.38	<.0001
rural	0.17031	0.06205	7.53	0.0064
FTEemployees	0.00003593	0.00001990	3.26	0.0718
pcthospdaysmedicaid	-0.01836	0.00416	19.49	<.0001
acutecarebeddays	-0.00000113	6.728252E-7	2.84	0.0930
lowincloweduc	0.84714	0.21600	15.38	0.0001
PCTASTHMATIC	0.02202	0.00736	8.94	0.0030
pctheartdisease	-0.02739	0.01084	6.38	0.0120
life_expectancy	0.10471	0.01863	31.58	<.0001
pctdualeligible	-0.01426	0.00249	32.76	<.0001
avgriskscore	0.65741	0.14515	20.51	<.0001

Note. Mean = -0.02504 using 344 hospitals; R^2 = 0.27; RMSE = 0.4339.

Similar to the regression analysis for all hospitals, for large hospitals with adjusted standard deviations, the variables having the greatest marginal influence on *G1_mortcompdev* are *pcthospdaysmedicaid, life_expectancy, pctdualeligible, avgriskscore* and *mortalityrate*. The variables having positive influence are *life_expectancy* and *avgriskscore*. The variables having the greatest negative influence are p*cthospdaysmedicaid*, *pctdualeligible* and *mortalityrate*. These variables' effects on *G1_mortcompdev* must be considered when assessing performance.

This process is repeated for all the G2-G6 variables, *pctROA*, *incomeperbed*, *pctOperatingMargin* and *avgmedicareLOS* variables. The full regression results can be accessed in the files whose links are shown in Appendix I. The regression model summaries for average standard deviations, adjusted standard deviations and for adjusted standard deviations in large hospitals are shown in the following tables, with *G2_readmissionsdev* shown in Exhibit 4.25 below.

Exhibit 4.25

Regression Models and Residuals for G2_readmissionsdev Based on Fits for All Hospitals and for Large Hospitals

Regression Model for Average of Standard Deviations for Unplanned Readmissions
Model for G2_readmissionsdev Fit with mean of -0.09297 for 593 of the 2,809 cases used
with Rsquare = 0.23 and RMSE= 0.3719
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-0.17409	0.28319	0.38	0.5390
rural	0.09027	0.03941	5.25	0.0223
lab_result_elec	-0.29908	0.13796	4.70	0.0306
lab_result_track	0.17581	0.10672	2.74	0.0981
IP_use_checklist	0.44173	0.16083	7.54	0.0062
elechealthrecords	0.13695	0.05717	5.74	0.0169
forprofithospital	-0.09616	0.04548	4.47	0.0349
govthospital	-0.10971	0.05330	4.24	0.0400
pcthospdaysmedicare	-0.00778	0.00230	11.46	0.0008
acutecarebeds	0.00043998	0.00015568	7.99	0.0049
totalbeddaysallservices	-0.00000176	4.638831E-7	14.40	0.0002
allservicesoccupancyrate	0.00111	0.00026744	17.25	<.0001
disadvtract	-1.07240	0.25769	17.32	<.0001
lowincloweduc	1.20457	0.25521	22.28	<.0001
PCTASTHMATIC	0.00793	0.00461	2.96	0.0861
pctheartdisease	-0.01751	0.00650	7.26	0.0073
pctdualeligible	-0.00472	0.00160	8.65	0.0034
avgriskscore	-0.32839	0.09397	12.21	0.0005
pctmales	0.00948	0.00451	4.41	0.0361

Regression Model for Adjusted Deviations for Unplanned Readmissions
Model for G2_readmissionsdev Fit with mean of -0.09038 for 623 of the 2,809 cases used
with Rsquare = 0.20 and RMSE= 0.3745
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	0.30651	0.20948	2.14	0.1439
rural	0.09353	0.03901	5.75	0.0168
forprofithospital	-0.08341	0.04489	3.45	0.0636
govthospital	-0.08273	0.05018	2.72	0.0997
pcthospdaysmedicare	-0.00740	0.00225	10.79	0.0011
acutecarebeds	0.00035883	0.00015315	5.49	0.0195
totalbeddaysallservices	-0.00000150	4.518744E-7	11.08	0.0009
allservicesoccupancyrate	0.00078833	0.00023018	11.73	0.0007
disadvtract	-1.10926	0.25155	19.45	<.0001
lowincloweduc	1.24412	0.25030	24.71	<.0001
PCTASTHMATIC	0.00869	0.00448	3.76	0.0528
pctheartdisease	-0.01948	0.00637	9.35	0.0023
pctdualeligible	-0.00496	0.00158	9.81	0.0018
avgriskscore	-0.29978	0.09196	10.62	0.0012
pctmales	0.00830	0.00446	3.47	0.0630

Regression Model for Adjusted Deviations for Unplanned Readmissions in Large Hospitals
Model for G2_readmissionsdev Fit with mean of -0.10962 for 344 of the 570 cases used
with Rsquare = 0.20 and RMSE= 0.3649
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-0.14898	0.30748	0.23	0.6283
forprofithospital	-0.13728	0.06356	4.66	0.0315
govthospital	-0.15242	0.05979	6.50	0.0112
pcthospdaysmedicare	-0.00848	0.00346	6.00	0.0148
totalbeddaysallservices	-6.32027E-7	2.11977E-7	6.30	0.0126
disadvtract	-1.99050	0.37681	27.91	<.0001
medianhousingval	3.065075E-7	1.59769E-7	3.73	0.0543
lowincloweduc	2.11158	0.40468	27.23	<.0001
pctdualeligible	-0.00473	0.00217	4.74	0.0301
avgriskscore	-0.25306	0.12366	4.19	0.0415
pctmales	0.01728	0.00649	7.10	0.0081

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	-0.09297	593	0.23	0.3719
Adjusted SD Regression	-0.09038	623	0.2	0.3745
Adjusted SD in Large Hosp Regr	-0.10962	344	0.2	0.3647

The variables with the greatest marginal influence are *lowincloweduc* and *disadvtract*. We see that *lowincloweduc* has a positive influence whereas *disadvtract* has a negative influence on *G2_readmissionsdev*. One can surmise that *lowincloweduc* patients may not have adequate resources at home or may not follow discharge instructions, either of which would lead to higher readmission rates. One possible reason why *disadvtract* patients may have a negative influence on readmissions is that they may not seek care as frequently so their readmission rates may be lower. The regression model for adjusted standard deviations in large hospitals appears to be the most parsimonious model with the fewest variables for *G2_readmissionsdev* regression model.

The regression model summaries for *G3_safetydev* are shown in Exhibit 4.26 for the average standard deviations, the adjusted standard deviation and the adjusted standard deviation for large hospitals.

Exhibit 4.26

Regression Models and Residuals for G3_safetydev Based on Fits for All Hospitals and for Large Hospitals

Regression Model for Average of Standard Deviations for Safety of Care
Model for G3_safetydev Fit with mean of 0.25605 for 590 of the 2,809 cases used
with Rsquare = 0.06 and RMSE= 0.5358
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-0.07679	0.33985	0.05	0.8213
op_surg_chklist	0.85022	0.28115	9.14	0.0026
criticalaccesshospital	1.19415	0.28003	18.18	<.0001
equippctoftotalassets	-0.00068490	0.00031175	4.83	0.0284
disadvtract	0.82560	0.35845	5.31	0.0216
lowincloweduc	-0.83766	0.36314	5.32	0.0214
PCTASTHMATIC	-0.01737	0.00693	6.29	0.0124
pctdiabetic	0.01200	0.00597	4.04	0.0449
avgriskscore	-0.22652	0.11008	4.23	0.0401

Regression Model for Adjusted Deviations for Safety of Care
Model for G3_safetydev Fit with mean of 0.24382 for 620 of the 2,809 cases used
with Rsquare = 0.04 and RMSE= 0.5376
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	0.79968	0.18761	18.17	<.0001
criticalaccesshospital	0.91277	0.27258	11.21	0.0009
pcthospdaysmedicaid	-0.00834	0.00389	4.59	0.0325
pcthospdaysmedicare	-0.00509	0.00301	2.86	0.0913
disadvtract	0.25340	0.13244	3.66	0.0562
PCTASTHMATIC	-0.00663	0.00324	4.19	0.0410
avgriskscore	-0.21761	0.10326	4.44	0.0355

Regression Model for Adjusted Deviations for Safety of Care in Large Hospitals
Model for G3_safetydev Fit with mean of 0.22341 for 344 of the 570 cases used
with Rsquare = 0.08 and RMSE= 0.3992
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-2.55346	0.99646	6.57	0.0108
numinternsandresidents	-0.00029377	0.00011284	6.78	0.0096
pcthospdaysmedicaid	-0.00888	0.00370	5.75	0.0171
disadvtract	0.60017	0.18024	11.09	0.0010
life_expectancy	0.03548	0.01249	8.07	0.0048
pctnonwhite	-0.00332	0.00146	5.19	0.0233

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	0.2506	590	0.06	0.5358
Adjusted SD Regression	0.24382	620	0.04	0.5376
Adjusted SD in Large Hosp Regr	0.22341	344	0.08	0.3392

Here, we see that *disadvtract* is statistically significant in all three models. Critical access hospitals (*criticalaccesshospital*) has the greatest marginal influence in the average and the adjusted standard deviations, but not for the adjusted standard deviation for large hospitals. This is probably due to the fact that most large hospitals are urban and are not critical access hospitals.

The regression model for adjusted standard deviations in large hospitals appears to be the most parsimonious model with the fewest variables for *G3_safetydev* regression model. *Disadvtract* appears to be the common statistically significant variable in all three models.

The regression model summaries for *G4_timlindev* are shown in Exhibit 4.27 for the average standard deviations, the adjusted standard deviation and the adjusted standard deviation for large hospitals. The total number of hospitals for the average of standard deviations and the adjusted standard deviations for large hospital regressions are decreased at 320 and 344, respectively, compared to 623 for the adjusted standard deviations for all hospitals.

Exhibit 4.27

Regression Models and Residuals for G4_timlindev Based on Fits for All Hospitals and for Large Hospitals

Regression model for Average of Timeliness
Model for G4_timelindev Fit with mean of -0.46688 for 320 of the 570 cases u
with Rsquare = 0.37 and RMSE= 0.5093
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-1.28094	1.39082	0.85	0.3578
op_surg_chklist	0.99753	0.52242	3.65	0.0571
IP_use_checklist	-1.04111	0.53336	3.81	0.0518
forprofithospital	0.46674	0.08745	28.49	<.0001
numinternsandresidents	-0.00099741	0.00021005	22.55	<.0001
pcthospdaysmedicare	-0.01032	0.00528	3.82	0.0516
equippctoftotalassets	-0.00077373	0.00042796	3.27	0.0716
acutecarebeddays	-0.00000397	0.00000149	7.16	0.0079
acutecarebeds	0.00123	0.00039781	9.58	0.0021
life_expectancy	0.03174	0.01475	4.63	0.0321
pctmales	-0.02763	0.00939	8.66	0.0035
pctnonwhite	-0.00992	0.00173	32.84	<.0001

Regression Model for Adjusted Deviations for Timeliness
Model for G4_timelindev Fit with mean of -0.30946 for 623 of the 2,809 cases used
with Rsquare = 0.36 and RMSE= 0.5228
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-1.19216	1.08145	1.22	0.2707
smallhosp	0.34864	0.12258	8.09	0.0046
mediumhosp	0.17818	0.05515	10.44	0.0013
forprofithospital	0.28516	0.05978	22.75	<.0001
emergencyservice	-0.25087	0.12420	4.08	0.0438
numinternsandresidents	-0.00057919	0.00017346	11.15	0.0009
pcthospdaysmedicare	-0.00731	0.00324	5.08	0.0245
acutecarebeddays	-0.00000644	0.00000135	22.78	<.0001
acutecarebeds	0.00172	0.00036888	21.82	<.0001
PCTASTHMATIC	-0.01743	0.00635	7.54	0.0062
pctheartdisease	0.02513	0.00887	8.03	0.0047
life_expectancy	0.02454	0.01289	3.62	0.0575
pctmales	-0.01269	0.00613	4.29	0.0388
pctnonwhite	-0.00979	0.00122	63.88	<.0001

Regression Model for Adjusted Deviations for Timeliness in Large Hospitals
l for G4_timelindev Fit with mean of -0.49360 for 344 of the 570 cases used
with Rsquare = 0.37 and RMSE= 0.5174
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-1.94316	1.11223	3.05	0.0815
forprofithospital	0.45016	0.08606	27.36	<.0001
numinternsandresidents	-0.00103	0.00020331	25.62	<.0001
pcthospdaysmedicare	-0.01205	0.00505	5.68	0.0177
acutecarebeddays	-0.00000401	0.00000147	7.46	0.0066
acutecarebeds	0.00125	0.00039335	10.14	0.0016
life_expectancy	0.03709	0.01411	6.91	0.0090
pctmales	-0.02356	0.00939	6.29	0.0126
pctnonwhite	-0.01070	0.00165	42.15	<.0001

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	-0.46688	320	0.37	0.5093
Adjusted SD Regression	0.30946	623	0.36	0.5228
Adjusted SD in Large Hosp Regr	0.4936	344	0.37	0.5174

For G1-G3 variables, the number of hospitals used in the analysis was similar in the all-hospitals calculations (both average and adjusted standard deviations) as is expected. This implies that not many hospitals report on the patient experience when measures such as *lab_result_elec*, *lab_result_track*, *op_surg_chklist*, *pnt_safety_cult*, *IP_use_checklist* and *elechealthrecords* are being included in the analysis. Profit status (*forprofithospital*) is common to all three models with the greatest positive marginal influence. Being male and non-white appears in all three models as statistically significant and appear to be negatively correlated with *G4_timlinde*v. The regression model for adjusted standard deviations in large hospitals appears to be the most parsimonious model with the fewest variables for *G4_timlindev* regression model. Also, when considering the positive mean values for the adjusted models, the adjusted standard deviation for large hospital remains the best model.

The regression model summaries for *G5_ptexpdev* are shown in Exhibit4.28 for the average standard deviation, the adjusted standard deviation and the adjusted standard deviation for large hospitals. The total number of hospitals for the average of standard deviations and the adjusted standard deviations for large hospital regressions are decreased at 320 and 344, respectively, compared to 623 for the adjusted standard deviations for all hospitals.

Exhibit 4.28

Regression Models and Residuals for G5_ptextdev Based on Fits for All Hospitals and for Large Hospitals

Regression model for Average of Standard Deviations for Patient Experience
Model for G5_ptexpdev Fit with mean of -0.24419 for 588 of the 2,809 cases u
with Rsquare = 0.37 and RMSE= 0.5671
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	1.00515	0.20253	24.63	<.0001
elechealthrecords	0.24296	0.08791	7.64	0.0059
smallhosp	0.33967	0.14451	5.53	0.0191
forprofithospital	-0.21576	0.06850	9.92	0.0017
emergencyservice	-0.23907	0.13884	2.97	0.0856
criticalaccesshospital	0.78349	0.29053	7.27	0.0072
FTEemployees	0.00010238	0.00002723	14.14	0.0002
numinternsandresidents	-0.00070685	0.00022254	10.09	0.0016
equippctoftotalassets	-0.00082848	0.00033087	6.27	0.0126
acutecarebeds	0.00174	0.00059908	8.40	0.0039
totalbedsallservices	-0.00199	0.00055178	13.04	0.0003
lowinceloweduc	0.44912	0.17133	6.87	0.0090
pctdiabetic	0.03785	0.00919	16.94	<.0001
pctheartdisease	-0.08140	0.01561	27.19	<.0001
pctdualeligible	-0.01126	0.00280	16.14	<.0001
pctnonwhite	-0.00885	0.00238	13.81	0.0002
mortalityrate	-0.09900	0.01778	31.01	<.0001

Regression Model for Adjusted Deviations for Patient Experience
Model for G5_ptexpdev Fit with mean of -0.23843 for 618 of the 2,809 cases used
with Rsquare = 0.33 and RMSE= 0.5890
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	1.39260	0.26041	28.60	<.0001
smallhosp	0.30876	0.15024	4.22	0.0403
forprofithospital	-0.23510	0.06925	11.53	0.0007
emergencyservice	-0.26599	0.14353	3.43	0.0643
criticalaccesshospital	0.73358	0.30125	5.93	0.0152
FTEemployees	0.00011287	0.00002754	16.79	<.0001
numinternsandresidents	-0.00046228	0.00022519	4.21	0.0405
acutebeddaysavailable	0.00000351	0.00000131	7.18	0.0076
totalbedsallservices	-0.00165	0.00045218	13.37	0.0003
lowinceloweduc	0.54545	0.17601	9.60	0.0020
pctdiabetic	0.03367	0.00931	13.08	0.0003
pctheartdisease	-0.07916	0.01585	24.93	<.0001
pctdualeligible	-0.01130	0.00289	15.31	0.0001
avgriskscore	-0.55520	0.15809	12.33	0.0005
pctnonwhite	-0.00780	0.00246	10.03	0.0016

Regression Model for Adjusted Deviations for Patient Experience in Large Hospitals
Model for G5_ptexpdev Fit with mean of -0.23173 for 344 of the 570 cases used
with Rsquare = 0.37 and RMSE= 0.5599
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	1.74004	0.41763	17.36	<.0001
forprofithospital	-0.33037	0.10025	10.86	0.0011
emergencyservice	-0.49005	0.28912	2.87	0.0910
FTEemployees	0.00011062	0.00003159	12.27	0.0005
numinternsandresidents	-0.00068306	0.00028697	5.67	0.0179
pctcarecostuncompensated	-0.06484	0.02560	6.42	0.0118
acutecarebeds	0.00158	0.00074473	4.51	0.0344
totalbedsallservices	-0.00185	0.00068720	7.23	0.0075
lowinceloweduc	0.84921	0.27886	9.27	0.0025
pctdiabetic	0.03964	0.01340	8.75	0.0033
pctheartdisease	-0.10435	0.02329	20.08	<.0001
pctdualeligible	-0.00949	0.00391	5.88	0.0158
avgriskscore	-0.52984	0.21578	6.03	0.0146
pctnonwhite	-0.00813	0.00345	5.55	0.0191

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	-0.24419	588	0.37	0.5671
Adjusted SD Regression	-0.23843	618	0.33	0.589
Adjusted SD in Large Hosp Regr	-0.23173	344	0.37	0.5599

For all the models analyzed, *forprofithospital* and *emergencyservice* were the two variables with statistically significant relationships to *G5_ptexpdev* and both were negatively correlated with patient experience. Interestingly, *lowinclowedu* was also common to all three models and is positively correlated with *G5_ptexpdev*. This indicates that low income and low education patients tend to have a positive patient experience during their hospital visits. The variable common to all three models with the greatest marginal influence was *pctheartdisease* where we see that it has a negative influence. This can be explained by the fact that patients with heart disease are complex patients often requiring multiple invasive procedures – all of which can lead to decreased satisfaction. From these regression models, the adjusted standard deviation for large hospitals appears to be the most parsimonious model.

The regression model summaries for *G6_opcaredev* are shown in Exhibit 4.29 for the average standard deviation, the adjusted standard deviation and the adjusted standard deviation for large hospitals. The total number of hospitals for the average of standard deviations and the adjusted standard deviations for large hospital regressions are decreased at 320 and 344, respectively, compared to 623 for the adjusted standard deviations for all hospitals.

Exhibit 4.29

Regression Models and Residuals for G6_opcaredev Based on Fits for All Hospitals and for Large Hospitals

Regression model for Average of Standard Deviations for Outpatient Care
Model for G6_opcaredev Fit with mean of 0.00057 for 592 of the 2,809 cases used
with Rsquare = 0.08 and RMSE= 0.4292
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	0.04583	0.23269	0.04	0.8439
op_surg_chklist	0.52158	0.19431	7.21	0.0075
pnt_safety_cult	0.12621	0.06087	4.30	0.0386
forprofithospital	0.09578	0.05012	3.65	0.0565
FTEemployees	0.00004554	0.00001551	8.63	0.0034
pcthospdaysmedicare	-0.00428	0.00248	2.98	0.0850
acutebeddaysavailable	-0.00000102	3.821022E-7	7.06	0.0081
avgriskscore	-0.40233	0.08385	23.03	<.0001

Regression Model for Adjusted Deviations for Outpatient Care
Model for G6_opcaredev Fit with mean of -0.00031 for 622 of the 2,809 cases used
with Rsquare = 0.06 and RMSE= 0.4340
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	0.53026	0.12001	19.52	<.0001
rural	-0.10034	0.04322	5.39	0.0206
forprofithospital	0.10182	0.04965	4.21	0.0407
FTEemployees	0.00005371	0.00001784	9.07	0.0027
acutecarebeddays	-0.00000153	5.630862E-7	7.34	0.0069
avgriskscore	-0.35958	0.08308	18.73	<.0001

Regression Model for Adjusted Deviations for Outpatient Care in Large Hospitals
Model for G6_opcaredev Fit with mean of -0.03188 for 344 of the 570 cases used
with Rsquare = 0.09 and RMSE= 0.3874
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	1.19245	0.32976	13.08	0.0003
forprofithospital	0.13657	0.06741	4.10	0.0436
FTEemployees	0.00004828	0.00001542	9.80	0.0019
acutecarebeds	-0.00034907	0.00014771	5.58	0.0187
pctdiabetic	-0.01565	0.00814	3.70	0.0554
pctheartdisease	0.02496	0.01499	2.77	0.0969
pctdualeligible	-0.00469	0.00263	3.18	0.0753
avgriskscore	-0.39698	0.14705	7.29	0.0073
pctmales	-0.01430	0.00723	3.91	0.0487
pctnonwhite	0.00527	0.00240	4.84	0.0286

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	0.00057	592	0.08	0.4292
Adjusted SD Regression	-0.00031	622	0.06	0.434
Adjusted SD in Large Hosp Regr	-0.03188	344	0.09	0.3874

The *avgriskscore* is the variable common to all three models with the greatest marginal influence. This variable has a negative influence on *G6_opcaredev*. This intimates that sicker patients, who may utilize outpatient services more frequently, may be more likely to have more negative deviations in outpatient care as reflected in *G6_opcaredev*. Here, the adjusted standard deviation for all hospitals appears to be the most parsimonious model and the adjusted standard deviation large hospitals appears to be the least parsimonious model for *G6_opcaredev*.

The regression model summaries for *pctROA* are shown in Exhibit 4.30 for the average standard deviation, the adjusted standard deviation and the adjusted standard deviation for large hospitals. Similar to the variables mentioned before, the number of hospitals used in the analyses are comparable at around 600 for the all-hospitals regressions and half that number for the large-hospitals regression at 344 hospitals.

Exhibit 4.30

Regression Models and Residuals for pctROA Based on Fits for All Hospitals and for Large Hospitals

Regression model for Average of Standard Deviations for pctROA
Model for pctROA Fit with mean of 6.61922 for 593 of the 2,809 cases used
with Rsquare = 0.13 and RMSE= 10.6617
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	0.03996	3.16885	0.00	0.9899
smallhosp	-7.94108	2.28770	12.05	0.0006
forprofithospital	7.97107	1.21086	43.34	<.0001
equippctoftotalassets	0.02456	0.00619	15.74	<.0001
pctcarecostuncompensated	0.41550	0.23369	3.16	0.0759
pctdualeligible	-0.14426	0.04111	12.31	0.0005
avgriskscore	4.10527	2.48304	2.73	0.0988

Regression Model for Adjusted Deviations for pctROA
Model for pctROA Fit with mean of 6.58688 for 623 of the 2,809 cases used
with Rsquare = 0.11 and RMSE= 10.7371
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	6.18842	1.16233	28.35	<.0001
smallhosp	-7.38411	2.29674	10.34	0.0014
forprofithospital	8.88743	1.18937	55.84	<.0001
pctcarecostuncompensated	0.44068	0.22689	3.77	0.0526
acutebeddaysavailable	0.00000948	0.00000461	4.23	0.0402
pctdualeligible	-0.09965	0.03326	8.98	0.0028

Regression Model for Adjusted Deviations for pctROA in Large Hospitals
Model for pctROA Fit with mean of 7.28435 for 344 of the 570 cases used
with Rsquare = 0.17 and RMSE= 7.1587
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	44.56219	22.12344	4.06	0.0448
forprofithospital	8.87935	1.15529	59.07	<.0001
acutecarebeds	0.02164	0.00912	5.63	0.0182
totalbedsallservices	-0.01823	0.00837	4.75	0.0301
pctdiabetic	-0.33480	0.11862	7.97	0.0051
pctheartdisease	0.50628	0.20024	6.39	0.0119
life_expectancy	-0.48069	0.26741	3.23	0.0731

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	6.61922	595	0.13	10.6617
Adjusted SD Regression	6.58688	623	0.11	10.7371
Adjusted SD in Large Hosp Regr	7.28435	344	0.17	7.1587

In all models, *forprofithospital* has the greatest marginal influence on *pctROA* which is also positive. We notice that *smallhosp* has the greatest, negative contribution to *pctROA* in the average standard deviations and the adjusted standard deviation for all hospitals. Here, the adjusted standard deviation for all hospitals appears to be the most parsimonious model with the fewest variables for *pctROA*.

The regression model summaries for *incomeperbed* are shown in Exhibit 4.31 for the average standard deviation, the adjusted standard deviation and the adjusted standard deviation for large hospitals. Similar to the variables mentioned before, the number of hospitals used in the analyses are comparable at around 600 for the all-hospitals regressions and half that number for the large-hospitals regression at 344 hospitals.

Exhibit 4.31

Regression Models and Residuals for incomeperbed Based on Fits for All Hospitals and for Large Hospitals

Regression model for Average of Standard Deviations for Income per Bed
Model for incomeperbed Fit with mean of 16,125.12537 for 593 of the 2,809 cases used
with Rsquare = 0.21 and RMSE=80021.9893
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	84255	21026	16.06	<.0001
rural	-14503	8185.75359	3.14	0.0770
elechealthrecords	22809	12259	3.46	0.0633
mediumhosp	-14879	8072.27225	3.40	0.0658
forprofithospital	49940	9378.61213	28.35	<.0001
govthospital	-51732	11412	20.55	<.0001
equippctoftotalassets	-102.37469	46.68067	4.81	0.0287
acutebeddaysavailable	1.49280	0.36903	16.36	<.0001
acutecarebeds	-200.78763	109.80323	3.34	0.0680
totalbeddaysallservices	0.27768	0.10934	6.45	0.0114
totalbeddaysavailallserv	-1.06857	0.24152	19.57	<.0001
allservicesoccupancyrate	-202.23513	50.64571	15.95	<.0001
disadvtract	-103281	53336	3.75	0.0533
lowincloweduc	129605	51973	6.22	0.0129
PCTASTHMATIC	-1065.96322	512.08580	4.33	0.0378
pctdualeligible	-1351.87093	282.38158	22.92	<.0001

Regression Model for Adjusted Deviations for Income per Bed
Model for incomeperbed Fit with mean of 15,315.92160 for 623 of the 2,809 cases used
with Rsquare = 0.21 and RMSE=80454.1101
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	94918	17050	30.99	<.0001
rural	-14420	8098.47055	3.17	0.0755
mediumhosp	-16031	7977.26566	4.04	0.0449
forprofithospital	49030	9262.88800	28.02	<.0001
govthospital	-59416	10747	30.57	<.0001
acutebeddaysavailable	1.38399	0.36623	14.28	0.0002
acutecarebeds	-180.78606	109.16396	2.74	0.0982
totalbeddaysallservices	0.29064	0.10766	7.29	0.0071
totalbeddaysavailallserv	-1.01981	0.23677	18.55	<.0001
allservicesoccupancyrate	-199.49313	50.80277	15.42	<.0001
disadvtract	-128916	51976	6.15	0.0134
lowincloweduc	152805	50923	9.00	0.0028
PCTASTHMATIC	-1152.14245	499.66369	5.32	0.0215
pctdualeligible	-1341.89341	280.71268	22.85	<.0001

Regression Model for Adjusted Deviations for Income per Bed in Large Hospitals
Model for incomeperbed Fit with mean of 23,656.37541 for 344 of the 570 cases used
with Rsquare = 0.24 and RMSE=77487.1071
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	152142	40338	14.23	0.0002
forprofithospital	61600	13294	21.47	<.0001
govthospital	-30036	13153	5.21	0.0230
numinternsandresidents	-103.57738	30.36025	11.64	0.0007
pcthospdaysmedicaid	-1645.39901	748.83400	4.83	0.0287
pctcarecostuncompensated	-6269.61601	3443.84837	3.31	0.0696
acutebeddaysavailable	1.09111	0.27720	15.49	0.0001
totalbeddaysallservices	1.01505	0.30053	11.41	0.0008
totalbeddaysavailallserv	-1.62542	0.36608	19.71	<.0001
allservicesoccupancyrate	-1453.46242	518.65530	7.85	0.0054
disadvtract	-156783	72854	4.63	0.0321
lowincloweduc	165442	73620	5.05	0.0253
pctdualeligible	-813.15955	391.04552	4.32	0.0383

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	16,125.13	593	0.21	80021.99
Adjusted SD Regression	15,315.92	623	0.21	80454.11
Adjusted SD in Large Hosp Regr	23,656.38	344	0.24	77487.11

We see *forprofithospital* and *totalbedsdaysavailallserv* have the largest marginal influence for all models. Here, *forprofithospital* has a positive influence whereas *totalbedsdaysavailallserv* has a negative influence. We see that *govthospital, allservicesoccupancyrate* and *lowinclowedu* also have highly statistically significant, negative relationships to *incomeperbed* in all three models. The model for adjusted standard deviation for large hospitals appears to be the most parsimonious model for *incomeperbed*.

The regression model summaries for *pctOperatingMargin* are shown in Exhibit 4.32 for the average standard deviation, the adjusted standard deviation and the adjusted standard deviation for large hospitals. Similar to the variables mentioned before, the number of hospitals used in the analyses are comparable at around 600 for the all-hospitals regressions and half that number for the large-hospitals regression model at 344 hospitals.

Exhibit 4.32

Regression Models and Residuals for pctOperatingMargin Based on Fits for All Hospitals and for Large Hospitals

Regression model for Average of Standard Deviations for %PCT Operating Margin
Model for pctoperatingmargin Fit with mean of 1.57072 for 593 of the 2,809 cases used
with Rsquare = 0.16 and RMSE= 1.5863
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	3.70283	0.61781	35.92	<.0001
smallhosp	-1.42394	0.37454	14.45	0.0002
mediumhosp	-0.29837	0.16997	3.08	0.0797
govthospital	-0.44190	0.22452	3.87	0.0495
pcthospdaysmedicare	0.03473	0.00940	13.66	0.0002
pctcarecostuncompensated	0.10858	0.03554	9.33	0.0024
acutebeddaysavailable	0.00001253	0.00000468	7.16	0.0077
totalbeddaysavailallserv	-0.00000995	0.00000427	5.42	0.0202
pctdiabetic	-0.01784	0.00738	5.84	0.0160
pctdualeligible	-0.01353	0.00739	3.35	0.0675
avgriskscore	-1.59953	0.41037	15.19	0.0001
pctnonwhite	0.00956	0.00561	2.90	0.0892

Regression Model for Adjusted Deviations for PCT Operating Margin
Model for pctoperatingmargin Fit with mean of 1.59033 for 623 of the 2,809 cases used
with Rsquare = 0.17 and RMSE= 1.6068
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	3.50038	0.62764	31.10	<.0001
smallhosp	-1.48994	0.37932	15.43	<.0001
mediumhosp	-0.34210	0.16924	4.09	0.0437
govthospital	-0.55193	0.21241	6.75	0.0096
pcthospdaysmedicare	0.03617	0.00930	15.12	0.0001
pctcarecostuncompensated	0.13714	0.03530	15.09	0.0001
acutebeddaysavailable	0.00001473	0.00000465	10.02	0.0016
totalbeddaysavailallserv	-0.00001196	0.00000425	7.94	0.0050
pctdiabetic	-0.05817	0.02357	6.09	0.0139
pctheartdisease	0.07262	0.04201	2.99	0.0844
pctdualeligible	-0.01920	0.00760	6.39	0.0117
avgriskscore	-1.47485	0.41093	12.88	0.0004
pctnonwhite	0.01602	0.00672	5.68	0.0174

Regression Model for Adjusted Deviations for PCT Operating Margin in Large Hospitals
Model for pctoperatingmargin Fit with mean of 1.85297 for 344 of the 570 cases used
with Rsquare = 0.15 and RMSE= 1.4184
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-5.23123	3.11069	2.83	0.0936
govthospital	-0.46307	0.22616	4.19	0.0414
pcthospdaysmedicare	0.05009	0.01254	15.95	<.0001
pctcarecostuncompensated	0.16317	0.06180	6.97	0.0087
acutebeddaysavailable	0.00001662	0.00000493	11.38	0.0008
totalbeddaysavailallserv	-0.00001374	0.00000453	9.19	0.0026
life_expectancy	0.09509	0.03911	5.91	0.0156
avgriskscore	-1.27299	0.38395	10.99	0.0010

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	1.57072	593	0.16	1.5863
Adjusted SD Regression	1.59033	623	0.17	1.6068
Adjusted SD in Large Hosp Regr	1.85297	344	0.15	1.4184

Pcthospdaysmedicare appears to have the greatest marginal influence in all three models with a positive influence on *pctOperatingMargin*. *Govthospital* and *avgriskscore* also appear to have statistically significant, negative correlations in all three models. Small (*smallhosp*) and medium (*mediumhosp*) hospitals have statistically significant, negative relationships with *pctOperatingMargin.* It is interesting to note that *pctcarecostuncompensated*, reflective of uncompensated care, appears to have a positive marginal influence in all three models. The model for adjusted standard deviation for large hospitals appears to be the most parsimonious model for *pctOperatingMargin*.

The regression model summaries for *avgmedicareLOS* are shown in Exhibit 4.33 for the average standard deviation, the adjusted standard deviation and the adjusted standard deviation for large hospitals. Similar to the variables mentioned before, the number of hospitals used in the analyses are comparable at around 600 for the all-hospitals regressions and half that number for the large-hospitals regression model at 343 hospitals.

Exhibit 4.33

Regression avgmedicareLOS Based on Fits for All Hospitals and for Large Hospitals

Regression model for Average Medicare LOS
Model for avgMedicareLOS Fit with mean of 4.15157 for 592 of the 2,809 cases used
with Rsquare = 0.38 and RMSE= 0.6984
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-1.29906	1.93689	0.45	0.5027
lab_result_track	-0.46276	0.15216	9.25	0.0025
smallhosp	-0.90951	0.15455	34.63	<.0001
emergencyservice	-0.30265	0.16527	3.35	0.0676
pcthospdaysmedicare	0.03067	0.00449	46.63	<.0001
equippctoftotalassets	0.00122	0.00041246	8.75	0.0032
pctcarecostuncompensated	0.05027	0.01569	10.26	0.0014
acutecarebeddays	0.00000604	0.00000194	9.70	0.0019
acutebeddaysavailable	-0.00000563	0.00000243	5.34	0.0211
totalbeddaysavailallserv	0.00000319	0.00000190	2.82	0.0934
disadvtract	1.15326	0.48207	5.72	0.0171
lowincloweduc	-1.08984	0.52919	4.24	0.0399
PCTASTHMATIC	0.03274	0.00873	14.06	0.0002
pctheartdisease	-0.02806	0.01196	5.51	0.0193
life_expectancy	0.05468	0.02308	5.61	0.0182
pctdualeligible	0.01654	0.00264	39.16	<.0001

Regression Model for Adjusted Medicare LOS
Model for avgMedicareLOS Fit with mean of 4.17840 for 622 of the 2,809 cases used
with Rsquare = 0.38 and RMSE= 0.7057
where rural_versus_urban ne 'N'

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-0.88412	1.88218	0.22	0.6387
smallhosp	-0.82445	0.15408	28.63	<.0001
emergencyservice	-0.30781	0.16696	3.40	0.0657
numinternsandresidents	0.00042690	0.00022723	3.53	0.0608
pcthospdaysmedicare	0.03419	0.00412	68.96	<.0001
pctcarecostuncompensated	0.05101	0.01531	11.10	0.0009
acutecarebeddays	0.00000259	5.098194E-7	25.79	<.0001
disadvtract	0.83468	0.48738	2.93	0.0873
lowincloweduc	-1.00759	0.52490	3.68	0.0554
PCTASTHMATIC	0.03342	0.00875	14.59	0.0001
pctheartdisease	-0.02381	0.01219	3.82	0.0512
life_expectancy	0.04362	0.02243	3.78	0.0523
pctdualeligible	0.01464	0.00314	21.73	<.0001
pctnonwhite	0.00591	0.00243	5.94	0.0151

Regression Model for Adjusted Medicare LOS in Large Hospitals
Model for avgMedicareLOS Fit with mean of 4.37374 for 343 of the 570 cases used
with Rsquare = 0.35 and RMSE= 0.6300
where rural_versus_urban ne 'N' and largehosp

Variable	Estimate	StdErr	FValue	ProbF
Intercept	-2.77035	1.88210	2.17	0.1420
govthospital	0.28498	0.10387	7.53	0.0064
FTEemployees	-0.00008756	0.00003500	6.26	0.0128
numinternsandresidents	0.00095560	0.00030957	9.53	0.0022
pcthospdaysmedicare	0.03931	0.00591	44.19	<.0001
acutecarebeddays	0.00000369	9.583153E-7	14.79	0.0001
PCTASTHMATIC	0.04269	0.01101	15.02	0.0001
pctheartdisease	-0.03665	0.01607	5.20	0.0232
life_expectancy	0.06456	0.02258	8.18	0.0045
pctdualeligible	0.00752	0.00426	3.12	0.0784
pctnonwhite	0.00947	0.00293	10.47	0.0013

	Mean	No Hospitals	R squared	RMSE
Average SD Regression	4.15157	591	0.38	0.6984
Adjusted SD Regression	4.17840	622	0.38	0.7057
Adjusted SD in Large Hosp Regr	4.37374	343	0.35	0.6300

The variables with the greatest marginal influence are *pcthospdaysmedicare* and *pctasthmatic*. Based on their positive influence, both of these variables lead to increased Medicare-patients length of stay values. Small hospitals (*smallhosp*) have a negative relationship with *avgmedicareLOS* for the average standard deviation and the adjusted standard deviation models. This effect could be due to smaller hospitals not offering more comprehensive services, resulting in decreased LOS. *Disadvtract*, not unexpectedly, has positive marginal influence on *avgmedicareLOS* in average standard deviation and the adjusted standard deviation models. *Pctdualeligible* is common to all three models with positively correlated margins. *Acutebeddays* is common to all three models with a positive influence, but appears to have greater marginal influence in only the adjusted deviation models. The regression model for adjusted standard deviation for large hospitals appears to be the most parsimonious mode for *avgmedicareLOS.*

The logistic analysis summaries for high performing hospitals (*highperformer)* and low performing hospitals (*lowperformer)* are shown in Exhibit 4.34 for all hospitals and for large hospitals. In Exhibit, 4.34, all high performing hospitals are shown in the left upper table, high performing large hospitals are shown in the left lower table while all low performing hospitals are shown in the right upper table and low performing large hospitals are shown in the right lower table.

Exhibit 4.34

Logistic Analysis Results for Highperformer and Lowperformer for all Hospitals and Separately for Large Hospitals

logistic function for highperformer derived with descending option built with stepwise strategy=backward alphaentry=.1 alphastay=.1

Obs	Parameter	Estimate	StdErr	oddsimpact	zval	p_value
1	Intercept highperformer=1	-2.4032	0.5920	.	.	.
2	smallhosp	1.3660	0.7533	3.91974	1.81344	0.0698
3	mediumhosp	0.8898	0.4267	2.43468	2.08537	0.037
4	FTEemployees	0.000640	0.000188	1.00064	3.41192	0.0006
5	numinternsandresiden	-0.00413	0.002020	0.99588	-2.04347	0.041
6	acutecarebeds	0.01018	0.005922	1.01023	1.71859	0.0857
7	totalbedsallservices	-0.01232	0.005645	0.98775	-2.18321	0.029
8	pctdualeligible	-0.03550	0.01834	0.96512	-1.93524	0.053

logistic function for highperformer derived with descending option in Large Hospitals built with stepwise strategy=backward alphaentry=.1 alphastay=.1

Obs	Parameter	Estimate	StdErr	oddsimpact	zval	p_value
1	Intercept highperformer=1	-3.5762	1.1537	.	.	.
2	FTEemployees	0.000839	0.000228	1.00084	3.68647	0.0002
3	numinternsandresiden	-0.00610	0.002202	0.99392	-2.77008	0.0056
4	totalbedsallservices	-0.00339	0.001464	0.99661	-2.31916	0.0204
5	pctheartdisease	0.09198	0.05371	1.09635	1.71254	0.0868
6	pctdualeligible	-0.05827	0.03501	0.94339	-1.66433	0.096

logistic function for lowperformer derived with descending option built with stepwise strategy=backward alphaentry=.1 alphastay=.1

Obs	Parameter	Estimate	StdErr	oddsimpact	zval	p_value
1	Intercept lowperformer=1	-4.5788	0.6727	.	.	.
2	govthospital	1.3511	0.3676	3.86151	3.67526	0.0002
3	acutebeddaysavailabl	-0.00003	9.259E-6	0.99997	-2.98573	0.0028
4	totalbeddaysavailall	0.000024	8.173E-6	1.00002	2.99219	0.0028
5	pctheartdisease	0.06056	0.02708	1.06244	2.23651	0.0253
6	pctdualeligible	0.03308	0.008938	1.03364	3.70123	0.0002

logistic function for lowperformer derived with descending option in Large Hospitals built with stepwise strategy=backward alphaentry=.1 alphastay=.1

Obs	Parameter	Estimate	StdErr	oddsimpact	zval	p_value
1	Intercept lowperformer=1	-9.4667	3.4006	.	.	.
2	govthospital	1.4773	0.5578	4.38109	2.64856	0.0081
3	pcthospdaysmedicaid	0.06178	0.03681	1.06373	1.67827	0.0933
4	acutecarebeddays	-0.00003	0.000012	0.99997	-2.97644	0.0029
5	totalbeddaysallservi	0.000032	0.000010	1.00003	3.12307	0.0018
6	allservicessoccupanc	-0.06507	0.02008	0.93700	-3.24099	0.0012
7	PCTASTHMATIC	0.09551	0.03216	1.10022	2.96979	0.003
8	pctdualeligible	0.04803	0.01464	1.04920	3.28008	0.001
9	pctmales	0.1597	0.07579	1.17319	2.10739	0.0351

From Exhibit, 4.34, for *highperformer*, we see that the number of full-time employees (*FTEemployees*) has the smallest p-values for all hospitals as well as for large hospitals, and the odds impact values are 1.0006 and 1.0008 respectively. With all other variables kept constant or *ceteris paribus*, increasing the number of full-time employees by 100, the odds impact value for all hospitals is raised by the power of 100 or $(1.0006)^{100}$ or 1.06182. This means that by hiring 100 employees, there is a 6% increase in the odds ratio that the hospital becomes a high performing hospital. Similarly for large hospitals, increasing the number of full-time employees by 100, the odds impact value for large hospitals is raised by the power of 100 or $(1.0008)^{100}$ or 1.0833. This means there is an 8.3% increase in the odds ratio that the large hospital becomes a high performing hospital. Recognize, however, that the decision to hire employees is not made in isolation, but is dependent of other factors such as increasing acute care beds or services offered, so the odds impact will be lower.

For all hospitals, small and medium hospitals have the largest impact on *highperformer* with the odds impact of 3.92 and 2.43 respectively. This indicates that small hospitals have four times and medium hospitals two and a half times the odds of being a high performing hospital, but the p-value at 0.7 for small hospitals may not be as significant as medium hospitals (p-value 0.037). These variables are categorial in nature so their effects on performance cannot be improved upon. For high performing large hospitals, *pctheartdisease* has the largest odds impact at 1.0964. This may be reflective of the complex services offered at large hospitals which may lead to better health outcomes as well as better profit margins. *Pctdualeligible* has largest negative impact for *highperformer* for all hospitals with an odds impact at 0.96512 which means that this variable's effect will have a 3.5% decreased odds of high performance.

From Exhibit, 4.34, for *lowperformer*, we see that for all hospitals, *govthospital* and *pctdualeligible* are the variables with the smallest p-values. Here we see that for all low performing hospitals, the odds impact for *govthospital* is 3.86151 and for *pctdualeligible,* it is 1.03364. In other words, being a government hospitals means a 3.86151 factor increase for being a low performing hospital whereas the increased odds of worse performance for *pctdualeligible* is only 3.4%. For low performing large hospitals, *govthospital* is the variable with greatest odds impact with a value of 4.38109. As is to be expected, p*ctdualeligible* has a positive impact for *lowperformer* with an odds impact at 1.0492 means that this variable's effect will be 4.92% increased odds of worse performance. For large, low performing hospitals, being male (*pctmales*) is the second biggest negative contributor (after *govthospital*) with an odds impact of 1.173. This is a phenomenon that warrants further investigation based on the hospital's demographics to help ameliorate this effect.

P*ctdualeligible,* is the only variable seen in all four models - both *highperformer* and *lowperformer* for all hospitals and for large hospitals models. *Pctdualeligible* has a positive impact for *lowperformer* and a negative impact on *highperformer*. Again, the effects of some of these variables are not large, but are highly statistically significant. As such, this variable is important in evaluating performance.

The next chapter looks at the leadership characteristics of hospital executives and their effects on hospital performance when accounting for hospital and patient characteristics using the new G-variables.

Chapter 5. Leadership Characteristics Effects in High and Low Performing Hospitals

To help identify high performing and low performing hospitals on both financial and clinical aspects, we used absolute deviations from normative performance. These hospitals identified would then be used to determine leadership characteristics, i.e., training or presence of CMO. Further analysis can then be done to study leadership characteristics and their effects on performance.

In order to identify high performing and low performing hospitals on both the clinical and financial dimensions, the following criteria were applied to the CMS data:

(1) must have reported either *G1_mortcompdev* or *G2_readmissionsdev*

(2) identify hospital as either high or low performer:

a. <u>High Performers</u>: More than three G1 – G6 deviations > 0.25 **or** number of national CMS ratings (of *betteron* ratings) > 3 **and** pctROA ≥ 5 **and** incomeperbed ≥ 350 **and** pctoperatingmargin ≥ 1.5

b. <u>Low Performers</u>: More than four G1 – G6 deviations < - 0.25 **or** number of national CMS ratings (of *betteron* ratings) = 0 **and** pctROA ≤ -10 **or** incomeperbed ≤ 0 **or** pctoperatingmargin ≤ -10

Recall, higher G-variable values mean better performance. The results of this analysis are shown in Table 5.1 for high performing hospitals and we see that there are forty-five high performing hospitals listed by Facility ID .

Table 5.1

High Performing Clinical and High Performing Financial Hospitals

Facility ID	MD CEO	CMO Present	System affiliation
520138	No	Yes	Yes
280040	No	Yes	Yes
100007	No	Yes	Yes
100087	No	Yes	Yes
100281	No	Yes	Yes

Table 5.1 (continued).

110005	No	Yes	Yes
290009	No	Yes	Yes
310064	No	Yes	Yes
340131	No	Yes	No
360012	No	Yes	Yes
380018	No	Yes	Yes
450571	No	Yes	Yes
230089	Yes	Yes	Yes
390044	Yes	Yes	Yes
440082	Yes	Yes	Yes
520098	Yes	Yes	Yes
420087	Yes	Yes	Yes
180038	No	Yes	Yes
340115	No	Yes	Yes
390228	No	Yes	Yes
360137	No	Yes	Yes
050169	No	Yes	Yes
210019	No	Yes	Yes
390111	No	Yes	Yes
100127	No	Yes	Yes
030115	No	Yes	Yes
390100	No	Yes	Yes
340002	No	Yes	Yes
490118	No	Yes	Yes
500058	No	Yes	No
150082	No	No	Yes
240078	No	No	Yes
230046	Yes	No	Yes
240036	No	No	Yes
050567	No	No	Yes
070002	No	No	Yes
030103	Yes	No	Yes
310075	No	No	Yes
520083	No	No	Yes
370091	No	No	Yes
050168	No	No	Yes
100075	No	No	Yes
360133	No	No	Yes
490040	Yes	No	Yes
430027	No	No	Yes

Once these hospitals are identified and cross-referenced by CMS facility identification codes, the CEO leadership training, CMO presence in the executive suite and hospital system affiliation can be obtained using secondary data. Table 5.1 also shows the results of these institutional characteristics for high performing hospitals.

Similarly, once low performing clinical and low performing financial hospitals are identified and cross-referenced by CMS facility identification codes, the CEO leadership training, CMO presence in the executive suite and hospital system affiliation can be obtained using secondary data. Table 5.2 shows the results of these institutional characteristics for low performing clinical and low performing financial hospitals. Here, based on our criteria, we see that there are thirty-two low performing hospitals.

Table 5.2

Low Performing Clinical and Low Performing Financial Hospitals

Facility ID	MD CEO	CMO Present	System affiliation
100017	Yes	Yes	Yes
100053	No	Yes	Yes
100086	No	Yes	Yes
100290	No	Yes	Yes
140007	No	Yes	Yes
140088	No	Yes	Yes
140191	No	Yes	Yes
180009	No	Yes	Yes
240004	No	Yes	No
250048	No	Yes	No
250104	No	Yes	Yes
310019	No	Yes	Yes
330056	Yes	Yes	No
330191	No	Yes	No
330193	No	Yes	No
330203	No	Yes	No
330234	Yes	Yes	Yes
330241	Yes	Yes	Yes
330259	Yes	Yes	Yes
340050	Yes	Yes	Yes
360003	Yes	Yes	Yes
370093	Yes	Yes	Yes
390001	No	Yes	Yes
390133	No	Yes	Yes
390142	No	Yes	Yes
400016	No	Yes	Yes
400032	No	Yes	No
400114	No	No	No
400118	No	No	No
420068	No	No	No
450209	No	No	Yes
490024	No	No	Yes

Combining the data from Tables 5.1 and 5.3, we can calculate the percentage of CEOs who are MDs, presence of CMOs and system affiliation by hospitals. Table 5.3

shows that high performing hospitals had a somewhat lower percentage with both MDs as CEOs and CMOs compared with low performing hospitals.

Table 5.3

Hospital Leadership Composition by Performance Category

	Percent MD	Percent CMO	Percent System Affiliation
High Performing	18	67	96
Low Performing	25	84	69

Additionally, high performing hospitals are more likely to affiliated with a health system (96%) compared with low performing hospitals (69%).

The Pearson Correlation coefficients are shown in Exhibit 5.1 for high and low performing hospitals.

Exhibit 5.1

Pearson Correlation for High and Low Performing Hospitals

Pearson Correlation Coefficients, N = 77
Prob > |r| under H0: Rho=0

	Performer_type	MDCEO	CMOPresent	systemaffil	highperffin	highperfclin
Performer_type	1.00000	-0.08773 0.4481	-0.19902 0.0827	0.36422 0.0011	-0.09861 0.3935	-0.14437 0.2103
MDCEO	-0.08773 0.4481	1.00000	0.08437 0.4656	0.13180 0.2532	0.25474 0.0254	0.04355 0.7068
CMOPresent	-0.19902 0.0827	0.08437 0.4656	1.00000	-0.00954 0.9343	0.03590 0.7566	0.07211 0.5331
systemaffil	0.36422 0.0011	0.13180 0.2532	-0.00954 0.9343	1.00000	0.11323 0.3269	-0.18462 0.1080
highperffin	-0.09861 0.3935	0.25474 0.0254	0.03590 0.7566	0.11323 0.3269	1.00000	0.11323 0.3269
highperfclin	-0.14437 0.2103	0.04355 0.7068	0.07211 0.5331	-0.18462 0.1080	0.11323 0.3269	1.00000

Note. Performer_type = 1 Means High-Performing Hospital

This table shows that system affiliation had a but statistically significant (p=0.0011) relationship to high performing hospitals with a correlation coefficient of weak 0.3642. There is a statistically significant (p-0.0254) correlation value of 0.25474 between MDs as CEOs (MD leadership) and financially high-performing hospitals. The impact of these factors require consideration of the magnitude of their effects on the expected value of the performance indicator – not just on the percentage of variations explained by them. It is noteworthy that the presence of a CMO shows a negative relationship to the high performing hospitals (-0.1990), but is not statistically significant at p~0.0827.

The maximum likelihood estimates are shown in Exhibit 5.2 for the relationship between MD CEO, presence of a CMO and system affiliation with high performing hospitals.

Exhibit 5.2

Maximum Likelihood Estimates for High-Performing Hospitals

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.8125	0.8848	0.8432	0.3585
MDCEO	1	-0.6875	0.6090	1.2742	0.2590
CMOPresent	1	-1.1219	0.6523	2.9577	0.0855
systemaffil	1	2.5291	0.8624	8.5993	0.0034

The statistically significant relationship seen for being a high performing hospital is for system affiliation which has a 2.53 estimate factor. This means system-affiliated hospitals have odds of high performance that are exp(2.53) or 12.5 times higher than non-system-affiliated hospitals. The CMO presence has a negative estimate, so we expect that this variable decreases the odds of being high performing hospital.

Using backward elimination, MD CEO was eliminated since it was not a statistically significant variable, and the resulting model shown in Exhibit 5.3 for high performing hospitals.

Exhibit 5.3

Maximum Likelihood Estimated for High-Performing Hospitals with MD CEO Excluded

Analysis of Maximum Likelihood Estimates					
Parameter	DF	Estimate	Standard Error	Wald Chi-Square	Pr > ChiSq
Intercept	1	-0.8253	0.8833	0.8729	0.3502
CMOPresent	1	-1.1602	0.6486	3.1998	0.0736
systemaffil	1	2.4008	0.8496	7.9844	0.0047

There is a statistically significant relationship for system affiliation which has a 2.4 factor estimate of being a high performing hospital. Therefore, the odds of being a high performing hospital can be calculated as exp(2.4008) or 11.032 times higher with system-affiliation. With CMO presence, the other statistically significant variable, the odds for being a high performing hospital are lower by a factor of exp(-1.1602) or 0.313.

The logistic model for high-performing, large hospitals is shown in Exhibit 5.4 below and shows the variables with odds impact ratios >1 are *FTEemployees* and *pctheartdisease*.

Exhibit 5.4

Logistic Model for High-Performing Large Hospitals

Obs	Parameter	Estimate	StdErr	oddsimpact	zval	p_value
1	Intercept: highperformer=1	-3.5762	1.1537	.	.	.
2	FTEemployees	0.000839	0.000228	1.00084	3.68647	0.0002
3	numinternsandresiden	-0.00610	0.002202	0.99392	-2.77008	0.0056
4	totalbedsallservices	-0.00339	0.001464	0.99661	-2.31916	0.0204
5	pctheartdisease	0.09198	0.05371	1.09635	1.71254	0.0868
6	pctdualeligible	-0.05827	0.03501	0.94339	-1.66433	0.096

Based on the p-values, *FTEemployee*s, on the margin, is the strongest indicator for high performing hospitals.

The preceding analysis does not support the model that a MD CEO or the presence of a CMO in the executive suite leads to a high performing hospital. It does show, however, that system affiliation was significantly associated with high performing hospitals. The number of hospitals used in the analysis for high performing hospitals may also be too small to draw any firm conclusions because of the significant number of other variables that need to be considered.

It is unexpected that MD CEOs have a significant, if weak, correlation with the financial performance of the hospital. One possible explanation for this could be MD CEOs, due to their core knowledge in patient care, are able to make more precise decisions regarding services offered which can have a direct positive financial impact. Similarly, for MD CEOs not having a significant correlation with clinical performance, an argument can be made that physicians' inputs into clinical performance is already maximized at many hospitals such that MD CEOs do not have further impact on clinical performance.

Chapter 6. Developing an ecosystem for excellence in performance in healthcare administration

The discordance of hospital ratings has been shown in past studies to be due to a host of factors including divergent measures of performance, limited variance in the metrics used or significant differences in the nature of the institutions and the populations they serve (Austin et al., 2015; Hota et al., 2020). CMS star ratings, generated based a statistical process of k-means clustering to group hospitals in scores of one through five stars, may be more representative of ranked measures more than actual ratings. As such, based on CMS methodology, most US hospitals will never be rated as 5-star hospitals as noted by Bilimoria (2021). Ratings, however, are representative of a score and are more meaningful than rankings since significant differences in ranking may be observed which may have immaterial differences in ratings. From a hospital managerial perspective, more granular detail is needed from CMS outcome ratings in order to be used effectively in improving hospital performance. This chapter aims to present what could be seen as an ideal set of organizational arrangements and processes to achieve hospital excellence. Using the same clinical metrics and financial data from CMS, we explore the elemental metrics, their character and domains of applicability, and the individuals responsible for the represented dimensions of performance. Interrelationships in responsibilities inferred from these data will be discussed and organizational processes for ideal engagement of managers in pursuit of excellence will be proposed.

Performance measures include not only clinical performance and client-driven metrics, but also finance, operations and learning and growth measures. Hospital administrators need relevant, reliable and timely measures to ascertain the aspects of performance that need improvement. Resources can then be allocated in support of such endeavors while more effectively conveying initiatives to managers, professional staff and other personnel involved in sustaining or improving performance.

The important stakeholders at the hospital level are represented by the patients, medical and other non-clinical staff and the hospital administration. This relationship can be represented diagrammatically in the exhibit below.

Exhibit 6.1

Model of Stakeholders at Hospital Level

Clinical excellence is achieved where the joint concerns of all stakeholders come together. Some of these common interests include:

- Patient Outcomes
- Reputation
- Communication
- Facilities
- Ambience
- Financial Concerns
- Services Offered
- Loyalty

The hospital leadership team needs to operationalize the metrics that best meet their organization's strategic visions while providing for the common interests listed above.

Using the clinical measures from CMS, Exhibit 6.2 and Exhibit 6.3 show the mortality components and the complications components, respectively, for the *G1_mortcompdev* domain, for a particular hospital that, for our exposition, we shall name “St. Elsehomme.” These exhibits list the measure identification from CMS along with a description of that measure as shown. The G-variable domain onto which these measures map (e.g., *G1_mortcompdev)* are also shown in these exhibits. At a granular level, the measure scores for this hospital, the unit of measurement along with the reference group and denominator cases are shown as well as the nature of the measure – subjective or objective – is identified. In line with a BSC approach, these exhibits identify whether the measure is a process or outcome measure, which is corroborated with the measurement method as shown in the exhibits, and whether the measure is an internal process metric or customer focused as seen by the scorecard factor column. The **loci of control** represents the parties responsible for improving that particular measure and include administration, employees (such as nursing, physical therapy, etc.) or medical practitioners. It is important to note that the loci of control is decided by the administrative and support team.

Exhibit 6.2

Measure Information for Mortality Components from the G1_mortcompdev Domain for St. Elsehomme

MEASURE ID	Measure Definition or Description	G-Variable Domain	Value (Score)	Unit of Measurement	Reference Group	Denominator (# of cases with inclusion criteria)	Measurement Scale (nominal, ordinal, interval or ratio)	Domain (process/ outcome)	Nature (subjective/ objective)	Measurement Method	Loci of Control	Score card Factor
MORT_30_AMI	Death rate for heart attack patients	G1_mortcompdev	11.4	RSCR based on number of patients dead with admitting dx of AMI	Patients admitted with an acute heart attack	274	Ratio of deaths (observed/expected) in AMI patients	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
MORT_30_CABG	Death rate for CABG surgery patients	G1_mortcompdev	3	RSCR based on number of patients dead after CABG surgery	Patients having CABG surgery	162	Ratio of deaths (observed/expected) in CABG patients	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
MORT_30_COPD	Death rate for COPD patients	G1_mortcompdev	6.5	RSCR based on number of patients dead with admitting dx of COPD	Patients admitted with COPD	247	Ratio of deaths (observed/expected) in COPD patients	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
MORT_30_HF	Death rate for heart failure patients	G1_mortcompdev	9.9	RSCR based on number of patients dead with admitting dx of heart failure	Patients admitted with heart failure	871	Ratio of deaths (observed/expected) in HF patients	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
MORT_30_PN	Death rate for pneumonia patients	G1_mortcompdev	12.2	RSCR based on number of patients dead with admitting dx of pneumonia	Patients admitted with pneumonia	847	Ratio of deaths (observed/expected) in pneumonia patients	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
MORT_30_STK	Death rate for stroke patients	G1_mortcompdev	10.3	RSCR based on number of patients dead with admitting dx of stroke	Patients admitted with a stroke	400	Ratio of deaths (observed/expected) in stroke patients	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process

Note. PE = physical exam; O=outcome; P=process; dx = diagnosis; EMR=electronic medical record.

Exhibit 6.3

Measure Information for Complications from the G1_mortcompdev Domain for St. Elsehomme

MEASURE ID	Measure Definition or Description	G-Variable Domain	Value (Score)	Unit of Measurement	Reference Group	Denominator (# of cases with inclusion criteria)	Measurement Scale (nominal, ordinal, interval or ratio)	Domain (process/ outcome)	Nature (subjective/ objective)	Measurement Method	Loci of Control	Scorecard Factor
COMP_HIP_KNEE	Rate of complications for single, primary total hip/knee joint replacement patients	G1_mortcompdev	2.6	Risk standardized complication rate (RSCR) based on number of patients admitted with a complication	Patients with single, primary TKA/THA, ≥65 years old, etc.	445	Ratio of complications (observed/expected)	O	Objective	PE and pt self report; EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
PSI_03	Pressure ulcer rate	G1_mortcompdev	0.52	RSCR per 1,000 discharges all inpatients ages ≥ 18 years and > 5 days stay	Stage III or IV pressure ulcer discharges for all inpatients ages ≥ 18 years and > 5 days stay	8452	Ratio of Stage > III pressure ulcer diagnosis on DC to total discharges for adult inpatients and > 5 day stay	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
PSI_06	Iatrogenic pneumothorax rate	G1_mortcompdev	0.21	Rate based on pneumothorax cases per 1,000 discharges, among patients ≥ 18 years	Surgical or medical discharges for patients ages ≥ 18 years	10582	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners	Internal Process
PSI_08	In-hospital fall with hip fracture rate	G1_mortcompdev	0.00	RSCR based on in-hospital fall with hip fracture (secondary diagnosis) per 1,000 discharges for patients ages ≥ 18 years	Discharges, ages 18 years and older with either a medical or a surgical DRG	3554	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
PSI_09	Perioperative hemorrhage or hematoma rate	G1_mortcompdev	2.51	hemorrhage or hematoma case following surgery per 1,000 surgical discharges for patients ages ≥ 18 years	Surgical discharges for patients ages ≥ 18 years for any operating room procedure	2875	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners	Internal Process
PSI_10	Postoperative acute kidney injury requiring dialysis rate	G1_mortcompdev	0.75	RSCR based on postoperative acute kidney failure requiring dialysis per 1,000 elective surgical discharges for patients ages ≥ 18 years	Elective surgical discharges for patients ages ≥ 18 years for any operating room procedure	1511	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners	Internal Process
PSI_11	Postoperative respiratory failure rate	G1_mortcompdev	2.72	RSCR based on postoperative respiratory failure cases per 1,000 elective surgical discharges for patients ages ≥ 18 years	Elective surgical discharges for patients ages ≥ 18 years for any operating room procedure	1862	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners	Internal Process
PSI_12	Perioperative pulmonary embolism or deep vein thrombosis rate	G1_mortcompdev	3.34	RSCR based on perioperative pulmonary embolism or proximal deep vein thrombosis (secondary diagnosis) per 1,000 elective surgical discharges for patients ages ≥ 18 years	Elective surgical discharges for patients ages ≥ 18 years for any operating room procedure	3110	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners	Internal Process
PSI_13	Postoperative sepsis rate	G1_mortcompdev	2.32	Rate based on postoperative sepsis cases (secondary diagnosis) per 1,000 elective surgical discharges for patients ages ≥ 18 years	Elective surgical discharges for patients ages ≥ 18 years for any operating room procedure	1457	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners	Internal Process
PSI_14	Postoperative wound dehiscence rate	G1_mortcompdev	0.74	RSCR based on postoperative reclosures of the abdominal wall with a diagnosis of disruption of internal operation (surgical) wound per 1,000 abdominopelvic surgical discharges for patients ages ≥ 18 years	Surgical or medical discharges, for patients ages 18 years and older, with any abdominopelvic procedures	854	Nominal	O		Diagnosis in EMR	Medical practitioners	Internal Process
PSI_15	Abdominopelvic accidental puncture or laceration rate	G1_mortcompdev	0.58	RSCR based on accidental punctures or lacerations (secondary diagnosis) per 1,000 discharges for patients ages ≥ 18 years, who have undergone an abdominopelvic procedure, in which a second abdominopelvic procedure follows	Patients ages ≥ 18 years, who have undergone an abdominopelvic procedure,	2575	Nominal	O	Objective	Diagnosis in EMR	Medical Practitioners	Internal Process

Note. PE = physical exam; O=outcome; P=process; dx = diagnosis; EMR=electronic medical record.

For example, as seen Exhibit 6.2 for St. Elsehomme, *MORT_30_AMI* or the death rate for AMI patients within 30 days of presentation based on a risk standardized complication rate (RSCR) is 11.4%. The total number of patients admitted with AMIs is shown as 274 cases. Not shown in this table is the national deathrate of 12.3%, which means that St. Elsehomme's performance is not different, statistically, from the national performance.

St. Elsehomme's individual measure scores for the components of *G1_mortcompdev* are also shown in the table in Exhibit 6.4, where we see the *MORT_30_AMI* is11.4% (from CMS 2018 data). Exhibit 6.4 also shows the calculations for the overall meanscore, normdev and p5scores across all US hospitals for the components of *G1_mortcompdev*. The p5score represents the score for entry into the top 5^{th} percentile performing hospitals; the targetdev is calculated specifically for St. Elsehomme for all their KPIs reported by CMS.

Exhibit 6.4

St. Elsehomme's Quality of Care Statistics with Standardized Deviations for 2018 data

Measure_ID	kpi	Score	meanscore	normdev	p5score	targetdev
MORT_30_CABG	KPI101_SURG_MORT	2.8	3.134	0.39045	2.100	-0.81758
PSI_4_SURG_COMP	KPI101_SURG_MORT	195.19	162.955	-1.66275	133.420	-3.18621
MORT_30_AMI	KPI102_MED_MORT	11.4	12.811	1.27133	11.100	-0.27033
MORT_30_COPD	KPI102_MED_MORT	8.4	8.536	0.12290	6.900	-1.35392
MORT_30_HF	KPI102_MED_MORT	10.6	11.563	0.56075	8.800	-1.04830
MORT_30_PN	KPI102_MED_MORT	13.3	15.695	1.13978	12.500	-0.38064
MORT_30_STK	KPI102_MED_MORT	10.9	13.841	1.98718	11.600	0.47300
COMP_HIP_KNEE	KPI103_SURG_COMPL	2.8	2.587	-0.39129	1.800	-1.84091
PSI_10_POST_KIDNEY	KPI103_SURG_COMPL	1.94	1.341	-2.17283	0.960	-3.55349
PSI_11_POST_RESP	KPI103_SURG_COMPL	4.69	7.518	1.04292	3.960	-0.26922
PSI_12_POSTOP_PULMEMB_DVT	KPI103_SURG_COMPL	3.3	3.793	0.51589	2.500	-0.83713
PSI_13_POST_SEPSIS	KPI103_SURG_COMPL	3.87	5.075	1.15565	3.620	-0.23983
PSI_14_POSTOP_DEHIS	KPI103_SURG_COMPL	0.7	0.954	1.60072	0.770	0.44081
PSI_15_ACC_LAC	KPI103_SURG_COMPL	1.65	1.292	-1.18376	0.900	-2.48016
PSI_9_POST_HEM	KPI103_SURG_COMPL	3.44	2.510	-2.79552	2.040	-4.20953
PSI_3_ULCER	KPI104_COMBINED_COMPL	0.62	0.489	-0.26975	0.110	-1.05008
PSI_6_IAT_PTX	KPI104_COMBINED_COMPL	0.27	0.271	0.01186	0.200	-1.35279
PSI_8_POST_HIP	KPI104_COMBINED_COMPL	0.08	0.110	2.13503	0.090	0.72091
PSI_90_SAFETY	KPI191_AGGR_SURG_COMPL	0.92	0.993	0.39661	0.770	-0.81240
EDAC_30_AMI	KPI201_EDAC_CAR_PULM	-6.8	6.169	0.58574	-24.600	-0.80391
EDAC_30_HF	KPI201_EDAC_CAR_PULM	8.7	3.995	-0.19928	-31.300	-1.69416
EDAC_30_PN	KPI201_EDAC_CAR_PULM	1.2	4.169	0.13153	-28.400	-1.31118
READM_30_AMI	KPI201_RETIRED	13.7	14.297	0.13420	1.600	-2.71946
READM_30_HF	KPI201_RETIRED	21.4	19.707	-0.27857	2.200	-3.15880
READM_30_PN	KPI201_RETIRED	16.6	15.080	-0.32002	1.600	-3.15775
READM_30_CABG	KPI202_READMIT_POST_DC	12.1	11.590	-0.13643	1.300	-2.88941
READM_30_COPD	KPI202_READMIT_POST_DC	20.3	17.771	-0.47404	1.900	-3.44941
READM_30_HIP_KNEE	KPI202_READMIT_POST_DC	4.1	3.702	-0.33239	0.400	-3.09368
READM_30_HOSP_WIDE	KPI202_READMIT_POST_DC	15.1	13.821	-0.29983	1.500	-3.18795

<u>Exhibit 6.4 continued</u>

Measure_ID	kpi	Score	meanscore	normdev	p5score	targetdev
OP_32	KPI203_OP_PROC_ADMIT	14.3	13.393	-0.22079	1.500	-3.11735
HAI_1_SIR	KPI301_DEVICE_INFECT	0.694	0.881	0.29880	0.212	-0.77088
HAI_2_SIR	KPI301_DEVICE_INFECT	1.125	0.939	-0.31141	0.244	-1.47518
HAI_3_SIR	KPI302_SURG_INFECT	1.103	1.023	-0.13136	0.284	-1.34090
HAI_4_SIR	KPI302_SURG_INFECT	1.047	1.194	0.17489	0.347	-0.83494
HAI_5_SIR	KPI303_ID_INFECT	0.488	1.017	0.82155	0.295	-0.29988
HAI_6_SIR	KPI303_ID_INFECT	0.603	0.765	0.35383	0.240	-0.79496
EDV	KPI400_RETIRED	.	.	.	.	.
ED_1b	KPI400_RETIRED	329	271.822	-0.52535	135.000	-1.78248
IMM_2	KPI400_RETIRED	94	90.951	0.21854	62.000	2.29359
OP_18b	KPI400_RETIRED	196	140.246	-1.30726	83.000	-2.64952
OP_18c	KPI400_RETIRED	258	249.984	-0.05832	111.000	-1.06947
OP_2	KPI400_RETIRED	.	68.422	.	29.000	.
OP_31	KPI400_RETIRED	.	94.804	.	78.000	.
OP_5	KPI400_RETIRED	.	8.187	.	2.000	.
VTE_6	KPI400_RETIRED	.	2.722	.	0.000	.
ED_2b	KPI401_ED_RM_WAIT_TIME	136	101.337	-0.48197	16.000	-1.66852
OP_22	KPI402_ED_LEFT_UNSEEN	2	1.530	-0.29166	0.000	-1.24213
OP_23	KPI403_ED_TIMELY_TX	85	73.206	0.61725	36.000	2.56447
OP_3b	KPI404_ED_AMI_XFER_TIME	.	63.474	.	30.000	.
H_CLEAN_LINEAR_SCORE	KPI501_ENVIRON_SCORE	86	87.918	-0.49952	82.000	1.04156
H_QUIET_LINEAR_SCORE	KPI501_ENVIRON_SCORE	79	82.228	-0.62844	73.000	1.16805
H_COMP_1_LINEAR_SCORE	KPI502_COMM_SCORE	91	91.476	-0.18300	87.000	1.53681
H_COMP_2_LINEAR_SCORE	KPI502_COMM_SCORE	93	91.473	0.60493	87.000	2.37720
H_COMP_3_LINEAR_SCORE	KPI502_COMM_SCORE	85	85.714	-0.16429	79.000	1.38135
H_COMP_5_LINEAR_SCORE	KPI502_COMM_SCORE	79	79.044	-0.01028	72.000	1.63645
H_COMP_6_LINEAR_SCORE	KPI502_COMM_SCORE	88	86.999	0.27869	81.000	1.94859
H_COMP_7_LINEAR_SCORE	KPI502_COMM_SCORE	84	81.795	0.78488	77.000	2.49132
H_HSP_RATING_LINEAR_S	KPI503_HOSP_RATING	89	88.384	0.18084	83.000	1.76082
H_RECMND_LINEAR_SCORE	KPI504_HOSP_RECOMMEND	91	87.977	0.68058	80.000	2.47660
IMM_3	KPI601_WORKER_FLU_VACC	97	88.851	0.67882	65.000	2.66551
OP_33	KPI602_BONE_EXT_RT_TX	91	85.836	0.28556	47.000	2.43309
PC_01	KPI603_OB_DELIVER_EARLY	0	1.663	0.49938	0.000	0.00000
OP_29	KPI604_OP_TIMELY_COLON_TX	99	86.965	0.62341	42.000	2.95267
OP_30	KPI604_OP_TIMELY_COLON_TX	99	90.878	0.56904	62.000	2.59217
SEP_1	KPI605_APPROP_SEPSIS_CARE	45	56.408	-0.64763	26.000	1.07867

The *meanscore* in Exhibit 6.4 is the mean score for all US hospitals that reported on this measure. *MORT_30_AMI* has a meanscore value of 12.811, and the normalized standard deviation (*normdev*) is 1.27113. To be in the top 5th percentile score (*p5score*) for

MORT_30_AMI, St Elsehomme must attain a score of 11.1%. Thus, the target deviation (*targetdev*) for St Elsehomme is -0.27033 below the *normdev* of 1.27113 in order to be in the top 5^{th} percentile.

This type of analysis can be used to examine the measures where St Elsehomme performs excellently as well as to identify the measures where more work is needed. For example, within *G1_mortcompdev* domain, the postoperative hemorrhage and hematoma KPI or *PSI_9_POST_HEM* rate is 3.44% based on 2879 cases from Exhibit 6.3. The *normdev* is -2.7966, and the *targetdev* is -4.2095, one of the highest deviations in the *G1_mortcompdev* domain. The loci of control for this measure is the medical practitioner or the surgeon since they are the operators that can help decrease this complication. In trying to improve this measure, peer review of the cases performed by these surgeons, examining operative techniques and adherence to best practices would be the steps the chief of surgery would have to follow in order to help improve performance scores in this measure.

Similarly, within *G1_mortcompdev* domain from Exhibit 6.4, the *PSI_8_POST_HIP* measure tracks in-hospital falls that result in hip fractures per 1000 adult discharges, and at St. ElseHomme, it has an occurrence rate of 0.08%. It has a *meanscore* of 0.110, a *normdev* of 2.1350, *p5score* of 0.090 and a *targetdev* of 0.7209. Thus, from a managerial perspective, this objective measure is based on internal processes and the loci of control, comprised of medical and nursing practitioners, physical therapy services and discharge management teams, are functioning at the top 5^{th} percentile level. Thus, other under-performing measures such as PSI_3_ULCER (which has a *score* of 0.62 with a *targetdev* of -1.0501) can adapt similar protocols and practices to improve overall pressure ulcer rates in patients. It is noteworthy that both these measures belong to the KPI_104_COMBINED_COMPL which includes *PSI_8_POST_HIP*, PSI_3_ULCER and PSI_6_IAT_PTX (iatrogenic pneumothorax or collapsed lung).

Exhibit 6.5 shows the *G2_readmissionsdev* or the measure for the readmissions, which, similar to *mortality* measures, is one of the two required measures necessary in order to be awarded a CMS star rating. EDAC is defined as excess days in acute care for medical conditions such as AMI, HF and PN and lower scores reflect better hospital performance. These measures are objective measurements since they are based on claims data from patients' medical charts and from a BSC perspective, EDAC within G2_*readmissionsdev* domain maps to an internal process.

Exhibit 6.5

Measure Information for Readmissions from the G2_readmissionsdev Domain for St. Elsehomme

MEASURE ID	Measure Definition or Description	G-Variable Domain	Value (Score)	Unit of Measurement	Reference Group	Denominator (# of cases with inclusion criteria)	Measurement Scale (nominal, ordinal, interval or ratio)	Domain (process/ outcome)	Nature (subjective/objective)	Measurement Method	Loci of Control	Score card Factor
Excess Days in Acute Care (EDAC)_30_ AMI	Hospital return days for acute myocardial infarction (AMI) or heart attack patients within 30 days of discharge	G2_readmission sdev	23.4	Excess days patients spent back in the hospital within 30 days after they were first treated and released for AMI per 100 discharges	Patients who discharged from the hospital after having a diagnosis of AMI	317	Nominal	O	Objective	Diagnosis in EMR; Predicted based on	Medical practitioners, nursing, therapy services and discharge management	Internal Process
EDAC_30_HF	Hospital return days for heart failure (HF) patients within 30 days of discharge	G2_readmission sdev	13.2	Excess days patients spent back in the hospital (in the ED, under observation, or in an inpatient unit) within 30 days after they were first treated and released for HF per 100 discharges	Patients who discharged from the hospital after having a diagnosis of HF	1001	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
EDAC_30_PN	Hospital return days for pneumonia (PN) patients within 30 days of discharge	G2_readmission sdev	7	Excess days patients spent back in the hospital within 30 days after they were first treated and released for PN per 100 discharges	Patients who discharged from the hospital after having a diagnosis of PN	874	Nominal	O	Objective	Diagnosis in EMR	Medical practitioners, nursing, therapy services and discharge management	Internal Process
OP_32	Rate of unplanned hospital visits after colonoscopy (per 1,000	G2_readmission sdev	15.5	Risk-standardized hospital visit rates after outpatient colonoscopy (per 1000	Hospital outpatient department colonoscopies	1801	Nominal	O	Objective	Diagnosis ir	Medical Practitioners	Internal Process
READM_30_CABG	Rate of readmission for CABG	G2_readmission sdev	11.6	Risk-standardized hospital rate of unplanned admissions for CABG surgery procedures	CABG surgery patients	158	Nominal	O	Objective	Diagnosis ir	Medical practitioners, nursing, therapy services and discharge management	Internal Process
READM_30_COPD	Rate of readmission for chronic obstructive pulmonary disease (COPD) patients	G2_readmission sdev	18.1	Risk-standardized hospital readmission rates COPD patients within 30 days of discharge	COPD patients	272	Nominal	O	Objective	Diagnosis ir	Medical practitioners, nursing, therapy services and discharge management	Internal Process
READM_30_HIP_KNEE	Rate of readmission after hip/knee replacement	G2_readmission sdev	4.1	Risk-standardized hospital rate of unplanned admissions for hip/knee replacement procedures	Patients with hip and knee replacement	413	Nominal	O	Objective	Diagnosis ir	Medical practitioners, nursing, therapy services and discharge management	Internal Process
READM_30_HOSP_ VIDE	Rate of readmission after discharge from hospital (hospital-wide)	G2_readmission sdev	15.3	Risk-standardized readmission rates for all medical, surgical/gynecological, neurological, cardiovascular, and cardiorespiratory patients	All medical, surgical/gynecological, neurological, cardiovascular, and cardiorespiratory patients readmitted within 30 days	2510	Nominal	O	Objective	Diagnosis ir	Medical practitioners, nursing, therapy services and discharge management	Internal Process

Note. PE = physical exam; O=outcome; P=process; dx = diagnosis; EMR=electronic medical record.

Similarly, risk-standardized hospital rates for unplanned readmission after CABG surgery, COPD, THA/TKA patients and overall readmission after discharge from hospital are shown in Exhibit 6.5. Unplanned admission after (hospital) outpatient department interventions such as outpatient colonoscopy are also part of the *G2_readmissionsdev* domain. These measures are objective measurements since they are based on claims data from patients' medical charts; lower rates of readmission reflect better hospital performance. The loci of control for this measure remains with medical practitioners, nursing, therapy services and discharge management.

From Exhibit 6.4, St Elsehomme appears to be below the top 5th percentile across all measures for readmission. Looking specifically at the readmission rate for primary hip and knee total joint replacements (*READM_30_HIP_KNEE*), Exhibit 6.5 shows a 4.1% readmission rate based on 413 cases. The *meanscore* is 3.702, the *normdev* is -0.3324; the *targetde*v is -3.0937. From a managerial perspective, this objective measure is based on internal processes and the loci of control, comprised of medical and nursing practitioners, physical therapy services and discharge management teams, are functioning well below the top 5th percentile level. This indicates that there is room for improvement along all phases of care such are operative times (surgeon), floor care (nurses and physicians), physical therapy services and discharge disposition and planning (physician and social worker).

As shown in Exhibit 6.6, the *G3_safetydev* domain consists of healthcare-associated infections (HAI) including infections of devices and other infectious disease processes.

Exhibit 6.6

Measure Information for Safety from the G3_safetydev Domain for St. Elsehomme

MEASURE ID	Measure Definition or Description	G-Variable Domain	Value (Score)	Unit of Measurement	Reference Group	Denominator (# of cases with inclusion criteria)	Measurement Scale (nominal, ordinal, interval or ratio)	Domain (process/ outcome)	Nature (subjective/ objective)	Measure ment Method	Loci of Control	Score card Factor
H_COMP_1_LINEAR_ SCORE	Nurse-patient communication - linear mean score	G5_ptexpdev	91	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_2_LINEAR_ SCORE	Doctor-patient communication - linear mean score	G5_ptexpdev	93	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_3_LINEAR_ SCORE	Staff-patient responsiveness - linear mean score	G5_ptexpdev	85	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_5_LINEAR_ SCORE	Communication to patients about medicines - linear mean score	G5_ptexpdev	79	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_6_LINEAR_ SCORE	Discharge information to patients - linear mean score	G5_ptexpdev	89	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_7_LINEAR_ SCORE	Care transition from hospital - linear mean score	G5_ptexpdev	84	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_CLEAN_LINEAR_ SCORE	Cleanliness of hospital facilities - linear mean score	G5_ptexpdev	86	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_HSP_RATING_ LINEAR_ SCORE	Overall hospital rating - linear mean score	G5_ptexpdev	90	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_RECMND_LINEAR_ SCORE	Recommend hospital - linear mean score	G5_ptexpdev	92	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer

Note. PE = physical exam; O=outcome; P=process; dx = diagnosis; EMR=electronic medical record.

These measures are objective measurements since they are based on claims data from patients' medical charts and from a BSC perspective, *safety* maps to internal processes. Lower rates are better since they reflect better care at that specific hospital compared with a national (average) hospital.

Exhibit 6.4 shows that the six measures for HAI reported for St. Elsehomme are below the top 5th percentile since the *targetdev* scores are all negative. The reported score for *HAI_2_SIR*, which is the rate of (observed to expected) urine-catheter associated urinary infections, is 1.125 based on 9 cases reported in the EMR. This has the highest *targetdev* for HAI at -1.4752. This objective measure is based on internal processes and the loci of control, belongs to the medical and nursing practitioners, physical therapy services and discharge management teams. This means that incremental progress in any of these teams could lead to better scores. To be addressed are questions such as: is the catheter necessary (medical practitioner), is the catheter being cared for properly (nursing and therapy services), is the catheter necessary on discharge and is there appropriate care on discharge (physician and management team)? Less catheter use could potentially reduce the number of infections whereas better care would also potentially lead to decreased infections.

Timeliness is another domain (*G4_timelindev*) and the measures are shown in Exhibit 6.7. Many of these measures deal with ED times.

Exhibit 6.7

Measure Information for Timeliness from the G4_timlindev Domain for St. Elsehomme

MEASURE ID (2021)	Measure Definition or Description	G-Variable Domain	Value (Score)	Unit of Measurement	Reference Group	Denominator (# of cases with inclusion criteria)	Measurement Scale (nominal, ordinal, interval or ratio)	Domain (process/outcome)	Nature (subjective/objective)	Measurement Method	Loci of Control	Scorecard Factor
ED_2b	Average (median) time patients spent in the ED, after the decision to admit them as an inpatient was made	G4_timelindev	136	Minutes	ED patients	521	Nominal	O	Objective	Hospital record	Medical and nursing practitioners	Internal Process
OP_22	Percent of patients who left before being seen	G4_timelindev	2	Percentage of ED patients	ED patients	42960	Ratio	O	Objective	Hospital record	Medical and nursing practitioners	Internal Process
OP_23	Percentage of patients who came to the ED with stroke-like symptoms who received brain scan results within 45 minutes of arrival	G4_timelindev	85	Percentage of ED patients with stroke-like symptoms	ED patients with stroke-like symptoms	13	Ratio	O	Objective	Hospital record	Medical and nursing practitioners	Internal Process
OP_3b	Median Time to Transfer to Another Facility for Acute Coronary Intervention	G4_timelindev	Not Available	Minutes	Patients with acute coronary symptoms	Not Available	Nominal	O	Objective	Hospital record	Administrators, medical and nursing practitioners	Internal Process

Note. PE = physical exam; O=outcome; P=process; dx = diagnosis; EMR=electronic medical record.

Measures ED_2b (time spent in ED before transfer to floor) and OP_3b (time to transfer patients for acute coronary intervention) deal with duration of time (minutes) and are objective measurements obtained from medical records. Lower numbers represent more expeditious care and could lead to better patient satisfaction, increased throughput and potentially increased revenue. The other 2 measures for *G4_timelindev* domain deal with percentage of patients who: left without being seen (OP_22) and stroke patients (OP_23) receiving timely brain scan; for the latter measure, higher percentages are better since it represents better hospital performance. All measures for *G4_timelindev* map to internal processes on the BSC.

From Exhibit 6.7, *OP_3b* is not reported since St Elsehomme probably has cardiac care services, so patients are not transferred. This may not be true of smaller hospitals and rural institutions where patients need to be transferred for appropriate cardiac care such as cardiac catheterizations or CABG operations. Also, for *OP_23*, the percentage of patients who came to the ED with stroke-like symptoms and received brain scan results within 45 minutes of arrival was 85%, but the denominator number of cases was small at 13, so a *targetdev* of 2.5645, while good, may not represent a large enough sample for statistical significance. ED wait times, however, at 136 minutes as seen from *ED_2b* in Exhibit 6.7, is based on 521 patients. The *meanscore* is 101.337 minutes and the *targetdev* is -1.6685 shown in Exhibit 6.4. This represents an improvement opportunity for medical staff as well as nursing staff. Potentially, the loci of control could also fall within the realm of administration and those responsible to increase ancillary staff to help decrease wait times. It is important to note that these wait times also affect patient care (time to brain scan, e.g.), satisfaction – patients leaving before being treated – resulting in decreased revenue. At St Elsehomme, 2% of patients left without being seen – based on a volume of 42,960 patients. This means around 1,000 patients left unseen, a t*argetdev* of -1.2421 for *OP_22*, indicating St Elsehomme is not within the top 5th percentile for patients not leaving the ED unseen.

The hospital consumer assessment of healthcare providers and systems (HCAHPS) patient survey captures a random sample of patients post-discharge. *Patient experience* under *G5_ptexpdev* domain includes the measures obtained from surveys measuring patients' hospital experiences and pertain to communication with patients. For example, St Elsehomme, shown in Exhibit 6.8, has a low score of 79% for *H-COMP-5* (communication to patients about medicines) with a high of 93% for *H-COMP-2* (doctor-patient communication).

Exhibit 6.8

Measure Information for Patient Experience from the G5_ptexpdev Domain for St. Elsehomme

MEASURE ID (2021)	Measure Definition or Description	G-Variable Domain	Value (Score)	Unit of Measurement	Reference Group	Denominator (# of cases with inclusion criteria)	Measurement Scale (nominal, ordinal, interval or ratio)	Domain (process/outcome)	Nature (subjective/objective)	Measurement Method	Loci of Control	Scorecard Factor
H_COMP_1_LINEAR_SCORE	Nurse-patient communication - linear mean score	G5_ptexpdev	91	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_2_LINEAR_SCORE	Doctor-patient communication - linear mean score	G5_ptexpdev	93	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_3_LINEAR_SCORE	Staff-patient responsiveness - linear mean score	G5_ptexpdev	85	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_5_LINEAR_SCORE	Communication to patients about medicines - linear mean score	G5_ptexpdev	79	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_6_LINEAR_SCORE	Discharge information to patients - linear mean score	G5_ptexpdev	89	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_COMP_7_LINEAR_SCORE	Care transition from hospital - linear mean score	G5_ptexpdev	84	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_CLEAN_LINEAR_SCORE	Cleanliness of hospital facilities - linear mean score	G5_ptexpdev	86	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_HSP_RATING_LINEAR_SCORE	Overall hospital rating - linear mean score	G5_ptexpdev	90	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer
H_RECMND_LINEAR_SCORE	Recommend hospital - linear mean score	G5_ptexpdev	92	Percent based on patient survey ratings	Patients who were discharged from the hospital surveyed within 6 weeks	2262	Ordinal	O	S	Survey	Administrators, Patients	Customer

Note. PE = physical exam; O=outcome; P=process; dx = diagnosis; EMR=electronic medical record.

From Exhibit 6.4, we see that while the scores are not 95th percentile overall, the targetdev is positive for all measures which means that the hospital is in the top 5th percentile for patient ratings based on normalized values. Quite consistently, the recommendation overall score (*H_RECMND-LINEAR-SCORE*) is 91% and the *targetdev* is positive at 2.4766. This is something that administrators are very interested in since they want to not only maintain, but keep on improving these scores since, eventually, it means more patient visits and increased revenue. These data are outcome variables that involve patient surveys and, therefore, are subjective. The loci of control are patients and administrators and its maps to the customer on the BSC. Administrators can use these results to effect change, for example, by encouraging the professional staff to provide better explanations to patients regarding medicine being used in their treatment.

The final domain deals with *practice protocols* and is represented as *G6_opcaredev*. It deals with a process measure *IMM_3* or the percentage of healthcare workers who have received influenza vaccinations and thus deals with preventive care. It also considers metrics such as appropriate scheduling of Cesarean-section deliveries, surveillance endoscopies and appropriate sepsis care as shown in Exhibit 6.9.

Exhibit 6.9

Measure Information for Outpatient Care from the G6_opcaredev Domain for St. Elsehomme

MEASURE ID	Measure Definition or Description	G-Variable Domain	Value (Score)	Unit of Measurement	Reference Group	Denominator (# of cases with inclusion criteria)	Measurement Scale (nominal, ordinal, interval or ratio)	Domain (process/ outcome)	Nature (subjective/ objective)	Measurement Method	Loci of Control	Score card Factor
IMM_3	Percent of healthcare workers given influenza vaccination	G6_opcaredev	97	Percentage of healthcare workers receiving influenza vaccine	Healthcare workers	4894	Nominal	Process	Objective	Hospital records	Administrators, medical and nursing practitioners	Internal Process
OP_29	Appropriate endoscopy/polyp surveillance follow-up interval in average risk patients with normal colonoscopy	G6_opcaredev	99	Percentage of patients	Colonoscopy patients at average	136	Ratio	O	Objective	Hospital records	Medical practitioners	Internal Process
OP_30	Colonoscopy interval for patients with a history of adenomatous polyps: endoscopy/polyp surveillance - avoidance of inappropriate use	G6_opcaredev	99	Percentage of patients	Colonoscopy patients with polyps	153	Ratio	O	Objective	Hospital records	Medical practitioners	Internal Process
OP_33	External Beam Radiotherapy for Bone Metastases	G6_opcaredev	91	Percentage of patients	Patients with bone metastases	32	Ratio	O	Objective	Hospital records	Medical practitioners	Internal Process
PC_01	Percent of newborns whose deliveries were scheduled too early (1-3 weeks early), when a scheduled delivery was not medically necessary	G6_opcaredev	0	Percentage of OB patients	OB patients with inappropriate scheduled delivery	53	Ratio	O	Objective	Hospital records	Medical practitioners	Internal Process
SEP_1	Percent of patients who received appropriate care for severe sepsis and septic shock	G6_opcaredev	45	Percent of Septic patients	Patients with sepsis	103	Ratio	O	Objective	Hospital records	Medical and nursing practitioners	Internal Process

Note. PE = physical exam; O=outcome; P=process; dx = diagnosis; EMR=electronic medical record.

The results for St Elsehomme as seen in Exhibit 6.4 show that the *targetdev* values are all positive, indicating the hospital is performing at the top 5th percentile level. Notice that the *PC_01* (Cesarian-section deliveries scheduled before actual delivery date) has a score of zero with 53 denominator cases. These results can be perplexing when considering a large institution with many scheduled deliveries, where the denominator cases appear to be small. This falls under the purview of the medical practitioner and from a managerial perspective, these numbers need to be verified and corrected as needed since it could potentially result in penalty charges (in the form of decreased payment) if these numbers are not accurately reported.

The loci of control are dependent on the hospital and on how the responsibilities are delegated within the institution. Every institution, based on deviations from norms of their individual KPIs, would concentrate on their unique set of measures depending on the nature of the institution and its performance relative to goals on each dimension. In Exhibit 6.2, we see that *Mort_30_AMI* is below the target deviation (top 5th percentile) and the loci of control belong to the medical practitioners, nursing, therapy services such as pharmacy and physical therapy as well as discharge management. Another way to represent such data are in the form of an inverted list. Exhibit 6.10 shows an example for such an inverted list for the mortality components of *G1_mortcompdev*for St Elsehomme. In this exhibit, the measure names are listed in the rows and the loci of control are listed in the columns. Here, the involvement of the different parties are represented by a '1' or '0' designation, where '1' indicates responsibility for the measure and '0' indicates no responsibility. This is a quick way to identify the parties responsible for the clinical KPIs and enact measures to improve performance.

Exhibit 6.10

Inverted list for Mortality Components of G1_mortcompdev Domain for St. Elsehomme

MEASURE ID (2021)	Measure Definition or Description	G-Variable Domain	Medical Pretitioners	Nursing	Therapy Services	Discharge Management	Admistration
COMP_HIP_KNEE	Rate of complications for **single, primary** total hip/knee joint replacement	G1_mortcompdev	1	1	1	1	0
MORT_30_AMI	Death rate for heart attack patients	G1_mortcompdev					0
MORT_30_CABG	Death rate for CABG surgery patients	G1_mortcompdev	1	1	1	1	0
MORT_30_COPD	Death rate for COPD patients	G1_mortcompdev	1	1	1	1	0
MORT_30_HF	Death rate for heart failure patients	G1_mortcompdev	1	1	1	1	0
MORT_30_PN	Death rate for pneumonia patients	G1_mortcompdev	1	1	1	1	0
MORT_30_STK	Death rate for stroke patients	G1_mortcompdev	1	1	1	1	0
PSI_04	Death rate among surgical inpatients with serious treatable complications	G1_mortcompdev	1	1	1	1	0

Note. 1=locus of control; 0=not within locus of control.

Using an inverted list designed to meet the needs of the particular organization is key when constructing such lists. In this example for St Elsehomme, administration was not listed as a locus of control. However, if there are factors that are impacted by managerial decisions such as, for example, equipment or personnel needs, administration becomes a locus of control within this inverted list. The loci of control can therefore be expanded to include other parties such as maintenance and housekeeping services, specific to the managerial needs of the institution.

Inverted lists are used to identify the loci of control for the underperforming areas within the hospital and strategies to improve performance can then be implemented. As mentioned previously, KPIs that fall solely under the medical practitioner's locus of control, such as surgical hematomas, may require simple interventions such as ensuring that proper equipment and support staff are available during the procedure or may require more stringent interventions such as peer review of the medical practitioner or remedial training. These inverted lists

In this chapter, we have attempted to link the granular detail of a particular hospital's data provided to CMS with normalized data based on national numbers. As illustrated, the detail provided by comparing the hospital's score with the normalized calculations along with the loci of control provide managerial insights into improving patient outcome. The loci of control can be adjusted according to the hospital environment and analyzed. Accordingly, administrative input can be much greater than we have stated in certain areas.

The next chapter discusses some of the limitations as well as practitioner implications on the managerial functions at the leadership level in hospitals.

Chapter 7. Discussion

A critical appraisal of the CMS star ratings was done which helped identify the limitations based on how those ratings are calculated and its inability to be used as a managerial tool for improvement.

In the first part of this staged study, we have proposed a clinical rating system whereby large hospitals can be compared with other large hospitals by using normalized CMS data while accounting for the characteristics of the hospital and the patients. This rating system allows for more meaningful "like" comparisons. These ratings can also be used to identify hospitals based on set targets, such as top 5^{th} percentile, etc., in different clinical domains.

This rating system was further used to help managers and administrators identify areas in need of improvement within the hospital. The development of an ecosystem whereby the individuals responsible for the performance domains were readily identifiable to effect improvement within those domains was undertaken. Other characteristics deemed important to the ecosystem were identified and these could be readily adapted for hospitals with differing needs. Classifying measures based on objectivity or whether it was a process or outcome variable as part of the ecosystem can help administrators devise strategies to improve on those measures.

Using our rating system, high clinical and high financial performing hospitals as well as low performing clinical and low performing financial hospitals were identified. Attempts to link administrator training to hospital performance were uncorrelated. Similarly, the presence of a CMO did not have any correlation with hospital performance. These results were probably due to the small sample size of hospitals used in the analysis.

There were several limitations in this study. One of the biggest limitations was the fact that 2018 data were used and applied to 2021 CMS methodology. This meant that top clinical performing hospitals could not be compared between ratings methods. This was a deliberated decision for this study to help decrease COVID-19 data interference. This could be overcome by utilizing data collected post-COVID-19 data as they become available.

The second limitation was in the way the G-variables were calculated based on simple averages of the weighted components. Alternatively, the G-variables could be calculated using weights based on the consensus among administrators of the relative importance of the component measures, considering the hospital's mission.

The third limitation was the financial data used in this study. While CMS requires reporting of financial and asset data by Medicare-approved hospitals, the integrity of these data needs to be questioned in light of the extreme values we saw during the analysis of the raw data. This limitation is difficult to overcome due to the proprietary nature of hospital financial data. Using IRS data may be an option, but that was beyond the scope of this analysis.

Another limitation was that only large hospitals were studied in the analysis. This decision was made because complex care is performed at large hospitals, so we focused on large hospitals. This analysis can be performed for small and medium hospitals using the same methodology and can be viewed as future work.

The qualitative part of this study was designed to be the second part of the study to look for relationships between leadership characteristics and style on hospital performance. This remains an important study and will be viewed as future work.

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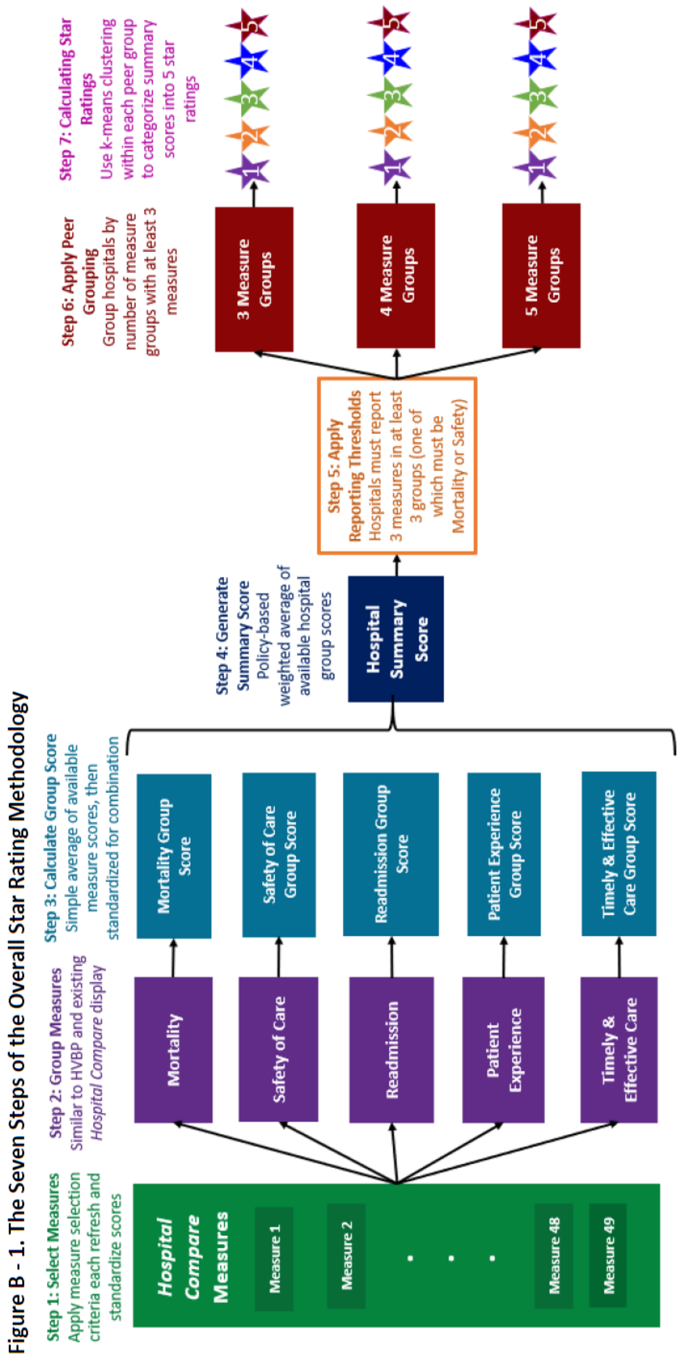
Appendix A. Methodology used by CMS to Calculate Hospital Star Ratings



With permission from CMS.gov

Appendix B.

Measure ID and Descriptions

Measure ID 2021	Measure Name 2021
COMP_HIP_KNEE	Complication Rate Following Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty (TKA)
Composite 1 Q1 to Q3	Communication with Nurses
Composite 2 Q5 to Q7	Communication with Doctors
Composite 3 Q4 and Q11	Responsiveness of Hospital Staff
Composite 5 Q13 to Q14	Communication about Medicines
Composite 6 Q16 to Q17	Discharge Information
Composite 7 Q20 to Q22	Care Transition
EDAC_30_AMI	Excess Days in Acute Care after Hospitalization for Acute Myocardial Infarction
EDAC_30_HF	Excess Days in Acute Care after Hospitalization for Heart Failure
EDAC_30_PN	Excess Days in Acute Care after Hospitalization for Pneumonia
EDV	Emergency Department Volume
FUH_30	Follow-up after Hospitalization for Mental Illness 30-Days
FUH_7	Follow-up after Hospitalization for Mental Illness 7-Days
HACRP_CAUTI	CAUTI_Score
HACRP_CDI	CDI_Score
HACRP_CLABSI	CLABSI_Score
HACRP_MRSA	MRSA_Score
HACRP_PSI90	CMS_PSI_90_Score
HACRP_SSI	SSI_Score
HACRP_Total	Total_HAC_Score
HAI_1	Central Line Associated Bloodstream Infection (ICU+select wards)
HAI_1_HVBP_Baseline	Central Line Associated Bloodstream Infection
HAI_1_HVBP_Performance	Central Line Associated Bloodstream Infection
HAI_2	Catheter Associated Urinary Tract Infections (ICU + select Wards)
HAI_2_HVBP_Baseline	Catheter Associated Urinary Tract Infections
HAI_2_HVBP_Performance	Catheter Associated Urinary Tract Infections
HAI_3	SSI - Colon Surgery
HAI_3_HVBP_Baseline	SSI - Colon Surgery
HAI_3_HVBP_Performance	SSI - Colon Surgery
HAI_4	SSI - Abdominal Hysterectomy
HAI_4_HVBP_Baseline	SSI - Abdominal Hysterectomy
HAI_4_HVBP_Performance	SSI - Abdominal Hysterectomy
HAI_5	MRSA Bacteremia
HAI_5_HVBP_Baseline	MRSA
HAI_5_HVBP_Performance	MRSA
HAI_6	Clostridium Difficile (C.Diff)

HAI_6_HVBP_Baseline	CDI
HAI_6_HVBP_Performance	CDI
HBIPS_2	Hours of physical-restraint use
HBIPS_3	Hours of seclusion
HBIPS_5	Patients discharged on multiple antipsychotic medications with appropriate justification
HCAHPS	Patient satisfaction survey results
HCAHPS_HVBP_Baseline	HCAHPS Measures
HCAHPS_HVBP_Performance	HCAHPS Measures
IMM_3	Healthcare Personnel Influenza Vaccination
IPFQR_IMM_2	Influenza Immunization
Linear Score	HCAHPS Linear Score for each measure
Linear Score	PCH HCAHPS Linear Score
MedCoPsy	Medication Continuation Following Inpatient Psychiatric Discharge
MORT_30_AMI	Acute Myocardial Infarction (AMI) 30-Day Mortality Rate
MORT_30_AMI_HVBP_Baseline	Acute Myocardial Infarction (AMI) 30-Day Mortality Rate
MORT_30_AMI_HVBP_Performance	Acute Myocardial Infarction (AMI) 30-Day Mortality Rate
MORT_30_CABG	30-Day All-Cause Mortality Following Coronary Artery Bypass Graft (CABG) Surgery
MORT_30_COPD	Chronic Obstructive Pulmonary Disease (COPD) 30-Day Mortality Rate
MORT_30_COPD_HVBP_Baseline	Chronic Obstructive Pulmonary Disease (COPD) 30-Day Mortality Rate
MORT_30_COPD_HVBP_Performance	Chronic Obstructive Pulmonary Disease (COPD) 30-Day Mortality Rate
MORT_30_HF	Heart Failure (HF) 30-Day Mortality Rate
MORT_30_HF_HVBP_Baseline	Heart Failure (HF) 30-Day Mortality Rate
MORT_30_HF_HVBP_Performance	Heart Failure (HF) 30-Day Mortality Rate
MORT_30_PN	Pneumonia 30-Day Mortality Rate
MORT_30_PN_HVBP_Baseline	Pneumonia 30-Day Mortality Rate
MORT_30_PN_HVBP_Performance	Pneumonia 30-Day Mortality Rate
MORT_30_STK	Acute Ischemic Stroke (STK) 30-Day Mortality Rate
MSPB_1	Spending per Hospital Patient with Medicare (Medicare Spending per Beneficiary)
MSPB_1_HVBP_Baseline	Spending per Hospital Patient with Medicare (Medicare Spending per Beneficiary)
MSPB_1_HVBP_Performance	Spending per Hospital Patient with Medicare (Medicare Spending per Beneficiary)
OP_10	Abdomen CT - Use of Contrast Material
OP_13	Cardiac Imaging for Preoperative Risk Assessment for Non-Cardiac Low-Risk Surgery
OP_18b	Median Time from ED Arrival to ED Departure for Discharged EDPatients
OP_18c	Median Time from ED Arrival to ED Departure for Discharged ED Patients-Psychiatric/Mental Health Patients
OP_2	Fibrinolytic Therapy Received Within 30 Minutes of ED Arrival
OP_22	Left without being seen
OP_23	Head CT or MRI Scan Results for Acute Ischemic Stroke or

	Hemorrhagic Stroke Patients who Received Head CT or M
OP_29	Appropriate Follow-Up Interval for Normal Colonoscopy in Average Risk Patients
OP_31	Cataracts - Improvement in Patient's Visual Function within 90 Days Following Cataract Surgery
OP_32	Facility 7-Day Risk Standardized Hospital Visit Rate after Outpatient Colonoscopy
OP_33	External Beam Radiotherapy for Bone Metastases
OP_35_ADM	Admissions for patients receiving outpatient chemotherapy
OP_35_ED	Emergency department (ED) visits for patients receiving outpatient chemotherapy
OP_36	Hospital visits after hospital outpatient surgery
OP_3b	Median Time to Transfer to Another Facility for Acute Coronary Intervention- Reporting Rate
OP_8	MRI Lumbar Spine for Low Back Pain
PAYM_30_AMI	Risk-Standardized Payment Associated with a 30-Day AMI Episode-of-Care for Acute Myocardial Infarction
PAYM_30_HF	Risk-Standardized Payment Associated with a 30-Day Episode of Care for Heart Failure
PAYM_30_PN	Risk-Standardized Payment Associated with a 30-Day Episode of Care for Pneumonia
PAYM_90_HIP_KNEE	Risk-Standardized Payment Associated with a 90-Day Episode of Care for THA/TKA
PC_01	Elective Delivery
PCH_15	Plan of Care for Pain - Medical Oncology and Radiation Oncology
PCH_25	External Beam Radiotherapy for Bone Metastases
PCH_26	Clostridium Difficile (C.Diff)
PCH_27	MRSA Bacteremia
PCH_28	Influenza Vaccination Coverage Among Healthcare Personnel (HCP)
PCH_30	Admissions for Patients Receiving Outpatient Chemotherapy
PCH_31	Emergency Department (ED) Visits for Patients Receiving Outpatient Chemotherapy
PCH_6	Surgical Site Infection from colon surgery (SSI: Colon)
PCH_7	Surgical Site Infection from abdominal hysterectomy (SSI: Hysterectomy)
PSI_10	Postoperative Acute Kidney Injury Requiring Dialysis Rate
PSI_11	Postoperative Respiratory Failure Rate
PSI_12	Perioperative Pulmonary Embolism (PE) or Deep Vein Thrombosis (DVT) Rate
PSI_13	Postoperative Sepsis Rate
PSI_14	Postoperative Wound Dehiscence Rate
PSI_15	Unrecognized Abdominopelvic Accidental Puncture/Laceration Rate
PSI_3	Pressure Ulcer Rate
PSI_4	Death among surgical inpatients with serious treatable complications Rate
PSI_6	Iatrogenic pneumothorax, adult Rate
PSI_8	In-Hospital Fall With Hip Fracture Rate
PSI_9	Perioperative Hemorrhage or Hematoma Rate

PSI_90	Patient Safety and Adverse Events Composite
Q18	Overall Rating of Hospital
Q19	Willingness to Recommend this Hospital
Q8	Cleanliness of Hospital Environment
Q9	Quietness of Hospital Environment
READM_30_AMI	Acute Myocardial Infarction (AMI) 30-Day Readmission Rate
READM_30_AMI_HRRP	Acute Myocardial Infarction (AMI) 30-Day Readmissions
READM_30_CABG	30-Day All-Cause Unplanned Readmission Following Coronary Artery Bypass Graft Surgery (CABG)
READM_30_CABG_HRRP	30-Day All-Cause Unplanned Readmission Following Coronary Artery Bypass Graft Surgery (CABG)
READM_30_COPD	Chronic Obstructive Pulmonary Disease (COPD) 30-Day Readmission Rate
READM_30_COPD_HRRP	Chronic Obstructive Pulmonary Disease (COPD) 30-Day Readmission Rate
READM_30_HF	Heart Failure (HF) 30-Day Readmission Rate
READM_30_HF_HRRP	Heart Failure (HF) 30-Day Readmissions
READM_30_HIP_KNEE	30-Day Readmission Rate Following Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty
READM_30_HIP_KNEE_HRRP	30-Day Readmission Rate Following Elective Primary Total Hip Arthroplasty (THA) and/or Total Knee Arthroplasty
READM_30_HOSP_WIDE	30-Day Hospital-Wide All-Cause Unplanned Readmissio Rate
READM_30_IPF	Rate of readmission after discharge from hospital
READM_30_PN	Pneumonia 30-Day Readmission Rate
READM_30_PN_HRRP	Pneumonia 30-Day Readmissions
SEP_1	Severe Sepsis and Septic Shock
SEP_SH_3HR	Septic Shock 3-Hour Bundle
SEP_SH_6HR	Septic Shock 6-Hour Bundle
SEV_SEP_3HR	Severe Sepsis 3-Hour Bundle
SEV_SEP_6HR	Severe Sepsis 6-Hour Bundle
SMD	Screening for Metabolic Disorders
Star Rating	HCAHPS Summary Star Rating
SUB_2	Alcohol Use Brief Intervention Provided or Offered
SUB_2a	Alcohol Use Brief Intervention
SUB_3	Alcohol and other Drug Use Disorder Treatment Provided or Offered at Discharge
SUB_3a	Alcohol and other Drug Use Disorder Treatment Provided at Discharge
TOB_2	Tobacco Use Treatment Provided or Offered
TOB_2a	Tobacco Use Treatment (during the hospital stay)
TOB_3	Tobacco Use Treatment Provided or Offered at Discharge
TOB_3a	Tobacco Use Treatment at Discharge
TR1	Transition Record with Specified Elements
TR2	Timely Transmission of Transition Record

AHRQ QI™ ICD-10-CM/PCS Specification v2021
Patient Safety Indicator 90 (PSI90)
www.qualityindicators.ahrq.gov

Table 1. Composite Weights for PSI 90 v2021

INDICATOR	HARM WEIGHT	VOLUME WEIGHT	COMPONENT WEIGHT
PSI 3 Pressure Ulcer Rate	0.3080	0.1048	0.1641
PSI 6 Iatrogenic Pneumothorax Rate	0.1381	0.0457	0.0321
PSI 8 In Hospital Fall With Hip Fracture Rate	0.1440	0.0194	0.0142
PSI 9 Postoperative Hemorrhage or Hematoma Rate	0.0570	0.1526	0.0442
PSI 10 Postoperative Acute Kidney Injury Requiring Dialysis Rate	0.3584	0.0310	0.0564
PSI 11 Postoperative Respiratory Failure Rate	0.2219	0.2125	0.2397
PSI 12 Perioperative Pulmonary Embolism or Deep Vein Thrombosis Rate	0.1557	0.2318	0.1835
PSI 13 Postoperative Sepsis Rate	0.3102	0.1384	0.2182
PSI 14 Postoperative Wound Dehiscence Rate	0.1441	0.0170	0.0125
PSI 15 Abdominopelvic Accidental Puncture or Laceration Rate	0.1474	0.0468	0.0351

Source: 2018 State Inpatient Databases, Healthcare Cost and Utilization Program, Agency for Healthcare Research and Quality. 2013-2014 Medicare Fee-for-Service claims data.

For more information, see Quality Indicator Empirical Methods and Composite User Guide.

Appendix C.

HCAHPS Questions

#	Question
Q1	During this hospital stay, how often did nurses treat you with courtesy and respect?
Q2	During this hospital stay, how often did nurses listen carefully to you?
Q3	During this hospital stay, how often did nurses explain things in a way you could understand?
Q4	During this hospital stay, after you pressed the call button, how often did you get help as soon as you wanted it?
Q5	During this hospital stay, how often did doctors treat you with courtesy and respect?
Q6	During this hospital stay, how often did doctors listen carefully to you?
Q7	During this hospital stay, how often did doctors explain things in a way you could understand?
Q8	During this hospital stay, how often were your room and bathroom kept clean?
Q9	During this hospital stay, how often was the area around your room quiet at night?
Q11	How often did you get help in getting to the bathroom or in using a bedpan as soon as you wanted?
Q13	Before giving you any new medicine, how often did hospital staff tell you what the medicine was for?
Q14	Before giving you any new medicine, how often did hospital staff describe possible side effects in a way you could understand?
Q16	During this hospital stay, did doctors, nurses or other hospital staff talk with you about whether you would have the help you needed when you left the hospital?
Q17	During this hospital stay, did you get information in writing about what symptoms or health problems to look out for after you left the hospital?
Q18	Using any number from 0 to 10, where 0 is the worst hospital possible and 10 is the best hospital possible, what number would you use to rate this hospital during your stay?
Q19	Would you recommend this hospital to your friends and family?
Q20	During this hospital stay, staff took my preferences and those of my family or caregiver into account in deciding what my health care needs would be when I left.
Q21	When I left the hospital, I had a good understanding of the things I was responsible for in managing my health.
Q23	When I left the hospital, I clearly understood the purpose for taking each of my medications.

- **HCAHPS Composite Measures**
  1. Communication with Nurses (Q1, Q2, Q3)
  2. Communication with Doctors (Q5, Q6, Q7)
  3. Responsiveness of Hospital Staff (Q4, Q11)
  4. Communication about Medicines (Q13, Q14)
  5. Discharge Information (Q16, Q17)
  6. Care Transition (Q20, Q21, Q22)
- **HCAHPS Individual Items**
  7. Cleanliness of Hospital Environment (Q8)
  8. Quietness of Hospital Environment (Q9)
- **HCAHPS Global Items**
  9. Hospital Rating (Q18)
  10. Recommend the Hospital (Q19)

Measure ID	Measure Name
Composite 1	Communication with Nurses
Composite 2	Communication with Doctors
Composite 3	Responsiveness of Hospital Staff
Composite 5	Communication about Medicines
Q8	Cleanliness of Hospital Environment
Q9	Quietness of Hospital Environment
Composite 6	Discharge Information
Composite 7	Care Transition
Q21	Overall Rating of Hospital
Q22	Willingness to Recommend this Hospital
Star Rating	HCAHPS Summary Star Rating
Linear Score	HCAHPS Linear Score for each measure

Appendix D.

Statistics for Domains

Readmission Statistics for 2019
EDAC and Risk-Adjusted Readmission Rates

Measurement Name	Number of Facilities	Minimum Value	1st Percentile	5th Percentile	Median Value	Mean Value	95th Percentile	99th Percentile	Maximum Value	Standard Dev
EDAC_30_AMI	2086	-52.8	-35.7	-24.6	2.6	6.1692	43.6	76.3	181.2	22.1417
EDAC_30_HF	3563	-66.6	-42.1	-31.3	1.3	3.9949	45.2	70.9	143.2	23.6105
EDAC_30_PN	4010	-51.5	-37.6	-28.4	1.3	4.1693	45.6	71.9	134.7	22.5751
OP_32	2971	1.3	1.4	1.5	14.5	13.3934	16.2	17.2	20.2	4.1061
READM_30_AMI	2172	1.2	1.4	1.6	15.6	14.2971	17.5	18.9	21.9	4.4494
READM_30_CABG	995	1.0	1.1	1.3	12.5	11.5901	14.8	16.3	22.1	3.7378
READM_30_COPD	3571	1.6	1.8	1.9	19.3	17.7714	21.3	22.5	26.1	5.3342
READM_30_HF	3689	1.7	2.0	2.2	21.4	19.7067	24.4	25.9	30.1	6.0783
READM_30_HIP_KNEE	2755	0.3	0.4	0.4	3.9	3.7025	4.9	5.5	8.4	1.1960
READM_30_HOSP_WIDE	4385	1.2	1.4	1.5	15.2	13.8209	16.5	17.3	18.9	4.2661
READM_30_PN	4137	1.4	1.5	1.6	16.4	15.0798	18.7	19.9	23.8	4.7502

Performance Statistics for Readmissions
with normscore=meanscore and targetscore=p5score

The MEANS Procedure

Variable	Label	N	N Miss	Minimum	Mean	Maximum	Std Dev
Score		34334	19748	-66.6000000	11.5206093	181.2000000	13.9788466
numfac	number of nonmissing values, Score	54082	0	995.0000000	3120.13	4385.00	991.3626224
meanscore	the mean, Score	54082	0	3.7024682	11.2284863	19.7067498	5.5147302
stddevscore	the standard deviation, Score	54082	0	1.1959875	9.3050611	23.6105268	8.3486960
nummiss	number of missing values, Score	54082	0	544.0000000	1796.73	3934.00	997.6281639
maxscore	the largest value, Score	54082	0	8.4000000	57.4063774	181.2000000	59.8207164
p99score	the 99th percentile, Score	54082	0	5.5000000	32.9901427	76.3000000	25.0478817
p95score	the 95th percentile, Score	54082	0	4.9000000	24.4351947	45.6000000	13.3046994
p75score	the upper quartile, Score	54082	0	4.3000000	15.9167024	22.5000000	4.3585706
p50score	the median, Score	54082	0	1.3000000	11.2523927	21.4000000	7.1826221
p25score	the lower quartile, Score	54082	0	-11.5000000	7.6361858	20.3000000	11.3441870
p5score	the 5th percentile, Score	54082	0	-31.3000000	-6.5941903	2.2000000	13.2769685
p1score	the 1st percentile, Score	54082	0	-42.1000000	-9.5195111	2.0000000	17.8169592
minscore	the smallest value, Score	54082	0	-66.6000000	-14.6957213	1.7000000	26.1781164
normdev	Std dev from meanscore	34334	19748	-7.9050426	-6.10544E-15	3.0316152	0.9998544
targetdev	Std dev from p5score	34334	19748	-9.2946929	-2.4702919	1.4950958	1.1674407

Timely Care Statistics for 2019
ED and Outpatient Metrics

Measurement Name	Number of Facilities	Minimum Value	1st Percentile	5th Percentile	Median Value	Mean Value	95th Percentile	99th Percentile	Maximum Value	Standard Dev
EDV	0	.	.	.	.	.	.	.	.	.
ED_1b	4016	49	94	135	255.0	271.822	446	649	1451	108.837
ED_2b	3999	0	1	16	86.0	101.337	233	355	1142	71.920
IMM_2	4180	0	26	62	96.0	90.951	100	100	100	13.952
IMM_3	4169	0	44	65	93.0	88.851	99	100	100	12.005
OP_18b	4066	50	68	83	135.0	140.246	216	272	471	42.649
OP_18c	3034	31	82	111	222.0	249.984	476	779	2192	137.451
OP_2	83	17	17	29	75.0	68.422	95	100	100	20.442
OP_22	3769	0	0	0	1.0	1.530	4	7	20	1.610
OP_23	1607	0	11	36	77.0	73.206	97	100	100	19.107
OP_29	2858	0	8	42	95.0	86.965	100	100	100	19.305
OP_30	2804	0	30	62	97.0	90.878	100	100	100	14.274
OP_31	56	7	7	78	99.5	94.804	100	100	100	13.502
OP_33	829	3	18	47	92.0	85.836	100	100	100	18.084
OP_3b	460	18	24	30	54.0	63.474	131	249	373	39.444
OP_5	2813	0	0	2	7.0	8.187	16	25	59	4.741
PC_01	2457	0	0	0	0.0	1.663	7	15	60	3.329
SEP_1	3087	0	12	26	58.0	56.408	84	93	100	17.614
VTE_6	1248	0	0	0	0.0	2.722	12	23	56	5.172

Performance Statistics for Timely Care
with normscore=meanscore and targetscore=p5score

The MEANS Procedure

Variable	Label	N	N Miss	Minimum	Mean	Maximum	Std Dev
Score		45535	44848	0	99.2408916	2192.00	98.0061913
numfac	number of nonmissing values, Score	90383	0	0	2396.58	4180.00	1492.92
meanscore	the mean, Score	85626	4757	1.5303794	87.6269118	271.8222112	72.1805876
stddevscore	the standard deviation, Score	85626	4757	1.6101433	31.3021512	137.4506646	36.6890689
nummiss	number of missing values, Score	90383	0	577.0000000	2360.42	4757.00	1492.92
maxscore	the largest value, Score	85626	4757	20.0000000	373.5555556	2192.00	585.2017902
p99score	the 99th percentile, Score	85626	4757	7.0000000	181.5000000	779.0000000	209.1221989
p95score	the 95th percentile, Score	85626	4757	4.0000000	134.2222222	476.0000000	130.1871887
p75score	the upper quartile, Score	85626	4757	2.0000000	101.4722222	315.0000000	84.5181564
p50score	the median, Score	85626	4757	0	85.6944444	255.0000000	66.7892653
p25score	the lower quartile, Score	85626	4757	0	70.7500000	209.0000000	54.1821732
p5score	the 5th percentile, Score	85626	4757	0	45.7777778	135.0000000	37.7546250
p1score	the 1st percentile, Score	85626	4757	0	24.5555556	94.0000000	28.2946920
minscore	the smallest value, Score	85626	4757	0	9.7222222	50.0000000	16.3837106
normdev	Std dev from meanscore	45535	44848	-17.5222935	3.436071E-16	7.4009965	0.9998133
targetdev	Std dev from p5score	45535	44848	-18.0216730	-1.4845876	5.4143132	1.1285613

Healthcare Associated Nonzero Infection Rates in 2019
Observed to Expected Ratios

Measurement Name	Number of Facilities	Minimum Value	1st Percentile	5th Percentile	Median Value	Mean Value	95th Percentile	99th Percentile	Maximum Value	Standard Dev
HAI_1_SIR	1655	0.064	0.116	0.212	0.742	0.88082	2.044	3.077	8.906	0.62526
HAI_2_SIR	1947	0.074	0.154	0.244	0.810	0.93902	2.045	2.988	5.445	0.59722
HAI_3_SIR	1496	0.092	0.181	0.284	0.904	1.02277	2.177	3.031	5.646	0.61078
HAI_4_SIR	533	0.163	0.243	0.347	0.937	1.19362	2.739	4.835	6.090	0.83838
HAI_5_SIR	1431	0.099	0.190	0.295	0.868	1.01674	2.294	3.295	4.944	0.64359
HAI_6_SIR	2799	0.017	0.133	0.240	0.687	0.76457	1.504	2.609	5.573	0.45663

Performance Statistics for Healthcare Associated Infection (HAI) Statistics
with normscore=meanscore and targetscore=p5score

The MEANS Procedure

Variable	Label	N	N Miss	Minimum	Mean	Maximum	Std Dev
score		11624	16918	0	0.7783280	8.9060000	0.6457655
numfac	number of nonmissing values, infrate	28542	0	533.0000000	1643.50	2799.00	674.2456360
meanscore	the mean, infrate	28542	0	0.7645681	0.9695914	1.1936248	0.1329751
stddevscore	the standard deviation, infrate	28542	0	0.4566288	0.6286427	0.8383801	0.1118949
nummiss	number of missing values, infrate	28542	0	0	0	0	0
maxscore	the largest value, infrate	28542	0	4.9440000	6.1006667	8.9060000	1.2989287
p99score	the 99th percentile, infrate	28542	0	2.6090000	3.3058333	4.8350000	0.7133335
p95score	the 95th percentile, infrate	28542	0	1.5040000	2.1338333	2.7390000	0.3666113
p75score	the upper quartile, infrate	28542	0	0.9350000	1.2283333	1.5150000	0.1829774
p50score	the median, infrate	28542	0	0.6870000	0.8246667	0.9370000	0.0883110
p25score	the lower quartile, infrate	28542	0	0.4780000	0.5539167	0.6660000	0.0644542
p5score	the 5th percentile, infrate	28542	0	0.2120000	0.2703333	0.3470000	0.0441394
p1score	the 1st percentile, infrate	28542	0	0.1160000	0.1695000	0.2430000	0.0416130
minscore	the smallest value, infrate	28542	0	0.0170000	0.0848333	0.1630000	0.0438087
normdev	Std dev from meanscore	11624	16918	-12.8350120	0.2371566	1.6745139	1.0789729
targetdev	Std dev from p5score	11624	16918	-13.9046915	-0.8979670	0.5255911	1.0808059

HCAHPS Statistics for 2019
Patient Experience and Recommendation

Measurement Name	Number of Facilities	Minimum Value	1st Percentile	5th Percentile	Median Value	Mean Value	95th Percentile	99th Percentile	Maximum Value	Standard Dev run
H_CLEAN_LINEAR_SCORE	3502	60	78	82	88.0	87.9183	94	96	99	3.84038
H_COMP_1_LINEAR_SCORE	3502	64	84	87	92.0	91.4763	95	97	98	2.60279
H_COMP_2_LINEAR_SCORE	3502	63	84	87	92.0	91.4732	95	97	99	2.52398
H_COMP_3_LINEAR_SCORE	3502	60	74	79	86.0	85.7136	93	95	99	4.34356
H_COMP_5_LINEAR_SCORE	3502	61	68	72	79.0	79.0440	86	90	95	4.27755
H_COMP_6_LINEAR_SCORE	3502	66	76	81	87.0	86.9989	92	94	99	3.59234
H_COMP_7_LINEAR_SCORE	3502	67	74	77	82.0	81.7947	86	88	97	2.80975
H_HSP_RATING_LINEAR_S	3502	67	78	83	89.0	88.3838	94	96	98	3.40750
H_QUIET_LINEAR_SCORE	3502	53	70	73	82.0	82.2282	90	94	97	5.13677
H_RECMND_LINEAR_SCORE	3502	59	75	80	88.5	87.9772	94	96	99	4.44157

Performance Statistics for Measures form Patient Surveys
with normscore=meanscore and targetscore=p5score

The MEANS Procedure

Variable	Label	N	N Miss	Minimum	Mean	Maximum	Std Dev
score		35020	13920	53.0000000	86.3007995	99.0000000	5.4519633
numfac	number of nonmissing values, score	48940	0	3502.00	3502.00	3502.00	0
meanscore	the mean, score	48940	0	79.0439749	86.3007995	91.4762993	3.9203660
stddevscore	the standard deviation, score	48940	0	2.5239768	3.6976180	5.1367671	0.8281514
nummiss	number of missing values, score	48940	0	1392.00	1392.00	1392.00	0
maxscore	the largest value, score	48940	0	95.0000000	98.0000000	99.0000000	1.2649240
p99score	the 99th percentile, score	48940	0	88.0000000	94.3000000	97.0000000	2.8653390
p95score	the 95th percentile, score	48940	0	86.0000000	91.9000000	95.0000000	3.2695899
p75score	the upper quartile, score	48940	0	82.0000000	88.8000000	93.0000000	3.7094853
p50score	the median, score	48940	0	79.0000000	86.5500000	92.0000000	4.1258754
p25score	the lower quartile, score	48940	0	76.0000000	83.9000000	90.0000000	4.3000439
p5score	the 5th percentile, score	48940	0	72.0000000	80.1000000	87.0000000	4.8466978
p1score	the 1st percentile, score	48940	0	68.0000000	76.1000000	84.0000000	4.9487878
minscore	the smallest value, score	48940	0	53.0000000	62.0000000	67.0000000	4.1231478
normdev	Std dev from meanscore	35020	13920	-5.4116190	-9.73902E-17	11.2810696	0.9998715
targetdev	Std dev from p5score	35020	13920	-7.1180641	-1.6774372	9.5088037	1.0041792

Appendix E.

KPI Groups Composition

Measure_ID	KPI renamed Mortality and Complication
MORT_30_CABG	KPI_101:SURG_MORT
PSI_4_SURG_COMP	KPI_101:SURG_MORT
MORT_30_AMI	KPI_102:MED_MORT
MORT_30_COPD	KPI_102:MED_MORT
MORT_30_HF	KPI_102:MED_MORT
MORT_30_PN	KPI_102:MED_MORT
MORT_30_STK	KPI_102:MED_MORT
COMP_HIP_KNEE	KPI_103:SURG_COMPL
PSI_10_POST_KIDNEY	KPI_103:SURG_COMPL
PSI_11_POST_RESP	KPI_103:SURG_COMPL
PSI_12_POSTOP_PULMEMB_DVT	KPI_103:SURG_COMPL
PSI_13_POST_SEPSIS	KPI_103:SURG_COMPL
PSI_14_POSTOP_DEHIS	KPI_103:SURG_COMPL
PSI_15_ACC_LAC	KPI_103:SURG_COMPL
PSI_9_POST_HEM	KPI_103:SURG_COMPL
PSI_3_ULCER	KPI_104:COMBINED_COMPL
PSI_6_IAT_PTX	KPI_104:COMBINED_COMPL
PSI_8_POST_HIP	KPI_104:COMBINED_COMPL
PSI_90_SAFETY	KPI_191:AGGR_SURG_COMPL

Measure_ID	KPI Unplanned Readmissions Groupings
EDAC_30_AMI	KPI_201:EDAC_CAR_PULM
EDAC_30_HF	KPI_201:EDAC_CAR_PULM
EDAC_30_PN	KPI_201:EDAC_CAR_PULM
OP_32	KPI_202:OP_PROC_ADMIT
READM_30_AMI	DELETE
READM_30_CABG	KPI_203:READMIT_POST_DC
READM_30_COPD	KPI_203:READMIT_POST_DC
READM_30_HF	DELETE
READM_30_HIP_KNEE	KPI_203:READIT_POST_DC
READM_30_HOSP_WIDE	KPI_203:READIT_POST_DC
READM_30_PN	DELETE

Measure_ID	KPI Infections Groupings
HAI_1_SIR	KPI_301:DEVICE_INFECT
HAI_2_SIR	KPI_301:DEVICE_INFECT
HAI_3_SIR	KPI_302:SURG_INFECT
HAI_4_SIR	KPI_302:SURG_INFECT
HAI_5_SIR	KPI_303:ID_INFECT
HAI_6_SIR	KPI_303:ID_INFECT
Measure_ID	KPI Timeliness Groupings
EDV	DELETE
ED_1b	DELETE
ED_2b	KPI_401:ED_WAIT_TIME
IMM_2	DELETE
OP_18b	DELETE
OP_18c	DELETE
OP_2	DELETE
OP_22	KPI_402:ED_LEFT_UNSEEN
OP_23	KPI_403:ED_TIMELY_TX
OP_31	DELETE
OP_3b	KPI_404:ED_AMI_TRANSFER_TIME
OP_5	DELETE
VTE_6	DELETE
Measure_ID	KPI Patient Ratings Groupings
H_CLEAN_LINEAR_SCORE	KPI_501:ENVIRON_SCORE
H_QUIET_LINEAR_SCORE	KPI_501:ENVIRON_SCORE
H_COMP_1_LINEAR_SCORE	KPI_502:COMM_SCORE
H_COMP_2_LINEAR_SCORE	KPI_502:COMM_SCORE
H_COMP_3_LINEAR_SCORE	KPI_502:COMM_SCORE
H_COMP_5_LINEAR_SCORE	KPI_502:COMM_SCORE
H_COMP_6_LINEAR_SCORE	KPI_502:COMM_SCORE
H_COMP_7_LINEAR_SCORE	KPI_502:COMM_SCORE
H_HSP_RATING_LINEAR_S	KPI_503:HOSP_RATING
H_RECMND_LINEAR_SCORE	KPI_504:HOSP_RECOMMEND
Measure_ID	KPI Practice Protocols Groupings
IMM_3	KPI_601:WORKER_FLU_VACC
OP_33	KPI_602:BONE_EXT_RT_TX
PC_01	KPI_603:OB_DELIVER_EARLY
OP_29	KPI_604:OP:TIMELY_TX
OP_30	KPI_604:OP:TIMELY_TX
SEP_1	KPI_605:APPROP_SEPSIS_CARE
OP-10	KPI_606:INAPP_OP_TX
OP-13	KPI_606:INAPP_OP_TX
OP-8	KPI_606:INAPP_OP_TX

Appendix F.

Simple Statistics for KPI Group 1-6

Variable	N	N Miss	Minimum	Mean	Maximum	Std Dev
KPI101_SURG_MORT_dev	1227	1582	-3.5097973	-0.0191005	2.4323256	0.8229056
KPI101_SURG_MORT_N	2809	0	0	0.6810253	2.0000000	0.8401852
KPI101_SURG_MORT_NX	2809	0	0	1.3189747	2.0000000	0.8401852
KPI102_MED_MORT_dev	2762	47	-3.1679766	-0.0474077	2.5405424	0.6846940
KPI102_MED_MORT_N	2809	0	0	3.9238163	5.0000000	1.3673149
KPI102_MED_MORT_NX	2809	0	0	1.0761837	5.0000000	1.3673149
KPI103_SURG_COMPL_dev	2173	636	-2.7020100	-0.0086649	1.4886334	0.4653276
KPI103_SURG_COMPL_N	2809	0	0	5.3481666	8.0000000	3.4935580
KPI103_SURG_COMPL_NX	2809	0	0	2.6518334	8.0000000	3.4935580
KPI104_COMBINED_COMPL_dev	2082	727	-5.7520975	0.0021299	1.6173649	0.6067131
KPI104_COMBINED_COMPL_N	2809	0	0	2.2232111	3.0000000	1.3141037
KPI104_COMBINED_COMPL_NX	2809	0	0	0.7767889	3.0000000	1.3141037
KPI191_AGGR_SURG_COMPL_dev	2082	727	-11.5186339	-0.0069371	3.0504610	0.9864912
KPI191_AGGR_SURG_COMPL_N	2809	0	0	0.7411890	1.0000000	0.4380595
KPI191_AGGR_SURG_COMPL_NX	2809	0	0	0.2588110	1.0000000	0.4380595
KPI201_EDAC_CAR_PULM_dev	2751	58	-5.0390632	0.0578154	2.3470165	0.8149627
KPI201_EDAC_CAR_PULM_N	2809	0	0	2.3837665	3.0000000	0.7343572
KPI201_EDAC_CAR_PULM_NX	2809	0	0	0.6162335	3.0000000	0.7343572
KPI201_RETIRED_dev	2751	58	-1.5481555	-0.0045040	2.8826804	0.6447479
KPI201_RETIRED_N	2809	0	0	2.3837665	3.0000000	0.7343572
KPI201_RETIRED_NX	2809	0	0	0.6162335	3.0000000	0.7343572
KPI202_READMIT_POST_DC_dev	2809	0	-1.3759671	-0.0183555	2.9317461	0.6205190
KPI202_READMIT_POST_DC_N	2809	0	1.0000000	2.7992168	4.0000000	0.8889072
KPI202_READMIT_POST_DC_NX	2809	0	0	1.2007832	3.0000000	0.8889072
KPI203_OP_PROC_ADMIT_dev	2043	766	-1.4628564	-0.000847468	2.9452717	0.9925361
KPI203_OP_PROC_ADMIT_N	2809	0	0	0.7273051	1.0000000	0.4454245
KPI203_OP_PROC_ADMIT_NX	2809	0	0	0.2726949	1.0000000	0.4454245
KPI301_DEVICE_INFECT_dev	1547	1262	-7.7495031	0.2586619	1.5723331	0.9624775
KPI301_DEVICE_INFECT_N	2809	0	0	1.0135279	2.0000000	0.9550969
KPI301_DEVICE_INFECT_NX	2809	0	0	0.9864721	2.0000000	0.9550969
KPI302_SURG_INFECT_dev	1253	1556	-3.7185595	0.3907362	1.6745139	1.0323060
KPI302_SURG_INFECT_N	2809	0	0	0.6034176	2.0000000	0.7444494
KPI302_SURG_INFECT_NX	2809	0	0	1.3965824	2.0000000	0.7444494
KPI303_ID_INFECT_dev	2087	722	-10.5302870	0.1858152	1.6743756	1.0490526
KPI303_ID_INFECT_N	2809	0	0	1.1477394	2.0000000	0.8001264
KPI303_ID_INFECT_NX	2809	0	0	0.8522606	2.0000000	0.8001264
KPI400_RETIRED_dev	2730	79	-8.9691591	-0.0058961	1.4852583	0.7440806
KPI400_RETIRED_N	2809	0	0	4.5250979	7.0000000	1.2797013
KPI400_RETIRED_NX	2809	0	2.0000000	4.4749021	9.0000000	1.2797013
KPI401_ED_RM_WAIT_TIME_dev	2602	207	-14.4696959	-0.0185777	1.4090180	0.9551004
KPI401_ED_RM_WAIT_TIME_N	2809	0	0	0.9263083	1.0000000	0.2613150
KPI401_ED_RM_WAIT_TIME_NX	2809	0	0	0.0736917	1.0000000	0.2613150
KPI402_ED_LEFT_UNSEEN_dev	2477	332	-11.4707930	-0.0263896	0.9504616	0.9732298

Appendix G.

CMS Financial Measures and Hospital Characteristics

Variable
Fiscal_Year_Begin_Date
Fiscal_Year_End_Date
FTE___Employees_on_Payroll
Number_of_Interns_and_Residents
Total_Days_Title_V
Total_Days_Title_XVIII
Total_Days_Title_XIX
Total_Days__V___XVIII___XIX___Un
Number_of_Beds
Total_Bed_Days_Available
Total_Discharges_Title_V
Total_Discharges_Title_XVIII
Total_Discharges_Title_XIX
Total_Discharges__V___XVIII___XI
Total_Days_Title_V___Total_for_a
Total_Days_Title_XVIII___Total_f
Total_Days_Title_XIX___Total_for
VAR31
Number_of_Beds___Total_for_all_S
Total_Bed_Days_Available___Total
Total_Discharges_Title_V___Total
Total_Discharges_Title_XVIII___T
Total_Discharges_Title_XIX___Tot
VAR37
Hospital_Total_Days_Title_V_For
Hospital_Total_Days_Title_XVIII
Hospital_Total_Days_Title_XIX_Fo
Hospital_Total_Days__V___XVIII__
Hospital_Number_of_Beds_For__Adu
Hospital_Total_Bed_Days_Availabl
Hospital_Total_Discharges_Title
VAR45
VAR46
Hospital_Total_Discharges__V___X
Cost_of_Charity_Care
Total_Bad_Debt_Expense
Cost_of_Uncompensated_Care
Total_Unreimbursed_and_Uncompens
Total_Salaries_From_Worksheet_A
Overhead_Non_Salary_Costs
Depreciation_Cost
Total_Costs
Inpatient_Total_Charges
Outpatient_Total_Charges

Variable
Combined_Outpatient___Inpatient
Wage_Related_Costs__Core_
Wage_Related_Costs__RHC_FQHC_
Total_Salaries__adjusted_
Contract_Labor
Wage_Related_Costs_for_Part__A
Wage_Related_Costs_for_Interns_a
Cash_on_Hand_and_in_Banks
Temporary_Investments
Notes_Receivable
Accounts_Receivable
Less__Allowances_for_Uncollectib
Inventory
Prepaid_Expenses
Other_Current_Assets
Total_Current_Assets
Land
Land_Improvements
Buildings
Leasehold_Improvements
Fixed_Equipment
Major_Movable_Equipment
Minor_Equipment_Depreciable
Health_Information_Technology_De
Total_fixed_Assets
Investments
Other_Assets
Total_Other_Assets
Total_Assets
Accounts_Payable
Salaries__Wages__and_Fees_Payab
Payroll_Taxes_Payable
Notes_and_Loans_Payable__Short_T
Deferred_Income
Other_Current_Liabilities
Total_Current_Liabilities
Mortgage_Payable
Notes_Payable
Unsecured_Loans
Other_Long_Term_Liabilities
Total_Long_Term_Liabilities
Total_Liabilities
General_Fund_Balance
Total_Fund_Balances

Variable
Total_Liabilities_and_Fund_Balan
DRG_Amounts_Other_Than_Outlier_P
DRG_amounts_before_October_1
DRG_amounts_after_October_1
DRG_Amounts_for_Model_4_BPCI_bef
DRG_Amounts_for_Model_4_BPCI_aft
Outlier_payments_for_discharges
Disproportionate_Share_Adjustmen
Allowable_DSH_Percentage
Managed_Care_Simulated_Payments
Total_IME_Payment
Inpatient_Revenue
Outpatient_Revenue
Gross_Revenue
Less_Contractual_Allowance_and_d
Net_Patient_Revenue
Less_Total_Operating_Expense
Net_Income_from_Service_to_Patie
Total_Other_Income
Total_Income
Total_Other_Expenses
Net_Income
Cost_To_Charge_Ratio
Net_Revenue_from_Medicaid
Medicaid_Charges
Net_Revenue_from_Stand_Alone_SCH
Stand_Alone_SCHIP_Charges
duplicate

Rural_Versus_Urban	Frequency	Percent	Cumulative Frequency	Cumulative Percent
N	76	1.26	76	1.26
R	2349	38.86	2425	40.12
U	3620	59.88	6045	100.00

Rural Urban Key
N=Unknown
R=Rural
U=Urban

CCN_Facility_Type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
CAH	1353	22.38	1353	22.38
CH	97	1.60	1450	23.99
LTC	377	6.24	1827	30.22
ORD	9	0.15	1836	30.37
PH	595	9.84	2431	40.22
RH	289	4.78	2720	45.00
RNM	14	0.23	2734	45.23
STH	3311	54.77	6045	100.00

Provider_Type	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	2615	43.26	2615	43.26
2	2189	36.21	4804	79.47
3	55	0.91	4859	80.38
4	37	0.61	4896	80.99
5	1149	19.01	6045	100.00

Type_of_Control	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	601	9.94	601	9.94
10	229	3.79	830	13.73
11	346	5.72	1176	19.45
12	67	1.11	1243	20.56
13	72	1.19	1315	21.75
2	2392	39.57	3707	61.32
3	22	0.36	3729	61.69
4	1460	24.15	5189	85.84
5	219	3.62	5408	89.46
6	110	1.82	5518	91.28
7	42	0.69	5560	91.98
8	87	1.44	5647	93.42
9	398	6.58	6045	100.00

Facility type Key	Provider type Key	Control type Key
CA=Critical_Access_Hosp CH=Children_Hosp LT=Long_Term_Care OR=Res_ORD_Demon PH=Psych_Hosp RH=Rural_Health_Clinic RN=Religious_nonMed_Healthcare ST=Short_Term_Hosp;	1=Gen_Short_Term 2=Gen_Long_Term 3=Cancer 4=Psychiatric 5=Rehabilitation 6=Religious_NonMed_Instit 7=Children 8=Alcohol_Drug 9=Other	1=Vol_NP_Church 2=Vol_NP_Other 3=Proprietary_Ind 4=Proprietary_Corp 5=Proprietary_Part 6=Proprietary_Other 7=Gov_Fed 8=Gov_City_County 9=Gov_County 10=Gov_State 11=Gov_Hosp_District 12=Gov_City 13=Gov_Other

Appendix H.

Shared Files for Reference

SAS-9 program to integrate data: Integrate and Transform Hospital Data 2022-05-10.sas

SAS-9 program to analyze data: Analyze performance with adjdevs 2022-06_02.sas

Correlation pdf File for attachment: https://mailmissouri-my.sharepoint.com/personal/dgxmc_umsystem_edu/Documents/AA%20Dissertation/Dissertation%20Proposals/Current%20data/correlation%20reports.pdf

All regression models pdf files to be attached: https://mailmissouri-my.sharepoint.com/personal/dgxmc_umsystem_edu/Documents/AA%20Dissertation/Dissertation%20Proposals/Current%20data/Regressions%20for%20pctROA%20large%20hosp.pdf

Logistics Analysis: https://mailmissouri-my.sharepoint.com/personal/dgxmc_umsystem_edu/Documents/AA%20Dissertation/Dissertation%20Proposals/Current%20data/Logistics%20models.pdf