2019

Hospital Characteristics Associated with Hospital Acquired Condition (HAC) Reduction Program Payment Penalties across Program Years

Emily D. Cochran
Virginia Commonwealth University

Emily Cochran
V00274575

Hospital Characteristics Associated with HAC Reduction Program Payment Penalties across Program Years

Emily Cochran, MS, RN

Virginia Commonwealth University School of Nursing

Dissertation Committee Members:

Marianne Baernholdt, PhD, MPH, RN, FAAN (Chair)

Leroy Thacker, PhD

Terry Jones, PhD, RN

Jan Clement, PhD

Emily Cochran
V00274575

Acknowledgements

This study and my training would not have been possible without the expertise and support of my dissertation committee, all of whom dedicated a great deal of time and attention to ensuring my success. Special thanks are deserved by Dr. Marianne Baernholdt for generously accepting responsibility as my committee chair and advisor. Her thorough feedback and attention to detail ensured this dissertation was a success. I also immensely appreciate the support of Dr. Leroy Thacker, who offered both his statistical expertise and a reassuring, encouraging attitude. I am thankful for Dr. Terry Jones, who contributed her immense expertise and fierce advocacy for nursing's role in the quality of healthcare healthcare. And last, but certainly not least, I am thankful for the contributions of Dr. Jan Clement, who added her critical perspective on health services and policy research and expanded the applicability of this work beyond the nursing discipline.

I would also like to recognize Dr. Alison Montpetit, who served as my advisor when I first started the doctoral program in the biobehavioral concentration. Dr. Montpetit was one of my undergraduate instructors, who early in my Bachelor's program introduced me to nursing research and gave me opportunities to work with her and other researchers. When I graduated, she recommended I apply to the doctoral program. I truly had never imagined that I would ever obtain a doctorate until I experienced her encouragement and confidence. I am grateful for her mentorship and support over the years.

Many thanks to VCU School of Nursing for their resources and dedication to the education of nurses. I would also like to express my gratitude to VCU Health System, who has demonstrated their commitment to the advancement of healthcare science and professional development by making financially possible for me to continue my education. I intend to use their investment to improve access to safe, high quality care for our community and the Commonwealth.

Emily Cochran
V00274575

I am especially grateful to my husband, David, whose unrelenting encouragement and support has been the cornerstone of my education. He has always urged me to keep going in times when I doubted myself, lost patience, or my motivation waned. I am so incredibly fortunate, not only for his emotional support, but for the many evenings and weekends he spent keeping our household running so that I could focus on my studies. *This accomplishment belongs to us both. Thank you.*

Table of Contents

Emily Cochran
V00274575

List of Tables

Emily Cochran
V00274575

List of Figures

Emily Cochran
V00274575

Abstract

Objective: The primary objective of this study was to examine the relationship between hospital structural characteristics and penalization status (penalized or not penalized) in any given hospital acquired condition (HAC) Reduction Program year, FY 2015 through 2018. Structural characteristics included hospital type, case mix index, average daily census, bed size, ownership, disproportionate share percentage, location, and American Nurses Credentialing Center Magnet status. The secondary objective of the study was to determine whether a hospital's penalization status across one or more HAC Reduction Program years is related to quality performance (Total HAC Score) in subsequent years. These objectives were achieved through retrospective, longitudinal, multivariate regression analysis using 4 publicly available data sources. **Background:** The intention of pay-for-performance programs, including the Centers for Medicare and Medicaid HAC Reduction Program, is to improve the quality of care delivered; however, the theoretical and conceptual basis of pay-for-performance programs and their efficacy in improving care are widely debated. This study was designed to address the gap in knowledge related to the efficacy of value-based reimbursement as a means of motivating providers and organizations to improve healthcare quality. **Results:** Higher average daily census, disproportionate share percentage, and case mix index were associated with increased likelihood of receiving a penalty in the HAC Reduction Program. Approximately half (49%) of who did not experience a penalty at all improved their Total HAC Score. 51% of hospitals with 1 year of penalty improved their Total HAC Score; 54% of hospitals with 2 years of penalty improved their Total HAC Score; 73% of hospitals with 3 years of penalty improved their Total HAC Score. **Conclusions:** Despite the inability of some hospitals to meet the benchmark to avoid penalty, the vast majority of hospitals improved their performance over time. This finding holds promise for value-based reimbursement as a means for improving HAC incidence.

Keywords: pay for performance, healthcare associated infections, healthcare quality indicators, organization and administration

Emily Cochran
V00274575

Dissertation Introduction

The title of this dissertation is, “Hospital Characteristics Associated with HAC Reduction Program Payment Penalties across Program Years.” This study will be a secondary data analysis using numerous publicly available datasets. A grant proposal will serve as the dissertation proposal for Chapters I-III, using the NIH SF424 form for R01 applications as a guide for content and page limits. Chapters IV and Chapter V will be Findings and Discussion & Conclusions, a manuscript for submission to *Quality Management in Healthcare* will explore and discuss the research findings. Chapter VI will be the Concluding Narrative, with additional information on the Results and Discussion due to the page limitation of the manuscript.

The primary aim of this study is to examine the relationship between hospital structural characteristics and penalization status (penalized or not penalized) in any given HAC Reduction Program year, FY 2015 through 2018. The secondary aim is to determine whether a hospital's penalization status (penalized or not penalized) across one or more HAC Reduction Program years is related to quality performance (Total HAC Score). In the manuscript, these aims will be referred to as “objectives” so that the manuscript is submission-ready. The study findings will contribute to a growing body of knowledge surrounding the efficacy of value-based reimbursement in quality improvement and measurement. To this end, the study will explore how organizational structural characteristics contribute to success and failure in quality measures in a well-known, high-stakes, national pay-for-performance program.

Emily Cochran
V00274575

Specific Aims

Hospital-acquired conditions (HACs) are a growing issue in healthcare that harms patients and leads to the extension or complication of care, increased healthcare costs, disability, and even death (Pittet & Donaldson, 2006). The HAC Reduction Program is a budget-neutral penalty-only program, existing among several Centers for Medicare and Medicaid (CMS) pay-for-performance structures offering incentives, or upside risk, such as Value-Based Purchasing (VBP) and the Medicare Access and CHIP Reauthorization Act (MACRA) (Centers for Medicare and Medicaid Services, 2017c). The intention of the pay-for-performance programs is to improve the quality, and therefore value, of care delivered; however, the theoretical and conceptual basis of pay-for-performance programs and the conclusiveness of their efficacy is widely debated (de Bruin, Baan, & Struijs, 2011; Eijkenaar, Emmert, Scheppach, & Schöffski, 2013; Emmert, Eijkenaar, Kemter, Esslinger, & Schöffski, 2012; Kondo et al., 2016; Mendelson et al., 2017; Van Herck et al., 2010). For the HAC Reduction Program the intention is to reduce preventable harm to patients (Center for Medicare and Medicaid Services, 2018).

In the HAC Reduction Program hospital performance is assessed using both Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators (PSIs) and Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) hospital-acquired infections (HAI). More specifically, the AHRQ Patient Safety Composite measure (PSI-90) and the CDC/NHSN HAI central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), surgical site infections (SSI), methicillin-resistant staphylococcus aureus (MRSA) bacteremia, and C. *difficile* laboratory-identified events are used to create an overall score.

Cross-sectional studies have found that some hospital structural characteristics contribute substantially to financial penalty in the CMS HAC Reduction Program: hospitals that have 400 or more beds, are academic, have a level I trauma center, have a higher case mix index (CMI), or have safety net status are more frequently penalized (Koenig et al., 2016; Rajaram et al., 2015; Soltoff, Koenig, Demehin, Foster, & Vaz, 2018). Additional structural characteristics, including DSH percentage, teaching status, Medicare and Medicaid patient volume, nurse staffing level, profit status, and Joint Commission accreditation, have demonstrated an inverse relationship to performance in both the HAC Reduction Program and Value-Based Purchasing (VBP) (Borah et al., 2012; Fuller, Goldfield, Averill, & Hughes, 2017; Koenig et al., 2016; Rajaram et al., 2015). Because not all hospitals required to participate in the HAC Reduction Program are scored in every measure due to low volume of patients or procedures (Centers for Medicare and Medicaid Services, 2017b), larger hospitals that have higher volumes of qualifying patients and procedures and also care for a higher proportion of complex and/or disadvantaged populations, disproportionately receive penalty status (Rajaram et al., 2015).

Although research has been conducted examining hospital characteristics as they relate to various CMS pay-for-performance programs within a single program year (Borah et al., 2012; Fuller et al., 2017; Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018), there is a gap in research related to how hospitals fare in the program year-to-year. Unlike previous cross-sectional studies (Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018), this study will explore hospital structural characteristics as related to both penalty status and HAC performance, across program years.

The primary aim of this study is to examine the relationship between hospital structural characteristics and penalization status (penalized or not penalized) in any given HAC Reduction Program year, FY 2015 through 2018. The null hypothesis is that there is no significant difference in the characteristics of hospitals penalized in the HAC Reduction Program in years FY 2015 to FY 2018.

The secondary aim is to determine whether a hospital's penalization status (penalized or not penalized) across one or more HAC Reduction Program years is related to quality performance (Total HAC Score). The null hypothesis is that there is no significant association between Total HAC Score and penalty status across years. This study will use a repeated

Emily Cochran
V00274575
measures analysis of variance to achieve the aims. The results from this study will inform a growing body of knowledge surrounding the efficacy of value-based reimbursement as a means of motivating providers and organizations to improve healthcare quality.

Background and Significance

This study is guided by Donabedian's three dimensions of care: structure, process, and outcome (Donabedian, 1988), but also informed by the tenets of agency theory, behavioral economics, and value theory as these are the theoretical basis for the pay for performance and VBP programs.

Economic and Behavioral Theories Underlying Value-Based Reimbursement

Agency theory. Value-based reimbursement is based on the economic theory of agency, which describes the payment arrangement or relationship between a principal (the patient, for example) and an agent (a provider's organization, for example) (Conrad, 2015). Agency theory describes this principal-agent relationship as a "contract" whereby the ideal would involve the agent, or provider, delivering the most efficient care possible, delivering quality by using as few resources as possible, and maximizing principal (patient) well-being (Dranove & White, 1987). Agency theory is supported by behavioral economics, which integrates economic theory with the contribution of human factors to healthcare quality (Jack Stevens, 2017).

Behavioral economics. Behavioral economics shows great potential for integration in quality and safety research, as the literature encourages incremental behavioral changes realistic for healthcare providers to drive change and make meaningful improvements (Jack Stevens, 2017). Himmelstein, Ariely, and Woolhandler state, "while higher pay clearly increases performance for straightforward manual tasks such as installing windshields (Lazear, 1996), a growing body of evidence from behavioral economics and social psychology indicates that rewards sometimes undermine motivation and worsen performance on complex cognitive tasks, especially when intrinsic motivation is high" (Himmelstein, Ariely, & Woolhandler, 2014a, p. 203). Himmelstein et al. (2014a) explain that pay-for-performance operates on the assumption that performance can be accurately ascertained, more detailed contracts will improve quality, variation in care is attributed to variation in performance, financial incentives add to motivation, and that hospitals or providers not meeting quality standards deserve fewer resources.

Behavioral economics draws on the work of Skinner (1953), who was a thought leader in the science of human behavior and wrote about the effects of reward and punishment on individuals' conduct. Not only did Skinner find that rewards positively reinforced good behavior, but he also found punishment important to establishing conditions that would be conducive to avoiding a certain behavior (Skinner, 1953). At face value, Skinner's work (1953) provides support for the theory of pay-for-performance in quality programs: if an individual or organization is behaving well (delivering standard or above-standard quality of care), they should receive additional resources as a reward in order to promote the positive behavior. Similarly, punishing hospitals for poor performance by either withholding incentives or issuing financial penalty has been thought to condition hospitals to provide better care. Skinner was not an organizational theorist, however, and much of his research involved basic human tasks instead of complex medical care delivered in dynamic, volatile, healthcare institutions. Therefore, the evidence and merit surrounding pay-for-performance as a way of improving healthcare quality is questionable (Himmelstein et al., 2014a).

Value theory. Value theory is very similar to axiology, which concerns itself with the study of what things are "good" and to what degree they are good (Shroeder, 2016). Shroeder (2016) explains that some, such as philosopher Immanuel Kant, might have held human life as having limitless value; however, in more modern perspectives, life has been widely categorized as an example of incommensurability of values, meaning no single value can be placed on it universally. From this point of view, the value of human life is higher if it is at risk of being taken, but lower if the aim is preserving it (Shroeder, 2016).

Maguire (2016) extrapolates the value theory to a value-based theory of reasons: the weight of the reason to perform a certain action hinges upon the value achieved by the outcome. In healthcare, the outcomes of saving a life or improving well-being, are heavily weighted reasons for performing an action, and can explain why healthcare providers might be intrinsically motivated to make behavioral modifications in order to do such actions. This predicates a vague understanding of value in healthcare, how performance can be extrinsically motivated, and how healthcare can or should measure the value, or amount of "good" being provided to patients. The amount of "good" is synonymous with quality, which healthcare quality trailblazer Avedis Donabedian (1966) describes as taking many different forms for different individuals, but measured primarily by the outcome of the care delivered.

Theoretical/Conceptual Framework

This study is guided by Donabedian's three dimensions of care: structure, process, and outcome (Donabedian, 1988). Structure accounts for the care setting; process considers the actual steps in care administration; and outcome takes into account the effects of the care delivered on a patient's overall health status (Donabedian, 1988). Donabedian introduced that economic efficiency, or valuation, be considered in quality improvement and proposed that practitioners maximize the cost-benefit of healthcare improvements, as increased cost will not always lead to an equal increase in the quality of care (Donabedian, 1966).

The transition to higher quality and lower costs by holding providers accountable is challenged conceptually by issues surrounding provider practices, clinical systems, payment models, and managerial systems (Mkanta, Katta, Basireddy, English, & Mejia de Grubb, 2016), all of which are examples of structure as defined by Donabedian (1966). Value-based reimbursement for hospitals has proliferated ahead of fully developed healthcare system structures to accommodate it. For example, the prevalence of fee-for-service and capitation models in the healthcare market continues to promote volume over value (Miller, 2009). Therefore, some healthcare systems and providers are reluctant to adapt to the team-based care required of value-based practices (Mkanta et al., 2016). In addition, there is insufficient availability of relevant data that allow for comprehensive monitoring of the quality of care across the continuum. This is a key component of defining value in healthcare (Mkanta et al., 2016). In summary, the impact of value-based reimbursement on care, costs, and outcomes remains poorly understood (Mkanta et al., 2016); however, structure and outcome are intrinsically linked (Donabedian, 1966).

In the proposed work, structural variables include: hospital type (acute care, critical access, children’s), volume of discharges, ownership (proprietary, non-profit, government owned, or otherwise), geographical location, and American Nurses Credentialing Center (ANCC) Magnet accreditation status. Processes related to the proposed research will not be measurable using publicly reported/available data. While evidence-based infection and complication prevention processes will not be investigated in this research, an organization’s structural characteristics can be key to implementing strategies for improving processes, and thus patient outcomes such as HACs (Donabedian, 1966). This study will examine the relationship between structural variables and penalty status in the HAC Reduction Program, then examine the Total HAC Score (the summary score of HAC outcomes measures) across program years. This conceptual framework is depicted in Figure 1.

Various hospital structural characteristics have demonstrated significant relationships with level of quality measured in both the HAC Reduction Program and Value-Based Purchasing (Borah et al., 2012; Fuller et al., 2017; Koenig et al., 2016; Rajaram et al., 2015). The infrastructure and resources provided by an organization are key to creating quality and value in healthcare (Mkanta et al., 2016); however, pay-for-performance structures are lacking conclusive or supportive evidence as tools for meaningful and sustainable quality improvements (de Bruin et al., 2011; Eijkenaar et al., 2013; Emmert et al., 2012; Kondo et al., 2016; Mendelson et al., 2017; Van Herck et al., 2010). In this study, associations will be explored between structural characteristics that may influence processes, which in turn, could impact quality care outcomes as measured in the CMS HAC Reduction Program.

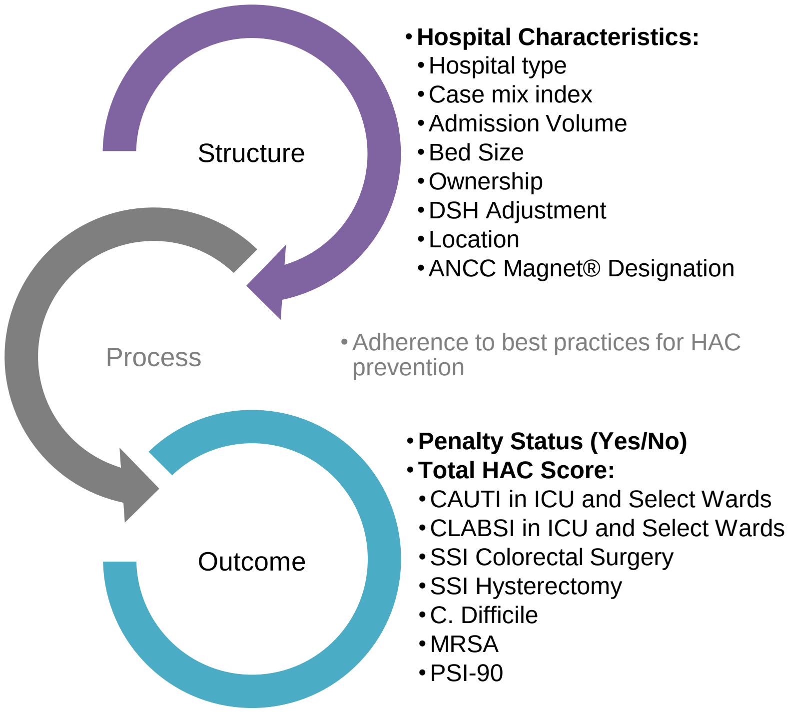


Figure 1. Conceptual framework for the proposed research.

Note. DSH = Disproporationate share; ANCC = American Nurses Credentialing Center; HAI = Hospital Acquired Condition; CAUTI = Catheter-associated urinary tract infection; CLABSI = Central line-associated bloodstream infection; SSI = Surgical site infection; MRSA = methicillin-resistant staphylococcus aureus; PSI = Patient Safety Indicator.

Scientific Premise & Background

The patient safety implications, contribution to inpatient morbidity and mortality, and financial burden of HACs have long been recognized. HACs have reduced considerably over the past ten years through various programs and efforts by various federal agencies, such as those by the Department of Health and Human Services, AHRQ, and the CDC (Bysshe et al., 2017). Despite having made significant progress, HACs continue to be costly both financially and to human quality of life, and the inclusion of HACs in the transition from fee-for-service to value-based reimbursement has further increased interest in accurately measuring, quantifying, and reducing HACs (Bysshe et al., 2017). Section 3008 of the Affordable Care Act (ACA) established the CMS HAC Reduction Program beginning with FY 2015 hospital discharges (Centers for Medicare and Medicaid Services, 2016a). The program was developed with the intention of reducing preventable infections and complications, which include both AHRQ PSIs and CDC NHSN HAIs.

Evidence suggests that structural characteristics of hospitals influence penalty status in the CMS HAC Reduction Program (Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018). Not all hospitals required to participate in the HAC Reduction Program are scored in every measure due to low volume of patients or procedures (Centers for Medicare and Medicaid Services, 2017b). This contributes to disproportionate penalty of larger hospitals that have higher volumes of qualifying patients and procedures. These financial penalties may harm the economic health of larger hospitals, which are also the hospitals that care for a higher proportion of complex and/or disadvantaged populations (Rajaram et al., 2015). Thus penalties may add to the high financial burden of caring for poor communities, and even threaten hospitals' ability to survive and continue to provide access to disadvantaged populations (Fos, 2017). Healthcare disparities and access to care for low-income patients could be worsened as a result of penalties in pay-for-performance structures (Fos, 2017). It is noteworthy that while HACs included in the HAC Reduction Program are risk adjusted, they are not adjusted for socioeconomic status (Agency for Healthcare Research and Quality, 2017; Dudeck, Aponte, Arcement, & Patel, 2017; McIlvennan, Eapen, & Allen, 2015).

HAC Reduction Program Methodology

HAC Reduction Program scores are determined for each hospital based on risk-adjusted performance, which is then compared to national performance, in two domains. Domain 1 is worth 15% of the Total HAC Score and is comprised of PSI-90 only; Domain 2 is worth 85% of the Total HAC Score and is comprised of six NHSN indicators: CAUTI and CLABSI for ICUs and select wards (medical and/or surgical units) and SSI associated with hysterectomy and colorectal surgery (Centers for Medicare and Medicaid Services, 2017b). While NHSN mandates surveillance on many different HAIs, this subset was selected for public reporting in the CMS Inpatient Quality Reporting Program and, subsequently, the HAC Reduction Program

(CDC, n.d.). Program methodology is further described in Figure 2.

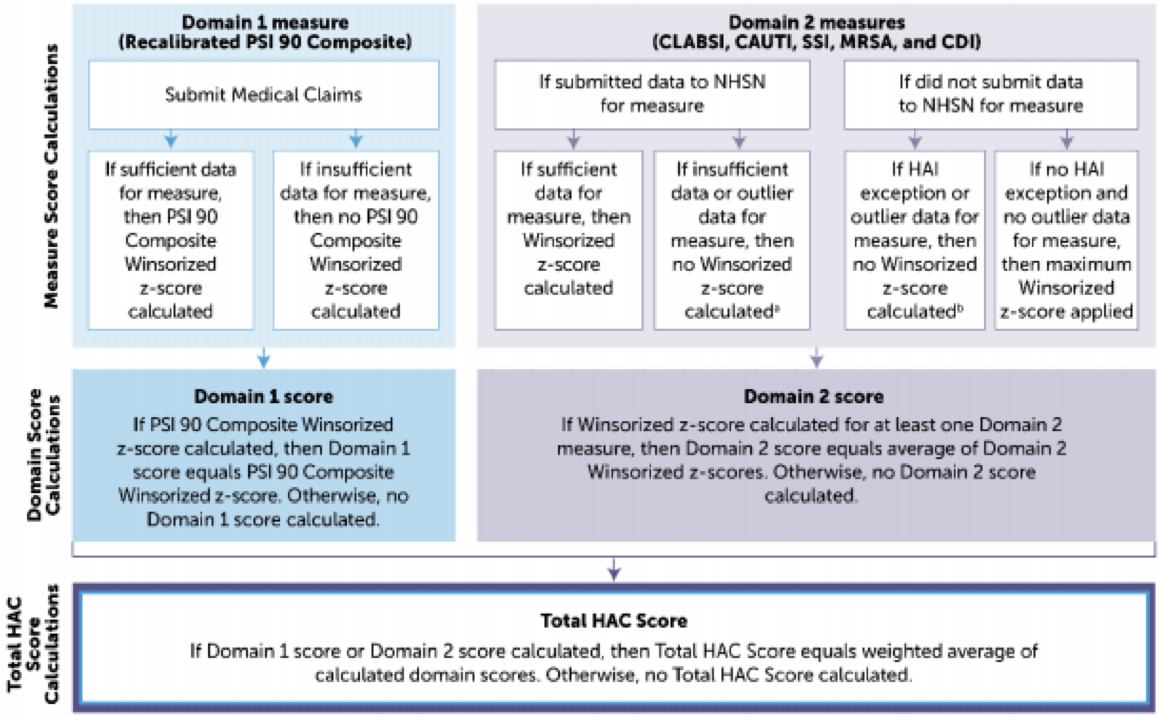


Figure 2. HAC Reduction Program Scoring Methodology (Centers for Medicare and Medicaid Services, 2017b).

Note. PSI = Patient Safety Indicator; HAI = Hospital Acquired Infection; CAUTI = Catheter-associated urinary tract infection; CLABSI = Central line-associated bloodstream infection; SSI = Surgical site infection; MRSA = methicillin-resistant staphylococcus aureus; CDI = *C. Difficile* Infection; HAC = Hospital Acquired Condition.

Hospitals in the HAC Reduction Program are assigned a Total HAC Score, as well as Winsorized z-scores for each measure. Higher Total HAC Scores indicate poor overall HAC performance. Based on performance across all individual HAC measures, the lowest quartile of Total HAC Score performance is the threshold above/below which a hospital is penalized (Centers for Medicare and Medicaid Services, 2017b). The HAC Reduction Program requires the Secretary of Health and Human Services to penalize hospitals that are in the lowest quartile of national performance. Hospitals with a Total HAC Score that is greater than the threshold are subject to payment reduction. Thresholds vary year-to-year based on overall nationwide performance. Incentives are not provided to hospitals that have Total HAC Scores above the

Emily Cochran
V00274575

lowest quartile. Measures in both domains follow AHRQ and NHSN standard specifications, respectively. HAIs are represented and scored using the risk-adjusted standardized infection ratio (SIR) for each measure in the HAC Reduction Program (Centers for Medicare and Medicaid Services, 2017b).

Domain 1 is comprised of Version 6.0.2 of the PSI-90 Patient Safety Composite (15% of program performance), which contains a total of 10 PSI measures, the components of which are detailed in Figure 3 (Agency for Healthcare Research and Quality, 2016b). These PSIs provide information on potential in hospital complications and adverse events following surgeries, procedures, and childbirth (AHRQ, n.d.). PSIs entail very complex specifications, as they are derived completely from administrative data and are therefore a classification of International Classification of Disease (ICD-9 and ICD10) codes into medical conditions. PSIs are intended to "identify potential adverse events that might need further study; provide the opportunity to assess the incidence of adverse events and in hospital complications using administrative data found in the typical discharge record; include indicators for complications occurring in hospital that may represent patient safety events; and indicators also have area level analogs designed to detect patient safety events on a regional level" (AHRQ, n.d.).

NHSN specifications are used in the HAC Reduction Program to identify cases eligible for reporting and scoring in Domain 2 (85% of program performance). CAUTI, CLABSI, MRSA, SSI, and *C. difficile* are all HACs surveilled through NHSN. A summary of NHSN specifications for each measure can be found in Appendix A.

How did the PSI-90 measure change between v 5.0.1 and v 6.0.1?

The modified PSI-90 incorporates:

- Updated patient population (2015 baseline)
- Three new safety indicators (PSI #9, PSI #10, and PSI #11)
- Two re-specified safety indicators (PSI #12 and PSI #15)
- Removal of one previous safety indicator (PSI #7)

In addition, the safety indicators included in the composite have been re-weighted to better reflect the relative importance and harm associated with each. In past versions of the PSI-90, accidental punctures and lacerations were the most highly weighted component indicators. Version 6.0.1 changes that—in the modified measure, the most heavily weighted metric is now post-operation sepsis.

Safety indicators in PSI-90 Version 5.0.1 vs. Version 6.0.1

Indicator Number	Indicator Name	PSI-90 Version 5.0.1	Version 5.0.1 Weight	PSI-90 Version 6.0.1	Version 6.0.1 Weight
PSI #3	Pressure Ulcer Rate	Yes	0.0391	Yes	0.0504
PSI #6	Iatrogenic Pneumothorax Rate	Yes	0.0905	Yes	0.0531
PSI #7	Central Venous CRBSI Rate	Yes	0.0301	No (removed)	NA
PSI #8	Postoperative Hip Fracture Rate	Yes	0.0025	Yes	0.0109
PSI #9	Perioperative Hemorrhage/ Hematoma Rate	No	NA	Yes (added)	0.0691
PSI #10	Physiologic and Metabolic Derangement Rate	No	NA	Yes (added)	0.0575
PSI #11	Postoperative Respiratory Failure Rate	No	NA	Yes (added)	0.3045
PSI #12	Perioperative PE DVT Rate	Yes	0.357	Yes (re-specified)	0.1839
PSI #13	Postoperative Sepsis Rate	Yes	0.0798	Yes	0.2552
PSI #14	Postoperative Wound Dehiscence Rate	Yes	0.0183	Yes	0.0104
PSI #15	Accidental Puncture or Laceration Rate	Yes	0.3827	Yes (re-specified)	0.0052

Figure 3. Changes to the PSI-90 Safety Composite Metric in detail (Fontana & Hawes, 2017).

Note. PSI = Patient Safety Indicator. CRBSI = catheter-related bloodstream infection; PE = pulmonary embolism; DVT = deep vein thrombosis.

Measurement error. Both PSIs and HAIs are clearly defined, but are still subject to occasional methodological updates. While this sometimes benefits patients, providers, and consumers (risk adjustment updates that better capture the complexity and risk factors of the population, for example), it can create confusion and lack consistency desired for comparing performance year-to-year. Although this is a consideration, the hospitals included in the HAC Reduction Program equally potentially influenced by similar challenges; hence, further investigation is needed to determine how methodological changes in measurement and scoring impact hospital penalty status.

While many agree that measuring the incidence and impact of HACs is a worthy cause, HAC measurement has been scrutinized in its current form since it was introduced as a key component of pay-for-performance (Bysshe et al., 2017). The inclusion of HAC measures in both VBP and the HAC Reduction Program to-date is intended to emphasize the importance reducing preventable negative outcomes that impact the quality of life for patients; however, the validity of HACs as performance measures has been controversial (Calderon, Kavanagh, & Rice, 2015; Fuller et al., 2017; Winters et al., 2016). Variability in HAI surveillance practices (Rau, 2016), for example, hospitals with a robust infection surveillance program will count more infections, and therefore unfairly penalizing them for identifying more infections compared to hospitals with less robust programs (Rau, 2016), and the sole reliance of PSIs on administrative data (Bysshe et al., 2017) are central to HAC measurement controversy. Issues of poor methodological reliability can lead to the inaccurate designation of a hospital as a poor performer, which, in turn, results in financial penalty for hospitals that are not poor performers (Soltoff et al., 2018).

Finally, over the years the HAC Reduction Program has been in place, outcome measures have seen numerous modifications: for example, CAUTI and CLABSI both changed from reporting only SIR to infections identified in ICUs and select wards in FY 2018 (Centers for Medicare and Medicaid Services, 2017b). Likewise, PSI-90 saw major changes in FY 2018 (Agency for Healthcare Research and Quality, 2016b) shifting from version 5.0.1 to 6.0.1 in 2017, meaning that the measurement of outcomes in the HAC Reduction Program lacks consistency across years. These changes are detailed in Figure 3. The changes include additions, removals, and re-specification of several PSIs which pose an overwhelming challenge for hospitals who wish to reduce infections and avoid financial penalty.

In addition, HACs lack sensitivity and precision in the measurement of nursing practice, as they capture only a small portion of nursing care and dismiss fundamental components of the doctrine of profession of nursing, such as symptom management (Jones, 2016). Therefore, measurement error is an important consideration to the interpretation of HAC Reduction Program scoring and public reporting.

Importance and Improvements to Current Knowledge

The most widely recognized and mandated pay-for-performance programs are the CMS hospital pay-for-performance which includes VBP and the Hospital Readmission Reduction Program (HRRP), and MACRA and the Merit-Based Incentive Program (MIPS) which incentivize physicians (Centers for Medicare and Medicaid Services, 2017c). However, private payors and hospital systems are now including similar arrangements in individual hospital and provider contracts (Atkinson, Masiulis, Felgner, & Schumacher, 2010; Caveney, 2016). Thus, it is important to understand if the pay-for-performance programs are effective. Despite increasing adoption by payors, one meta-analysis and systematic review found the benefits of pay-for-performance programs to be “modest” to performance improvement and focused disproportionately on process measures instead of outcomes (Ogundeji, Bland, & Sheldon, 2016). Outcome measures reflect the effects of the care delivered on overall health status, such as mortality, readmissions, and infection rates (Donabedian, 1966). While outcomes are of superior importance in the realm of quality measurement, structure and process measures are important in understanding the conditions of care (Donabedian, 1966). Structure and process are unmistakably related, however, the relationships between process and outcome, and between structure and both process and outcome, are not as clear (Donabedian, 1966). This study will focus on performance as related to outcomes (HACs) and explore their relationship with structure.

Previous research suggests that structural characteristics of hospitals contribute to being penalized or not in the HAC Reduction Program (Koenig et al., 2016; Rajaram et al., 2015). Hospitals that are large (400 or more beds), academic, have a level I trauma center, or who have a higher CMI are more often subject to penalty (Koenig et al., 2016; Rajaram et al., 2015). Also more frequently penalized are hospitals with safety net status, meaning that the organization is part of the highest quartile of disproportionate share (DSH) payments awarded to large urban hospitals that care for a high proportion of uninsured patients (Rajaram et al., 2015). Safety-net hospitals are defined as being in the top quartile of DSH patient percentage and Medicare uncompensated care (UCC) payments per bed are at a greater risk for financial penalty in both VBP and the Hospital Readmissions Reduction Program, as well (Gilman et al., 2015). Hospitals performing in the worst quartile are subject to a 1% penalty in reimbursement for that fiscal/payment year. This can translate to well over a million dollars for a high-revenue hospital (Rau, 2016). Penalties can be particularly impactful for safety-net hospitals, as some already operate at low margins and cumulative losses could become detrimental over time, particularly if losses result in eventual closure (Gilman et al., 2015). Even for small, low-volume hospitals, closure can restrict access to care for the community affected.

Although previous research has shown hospital characteristics are related to being penalized by various CMS pay-for-performance programs within a single program year (Borah et al., 2012; Fuller et al., 2017; Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018), there has been no exploration on how hospitals fare year-to-year. By characterizing the effects of the HAC Reduction program over time, our results can inform decisions by healthcare policy stakeholders, such as the general public, policy makers, and technical experts who serve as advisors to CMS and AHRQ. Although healthcare providers and members of the general public are often familiar with other, more publicized components of the ACA such as medical insurance coverage, findings from this study will assist stakeholders in making knowledgeable advocacy and policy. Advocacy may include participation in CMS public comment opportunities regarding elements of the ACA affecting hospitals, patients, and healthcare quality standards. This study intends to provide valuable insight into the role of pay-for performance structures in incentivizing healthcare quality improvement, which can be leveraged to influence policy makers (Penuel & Means, 2013). In addition, this study will contribute to the practice of nurse leaders and administrators by exploring how nurse-sensitive structural characteristics, such as Magnet accreditation, contribute to HAC performance.

Innovation

This study is innovative in that it compares performance in the HAC Reduction Program within and across multiple program years. While research has been conducted with regard to hospital characteristics (Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018), measure validity (Winters et al., 2016), and program reliability (Soltoff et al., 2018) in CMS pay-for-performance programs, studies have so far only been conducted within the same program year, limiting applicability and the ability to make inferences regarding impact to hospitals and patient outcomes over time. In addition, the current study's results will contribute to a growing body of research on the efficacy and validity of quality measures and pay-for-performance programs (Ogundeji et al., 2016), which have found inconclusive or conflicting evidentiary support in improving care in a meaningful and sustainable way (de Bruin et al., 2011; Eijkenaar et al., 2013; Emmert et al., 2012; Kondo et al., 2016; Mendelson et al., 2017; Van Herck et al., 2010). This study is well-suited for an AHRQ-sponsored National Research Service Award (NRSA) Individual Postdoctoral Fellowship (F32) grant, PA-17-481, as it aligns with AHRQ's mission of making health care safer, higher quality, more accessible, equitable and affordable for all.

Approach

Study Design

The proposed research is a descriptive study involving retrospective, longitudinal multivariate regression analysis using multiple publicly available datasets. The primary aim of this study is to examine the relationship between hospital structural characteristics and penalization status (penalized or not penalized) in any given HAC Reduction Program year, FY 2015 through 2018. The secondary aim is to determine whether a hospital's penalization status (penalized or not penalized) across one or more HAC Reduction Program years is related to quality performance (Total HAC Score). Although secondary, retrospective analysis may pose methodological concerns associated with procedures used in the primary analysis: i.e. bias, representativeness, missing data from the primary source, and issues with data linkage (Clarke & Cossette, 2000; Harron et al., 2017), it is the only means of ascertaining CMS pay-for-performance program performance.

Sample. The sample will include hospitals that were in the CMS HAC Reduction Program from FY 2015 to FY 2018 for which complete data are available. Any hospital participating in the Inpatient Prospective Payment System/Long-Term Care Hospital Prospective Payment System is initially qualified for inclusion in the HAC Reduction Program. Approximately 3,233 hospitals will meet these criteria based on initial query of data files necessary for the analysis of the primary and secondary aims. Hospitals with incomplete data in any one of the three datasets (Hospital Compare HAC Reduction Program file, Hospital Compare Hospital General Information file, and CMS Payment Update Impact File) will be omitted. For the primary aim, a sample size of 3,233 is sufficient to examine hospital structural characteristics associated with HAC Reduction Program payment penalty. Since the sample size of interest is large and power is not expected to be an issue (James Stevens, 2002), positive power analysis will be done after the analysis of the primary and secondary aims to determine power based on the sample and effect size observed.

Data Sources. Three publicly available data sets will be used in the study. They are the (1) the Hospital Compare HAC Reduction Program file, (2) the Hospital Compare Hospital General Information file, and (3) the CMS Payment Update Impact File. Both Hospital Compare datasets are publicly available via the Data.Medicare.gov website Data Archive. The CMS Payment Update Impact File is also available publicly in multiple formats through the National Bureau of Economic Research for FY 1986 to most recent FY (Roth, 2017). In addition, a fourth dataset will be derived via manual data entry from the ANCC Magnet "Find a Facility" website tool (American Nurses Credentialing Center, 2018). Data for all eligible hospitals will be extracted and linked across datasets using hospital CMS Certification Numbers (CCN) to create a single dataset.

Procedures. In order to begin analysis for the primary and secondary aims, a single dataset must be constructed with all necessary variables. First, the Hospital Compare HAC Reduction Program dataset will be used to assess eligible hospital performance across HAC measures and in the overall program. The binary variable for HAC Reduction Penalty Status is readily available in Hospital Compare files for FY 2017 and 2018, but will require calculation for FY 2015 and 2016 based on Total HAC Score falling above or below the lowest quartile of performance for all eligible hospitals (above the lowest quartile indicates status of “no”, below indicates “yes”). The HAC Reduction Program’s list of participating hospitals for each included FY will be combined with the CMS Payment Update Impact File and Hospital General Information files for the corresponding time period using each hospital’s CCN as the unique identifier. Hospitals included in the HAC Reduction Program, but not included in the CMS Payment Update Impact File and/or Hospital Compare Hospital General Information file will be omitted. Hospitals not accredited as Magnet will be retained in the sample, as accreditation will be used as a descriptive variable. Magnet accreditation status data will require name and address to be used to link hospitals into the overall dataset, as CCN is not readily available from the ANCC Magnet website and must be manually matched using Hospital Compare and American Hospital Association datasets. Binary variables will be created indicating Magnet designation status for each of the HAC Reduction Program years researched (2015-2018).

The study does not require IRB review, as it does not fall within the regulatory definition of research involving human subjects as defined by 45 CFR 46.102. The proposed study utilizes only publicly available data sets, and do not contain any patient information.

Variables

Variables for primary aim. Table 1 lists the variables for the study. The dependent variable for this analysis is penalty status for any one program year, FY 2015 through 2018. HAC

Emily Cochran
V00274575
Reduction Program Penalty Status is a binary variable (yes/no) within the Hospital Compare HAC Reduction Program file, which will be used to indicate whether penalty was issued by CMS to an individual hospital in any program year. Hospital structural characteristics that are expected to be related to penalty status are outlined in Table 1. Hospital type is described by CMS as: acute care, children's, or critical access. A hospital's CMI represents the average diagnosis-related group (DRG) relative weight for that hospital, which is calculated by summing the DRG weights for all Medicare discharges and dividing by the number of discharges; higher CMI indicates more complex and resource-intensive caseloads (U.S. Department of Health & Human Services, 2018). Admission volume is measured by the average daily census, which captures the mean number of individuals hospitalized as inpatients; bed size is the number of licensed beds. Ownership describes who owns the hospital, whether it is owned by the government (federal, state, local, or hospital district or authority), physicians, is proprietary, tribal, or voluntary non-profit (church, other, or private) (Roth, 2017).

DSH adjustment is reported as the Disproportionate Share Hospital Patient Percentage (DPP) as determined from most recent update of the Provider Specific File (PSF) & Social Security Administration data (Roth, 2017). Hospitals are determined as qualifying for DSH payments by a formula or by demonstrating that more than 30 percent of their total net inpatient care revenues come from State and local governments for indigent care not including Medicare or Medicaid (Centers for Medicare and Medicaid Services, 2017a). Location has two descriptive variables: Core Based Statistical Area (CBSA) designation (urban or rural; large or other) and region (New England, Middle Atlantic, South Atlantic, East North Central, East South Central, West North Central, West South Central, Mountain, Pacific, Puerto Rico). ANCC Magnet designation will be included as an indicator of hospital commitment to nursing excellence, as Magnet-recognized hospitals are considered to retain superior nursing talent and exhibit better patient outcomes (American Nurses Association, n.d.). Many HACs are viewed as nurse-sensitive outcomes; therefore, a hospital structural measure such as Magnet status, which is indicative of quality nursing care, is necessary to evaluate the effect of the nursing care on outcomes such as HAC performance (Jones, 2016). Variables included in the primary aim, including concepts, variables, operational definitions, sources, and dataset variable names to be used in analysis are described in Table 1. A binary variable will be constructed to indicate whether a given hospital had been penalized in any other program year, using a SAS IF-THEN statement across the included program years (if Payment_Reduction= 'yes' then Penalty_In_Other_Year= '1'). This calculated variable will then be used as an independent/predictor variable along with hospital characteristic variables.

Variables for secondary aim. Total HAC Score will be used to measure whether a hospital has improved its performance across program years. Described further in Figure 2, Domain 1 (PSI-90) is worth 15% of the Total HAC Score, whereas Domain 2 (HAI) is worth 85%. Not all hospitals are scored in both domains or for every measure depending on patient or procedural volumes, as detailed in Figure 2. In such events, the Total HAC Score will be based exclusively on the hospital's Domain 1, or PSI-90 score, as applicable (Centers for Medicare and Medicaid Services, 2017b).

Of note, for FY 2015 through 2017, Winsorization was not used for the calculation of the Total HAC Score. Instead, hospitals' Total HAC Scores were determined points assigned by relative rank/performance decile only (Centers for Medicare and Medicaid Services, 2017d). This methodology is further described in Appendix B. Winsorization is a statistical procedure that involves ranking hospitals on a spectrum from best to worst performing and, "if a hospital's measure result falls between the minimum and 5th percentile, CMS sets the hospital's measure result equal to the 5th percentile"; "if a hospital's measure result falls between the 95th percentile and maximum, CMS sets the hospital's measure results equal to the 95th percentile" (Centers for Medicare and Medicaid Services, 2017b). This process is performed to reduce the effects of extremely high or low measure results (Centers for Medicare and Medicaid Services, 2017d). Therefore, hospitals cannot directly compare measure scores, the two domain scores, and Total HAC Scores between FY 2018 and any previous program years (Centers for Medicare and Medicaid Services, 2017b). Thus, FY 18 will not be included in these analyses for aim 2.

Although measure specification and definition changes within PSIs and HAIs across program years and therefore pose challenges with in consistent measurement of HAC performance over time, the methodology for the calculation of Total HAC Score remained consistent from program years 2015 to 2017. In light of this, the Total HAC Score will be used to measure performance improvement or decline over program years for FY 2015 to FY 2017.

Table 1. Variables, operational definitions, sources, and variable names for analysis.

Variable	Operational Definition	Source	Dataset Variable Name
Independent Variables for Primary Aim (FY 2015-2018)			
Hospital type	Hospital description as acute care, children's, or critical access by CMS.	Hospital Compare Hospital General Information file	Hospital Type
Case mix index	Average DRG relative weight for each hospital, calculated by summing the DRG weights for all Medicare discharges and dividing by the number of discharges and paid under Hospital Specific Payment rate (Roth, 2017).	CMS Payment Update Impact File	CMIV
Admission Volume	Average daily patient census.	CMS Payment Update Impact File	Average Daily Census
Bed Size	Number of beds licensed to hospital.	CMS Payment Update Impact File	BEDS
Ownership	Hospital ownership description: owned by government (federal, state, local, or hospital district or authority), physician, proprietary, tribal, voluntary non-profit (church, other, or private).	Hospital Compare Hospital General Information file	Hospital Ownership
DSH Adjustment	DSH Patient Percentage as determined from most recent update of the Provider Specific File & Social Security Administration Data (Roth, 2017).	CMS Payment Update Impact File	DSHPCT
Location	1. CMS Core Based Statistical Area designation categorized by CMS as urban or rural, large, or other. 2. Region categorized as New England, Middle Atlantic, South Atlantic, East North Central, East South Central, West North Central, West South Central, Mountain, Pacific, or Puerto Rico.	CMS Payment Update Impact File	REGION, URGEO
ANCC Magnet Status	Yes/No, binary variable related to whether the hospital is accredited with Magnet status for each HAC Reduction Program year (2015-2018).	ANCC	n/a
Dependent Variable for Primary Aim (FY 2015-2018) / Independent Variable for Secondary Aim (FY 2015-2017)			
HAC Reduction Program Status	Yes/No, binary variable related to whether penalty was issued by CMS.	Hospital Compare HAC Reduction Program file	Payment_ Reduction

Penalty in Any Other Program Year (Covariate)	Yes/No covariate binary variable constructed to indicate whether a given hospital had been penalized in any other program year (if Payment_Reduction= 'yes' then Penalty_In_Other_Year= '1').	Calculated	Penalty_In_Other_Year
Dependent Variable for Secondary Aim (FY 2015-2017)			
Total HAC Score	Total HAC Score based on hospitals' performance on 6 quality measures: PSI-90 and NHSN CLABSI, CAUTI, SSI for Colon Surgery and Abdominal Hysterectomy, MRSA bacteremia, and *Clostridium difficile infection* measures. Hospitals with a Total HAC Score greater than the 75th percentile of the Total HAC Score distribution are subject to a payment reduction (Centers for Medicare and Medicaid Services, 2017b).	Hospital Compare HAC Reduction Program file	Total_HAC_Score

Note. CMS = Centers for Medicare and Medicaid Services; CMI = Case Mix Index; DRG = diagnosis-related group; DSH = Disproportionate Share; ANCC = American Nurses Credentialing Center; HAC = Hospital Acquired Condition; PSI = Patient Safety Indicator; NHSN = National Health and Safety Network; CLABSI = Central line-associated bloodstream infection; CAUTI = Catheter-associated urinary tract infection; SSI = Surgical site infection; MRSA = methicillin-resistant staphylococcus aureus.

Data Analysis and Management Plan

Analytical model selection. For the primary aim, an analytical approach allowing for multiple independent variables (structural characteristics) and a single, binary dependent variable (penalty status) was necessary (Kim & Mallory, 2016). The approach must also control for the covariate of penalty status in any other program year and allow for repeated measurement of independent and dependent variables for each program year studied (FY 2015-2018). Thus, repeated measures analysis of covariance (ANCOVA) was selected as the analytical method for the primary aim.

The secondary aim requires an approach appropriate for evaluating the relationship between a single binary independent variable (hospital penalty status) and a continuous dependent variable (Total HAC Score) over time (program years FY 2015 to 2017) (Kim & Mallory, 2016). A one-way repeated measures analysis of variance (ANOVA) will be used for the secondary aim. SAS software will be used for statistical tests in both aims.

Primary Aim: The primary aim of this study is to examine the relationship between hospital structural characteristics and penalization status (penalized or not penalized) in any given HAC Reduction Program year, FY 2015 through 2018.

Analysis plan for primary aim. A binary logistic regression with repeated measures ANCOVA will be used to test for a relationship between each hospital characteristic (independent variable) and HAC Reduction Program penalty status (dependent variable) for each program year (2015-2018). In order to assess the relationship between and across these variables and HAC Reduction Program penalty status, structural variables will be used in a univariate, then multivariate model. For the multivariate model, the model statement will be modified to model categorical outcomes with fixed effects and repeated measures, using the SAS GLIMMIX procedure to account for repeated measurement of the independent and dependent variables for each program year (Schabenberger, 2005). Univariate testing will be performed for any variables determined to be confounding in the multivariate model.

The null hypothesis is that there is no significant difference in the characteristics of hospitals penalized in the HAC Reduction program from program years FY 2015 to FY 2018, which will be tested against the alternative hypothesis that there is an association among hospital characteristics across all program years. If the p-value is less than the assumed significance level of $\alpha = 0.05$, the null hypothesis will be rejected in favor of the alternative. Descriptive statistics including calculating means, standard deviations, and ranges for the continuous variables, and counts with frequencies for categorical variables will be used to describe the characteristics of the sample. Frequencies, proportions, and 95% confidence intervals will also be used for each categorical group. Data will be assumed normal and homoscedasticity will be checked graphically. Multicollinearity will be addressed using backward elimination if any variable is found to have a significant effect on the outcome (penalty status).

Secondary Aim: The secondary aim is to determine whether a hospital's penalization status (penalized or not penalized) across one or more HAC Reduction Program years is related to quality performance (Total HAC Score).

Analysis plan for secondary aim. ANOVA will be used to evaluate the relationship between hospital penalty (independent variable) and change in Total HAC Score (dependent variable) across program years FY 2015 to 2017. Descriptive statistics will be used to describe the sample, including calculating means, standard deviations, and ranges for the continuous variables, and counts with frequencies for categorical variables. Frequencies, proportions, and 95% confidence intervals will also be used for each categorical group.

The null hypothesis for the secondary aim states there is no significant association between Total HAC Score and penalty status across program years (2015-2017), which will be tested against the alternative hypothesis that there is an association among hospital characteristics across years. If the p-value is less than the assumed significance level of $\alpha = 0.05$, our null hypothesis will be rejected in favor of the alternative. Data will be assumed normal and homoscedasticity will be checked graphically.

Limitations

There are several limitations in this study, which include the use of secondary data described previously (Clarke & Cossette, 2000), methodological issues with the original (CMS, AHRQ, and NHSN) measurements and scoring, elapsed time since the primary data collection and analysis, and missing data for some hospitals. Methodological changes across program years in the HAC Reduction Program do not provide for optimal comparison of program results over time. This could pose the threat of measurement bias (Hulley, Cummings, Browner, Grady, & Newman, 2013). An additional methodological change is to the PSI-90 Patient Safety Composite, in which three measures were added and one was removed; weightings of three PSI measures were also increased, shifting weight from other measures within the composite (Centers for Medicare and Medicaid Services, 2017b), and underwent an update in risk adjustment, or “rebaseline” of the SIR in 2017 (Centers for Disease Control and Prevention, 2018b). Finally, data collection and surveillance procedures related to HAI measures has also been suspected to influence hospital performance (Rau, 2016).

These numerous changes to and challenges with the HAC Reduction Program methodology apply to all hospitals, giving no one hospital an unfair advantage. In addition, CMS endorses the comparison of measure scores, domain scores, and Total HAC Scores across all program years, with the exception of 2018 when the Winsorization scoring method was adopted (Centers for Medicare and Medicaid Services, 2017b). Therefore, the proposed study intends to use the measures and program methodology as they exist during the program years studied, to achieve the primary and secondary aims. The researchers acknowledge that the proposed research assumes validity of each HAC metric in measuring hospital performance, although it has been controversial (Calderon et al., 2015; Fuller et al., 2017; Winters et al., 2016).

Emily Cochran
V00274575

Appendix A

NHSN HAI Specifications

CLABSI, CAUTI, MRSA, and *C. difficile* are captured by NHSN by “date of event” (DOE), which is the date the first element used to meet an NHSN site-specific infection criterion occurs for the first time within the seven-day infection window period (Centers for Disease Control and Prevention, 2018a, pp. 2–7). SSI is captured by the date of the procedure by which the infection originated.

A CAUTI is a urinary tract infection in which an indwelling urinary catheter had been in place for >2 days and was either present for any portion of the calendar day on the DOE or the catheter was removed the day before the DOE. The patient must also have had at least one of the following signs or symptoms: fever (>38.0°C), suprapubic tenderness, costovertebral angle pain or tenderness, urinary urgency, urinary frequency, or dysuria (Centers for Disease Control and Prevention, 2018a). In addition, the patient must have had a urine culture with no more than two species of organisms identified, at least one of which is a bacterium of ≥105 colony forming units/ml (Centers for Disease Control and Prevention, 2018a, pp. 7–5).

NHSN defines CLABSI as a laboratory-confirmed bloodstream infection where an eligible bloodstream infection (BSI) organism is identified and an eligible central line is present on the laboratory-confirmed bloodstream infection date of event or the day before (Centers for Disease Control and Prevention, 2018a). Central lines eligible for inclusion been in place for more than two consecutive calendar days following the first access of the central line, in an inpatient location, during the admission included in the program (Centers for Disease Control and Prevention, 2018a). Lines are eligible for CLABSI events and remain eligible for CLABSI events until the day after removal from the body or patient discharge, whichever occurs first. An eligible organism for inclusion is one that meets the criteria for a laboratory-confirmed bloodstream infection in NHSN (Centers for Disease Control and Prevention, 2018a, pp. 4–6).

Procedures eligible for SSI surveillance for colon surgery or hysterectomy are defined by ICD-10 or CPT codes designated for inclusion by NHSN. Procedures require incision of the skin or mucous membrane and must take place in an operating room (Centers for Disease Control and Prevention, 2018a). Infections included as SSI for colon surgery and hysterectomy must occur within 30 after the procedure and involve a part of the body, as the HAC Reduction Program includes only deep incisional and organ/space SSI, which is monitored for a longer time period than superficial incisional SSI. To qualify as an SSI, the patient must have purulent drainage, a deep incision that spontaneously dehisces or is intentionally opened or aspirated, test positive for an organism, and must have had either fever (>38.0°C) or localized tenderness (Centers for Disease Control and Prevention, 2018a, pp. 9–10).

MRSA surveillance includes *staphylococcus aureus* cultured from any specimen that tests oxacillin-resistant, cefoxitin-resistant, or methicillin-resistant by standard susceptibility testing methods, or by a laboratory test for MRSA detection from isolated colonies. *C. difficile* requires a positive test for the organism. Both MRSA and *C. difficile* monitored at the overall facility-wide level for inpatient areas (Centers for Disease Control and Prevention, 2018a).

Emily Cochran
V00274575

Appendix B

FY 2015, 2016, and 2017 HAC Reduction Program Scoring Methodology (Centers for Medicare and Medicaid Services, n.d.).

FY 2015, 2016, and 2017 Scoring Methodology

The domain weights and measures for FY 2017 were the same as FY 2018. However, in FY 2016, CMS included only SSI, CLABSI, and CAUTI in Domain 2 and Domain 2 received a weight of 75 percent in the Total HAC Score. In FY 2015, CMS included only CLABSI and CAUTI in Domain 2 and Domain 2 received a weight of 65 percent.

In FY 2015, FY 2016, and FY 2017, CMS calculated measure results for each measure for which a hospital has sufficient data. A performance decile* was then assigned for each measure based on the hospital’s measure result. For each hospital for each measure, CMS assigned a measure score between 1 and 10 based on the decile in which the hospital’s measure result fell. For hospitals with a non-zero measure result for a given measure, CMS assigned x points to hospitals that fell within the x^{th} performance decile, ranging from a minimum of 1 point assigned to hospitals in the first performance decile (best-performing hospitals) to a maximum of 10 points assigned to hospitals in the tenth performance decile (worst-performing hospitals)*. Higher scores indicated worse performance.

Percentile	Points
1st - 10th	1
11th - 20th	2
21st – 30th	3
31st – 40th	4
41st – 50th	5
51st – 60th	6
61st – 70th	7
71st – 80th	8
81st – 90th	9
91st – 100th	10

Refer to the FY 2017 HAC Reduction Program HSR User Guide (PDF-1.2 MB) for more information on the scoring methodology used for the FY 2017 HAC Reduction Program.

* Hospitals received the minimum of one point for measures with a measure result of zero (vol. 79, FR 28140-28141) regardless of the performance decile. For example, for the CAUTI measure, if 13 percent of hospitals had an SIR of 0, one point would be assigned to each of the hospitals and two points would be assigned to the remaining 7 percent of hospitals in the second decile because their SIR was larger than 0.

Note. CMS = Centers for Medicare and Medicaid Services; HAC = Hospital Acquired Condition; SSI = Surgical site infection; CLABSI = Central line-associated bloodstream infection; CAUTI = Catheter-associated urinary tract infection.

Emily Cochran
V00274575

Hospital Characteristics Associated with HAC Reduction Program Payment Penalties across Program Years:

Manuscript Submission to *Quality Management in Healthcare*

Dissertation Chapters IV-V

Emily Cochran
V00274575

Abstract

Objective: The primary objective of this study was to examine the relationship between hospital structural characteristics and penalization status (penalized or not penalized) in any given hospital acquired condition (HAC) Reduction Program year, FY 2015 through 2018. Structural characteristics included hospital type, case mix index, average daily census, bed size, ownership, disproportionate share percentage, location, and American Nurses Credentialing Center Magnet status. The secondary objective of the study was to determine whether a hospital's penalization status across one or more HAC Reduction Program years is related to quality performance (Total HAC Score) in subsequent years. These objectives were achieved through retrospective, longitudinal, multivariate regression analysis using 4 publicly available data sources. **Background:** The intention of pay-for-performance programs, including the Centers for Medicare and Medicaid HAC Reduction Program, is to improve the quality of care delivered; however, the theoretical and conceptual basis of pay-for-performance programs and their efficacy in improving care are widely debated. This study was designed to address the gap in knowledge related to the efficacy of value-based reimbursement as a means of motivating providers and organizations to improve healthcare quality. **Results:** Higher average daily census, disproportionate share percentage, and case mix index were associated with increased likelihood of receiving a penalty in the HAC Reduction Program. Approximately half (49%) of who did not experience a penalty at all improved their Total HAC Score. 51% of hospitals with 1 year of penalty improved their Total HAC Score; 54% of hospitals with 2 years of penalty improved their Total HAC Score; 73% of hospitals with 3 years of penalty improved their Total HAC Score. **Conclusions:** Despite the inability of some hospitals to meet the benchmark to avoid penalty, the vast majority of hospitals improved their performance over time. This finding holds promise for value-based reimbursement as a means for improving HAC incidence.

Keywords: pay for performance, healthcare associated infections, healthcare quality indicators, organization and administration

Emily Cochran
V00274575

Introduction

Hospital-acquired conditions (HACs) are an issue in healthcare that harms patients and leads to the extension or complication of care, increased healthcare costs, disability, and even death (Pittet & Donaldson, 2006). The HAC Reduction Program, implemented in 2014, is a budget-neutral penalty-only program, existing among several Centers for Medicare and Medicaid (CMS) pay-for-performance structures offering incentives, such as Value-Based Purchasing (VBP) and the Medicare Access and CHIP Reauthorization Act (MACRA) (Centers for Medicare and Medicaid Services, 2017c). It is unclear whether the program functions as intended. The intention of all pay-for-performance programs is to improve the quality, and therefore value, of care delivered; however, the theoretical and conceptual basis of pay-for-performance programs and their efficacy is widely debated (de Bruin et al., 2011; Eijkenaar et al., 2013; Emmert et al., 2012; Kondo et al., 2016; Mendelson et al., 2017; Van Herck et al., 2010). The HAC Reduction Program was created to reduce preventable harm to patients (Center for Medicare and Medicaid Services, 2018).

In the HAC Reduction Program, hospital performance is assessed using several nurse-sensitive outcomes measures (Burston, Chaboyer, & Gillespie, 2014), including the Agency for Healthcare Research and Quality (AHRQ) Patient Safety Indicators (PSIs) and Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) hospital-acquired infections (HAI). More specifically, an overall score is calculated using the AHRQ Patient Safety Composite measure (PSI-90) and the CDC/NHSN HAI central line-associated bloodstream infections (CLABSI), catheter-associated urinary tract infections (CAUTI), surgical site infections (SSI), methicillin-resistant staphylococcus aureus (MRSA) bacteremia, and C. *difficile* laboratory-identified events.

Cross-sectional studies have found that some hospital structural characteristics are related to financial penalty in the CMS HAC Reduction Program. Hospitals that are academic medical centers, with 400 or more beds, have a level I trauma center, a high case mix index (CMI), and/or safety net status are more frequently penalized (Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018). Additional structural characteristics that are associated with poorer performance in both the HAC Reduction Program and Value-Based Purchasing (VBP) include higher disproportionate share (DSH) percentage, high Medicare and Medicaid patient volume, for profit status, teaching status , and Joint Commission accreditation (Borah et al., 2012; Fuller et al., 2017; Koenig et al., 2016; Rajaram et al., 2015). Though American Nurses Credentialing Center (ANCC) Magnet accreditation has not been explored as a structural characteristic in relation to the HAC Reduction Program specifically, Magnet accreditation has been associated with reduced HAC incidence (Barnes, Rearden, & McHugh, 2016; Bergquist-Beringer, Cramer, Potter, Stobinski, & Boyle, 2018).

Because not all hospitals required to participate in the HAC Reduction Program are scored in every measure due to low volume of patients or procedures (Centers for Medicare and Medicaid Services, 2017b), larger hospitals that have higher volumes of qualifying patients and procedures and also care for a higher proportion of complex and/or disadvantaged populations, disproportionately receive penalty status (Rajaram et al., 2015). The above studies were all cross-sectional studies within a single (Borah et al., 2012; Fuller et al., 2017; Koenig et al., 2016; Rajaram et al., 2015) or two program years (Soltoff et al., 2018). The aim/purpose of this study is to examine how hospitals fare in the HAC reduction program across years. A longitudinal design studying multiple program years will precipitate a better understanding of inter-hospital variability and changes in quality which may be linked to participation in the program (Penuel & Means, 2013), as there is a gap in research related to how hospitals fare in the program year-to-year.

This study will explore associations between structural characteristics that may influence processes, which in turn, could impact quality care outcomes as measured in the CMS HAC Reduction Program. Processes related to HACs will not be examined in this study. The primary aim of this study is to examine the relationship between hospital structural characteristics and

Emily Cochran
V00274575
penalization status (penalized or not penalized) in any given HAC Reduction Program year, FY 2015 through 2018. The secondary aim is to determine whether a hospital's penalization status (penalized or not penalized) across one or more HAC Reduction Program years is related to quality performance (Total HAC Score).

The Conceptual Model

The results from this study inform a growing body of knowledge surrounding the efficacy of value-based reimbursement as a means to motivate providers and organizations to improve healthcare quality. The study design was guided by Donabedian's three dimensions of quality : structure, process, and outcome (Donabedian, 1988). Structure accounts for the care setting; process considers the actual steps in care administration; and outcome takes into account the effects of the care delivered on a patient's overall health status (Donabedian, 1988).

Donabedian introduced that economic efficiency, or valuation, be considered in quality improvement and proposed that practitioners maximize the cost-benefit of healthcare improvements, as increased cost will not always lead to an equal increase in the quality of care (Donabedian, 1966). An organization's structural characteristics can be key to implementing strategies for improving processes, and thus patient outcomes such as HACs (Donabedian, 1966). Pay-for-performance programs lack the evidence necessary to produce processes for meaningful and sustainable quality improvements (de Bruin et al., 2011; Eijkenaar et al., 2013; Emmert et al., 2012; Kondo et al., 2016; Mendelson et al., 2017; Van Herck et al., 2010).

Methods

Study Design

This is a descriptive study involving retrospective, longitudinal multivariate regression analysis using multiple publicly available datasets, three available through CMS and one through ANCC. The primary objective is to examine the relationship between hospital structural characteristics and penalization status (penalized or not penalized) in any given HAC Reduction Program year, FY 2015 through 2018. The secondary objective is to determine whether a hospital's penalization status across one or more HAC Reduction Program years is related to quality performance (Total HAC Score) in subsequent years.

Sample. The sample included hospitals that were in the CMS HAC Reduction Program from FY 2015 to FY 2018 for which complete data were available. Any hospital participating in the Inpatient Prospective Payment System/Long-Term Care Hospital Prospective Payment System is qualified for inclusion in the HAC Reduction Program. The initial sample size was 3,233 in the primary objective and 3,382 in the secondary objective. Hospitals with incomplete data in any one of the three datasets were omitted during data management procedures.

Data Sources. Three publicly available datasets were used in the study. They are (1) the Hospital Compare HAC Reduction Program file, (2) the Hospital Compare Hospital General Information file, and (3) the CMS Payment Update Impact File. Both Hospital Compare datasets were publicly available via the Data.Medicare.gov website Data Archive. The CMS Payment Update Impact File is available through the National Bureau of Economic Research for FY 1986 to most recent FY (Roth, 2017). In addition, a fourth dataset was created manually from the ANCC Magnet “Find a Facility” website tool (American Nurses Credentialing Center, 2018). Each year’s data for all eligible hospitals were extracted and linked across datasets using hospital CMS Certification Numbers (CCN) to create a single dataset. Variables provided by each data source are detailed in Appendix A.

Procedures. A single dataset was constructed with all necessary variables through several steps. First, the Hospital Compare HAC Reduction Program dataset was used to extract data for HAC measures and in the overall program for eligible hospitals. The binary variable for HAC Reduction Penalty Status is already calculated in the in Hospital Compare files for FY 2017 and 2018, but required calculation for FY 2015 and 2016. Therefore, the binary variable was calculated for FY 2015 and 2016 based on Total HAC Score falling above or below the lowest quartile of performance for all eligible hospitals (above the lowest quartile indicates status of “no”, below indicates “yes”). The third step was to combine the HAC Reduction Program dataset with the CMS Payment Update Impact File and Hospital General Information files for the corresponding time period using each hospital's CCN as the unique identifier. Hospitals included in the HAC Reduction Program, but not included in the CMS Payment Update Impact File and/or Hospital Compare Hospital General Information file were omitted. Hospitals not accredited as Magnet were retained in the sample, as accreditation was used as a descriptive variable. In the final step, to obtain the Magnet accreditation status, name and address were used from the Magnet data to link hospitals into the overall/combine dataset, as CCN is not readily available from the ANCC Magnet website and must be manually matched using Hospital Compare and American Hospital Association datasets. Binary variables were created indicating Magnet designation status for each of the HAC Reduction Program years researched (2015-2018).

Variables. Variables included in the primary and secondary objectives are described in Appendix A. The figure includes concepts, variable name, operational definitions, sources, and dataset variable names to be used in analysis. Independent variables for the primary objective were hospital type, CMI, average daily census, bed size, ownership, DSH adjustment, location, and ANCC Magnet Status. The dependent variable for the second objective was constructed to indicate whether a given hospital had been penalized the initial program year studied (2015) in comparison with the following years (2016-2017) studied. Total HAC Score was used to measure whether a hospital has improved its performance.

A minor adjustment to the data acquisition plan was necessary during analysis preparation. Two versions of CMI were available for each HAC Reduction Program year. For example, in FY 2015, CMI version 31 and 32 were available and version 32 was used for analysis; for FY 2016, version 32 and 33 were available and version 33 was used for analysis, and so on. Different versions of CMI are based on the DRG grouper logic us year (Centers for Medicare and Medicaid Services, 2016b); therefore, it was appropriate to proceed with the analysis by comparing CMI versions across years. For the purpose of this study, only the most recent year

Emily Cochran
V00274575

of CMI available was extracted. Data management completed prior to analysis is detailed in Appendix B.

Analysis Preparation

Three steps were taken to prepare the data for analysis. First, due to an unanticipated lack of variation, the variable for hospital type was removed from the model after determining that all hospitals meeting criteria for inclusion in the dataset were categorized as "acute care hospitals." Hospitals with a CMS Certification Number (CCN) available for each of the four years studied in the primary objective and all three years studied in the secondary objective were then filtered to include those with complete data for the dependent variable (penalty status for objective 1 and HAC score for objective 2). Hospitals with no data for penalty status for the primary objective, or that lacked 2015 or 2017 performance data necessary to calculate total HAC score for the secondary objective, were excluded. For the secondary objective, at least two Total HAC Scores are necessary to evaluate a potential difference in Total HAC Score between years. Thus, 3,399 hospitals were the sample for the primary objective and 3,382 hospitals were the total sample for the secondary objective, as described in Table 1.

Table 1

Number (n) of Hospitals Included in Each Objective for Each Program Year Studied

	2015	2016	2017	2018	Total Observations Across Years
Primary Objective					
All Years	3399	3399	3399	3399	13596
All Years, with Penalty Status Available	3280	3211	3267	3258	13016
Secondary Objective					
All Years	3382	3382	3382	n/a	10146
All Years, with Total HAC Score for 2015 & 2017	3204	3204	3204	n/a	9612

In the second step, since multicollinearity was a concern due to the potential relation of some structural characteristics, a pairwise comparison of Pearson correlations for non-categorical variables was performed prior to the analysis for the primary objective. A nearly perfect correlation was observed between average daily census and bed size (r= 0.97).

Therefore, before proceeding to final model and to check for collinearity, the two variables were examined in an ANCOVA model first separately and then together. Using bed size alone in the model, average daily census yielded significant results (F= 318.91, *p*= <.0001) and a negative parameter estimate (t= -51.33). Average daily census was also significant if run separately in the model (F= 204.62, *p*= <.0001) with a negative parameter estimate (t= -43.10). Together in the model, both remained significant (average daily census F= 42.95, *p*= <.0001, bed size F= 10.19, *p*= 0.0014), but parameter estimates changed substantially (average daily census t= 6.55; bed size t= -3.19) indicating multicollinearity. Therefore, bed size was excluded from the initial model in favor of average daily census, which more accurately describe patient volumes rather than facility capacity. No other pairwise Pearson correlations were found to have a strong, or even moderate, positive or negative correlation by commonly accepted interpretations (r= less than 0.50 or greater than -0.50) (Hinkle, Wiersma, & Jurs, 2003). A matrix of correlation coefficients is presented in Table 2.

The third and final step was done in preparation for the examination of the secondary objective. A categorical variable was constructed to indicate how many years a given hospital had experienced a penalty status of “yes” in the years 2015 through 2017, ranging from values 0-3; 0 indicating hospitals that had not received any penalty in the years studied, 1 indicating one year of penalty, 2 indicating 2 years of penalty, and 3 indicating 3 years of penalty (penalty for all included years). A binary variable was then created to indicate whether a given hospital had a reduction in Total HAC Score for the time period (1, or “yes,” indicates improvement in Total HAC Score from 2015-2017). Because hospitals cannot directly compare measure scores after the adoption of Winsorization methodology by CMS, FY 18 results were not included in the analyses of Total HAC Score for objective 2. Winsorization and related changes are further detailed in Appendix C.

Results (Chapter IV)

Results for Primary Objective

The number of hospitals qualifying for and included in each objective for each program year studied is summarized in Table 1. In each year studied, approximately 2,500 hospitals were penalized and approximately 750 hospitals were not (see Tables 3 and 4). Average daily census was substantially higher in hospitals receiving penalty (M= 158.16, SD= 170.49) across the years studied than those that were not (M= 97.69, SD= 124.33). Similarly, DSH percentage was higher for penalized hospitals in all four years (M= 0.32, SD= 0.19) than non-penalized hospitals (M= 0.28, SD= 0.17). CMI was also higher for the penalized group across years (M= 1.62, SD= 0.37) than the group not receiving a penalty (M= 1.53, SD= 0.37).

Hospitals in the South Atlantic region comprised the highest percentage of penalized hospitals across years 2015 to 2018 (18%), followed by Pacific (15%) and Middle Atlantic (15%) regions. The majority of hospitals penalized were in the large urban CMS core based statistical area (CBSA) category (48%); the next highest percentage CBSA category was other urban (34.3%) across years. Non-Magnet-accredited organizations encompassed the overwhelming majority of penalized hospitals across years (82-88%). For hospital ownership, privately-owned voluntary non-profit organizations made up 45% of all penalized hospitals in the time period studied, followed by proprietary-owned hospitals at 18%.

Next, using the process of backward elimination, hospital structural variables for each year were included into a binary logistic regression ANCOVA fixed effects model in order to examine the effect of average daily census, ownership, geographical location, and Magnet accreditation on penalty status. This initial model yielded significant associations between all the variables and penalty status, with the exception of Magnet accreditation status (p= 0.5461) and hospital ownership (p= 0.1002) (see Table 5). Therefore, using the process of backward elimination to obtain a parsimonious model, Magnet status and hospital ownership were excluded in subsequent models.

The next ANCOVA model indicated the need to eliminate CBSA (p= 0.0681), which designates hospitals as large urban, other urban, or rural (see Table 6). Thus, the final multivariate model excluding hospital type, Magnet Status, hospital ownership, and CBSA maintained a significant association between penalty and average daily census (F= 88.56, *p* <.0001), DSH percentage (F= 15.82, *p* <.0001), region, and CMI (F= 13.98, *p* <.0001). Results for the final ANCOVA fixed effects model shown in Table 7 and are reported with greater detail in Table 8, including the categories within each hospital characteristic.

Table 8

Results for Final Fixed Effects Model of Hospital Structural Characteristics, Including Variable Categories

Fixed Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	-2.2149	0.2011	3346	-11.01	<.0001
Average Daily Census	0.00228	0.000242	9549	9.41	<.0001
Disproportionate Share (DSH) Percentage	0.7031	0.1768	9549	3.98	<.0001
Region					
New England	0.2498	0.1681	9549	1.49	0.1373
Middle Atlantic	0.1346	0.1232	9549	1.09	0.2747
South Atlantic	-0.1667	0.1149	9549	-1.45	0.1467
East North Central	-0.4117	0.1184	9549	-3.48	0.0005
East South Central	-0.51	0.1381	9549	-3.69	0.0002
West North Central	-0.3592	0.1409	9549	-2.55	0.0108
West South Central	-0.4774	0.1169	9549	-4.08	<.0001
Mountain	0.01125	0.1388	9549	0.08	0.9354
Pacific	0	n/a	n/a	n/a	n/a
Case Mix Index (CMI)	0.3701	0.09899	9549	3.74	0.0002

Note. Coefficients of zero due to redundancy are reported "n/a."

Odds ratios calculated from the parameter estimates indicate that a 1% increase in DSH doubled the likelihood that a hospital would be penalized, and a 1-unit increase in CMI demonstrated a 50% increase in the likelihood of hospital penalty. For each 10-patient increase in average daily census, the odds of hospital penalty increased by 2%. In comparison to hospitals in the Pacific region, hospitals located in the East North and South Central, West North and South Central regions demonstrated a significantly lower probability of hospital penalty than all other regions. The East North Central region contains the states of Wisconsin, Michigan, Illinois, Indiana, and Ohio; East South Central contains Kentucky, Tennessee, Mississippi, and Alabama; West North Central contains North and South Dakota, Minnesota, Iowa, Nebraska, Kansas, and Missouri; West South Central includes Texas, Louisiana, Arkansas, and Oklahoma (US Census Bureau, 2000a). A map of regional categorizations can be found in Appendix D.

Results for Secondary Objective

The secondary objective was to determine whether a hospital's penalization status across one or more HAC Reduction Program years was related to quality performance (Total HAC Score). Frequencies and proportions describing the relationship of penalty in any given program year with whether organizations had a reduction in Total HAC Score from 2015 to 2017 are described in in Table 9. To summarize, 49% of hospitals with no penalty in any year improved their Total HAC Score; 51% of hospitals with 1 year of penalty improved their Total HAC Score; 54% of hospitals with 2 years of penalty improved their Total HAC Score; 73% of hospitals with 3 years of penalty improved their Total HAC Score**.**

Table 9

Frequencies and Proportions of the Effect of Penalty in Any Given Program Year on Whether Organizations Had a Reduction in Total HAC Score from 2015 to 2017 (n= 3204).

	Total HAC Score Reduction: No		Total HAC Score Reduction: Yes		Total	All Hospitals with Total HAC Score Reduction: Yes
	n	%	n	%	n	%
0 Years of Penalty	959	61.8%	912	55.2%	1871	48.7%
1 Year of Penalty	349	22.5%	361	21.8%	710	50.8%
2 Years of Penalty	177	11.4%	205	12.4%	382	53.7%
3 Years of Penalty	66	4.3%	175	10.6%	241	72.6%
Subtotal for Total HAC Score Reduction Group	1551	48.4%	1653	51.6%	3204	51.6%

One-way ANOVA testing (see Table 10 in Appendix) indicated there was a significant effect of hospital's penalization status on subsequent Total HAC scores (df= 3, F= 16.751, p= 0.000). Because it was of interest if differences existed between hospitals grouped by years of penalty

(0-3 years), the Tukey adjustment method for comparison between multiple groups was used for post-hoc testing. Significant differences were found between hospitals having 3 years of penalty and all other penalty year groups (all p= 0.000). The mean difference in the reduction of Total HAC Score between hospitals penalized in all 3 years and those not penalized at all was also significant in relation to other groups (diff= 0.239, p= 0.000). In addition, Total HAC Score reduction between hospitals receiving penalty 3 years and those receiving penalty 0, 1, and 2 years of the years studied (each 3 pairs) demonstrated a significant relationship.

In summary, the analysis of the data resulted in numerous significant findings. For the primary objective, increased average daily census, DSH percentage, and CMI were all associated with significantly higher probability of penalty across years in the HAC Reduction Program. Regionally, hospitals located in Midwestern states as defined by the US Census Bureau (US Census Bureau, 2000b) were less likely to be penalized than hospitals located in other regions. While 49% of hospitals with no penalty improved their Total HAC Score, as years of penalty increased from 1-3 years, the percentage of hospitals that improved their HAC score within each group also increased.

Discussion (Chapter V)

The study found significant differences in some structural characteristics of hospitals penalized in the HAC Reduction program from program years FY 2015 to FY 2018. Further, a significant association was found between improvement in Total HAC Score for hospitals receiving penalty for 3 years and whether a hospital was penalized across program years (2015-2017). The significant relationship between certain structural characteristics and penalty were similar to results from other cross-sectional studies (Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018), with differences observed in some characteristics, possibly resulting from the execution of a longitudinal analysis. This relationship will be discussed further here.

Structural Characteristics (Primary Objective)

Emily Cochran
V00274575

The evaluation of various structural characteristics was key to achieving the primary objective. Though previous research indicates that hospital structural characteristics are associated with financial penalty in the HAC Reduction Program (Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018) and performance in the HAC Reduction Program and VBP (Borah et al., 2012; Fuller et al., 2017; Koenig et al., 2016; Rajaram et al., 2015), this study examined the association between hospital structural characteristics and penalty status across program years (2015-2018). The study results indicated that increased average daily census, DSH percentage, and CMI demonstrated a statistically significant association with HAC Reduction Program penalty across years. Modest increases in DSH percentage and CMI demonstrated the most significant increase in the odds of a hospital receiving a penalty. Both DSH percentage and CMI are indicators of patient complexity, and this study's results are consistent with findings from previous cross-sectional studies that found hospitals with high patient volume and procedures and those with a higher proportion of complex and/or disadvantaged populations are penalized more frequently (Rajaram et al., 2015). Therefore, risk adjustments currently used could be incomplete. It may be prudent for DSH percentage and CMI to be incorporated into risk adjustment in the HAC-reduction program and other value-based reimbursement programs as some have suggested (Fuller et al., 2017).

Region was found in this study to be significantly associated with penalty. Organizations located in the Midwestern region were less likely to be penalized in the HAC Reduction Program than hospitals located in other regions. One possible explanation could be that there are fewer academic medical centers in the Midwest. Academic medical centers have higher proportions of ICU patients and treat patients with more comorbidities (Burke et al., 2018) and, thus, higher CMI. With fewer Academic Medical Centers the Midwest regions also have fewer complex patients and therefore a reduced likelihood of HAC prevalence, and therefore penalty. In the Midwestern Census area, 71% are nonteaching hospitals compared to 68% in the Northeast, 74% in the West, and 87% in the South (Burke et al., 2018).

Emily Cochran
V00274575

Though HACs are often used as measurements of nursing care, process, and structure (American Nurses Association, n.d.; Burston et al., 2014), this study used one measure of nursing structure: ANCC Magnet accreditation status. Magnet status was selected for use in this study because of its association with reduced HAC incidence (Barnes et al., 2016; Bergquist-Beringer et al., 2018). It was somewhat surprising that Magnet status, hospital ownership, and CBSA were not significant, and therefore, not retained in the final model. Hospitals who are Magnet accredited had been shown in previous research to have lower HAC incidence (Barnes et al., 2016; Bergquist-Beringer et al., 2018) and hospitals penalized more frequently have been shown to hold more quality accreditations, such as Joint Commission accreditation (Rajaram et al., 2015). Previous research has also indicated that penalized hospitals are more likely to be urban or voluntary non-profit owned (Soltoff et al., 2018). The nonsignificant results in this study for Magnet status, hospital ownership, and CBSA may be related to the use of a repeated measures ANCOVA model rather than the cross-sectional logistic regression used in previous studies, which better detects within-subject change over time and typically has higher statistical power than cross-sectional designs (Guo, Logan, Glueck, & Muller, 2013).

Penalty Status and Total HAC Score (Secondary Objective)

The findings suggest that hospitals with 3 years of penalty are more likely to have a reduction in Total HAC Score than hospitals with fewer years of penalty, and the majority of hospitals demonstrated a reduction in Total HAC Score regardless of the number of years of penalty. It is possible that public reporting of the HAC Reduction Program results has driven this reduction over time (James, 2012). Despite the inability of hospitals to avoid penalty while still reducing their Total HAC Score from 2015 to 2017, the vast majority (73%) of hospitals experiencing penalty in all 3 years did have improved Total HAC Scores. The remaining 27% of hospitals did not see improvement in Total HAC Score. Reduction in overall Total HAC Scores is a promising indicator that HAC rates are improving, regardless of penalty status.

Though the study results do not directly address concerns related to methodological reliability of the HAC Reduction Program, HAIs, or PSIs as mechanisms of measuring quality performance (Bysshe et al., 2017; Rau, 2016; Soltoff et al., 2018), the results do imply that the majority of hospitals are not being unfairly or repeatedly penalized despite improvement in their Total HAC Scores. The HAC Reduction Program bases the penalty threshold upon the performance of all eligible hospitals in a given program year, meaning that since hospitals are improving overall, the penalty threshold will change accordingly. To avoid penalty in the HAC Reduction Program, hospitals would need to improve at a faster pace than their peers. The minority of hospitals that do experience penalty may consider prioritizing the robust implementation of evidence-based HAC prevention practices, such as those offered by CMS, AHRQ, and CMS toolkits, to prevent sustained penalty in the HAC Reduction Program (Agency for Healthcare Research and Quality, 2016a; Centers for Medicare and Medicaid Services, 2017b). In summary, the current study found that Total HAC Score is a valid measurement of quality improvement related to HAC incidence for the majority of hospitals, an assumption which has been reportedly controversial (Calderon et al., 2015; Fuller et al., 2017; Winters et al., 2016).

Study Limitations

Limitations in this study include methodological changes and issues around missing data, hospital type, CMI, and Magnet status variables.

Methodological changes. The most significant limitation of this study is that methodological changes across HAC Reduction Program years do not create the most robust methodological conditions for comparisons over time. Such methodological changes could precipitate measurement bias (Hulley et al., 2013). Nonetheless, statisticians contracted by CMS encourage the comparison of performance across years, with the exception of 2018 when the Winsorization scoring method was adopted (Centers for Medicare and Medicaid Services, 2017b) since no hospital is uniquely subjected to the yearly methodological changes. The use of a binary variable to indicate whether a reduction in Total HAC Score was achieved for hospitals between 2015 and 2017 was also suboptimal.

A second methodological limitation is that, though using the Total HAC Score as a continuous dependent variable was considered, the raw value is not a clinically meaningful metric. Instead, it is a composite with a changing penalty threshold each year. The Total HAC Score does not translate directly to a rate or quantification of HAC incidence, rather, it is directionally indicative of improvement with decline (Centers for Medicare and Medicaid Services, n.d.). Also, since penalty threshold varies from year to year, a Total HAC Score that indicates good performance relative to other hospitals in one year may result in penalty the next year if the penalty threshold is set differently for that year. Therefore, there is an opportunity for more robust and informative future analysis of the HAC Reduction Program that may examine Total HAC Score as a continuous outcome variable. For example, this might involve calculating the percent difference between years for all hospitals in relation to the respective benchmark for each program year.

Missing data. Another limitation is that data for 178 hospitals were not available for analysis in the secondary objective. It was not feasible to calculate the difference in Total HAC Score and penalty status for those 178 hospitals in the current study, as those hospitals had missing Total HAC Scores or penalty status in one or more of the included years. Therefore, these hospitals may be included in the assignment of relative rank/performance decile used by CMS to calculate the penalty threshold in any given year (2015 through 2017), but were excluded from the one-way ANOVA in this study. Although secondary, retrospective analysis may pose methodological concerns associated with procedures used in the primary data collection and analysis: i.e. bias, representativeness, missing data from the primary source, and issues with data linkage (Clarke & Cossette, 2000; Harron et al., 2017), it is the only means of ascertaining CMS pay-for-performance program performance.

Hospital type. An important distinction for NHSN HAI surveillance criteria and value-based reimbursement programs as a whole is hospital type (American Hospital Association, 2014; Burke et al., 2018; Fernando, Gray, & Gottlieb, 2017; McIlvennan et al., 2015; Peasah, Mckay, Harman, Al-Amin, & Cook, 2013). Hospital type is whether the hospital is designated as acute care, children's, or critical access by CMS; however, it is not stated explicitly in CMS guidelines that acute care hospitals are the only hospitals subject to payment penalty in the HAC Reduction Program. Instead, only exempted hospitals and units are described (Centers for Medicare and Medicaid Services, 2018). Therefore, an alternative structural characteristic or variables, such as teaching status or trauma designation, would have been more meaningful alternatives for inclusion in this study.

CMI. Variation in coding practices among hospitals included in the study may impact the interpretation of CMI's effect on penalty status in general. Consistency in CMI versions across program years was not possible given that several years were studied. Slightly different results from the model could have been obtained for different CMI versions, which rely on the DRG grouper version in use during a given HAC Reduction Program year. This lack of consistency serves as an important reminder that CMI relies heavily upon coding used for billing and administrative purposes, and variation in coding does impact the appropriate capture of complications and comorbidities used to determine illness severity (Yang & Reinke, 2006). While CMI has been used in some similar studies as an indicator of patient complexity (Fuller et al., 2017; Rajaram et al., 2015), validity concerns with CMI are not addressed in those studies.

Magnet status. Magnet accreditation status is publicly available, unlike many other nursing structural measures such as staffing level, nurse-to-patient ratios, training resources, or facilities; however, Magnet status may not be wholly reliable as a single measure of nursing structure. There is a strong body of literature establishing relationships between increased nurse staffing (B. Mitchell, Gardner, Stone, Hall, & Pogorzelska-Maziarz, 2018), good nurse work environments (Kelly, Kutney-Lee, Lake, & Aiken, 2013), and nurse specialty certifications

(Boyle, 2017) with reduced HAC rates. Magnet hospitals are also characteristically large, academic medical centers in urban locations (Friese, Xia, Ghaferi, Birkmeyer, & Banerjee, 2015). Since Magnet status was not significant and eliminated from the model early in the analysis, additional, more specific measures of nursing structure may have yielded greater sensitivity to nursing care and subsequently different results.

Implications for Future Research

Implications for healthcare administration. The results from this study have potential applications for healthcare administration related to the scopes of safety culture, leadership, and the contribution of nursing care in HAC prevention, as leadership and culture play an integral role in successful organizational quality and safety improvement (Berwick, 2008; Kaplan, Provost, Froehle, & Margolis, 2012; Lanham, 2013; Lukas et al., 2007). Structural characteristics driving organizational change such as mission, vision, and strategy, operational functions and processes, and infrastructure are foundational in organizational safety culture (Lukas et al., 2007; Sorra & Dyer, 2010). Leadership culture, teamwork, and a spirit of continuous organizational improvement are key elements of improving patient safety and quality metrics, including HACs. These elements overlap considerably with the dimensions of the AHRQ Hospital Survey on Patient Safety Culture, which has demonstrated overall acceptable psychometric properties as a measure of overall organizational safety culture (Sorra & Dyer, 2010). Additionally, evidence has shown that higher scores on the AHRQ Hospital Survey on Patient Safety Culture are correlated with better patient outcomes (DiCuccio, 2015), including HACs (Reis, Paiva, & Sousa, 2018).

The publicly available hospital characteristics such as those included in the current study allow for convenient and standardized quality assessment; however, many popular sources available free of cost do not capture organizationally-established measures of structure, process, and outcomes. Future research on this topic should investigate organizational leadership and safety culture in relation to HACs or leveraging mixed methods by integrating

Emily Cochran
V00274575

qualitative surveys with publicly reported data, such as the AHRQ Hospital Survey on Patient Safety Culture.

Policy implications. The results from this study offer several implications to policy and factors to consider for future research, including the impact of the methodology and efficacy of value-based reimbursement program. First, this study emphasizes the importance and impact of controlling for hospital structural characteristics in data analyses used for the development of policy, such as the ACA, under which the HAC Reduction Program was legislated. Differences in methodological approaches are an important policy consideration when hospital performance is measured and simplified for public consumption (for example, Leapfrog Safety Scores or CMS Star Ratings) (James, 2012). Although the methodology used within programs is not legislated, public reporting is (James, 2012). Certain standards of validation and reliability should be considered to be mandated with the public reporting of hospital performance, as accuracy has been and remains a major concern for providers (James, 2012).

The principles underpinning value-based reimbursement programs and policies, that penalty or reward will incentivize the improvement of quality and safety, has been wrought with controversy (American Hospital Association, 2014; Association of American Medical Colleges, 2014; de Bruin et al., 2011; Eijkenaar et al., 2013; Emmert et al., 2012; Kondo et al., 2016; Mendelson et al., 2017; Van Herck et al., 2010; Woolhandler & Himmelstein, 2015). The current study does not precipitate any conclusions regarding the efficacy of pay-for-performance policies as a whole, but does indicate that penalties associated with the HAC Reduction Program may drive improvement in HACs across the board, regardless of penalty status. Additional research is needed to better understand policies and other mechanisms by which hospitals can be motivated to improve and sustain improved performance.

Conclusion (Chapter V)

This study explored hospital structural characteristics as related to both penalty status and HAC performance, across program years. Additionally, the study determined whether a hospital's penalization status across one or more HAC Reduction Program years is related to HAC performance. The study found that, with increasing average daily census, DSH percentage, and CMI, hospitals were more likely to be penalized in the program. Regional differences were observed, with hospitals located geographically in the Midwest demonstrating less likelihood of receiving HAC Reduction Program penalty. This study's results suggest that, despite the inability of some hospitals to meet the benchmark to avoid penalty, the majority of hospitals improved their Total HAC Score across the years studied. This finding suggests that hospitals are not being unfairly or repeatedly penalized despite improvement in their Total HAC Scores, potentially indicating an encouraging reduction of HAC incidence, or outcomes, across the country.

Numerous implications of this research were identified in the areas of organizational administration and healthcare policy. An organization or hospital's mission, vision, and strategy, as well as operational infrastructure can have a tremendous impact on the ability to improve quality and safety for patients. Though some pay-for-performance programs are mandated to measure quality, more care should be taken to ensure that ensure that metrics are methodologically sound and account for key structural characteristics such as DSH percentage and CMI, especially where performance is reported for public consumption.

Given the numerous limitations of this study, accurate measurement of quality pertaining to healthcare delivery is paramount in ensuring that value-based reimbursement policies are meaningful to providers and patients. Measurement and instrumentation related to quality in healthcare and nursing are perhaps the most challenging aspects of achieving effective pay-for-performance strategies: primary data sources are rarely available and secondary sources sometimes leave much to be desired. With regard to the foundational principles of value-based reimbursement, there is a substantial gap in the availability of reliable nursing-sensitive quality indicators; still, nursing care is the mainstay of our nation's healthcare system. It is essential that we better understand the modalities by which positive change is facilitated and how such

Emily Cochran
V00274575

change can be rewarded in order to reduce patient harm and improve the health and well-being of the population.

Value-based reimbursement policy remains a promising area of research as healthcare and nursing experts strive to understand the how care quality can be measured and incentivized. Quality improvement, systems, organizational, and behavioral economics theories are the underlying framework for pay-for-performance, but inspire debate surrounding efficacy in improving patient outcomes for researchers, policy experts, providers, and organizations.

Appendices (Manuscript)

Appendix A

Variables, operational definitions, sources, and variable names for analysis.

Variable	Operational Definition	Source	Dataset Variable Name
Independent Variables for Primary Objective (FY 2015-2018)			
Hospital type	Hospital description as acute care, children's, or critical access by CMS.	Hospital Compare Hospital General Information file	Hospital Type
Case mix index	Average DRG relative weight for each hospital, calculated by summing the DRG weights for all Medicare discharges and dividing by the number of discharges and paid under Hospital Specific Payment rate (Roth, 2017).	CMS Payment Update Impact File	CMI
Average Daily Census	Average daily patient census.	CMS Payment Update Impact File	Average Daily Census
Bed Size	Number of beds licensed to hospital.	CMS Payment Update Impact File	BEDS
Ownership	Hospital ownership description: owned by government (federal, state, local, or hospital district or authority), physician, proprietary, tribal, voluntary non-profit (church, other, or private).	Hospital Compare Hospital General Information file	Hospital Ownership
DSH Adjustment	DSH Patient Percentage as determined from most recent update of the Provider Specific File & Social Security Administration Data (Roth, 2017).	CMS Payment Update Impact File	DSHPCT
Location	1. CMS Core Based Statistical Area designation categorized by CMS as urban or rural, large, or other. 2. Region categorized as New England, Middle Atlantic, South Atlantic, East North Central, East South Central, West North Central, West South Central, Mountain, Pacific, or Puerto Rico.	CMS Payment Update Impact File	REGION, URGEO
ANCC Magnet Status	Yes/No, binary variable related to whether the hospital is accredited with Magnet status for each HAC Reduction Program year (2015-2018).	ANCC	n/a
Dependent Variable for Primary Objective (FY 2015-2018) / Independent Variable for Secondary Objective (FY 2015-2017)			
HAC Reduction Program Status	Yes/No, binary variable related to whether penalty was issued by CMS.	Hospital Compare HAC Reduction Program file	Payment_ Reduction
Penalty in Any Other Program Year (Covariate)	Yes/No covariate binary variable constructed to indicate whether a given hospital had been penalized in any other program year (if Payment_Reduction= 'yes' then Penalty_In_Other_Year= '1').	Calculated	Penalty_In_ Other_Year
Dependent Variable for Secondary Objective (FY 2015-2017)			
Total HAC Score	Total HAC Score based on hospitals' performance on 6 quality measures: PSI-90 and NHSN CLABSI, CAUTI, SSI for Colon Surgery and Abdominal Hysterectomy, MRSA bacteremia, and *Clostridium difficile infection* measures. Hospitals with a Total HAC Score greater than the 75th percentile of the Total HAC Score distribution are subject to a payment reduction (Centers for Medicare and Medicaid Services, 2017b).	Hospital Compare HAC Reduction Program file	Total_HAC _Score

Note. CMS = Centers for Medicare and Medicaid Services; CMI = Case Mix Index; DRG = diagnosis-related group; DSH = Disproportionate Share; ANCC = American Nurses Credentialing Center; HAC = Hospital Acquired Condition; PSI = Patient Safety Indicator; NHSN = National Health and Safety Network; CLABSI = Central line-associated bloodstream infection; CAUTI = Catheter-associated urinary tract infection; SSI = Surgical site infection; MRSA = methicillin-resistant staphylococcus aureus.

Emily Cochran
V00274575

Appendix B

Data Analysis and Management Plan

Each study objective requires a different analytical and data management approach. SAS software will be used for statistical tests in both objectives. Post hoc power analysis will not be necessary, as effect size was considered large due to the sample size (>100) in both objectives, and nonsignificant results indicating potential Type II error were not present (James Stevens, 2002).

Primary Objective

For the primary objective, an analytical approach allowing for multiple independent variables (structural characteristics) and a single, binary dependent variable (penalty status) for each program year is necessary (Kim & Mallory, 2016). The approach must control for the covariate of penalty status in any other program year and allow for repeated measurement of independent and dependent variables for each program year studied (FY 2015-2018). Thus, a binary logistic regression with repeated measures ANCOVA will be used to test for a relationship between each hospital characteristic (independent variable) and HAC Reduction Program penalty status (dependent variable) for each program year (2015-2018). In order to assess the relationship between and across these variables and HAC Reduction Program penalty status, structural variables will be used in a univariate, then multivariate model. Descriptive statistics including calculating means, standard deviations, and ranges for the continuous variables, and counts with frequencies for categorical variables will be used to describe the characteristics of the sample.

The null hypothesis is that there is no significant difference in the characteristics of hospitals penalized versus not penalized in the HAC Reduction program from program years FY 2015 to FY 2018, which will be tested against the alternative hypothesis that there is an association among hospital characteristics across all program years. If the p-value is less than the assumed significance level of $\alpha = 0.05$, the null hypothesis will be rejected in favor of the alternative. Frequencies, proportions, and 95% confidence intervals will be used for each categorical group. Data will be assumed normal and homoscedasticity will be checked graphically. Multicollinearity will be addressed using backward elimination if any variable is found to have a significant effect on the outcome (penalty status).

Secondary Objective

The secondary objective requires an approach appropriate for evaluating the relationship between a single binary independent variable (hospital penalty status) and a continuous dependent variable (Total HAC Score) over time (program years FY 2015 to 2017) (Kim & Mallory, 2016). A general linear mixed model will be used for the secondary objective. Themodel statement will be modified to model categorical outcomes with fixed effects and repeated measures, using the SAS GLIMMIX procedure to account for repeated measurement of the independent and dependent variables for each program year (Schabenberger, 2005). Univariate testing will be performed for any variables determined to be confounding in the multivariate model.

The null hypothesis for the secondary objective states there is no significant association between Total HAC Score and penalty status across program years (2015-2017), which will be tested against the alternative hypothesis that there is an association among hospital characteristics across years. If the p-value is less than the assumed significance level of α = 0.05, our null hypothesis will be rejected in favor of the alternative. Data will be assumed normal and homoscedasticity will be checked graphically.

Emily Cochran
V00274575

Appendix C

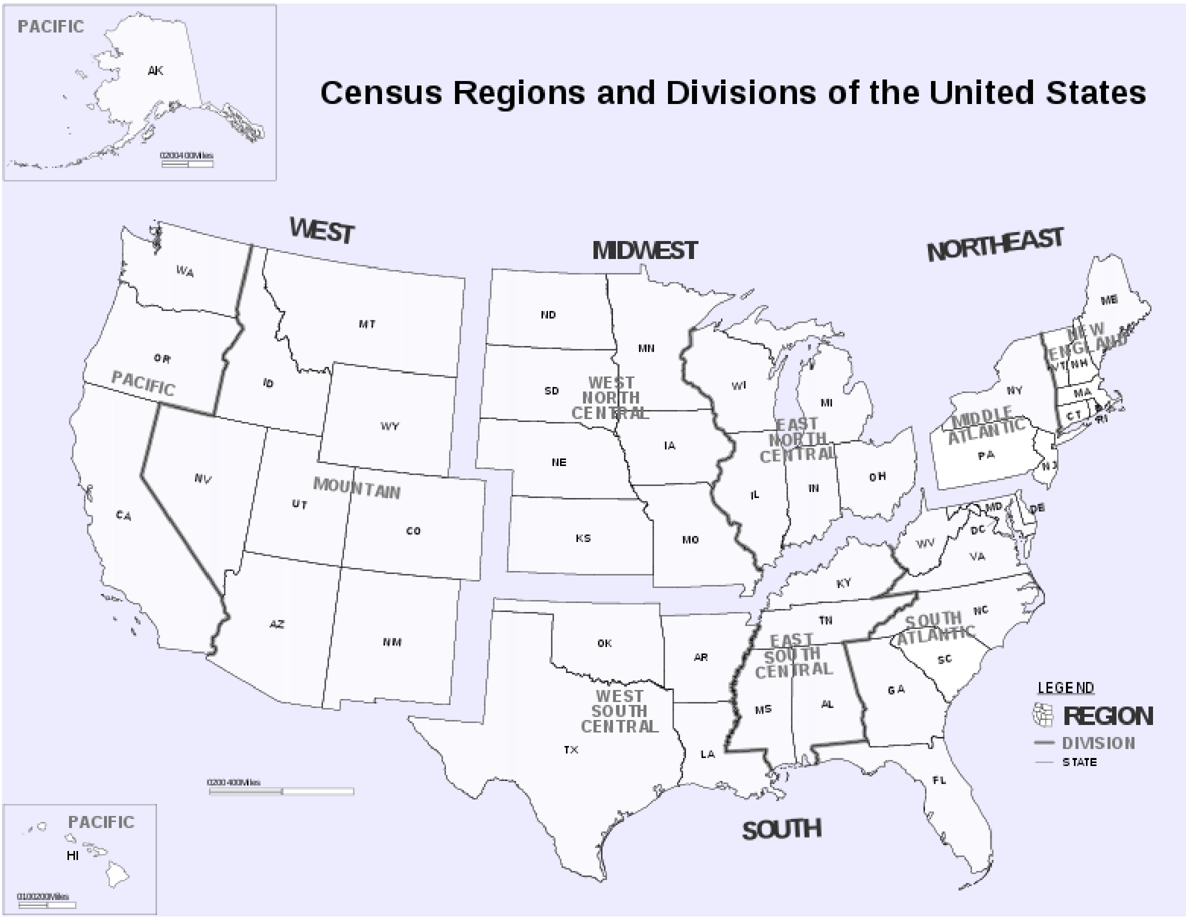
Winsorization and Consistency in HAC Reduction Program Methodology

Of note, for FY 2015 through 2017, Winsorization was not used for the calculation of the Total HAC Score. Instead, hospitals' Total HAC Scores were determined points assigned by relative rank/performance decile only (Centers for Medicare and Medicaid Services, 2017d). This methodology is further described in Appendix B. Winsorization is a statistical procedure that involves ranking hospitals on a spectrum from best to worst performing and, "if a hospital's measure result falls between the minimum and 5th percentile, CMS sets the hospital's measure result equal to the 5th percentile"; "if a hospital's measure result falls between the 95th percentile and maximum, CMS sets the hospital's measure results equal to the 95th percentile" (Centers for Medicare and Medicaid Services, 2017b). This process is performed to reduce the effects of extremely high or low measure results (Centers for Medicare and Medicaid Services, 2017d).

Although measure specification and definition changes within PSIs and HAIs across program years and therefore pose challenges with in consistent measurement of HAC performance over time, the methodology for the calculation of Total HAC Score remained consistent from program years 2015 to 2017. In light of this, the Total HAC Score was used to measure performance improvement or decline over program years for FY 2015 to FY 2017.

Appendix D

Census Regions and Divisions of the United States Map (US Census Bureau, 2000b), identifying areas included in each category of the variable “region” for the primary objective.



Note: Variables numbered: 1= New England; 2= Middle Atlantic; 3= South Atlantic; 4= East North Central; 5= East South Central; 6= West North Central; 7= West South Central; 8= Mountain; 9= Pacific; 40= Puerto Rico.

Tables (Manuscript)

Table 2

Pairwise Pearson Correlations for Non-categorical Variables

	Penalty Status	Average Daily Census	Bed Size	DSH %	CMI	Region	Magnet Status
Penalty Status	1	0.183	0.167	0.078	0.091	-0.028	0.074
Average Daily Census	0.183	1	0.970	0.189	0.406	-0.111	0.379
Bed Size	0.167	0.970	1	0.205	0.405	-0.084	0.356
Disproportionate Share (DSH) Percentage	0.078	0.189	0.205	1	-0.070	0.171	-0.045
Case Mix Index (CMI)	0.091	0.406	0.405	-0.070	1	0.193	0.216
Region	-0.028	-0.111	-0.084	0.171	0.193	1	-0.087
Magnet Status	0.074	0.379	0.356	-0.045	0.216	-0.087	1

Table 3

Descriptive Statistics for Hospitals Grouped as Not Penalized for each HAC Reduction Program Year Studied, 2015 to 2018.

	Hospitals **Not Penalized**									
Hospital Characteristics	2015		2016		2017		2018		Total for All Years	
Average Daily Census (mean, SD)	96.85	121.62	100.16	121.93	90.03	118.48	103.74	134.37	97.69	124.33
Bed size (mean, SD)	173.59	169.48	180.11	171.44	166.44	167.66	182.08	183.46	175.53	173.20
DSH Percentage (mean, SD)	0.28	0.17	0.28	0.17	0.29	0.18	0.29	0.18	0.28	0.17
Case Mix Index (CMI) (mean, SD)	1.50	0.35	1.54	0.34	1.52	0.39	1.58	0.41	1.53	0.37
CBSA (n, %)										
Large urban	982	38%	976	40%	924	37%	961	38%	3843	38%
Other urban	856	33%	825	33%	849	34%	890	35%	3420	34%
Rural	718	28%	663	27%	708	28%	636	25%	2725	27%
Not Available	2	0%	0	0%	18	1%	22	1%	42	0%
Total	2558	100%	2464	100%	2499	100%	2509	100%	10030	100%

Hospital Ownership (n, %)											
Government (all)		426	17%	397	16%	413	17%	369	15%	1605	16%
Physician		54	2%	48	2%	52	2%	65	3%	219	2%
Proprietary		553	22%	543	22%	557	22%	543	22%	2196	22%
Tribal		3	0%	4	0%	4	0%	2	0%	13	0%
Voluntary (all)		1522	59%	1472	60%	1452	58%	1515	60%	5961	59%
Not Available		0	0%	0	0%	21	1%	15	1%	36	0%
	Total	2558	100%	2464	100%	2499	100%	2509	100%	10030	100%
Hospital Type (n, %)											
Acute Care		2558	100%	2464	100%	2499	100%	2509	100%	10030	100%
Magnet Status (n, %)											
Accredited		215	8%	218	9%	224	9%	267	11%	924	9%
Not Accredited		2276	89%	2215	90%	2248	90%	2242	89%	8981	90%
Not Available		67	3%	31	1%	27	1%	0	0%	125	1%
	Total	2558	100%	2464	100%	2499	100%	2509	100%	10030	100%
Region (n, %)											
New England		96	4%	85	3%	92	4%	99	4%	372	4%
Middle Atlantic		267	10%	258	10%	236	9%	254	10%	1015	10%
South Atlantic		434	17%	434	18%	387	15%	381	15%	1636	16%
East North Central		397	16%	391	16%	400	16%	410	16%	1598	16%
East South Central		254	10%	253	10%	255	10%	227	9%	989	10%
West North Central		206	8%	194	8%	221	9%	220	9%	841	8%
West South Central		452	18%	411	17%	428	17%	424	17%	1715	17%
Mountain		159	6%	161	7%	184	7%	179	7%	683	7%
Pacific		291	11%	277	11%	278	11%	293	12%	1139	11%
Not Available		2	0%	0	0%	18	1%	22	1%	42	0%
	Total	2558	100%	2464	100%	2499	100%	2509	100%	10030	100%

Note. DSH= Disproportionate Share; CBSA= CMS Core Based Statistical Area (CBSA)

Table 4

Descriptive Statistics for Hospitals Grouped as Penalized for each HAC Reduction Program Year Studied, 2015 to 2018.

	Hospitals **Penalized**									
Hospital Characteristics	2015		2016		2017		2018		Total for All Years	
Average Daily Census (mean, SD)	168.01	170.90	158.88	177.52	172.79	173.59	132.96	156.75	158.16	170.49
Bed size (mean, SD)	263.82	222.56	251.38	226.07	269.06	225.05	215.41	203.12	249.91	220.30
DSH Percentage (mean, SD)	0.31	0.19	0.31	0.19	0.32	0.20	0.33	0.20	0.32	0.19
Case Mix Index (CMI) (mean, SD)	1.63	0.34	1.63	0.37	1.63	0.38	1.58	0.39	1.62	0.37
CBSA (n, %)										
Large urban	357	49%	353	47%	391	51%	333	44%	1434	48%
Other urban	254	35%	264	35%	263	34%	242	32%	1023	34%
Rural	111	15%	128	17%	104	14%	161	21%	504	17%
Not Available	0	0%	2	0%	10	1%	13	2%	25	1%
Total	722	100%	747	100%	768	100%	749	100%	2986	100%
Hospital Ownership (n, %)										
Government (all)	139	19%	120	17%	111	15%	143	20%	513	71%
Physician	6	1%	9	1%	13	2%	8	1%	36	1%
Proprietary	126	17%	126	17%	136	18%	159	21%	547	18%
Tribal	0	0%	0	0%	1	0%	3	0%	4	0%
Voluntary non-profit (all)	449	62%	492	66%	502	65%	436	58%	1879	63%
Not Available	2	0%	0	0%	5	1%	0	0%	7	0%
Total	722	100%	747	100%	768	100%	749	100%	2986	100%
Hospital Type (n, %)										
Acute Care	722	100%	747	100%	768	100%	749	100%	2986	100%
Magnet Status (n, %)										
Accredited	96	13%	114	15%	135	18%	89	12%	434	15%
Not Accredited	606	84%	623	83%	626	82%	660	88%	2515	84%
Not Available	20	3%	10	1%	7	1%	0	0%	37	1%
Total	722	100%	747	100%	768	100%	749	100%	2986	100%
Region (n, %)										

Emily Cochran
V00274575

New England	39	5%	49	7%	42	5%	34	5%	164	5%
Middle Atlantic	102	14%	105	14%	129	17%	109	15%	445	15%
South Atlantic	124	17%	123	16%	136	18%	140	19%	523	18%
East North Central	101	14%	99	13%	95	12%	88	12%	383	13%
East South Central	47	7%	40	5%	44	6%	71	9%	202	7%
West North Central	56	8%	59	8%	41	5%	39	5%	195	7%
West South Central	73	10%	90	12%	102	13%	97	13%	362	12%
Mountain	73	10%	63	8%	50	7%	52	7%	238	8%
Pacific	107	15%	117	16%	119	15%	106	14%	449	15%
Not Available	0	0%	2	0%	10	1%	13	2%	25	1%
Total	722	100%	747	100%	768	100%	749	100%	2986	100%

Note. DSH= Disproportionate Share; CBSA= CMS Core Based Statistical Area (CBSA)

Table 5

Fixed Effects Model of Impact on Hospital Penalty Status, Eliminating Hospital Type and Bed Size

Effect	Num DF	Den DF	F Value	Pr > F
Average Daily Census	1	9492	53.01	<.0001
Disproportionate Share (DSH) Percentage	1	9492	12.12	0.0005
Hospital Ownership	9	9492	1.63	0.1002
Region	8	9492	6.55	<.0001
Case Mix Index	1	9492	13.96	0.0002
CMS Core Based Statistical Area (CBSA)	2	9492	3.42	0.0327
Magnet Status	1	9492	0.36	0.5461

Table 6

Fixed Effects Model of Impact on Hospital Penalty Status, Eliminating Hospital Type, Magnet Status, and Hospital Ownership

Effect	Num DF	Den DF	F Value	Pr > F
Average Daily Census	1	9547	77.39	<.0001
Disproportionate Share (DSH) Percentage	1	9547	15.61	<.0001
Region	8	9547	6.91	<.0001
Case Mix Index (CMI)	1	9547	9.32	0.0023
CMS Core Based Statistical Area (CBSA)	2	9547	2.69	0.0681

Table 7

Fixed Effects Model of Impact on Hospital Penalty Status, Eliminating Hospital Type, Magnet Status, Hospital Ownership, and CBSA

Effect	Num DF	Den DF	F Value	Pr > F
Average Daily Census	1	9549	88.56	<.0001
Disproportionate Share (DSH) Percentage	1	9549	15.82	<.0001
Region	8	9549	7.98	<.0001
Case Mix Index (CMI)	1	9549	13.98	0.0002

Table 10

Tukey Post Hoc Test Comparing Multiple Groups of Number of Years of Penalty within the Secondary Objective

Group 1: # Years of Penalty	Group 2: # Years of Penalty	Mean Difference (Years of Penalty)	Std. Error	*p*	95% Confidence Interval	
					Lower Bound	Upper Bound
0	1	-0.021	0.022	0.772	-0.08	0.04
	2	-0.049	0.028	0.290	-0.12	0.02
	3	-.239*	0.034	0.000	-0.33	-0.15
1	0	0.021	0.022	0.772	-0.04	0.08
	2	-0.028	0.031	0.807	-0.11	0.05
	3	-.218*	0.037	0.000	-0.31	-0.12
2	0	0.049	0.028	0.290	-0.02	0.12
	1	0.028	0.031	0.807	-0.05	0.11
	3	-.189*	0.041	0.000	-0.29	-0.08
3	0	.239*	0.034	0.000	0.15	0.33
	1	.218*	0.037	0.000	0.12	0.31
	2	.189*	0.041	0.000	0.08	0.29

Note. *The mean difference is significant at the 0.05 level.

Emily Cochran
V00274575

Chapter VI: Concluding Narrative

The design of the study described in this dissertation was selected based on existing research related to this topic, guided also by philosophical and theoretical underpinnings related to value-based reimbursement. The process of identifying gap in existing literature, selecting a conceptual model, and developing a grant proposal and manuscript are further described here in a concluding narrative.

Gap in Existing Literature

There is a strong body of evidence indicating that additional research is necessary to fully explore the effects of pay-for-performance on the quality of care delivered (de Bruin et al., 2011; Eijkenaar et al., 2013; Emmert et al., 2012; Kondo et al., 2016; Mendelson et al., 2017; Ogundeji et al., 2016; Tao, Agerholm, & Burström, 2016; Van Herck et al., 2010). Pay-for performance programs developed by the Centers for Medicare and Medicaid Services (CMS) and commercial payors have been developed to incentivize quality and safety performance for hospitals and providers, but whether these programs achieve their intent is debated. One meta-analysis and systematic review found the benefits of pay-for-performance programs to be "modest" to quality improvement and focused disproportionately on process measures instead of outcomes (Chee, Ryan, Wasfy, & Borden, 2016; Ogundeji et al., 2016). Another study found penalties for hospital-acquired conditions (HACs) are attributed to chance alone, given poor reliability of statistical procedures within the related CMS program (Koenig et al., 2016). Behavioral economists and social psychologists suggest that monetary incentives actually "undermine motivation and worsen performance on complex cognitive tasks" such as those in healthcare, in which intrinsic motivation is high (Himmelstein, Ariely, & Woolhandler, 2014b, p. 203).

Organizational structural characteristics play an important role in how facilities fare in quality performance programs and value-based reimbursement (Koenig et al., 2016; Rajaram et al., 2015). Experts in the area of pay-for-performance argue that these incentive or penalty models should be carefully piloted in and evaluated in various organizational settings before adoption in order to maximize payment without diminishing providers' intrinsic or altruistic motivations to care for patients (Conrad, 2015).

Although previous research has shown hospital characteristics are related to being penalized by various CMS pay-for-performance programs within a single program year (Borah et al., 2012; Fuller et al., 2017; Koenig et al., 2016; Rajaram et al., 2015; Soltoff et al., 2018), there has been no exploration on how hospitals fare programs year-to-year. By characterizing the effects of the HAC Reduction program over time, the results of this study may inform decisions by healthcare policy stakeholders, such as the general public, policy makers, and technical experts who serve as advisors to CMS and AHRQ. This study was designed to address the gap in knowledge related to the efficacy of value-based reimbursement as a means of motivating providers and organizations to improve healthcare quality.

Conceptual Model Selection

The conceptual model for this study was chosen based on positivist and mid-range theories, drawing from both need for empirical validation of health policy phenomena (Crotty, 1998) and the need to classify performance at the organization level based on care delivered at the patient level (Liehr & Smith, 2016). Such supporting theories include agency theory, value theory, and behavioral economics.

The conceptual model offering the most alignment with underlying theories is Donabedian's Model of Healthcare Quality Improvement, which involves a three-pronged approach to assessing quality of care: evaluation of structure, process, and outcome (Donabedian, 1988). Structure accounts for the care setting; process considers the actual steps in care administration; outcome takes into account the effects of the care delivered on overall health status (Donabedian, 1988). Donabedian introduced that valuation be considered in quality improvement. He suggested that practitioners maximize the cost-benefit of healthcare improvements, as increased cost will not always lead to an equal increase in quality of care

Emily Cochran
V00274575

(Donabedian, 1988). Donabedian's theory can be related to almost any aspect of quality improvement research, particularly the efficacy of pay-for performance programs, as related quality metrics very frequently measure outcomes and value (which according to Donabedian, is the summation of structure and process in an organization).

Other frameworks were considered by the student, such as the quality health outcomes model, which is based upon Donabedian's work and suggests indicators can be dynamic and interact upon one another in a reciprocal fashion (P. H. Mitchell, Ferketich, & Jennings, 1998). This model was not used because the research question focused on structure and outcome only. The Model for Understanding Success in Quality (MUSIQ) is a model developed by a panel of quality improvement experts that delineates key factors that influence the success of quality improvement projects and related contextual factors from the micro to macrosystem level (Kaplan et al., 2012). The MUSIQ could potentially be leveraged for future applications in the student's program of research because it accounts for interactions and relationships between the organization, quality improvement team, microsystem (departments or units), and culture of leadership, staff, and project sponsors (Kaplan et al., 2012).

Proposal and Manuscript

A grant proposal and manuscript were developed to explain the study design and report the findings for this dissertation. Using existing research, the study examined the relationship between hospital structural characteristics and penalization status (penalized or not penalized) in any given hospital acquired condition (HAC) Reduction Program year, FY 2015 through 2018 and to determine whether a hospital's penalization status across one or more HAC Reduction Program years is related to quality performance (Total HAC Score) in subsequent years. A grant proposal, which serves as Chapters I-III of the dissertation, was written to explore this topic through retrospective, longitudinal, multivariate regression analysis using multiple publicly available data sources.

The manuscript serves as Chapters IV-V and was written for submission to *Quality Management in Healthcare,* which *h*as published over 65 articles related to pay-for-performance, including some in relation specifically to nursing implications. Articles accepted by *Quality Management in Healthcare* are focused on "organizational structure and processes as these affect the quality of care and patient outcomes" (Quality Management in Healthcare, 2019) . Content must build knowledge about the statistical tools used in the evaluation of care and patient outcomes, evaluate strategies designed to substantiate quantifiable quality improvements, facilitate collaboration between providers and payors or regulators in pursuit of improved patient outcomes, and explore links among the administrative and managerial aspects of patient care and organizational quality governance (Quality Management in Healthcare, 2019). This study is aligned with these objectives because it evaluates the relationship between hospital structure and patient outcomes in a program initiated by an entity which is both a payor and regulator.

The manuscript details the methods, findings and discussion for the work proposed in Chapters I-III. The study explored hospital structural characteristics related to both penalty status and HAC performance, across program years. In addition, whether a hospital's penalization status across one or more HAC Reduction Program years is related to HAC performance was studied. The study found that with increasing average daily census, DSH percentage, and CMI, hospitals were more likely to be penalized in the program. Regional differences were observed, with hospitals located geographically in the Midwest demonstrating less likelihood of receiving HAC Reduction Program penalty. The majority of hospitals improved their Total HAC Score across the years studied, which is indicative of a potential downward trend in HAC incidence across the country.

Implications

Several implications for healthcare administration and healthcare policy were identified in this study. With regard to healthcare administration, an organization's infrastructure, including

Emily Cochran
V00274575

the structural characteristics included in this study, can have a substantial impact on the ability of an organization to improve quality and safety for patients. Structural characteristics can also include mission, vision, and strategy, operational functions and processes. Leadership culture, teamwork, and a spirit of continuous organizational improvement are key elements of improving patient safety and quality metrics, including HACs. Because the ability of an organization to improve is multifaceted, future research could study leadership and safety culture in relation to HACs or leveraging mixed methods by integrating qualitative surveys with publicly reported data.

Another implication, related to healthcare policy, is that this study underscores the significance of controlling for hospital structural characteristics in data analyses used for the development of healthcare policies, such as the Affordable Care Act, under which the HAC Reduction Program and public quality reporting were legislated. The principles underpinning value-based reimbursement programs and policies and public reporting of quality data have been controversial. The methodology used in value-based programs and in public reporting should be very robust, and legislation should insist upon the utmost accuracy and integrity of publicly reported quality data. That said, it is possible that public reporting of HAC data could be responsible for the overall decline in HACs observed across program years in this study.

Conclusion

The use of value-based reimbursement programs as a method of motivating providers and organizations to improve healthcare quality provided an opportunity for additional research, particularly related to how organizations fare programs like the HAC Reduction Program over time. A grant proposal was written to serve as Chapters I-III of the student's dissertation, using Donabedian's structure, process, and outcome as the guiding conceptual model. The model selection was informed by value theory, agency theory, and behavioral economics. The study was designed was a retrospective, longitudinal, multivariate regression analysis using secondary, public data sources. The proposal required some minor adjustments during the analysis, which are detailed with the results of the study in the manuscript serving as Chapters IV-V. Ultimately, the study found that most hospitals improved their Total HAC Score across the years studied, regardless of penalty status. This indicates that the HAC Reduction Program, though perhaps indirectly through public reporting, may be reducing HAC incidence. Because several characteristics (average daily census, DSH percentage, and CMI) were significantly associated with penalty, policy makers should consider enhancing risk adjustment methods in the HAC Reduction Program to adjust for hospital structural characteristics such as these, which represent the acuity and complexity of patients.

Emily Cochran
V00274575

References

Agency for Healthcare Research and Quality. (2016a). AHRQ Tools To Reduce Hospital-Acquired Conditions | Agency for Healthcare Research & Quality. Retrieved October 30, 2017, from https://www.ahrq.gov/professionals/quality-patient-safety/hac/tools.html

Agency for Healthcare Research and Quality. (2016b). PSI 90 Fact Sheet. Retrieved September 6, 2017, from https://www.qualityindicators.ahrq.gov/News/PSI90_Factsheet_FAQ.pdf

Agency for Healthcare Research and Quality. (2017). *AHRQ Patient Safety Indicators (PSI) Parameter Estimates*. Retrieved from http://www.qualityindicators.ahrq.gov

AHRQ. (n.d.). AHRQ - Quality Indicators. Retrieved March 15, 2018, from http://www.qualityindicators.ahrq.gov/modules/psi_resources.aspx

American Hospital Association. (2014). *Quality Reporting and Pay-for-Performance*. Retrieved from http://www.aha.org/content/14/ip-qualreport.pdf

American Nurses Association, A. N. C. C. (n.d.). Why Become an ANCC Magnet Recognized Organization? Retrieved August 30, 2018, from https://www.nursingworld.org/organizational-programs/magnet/why-become-magnet/

American Nurses Credentialing Center. (2018). Find a Magnet Hospital or Facility. Retrieved September 20, 2018, from https://www.nursingworld.org/organizational-programs/magnet/find-a-magnet-facility/

Association of American Medical Colleges. (2014). AAMC Expresses Concerns about the Two-Midnight Rule and the HAC Reductions Program: Washington Highlights/ Government Affairs. Retrieved September 27, 2017, from https://www.aamc.org/advocacy/washhigh/highlights2014/385158/071114aamcexpressesconcernsaboutthetwo-midnightruleandthehacre.html

Atkinson, G. J., Masiulis, K. E., Felgner, L., & Schumacher, D. N. (2010). Provider-Initiated Pay-for-Performance in a Clinically Integrated Hospital Network. *Journal For Healthcare Quality*, *32*(1), 42–50. https://doi.org/10.1111/j.1945-1474.2009.00063.x

Barnes, H., Rearden, J., & McHugh, M. D. (2016). Magnet® Hospital Recognition Linked to Lower Central Line-Associated Bloodstream Infection Rates. *Research in Nursing & Health*, *39*(2), 96–104. https://doi.org/10.1002/nur.21709

Bergquist-Beringer, S., Cramer, E., Potter, C., Stobinski, J. X., & Boyle, D. K. (2018). Exploring the Relationship Between Nursing Specialty Certification and Surgical Site Infections. *JONA: The Journal of Nursing Administration*, *48*(7/8), 400–406. https://doi.org/10.1097/NNA.0000000000000636

Berwick, D. M. (2008). The Science of Improvement. *JAMA*, *299*(10), 1182–1184. https://doi.org/10.1001/jama.299.10.1182

Borah, B. J., Rock, M. G., Wood, D. L., Roellinger, D. L., Johnson, M. G., & Naessens, J. M. (2012). Association between value-based purchasing score and hospital characteristics. *BMC Health Services Research*, *12*, 464. https://doi.org/10.1186/1472-6963-12-464

Boyle, D. K. (2017). Nursing Specialty Certification and Patient Outcomes: What We Know in Acute Care Hospitals and Future Directions. *Journal of the Association for Vascular Access*, *22*(3), 137–142. https://doi.org/10.1016/J.JAVA.2017.06.002

Burke, L., Khullar, D., Orav, E. J., Zheng, J., Frakt, A., & Jha, A. K. (2018). Do Academic Medical Centers Disproportionately Benefit The Sickest Patients? *Health Affairs*, *37*(6), 864–872. https://doi.org/10.1377/hlthaff.2017.1250

Burston, S., Chaboyer, W., & Gillespie, B. (2014). Nurse-sensitive indicators suitable to reflect nursing care quality: a review and discussion of issues. *Journal of Clinical Nursing*, *23*(13–14), 1785–1795. https://doi.org/10.1111/jocn.12337

Bysshe, T., Gao, Y., Heaney-Huls, K., Hockenberry, J., Hovey, L., Laffan, A., … Watts, E. (2017). *Final Report Estimating the Additional Hospital Inpatient Cost and Mortality Associated with Selected Hospital Acquired Conditions*. Retrieved from www.ahrq.gov

Calderon, L. E., Kavanagh, K. T., & Rice, M. K. (2015). Questionable validity of the catheter-associated urinary tract infection metric used for value-based purchasing. *American*

Emily Cochran
V00274575
Journal of Infection Control, *43*(10). https://doi.org/10.1016/j.ajic.2015.05.024

Caveney, B. J. (2016). Pay-for-Performance Incentives: Holy Grail or Sippy Cup? *North Carolina Medical Journal*, *77*(4), 265–268. https://doi.org/10.18043/ncm.77.4.265

CDC. (n.d.). *Operational Guidance for Reporting Surgical Site Infection (SSI) Data to CDC's NHSN for the Purpose of Fulfilling CMS's Hospital Inpatient Quality Reporting (IQR) Program Requirements*. Retrieved from http://www.cdc.gov/nhsn/CDA_eSurveillance.html

Center for Medicare and Medicaid Services. (2018). Hospital-Acquired Condition Reduction Program Fiscal Year 2019 Fact Sheet Overview. Retrieved November 18, 2018, from https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQn

Centers for Disease Control and Prevention. (2018a). National Healthcare Safety Network (NHSN) Patient Safety Component Manual. Retrieved from https://www.cdc.gov/nhsn/pdfs/pscmanual/pcsmanual_current.pdf

Centers for Disease Control and Prevention. (2018b). NHSN- 2015 Rebaseline. Retrieved September 20, 2018, from https://www.cdc.gov/nhsn/2015rebaseline/index.html

Centers for Medicare and Medicaid Services. (n.d.). QualityNet - Hospital-Acquired Condition (HAC) Reduction Program Scoring Methodology. Retrieved September 20, 2018, from https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1228774298601

Centers for Medicare and Medicaid Services. (2016a). Acute Inpatient PPS. Retrieved February 16, 2017, from https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteinpatientPPS/index.html

Centers for Medicare and Medicaid Services. (2016b). FY 2017 Final Rule and Correction Notice Data Files. Retrieved January 21, 2019, from https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/FY2017-IPPS-Final-Rule-Home-Page-Items/FY2017-IPPS-

Final-Rule-Data-Files.html

Centers for Medicare and Medicaid Services. (2017a). Disproportionate Share Hospital (DSH). Retrieved December 11, 2017, from https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/dsh.html

Centers for Medicare and Medicaid Services. (2017b). Hospital-Acquired Condition Reduction Program Fiscal Year 2018 Fact Sheet. Retrieved September 6, 2017, from https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Downloads/FY2018-HAC-Reduction-Program-Fact-Sheet.pdf

Centers for Medicare and Medicaid Services. Hospital Inpatient Prospective Payment Systems for Acute Care Hospitals and the Long-Term Care Hospital Prospective Payment System (2017). Retrieved from https://s3.amazonaws.com/public-inspection.federalregister.gov/2017-16434.pdf

Centers for Medicare and Medicaid Services. (2017d). QualityNet - Hospital-Acquired Condition (HAC) Reduction Program. Retrieved September 6, 2017, from https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier2&cid=1228774189166

Centers for Medicare and Medicaid Services. (2018). *Overview of the FY 2019 HAC Reduction Program and HRRP*. Retrieved from https://www.qualityreportingcenter.com/wp-content/uploads/2018/07/FY19_HACRP_HRRP_HSR_RC_Slides_vFINAL5081.pdf

Chee, T. T., Ryan, A. M., Wasfy, J. H., & Borden, W. B. (2016). Current state of value-based purchasing programs. *Circulation*, *133*(22). https://doi.org/10.1161/CIRCULATIONAHA.115.010268

Clarke, S. P., & Cossette, S. (2000). Secondary analysis: theoretical, methodological, and practical considerations. *The Canadian Journal of Nursing Research = Revue Canadienne de Recherche En Sciences Infirmieres*, *32*(3), 109–129. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/11928128

Conrad, D. A. (2015). The Theory of Value-Based Payment Incentives and Their Application to Health Care. *Health Services Research*, *50 Suppl 2*, 2057–2089. https://doi.org/10.1111/1475-6773.12408

Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process*. Sage Publications. Retrieved from https://books.google.com/books/about/The_Foundations_of_Social_Research.html?id=_u9uem2WfYwC

de Bruin, S. R., Baan, C. A., & Struijs, J. N. (2011). Pay-for-performance in disease management: a systematic review of the literature. *BMC Health Services Research*, *11*(1), 272. https://doi.org/10.1186/1472-6963-11-272

DiCuccio, M. H. (2015). The Relationship Between Patient Safety Culture and Patient Outcomes. *Journal of Patient Safety*, *11*(3), 135–142. https://doi.org/10.1097/PTS.0000000000000058

Donabedian, A. (1966). Evaluating the Quality of Medical Care. *The Milbank Memorial Fund Quarterly*, *44*(3). Retrieved from http://www.jstor.org/stable/3348969

Donabedian, A. (1988). The Quality of Care. *JAMA*, *260*(12), 1743. https://doi.org/10.1001/jama.1988.03410120089033

Dranove, D., & White, W. D. (1987). Agency and the organization of health care delivery. *Inquiry*, *24*(4), 405–415. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2961701

Dudeck, M., Aponte, Z., Arcement, R., & Patel, P. (2017). *NHSN: An Update on the Risk Adjustment of HAI Data*. Retrieved from https://www.cdc.gov/nhsn/pdfs/rebaseline/rebaseline-webinar-p1.pdf

Eijkenaar, F., Emmert, M., Scheppach, M., & Schöffski, O. (2013). Effects of pay for performance in health care: a systematic review of systematic reviews. *Health Policy (Amsterdam, Netherlands)*, *110*(2–3), 115–130. https://doi.org/10.1016/j.healthpol.2013.01.008

Emmert, M., Eijkenaar, F., Kemter, H., Esslinger, A. S., & Schöffski, O. (2012). Economic evaluation of pay-for-performance in health care: a systematic review. *The European Journal of Health Economics : HEPAC : Health Economics in Prevention and Care*, *13*(6), 755–767. https://doi.org/10.1007/s10198-011-0329-8

Fernando, S. A., Gray, T. J., & Gottlieb, T. (2017). Healthcare-acquired infections: prevention strategies. *Internal Medicine Journal*, *47*(12), 1341–1351. https://doi.org/10.1111/imj.13642

Fontana, E., & Hawes, K. (2017, July). The big PSI-90 change that could impact your P4P performance | Advisory Board. *Advisory Board*. Retrieved from https://www.advisory.com/research/revenue-cycle-advancement-center/at-the-margins/2017/07/psi-90

Fos, E. B. (2017). The unintended consequences of The Centers for Medicare and Medicaid Services pay-for-performance structures on safety-net hospitals and the low-income, medically vulnerable population. *Health Services Management Research*, *30*(1), 10–15. https://doi.org/10.1177/0951484816678011

Friese, C. R., Xia, R., Ghaferi, A., Birkmeyer, J. D., & Banerjee, M. (2015). Hospitals In “Magnet” Program Show Better Patient Outcomes On Mortality Measures Compared To Non-’Magnet’ Hospitals. *Health Affairs (Project Hope)*, *34*(6), 986–992. https://doi.org/10.1377/hlthaff.2014.0793

Fuller, R. L., Goldfield, N. I., Averill, R. F., & Hughes, J. S. (2017). Is the CMS Hospital-Acquired Condition Reduction Program a Valid Measure of Hospital Performance? *American Journal of Medical Quality*, *32*(3), 254–260. https://doi.org/10.1177/1062860616640883

Gilman, M., Hockenberry, J. M., Adams, E. K., Milstein, A. S., Wilson, I. B., & Becker, E. R. (2015). The financial effect of value-based purchasing and the hospital readmissions reduction program on safety-net hospitals in 2014: A cohort study. *Annals of Internal Medicine*, *163*(6). https://doi.org/10.7326/M14-2813

Guo, Y., Logan, H. L., Glueck, D. H., & Muller, K. E. (2013). Selecting a sample size for studies with repeated measures. *BMC Medical Research Methodology*, *13*, 100. https://doi.org/10.1186/1471-2288-13-100

Harron, K., Dibben, C., Boyd, J., Hjern, A., Azimaee, M., Barreto, M. L., & Goldstein, H. (2017). Challenges in administrative data linkage for research. *Big Data & Society*, 1–12. https://doi.org/10.1177/2053951717745678

Himmelstein, D. U., Ariely, D., & Woolhandler, S. (2014a). Pay-for-Performance: Toxic to Quality? Insights from Behavioral Economics. *International Journal of Health Services*, *44*(2), 203–214. https://doi.org/10.2190/HS.44.2.a

Himmelstein, D. U., Ariely, D., & Woolhandler, S. (2014b). Pay-for-Performance: Toxic to Quality? Insights from Behavioral Economics. *International Journal of Health Services*, *44*(2). https://doi.org/10.2190/HS.44.2.a

Hinkle, D., Wiersma, W., & Jurs, S. (2003). *Applied Statistics for the Behavioral Sciences* (5th ed). Boston: Houghton Mifflin.

Hulley, S., Cummings, S., Browner, W., Grady, D., & Newman, T. (2013). *Designing Clinical Research*. Philadelphia: Lippincott Williams & Wilkins.

James, J. (2012). Health Policy Brief: Public Reporting on Quality and Costs. *Health Affairs*. https://doi.org/10.1377/hpb2012.6

Jones, T. L. (2016). Outcome Measurement in Nursing: Imperatives, Ideals, History, and Challenges. *OJIN: The Online Journal of Issues in Nursing*, *21*(2). Retrieved from http://ojin.nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Vol-21-2016/No2-May-2016/Outcome-Measurement-in-Nursing.html#Edwardson

Kaplan, H. C., Provost, L. P., Froehle, C. M., & Margolis, P. A. (2012). The Model for Understanding Success in Quality (MUSIQ): building a theory of context in healthcare quality improvement. *BMJ Quality & Safety*, *21*(1), 13–20. https://doi.org/10.1136/bmjqs-2011-000010

Kelly, D., Kutney-Lee, A., Lake, E. T., & Aiken, L. H. (2013). The critical care work environment and nurse-reported health care-associated infections. *American Journal of Critical Care : An Official Publication, American Association of Critical-Care Nurses*, *22*(6), 482–488. https://doi.org/10.4037/ajcc2013298

Kim, M. J., & Mallory, C. (2016). *Statistics for evidence-based practice in nursing* (2nd ed.). Burlington, MA.

Koenig, L., Soltoff, S. A., Demiralp, B., Demehin, A. A., Foster, N. E., Steinberg, C. R., … Xu, S. (2016). Complication Rates, Hospital Size, and Bias in the CMS Hospital-Acquired Condition Reduction Program. *American Journal of Medical Quality*, 106286061668184. https://doi.org/10.1177/1062860616681840

Kondo, K. K., Damberg, C. L., Mendelson, A., Motu'apuaka, M., Freeman, M., O'Neil, M., … Kansagara, D. (2016). Implementation Processes and Pay for Performance in Healthcare: A Systematic Review. *Journal of General Internal Medicine*, *31 Suppl 1*(S1), 61–69. https://doi.org/10.1007/s11606-015-3567-0

Lanham, H. J. (2013). A Complexity Science Perspective of Organizational Behavior in Clinical Microsystems. In J. P. Sturmberg & C. M. Martin (Eds.), *Handbook of Systems and Complexity in Health* (pp. 713–723). New York, NY: Springer New York. https://doi.org/10.1007/978-1-4614-4998-0

Lazear, E. P. (1996). *Performance Pay and Productivity* (No. 5672). 1996. Retrieved from http://www.nber.org/papers/w5672.pdf

Liehr, P., & Smith, M. J. (2016). Middle Range Theory A Perspective on Development and Use. *Advances in Nursing Science*, *00*(00), 1–13. https://doi.org/10.1097/ANS.0000000000000162

Lukas, C. V., Holmes, S. K., Cohen, A. B., Restuccia, J., Cramer, I. E., Shwartz, M., & Charns, M. P. (2007). Transformational change in health care systems. *Health Care Management Review*, *32*(4), 309–320. https://doi.org/10.1097/01.HMR.0000296785.29718.5d

Maguire, B. (2016). The Value-Based Theory of Reasons. *Ergo*, *3*(9), 233–262. https://doi.org/10.3998/ergo.12405314.0003.009

McIlvennan, C. K., Eapen, Z. J., & Allen, L. A. (2015). Hospital readmissions reduction program. *Circulation*, *131*(20), 1796–1803. https://doi.org/10.1161/CIRCULATIONAHA.114.010270

Mendelson, A., Kondo, K., Damberg, C., Low, A., Motu'apuaka, M., Freeman, M., … Kansagara, D. (2017). The Effects of Pay-for-Performance Programs on Health, Health Care Use, and Processes of Care: A Systematic Review. *Annals of Internal Medicine*. https://doi.org/10.7326/M16-1881

Miller, H. D. (2009). From Volume To Value: Better Ways To Pay For Health Care. *Health Affairs*, *28*(5), 1418–1428. Retrieved from https://www-healthaffairs-org.proxy.library.vcu.edu/doi/pdf/10.1377/hlthaff.28.5.1418

Mitchell, B., Gardner, A., Stone, P., Hall, L., & Pogorzelska-Maziarz, M. (2018). Hospital Staffing and Health Care-Associated Infections: A Systematic Review of the Literature. *The Joint Commission Journal on Quality and Patient Safety*, *44*, 613–622. https://doi.org/10.1016/j.jcjq.2018.02.002

Mitchell, P. H., Ferketich, S., & Jennings, B. M. (1998). Quality Health Outcomes Model. *Image: The Journal of Nursing Scholarship*, *30*(1), 43–46. https://doi.org/10.1111/j.1547-5069.1998.tb01234.x

Mkanta, W. N., Katta, M., Basireddy, K., English, G., & Mejia de Grubb, M. C. (2016). Theoretical and Methodological Issues in Research Related to Value-Based Approaches in Healthcare. *Journal of Healthcare Management*, *61*(6), 402–418. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/28319958

Ogundeji, Y. K., Bland, J. M., & Sheldon, T. A. (2016). The effectiveness of payment for performance in health care: A meta-analysis and exploration of variation in outcomes. *Health Policy (Amsterdam, Netherlands)*, *120*(10), 1141–1150. https://doi.org/10.1016/j.healthpol.2016.09.002

Emily Cochran
V00274575
Peasah, S. K., Mckay, N. L., Harman, J. S., Al-Amin, M., & Cook, R. L. (2013). Medicare Non-Payment of Hospital-Acquired Infections: Infection Rates Three Years Post Implementation Background: Medicare ceased payment for some, *3*(3). https://doi.org/10.5600/mmrr.003.03.a08

Penuel, W. R., & Means, B. (2013). Using Large-Scale Databases in Evaluation: Advances, Opportunities, and Challenges. In J. Goodwin (Ed.), *SAGE Secondary Data Analysis* (pp. v4-191-v4-212). London, UK: SAGE Publications, Ltd. https://doi.org/10.4135/9781473963702

Pittet, D., & Donaldson, L. (2006). Challenging the world: patient safety and health care-associated infection. *International Journal for Quality in Health Care*, *18*(1), 4–8. https://doi.org/10.1093/intqhc/mzi093

Quality Management in Healthcare. (2019). About the Journal : Quality Management in Healthcare. Retrieved May 4, 2019, from https://journals.lww.com/qmhcjournal/Pages/aboutthejournal.aspx

Rajaram, R., Chung, J. W., Kinnier, C. V., Barnard, C., Mohanty, S., Pavey, E. S., … Bilimoria, K. Y. (2015). Hospital Characteristics Associated With Penalties in the Centers for Medicare and Medicaid Services Hospital-Acquired Condition Reduction Program. *JAMA*, *314*(4), 375. https://doi.org/10.1001/jama.2015.8609

Rau, J. (2016, April 20). How Medicare Penalizes Hospitals for Being Too Careful - The New York Times. *New York Times*. Retrieved from https://www.nytimes.com/2016/04/21/health/how-medicare-penalizes-hospitals-for-being-too-careful.html

Reis, C. T., Paiva, S. G., & Sousa, P. (2018). The patient safety culture: a systematic review by characteristics of Hospital Survey on Patient Safety Culture dimensions. *International Journal for Quality in Health Care*, *30*(9), 660–677. https://doi.org/10.1093/intqhc/mzy080

Roth, J. (2017). CMS Impact File Hospital Inpatient Prospective Payment System (IPPS).

Retrieved December 6, 2017, from http://www.nber.org/data/cms-impact-file-hospital-inpatient-prospective-payment-system-ipps.html

Schabenberger, O. (2005). *Introducing the GLIMMIX Procedure for Generalized Linear Mixed Models*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.463.6093&rep=rep1&type=pdf

Shroeder, M. (2016). Value Theory. Retrieved June 2, 2018, from https://plato.stanford.edu/archives/fall2016/entries/value-theory/

Skinner, B. F. (1953). *Science and Human Behavior*. B.F. Skinner Foundation. https://doi.org/10.1002/sce.37303805120

Soltoff, S., Koenig, L., Demehin, A. A., Foster, N. E., & Vaz, C. (2018). Identifying Poor-Performing Hospitals in the Medicare Hospital-Acquired Condition Reduction Program: An Assessment of Reliability. *Journal for Healthcare Quality : Official Publication of the National Association for Healthcare Quality*, 1. https://doi.org/10.1097/JHQ.0000000000000128

Sorra, J. S., & Dyer, N. (2010). Multilevel psychometric properties of the AHRQ hospital survey on patient safety culture. *BMC Health Services Research*, *10*(1), 199. https://doi.org/10.1186/1472-6963-10-199

Stevens, J. (2002). *Applied multivariate statistics for the social sciences* (eth). Mahwah, NJ: L. Erlbaum.

Stevens, J. (2017). The promising contributions of behavioral economics to quality improvement in health Care. *Pediatric Quality & Safety*, *2*(3), e23. Retrieved from http://ovidsp.tx.ovid.com.proxy.library.vcu.edu/sp-3.28.0a/ovidweb.cgi?&S=NGEFFPEDHADDFEOENCFKCFIBALDNAA00&Complete+Reference=S.sh.27%7C1%7C1

Tao, W., Agerholm, J., & Burström, B. (2016). The impact of reimbursement systems on equity in access and quality of primary care: A systematic literature review. *BMC Health Services*

Research, *16*(1), 542. https://doi.org/10.1186/s12913-016-1805-8

U.S. Department of Health & Human Services. (2018). Case Mix Index. Retrieved October 9, 2018, from https://healthdata.gov/dataset/case-mix-index

US Census Bureau. (2000a). Census Regions and Division of the United States. Retrieved January 23, 2019, from https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf

US Census Bureau. (2000b). Census Regions and Division of the United States.

Van Herck, P., De Smedt, D., Annemans, L., Remmen, R., Rosenthal, M. B., & Sermeus, W. (2010). Systematic review: Effects, design choices, and context of pay-for-performance in health care. *BMC Health Services Research*, *10*(1), 247. https://doi.org/10.1186/1472-6963-10-247

Winters, B. D., Bharmal, A., Wilson, R. F., Zhang, A., Engineer, L., Defoe, D., … Pronovost, P. J. (2016). Validity of the Agency for Health Care Research and Quality Patient Safety Indicators and the Centers for Medicare and Medicaid Hospital-acquired Conditions: A Systematic Review and Meta-Analysis. *Medical Care*, *54*(12), 1105–1111. https://doi.org/10.1097/MLR.0000000000000550

Woolhandler, S., & Himmelstein, D. U. (2015). Collateral Damage: Pay-for-Performance Initiatives and Safety-Net Hospitals. *Annals of Internal Medicine*, *163*(6), 473. https://doi.org/10.7326/M15-1393

Yang, C.-M., & Reinke, W. (2006). Feasibility and validity of International Classification of Diseases based case mix indices. *BMC Health Services Research*, *6*, 125. https://doi.org/10.1186/1472-6963-6-125