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Effect of Bundled Payments as a Care Improvement Initiative on Hospital Care of Total Joint and Sepsis: A Perspective on Organizational Effectiveness

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EFFECT OF BUNDLED PAYMENTS AS A CARE IMPROVEMENT INITIATIVE ON HOSPITAL CARE OF TOTAL JOINT AND SEPSIS: A PERSPECTIVE ON ORGANIZATIONAL EFFECTIVENESS

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Abstract

This study investigates the potential impact of the Bundled Payments for Care Improvement (BPCI) initiative from Center for Medicare and Medicaid Services on hospital performance and behavior related to effectiveness and efficiency. The BPCI is under the Affordable Care Act and provides hospitals with a fixed amount of reimbursement for a total episode of care. Building on the agency theory, I argue that the BPCI initiative has the potential to enhance the effectiveness and efficiency of hospital care. This quasi-experimental study examines the changes in hospital care outcomes of patients with replacement of the lower extremity or sepsis in BPCI-participating hospitals and their counterparts in non-participating hospitals. Based on the 2013–2017 inpatient discharge data of Nevada, I apply the difference-in-differences modeling to evaluate hospital care outcomes before and after BPCI initiative implementation. The study produced mixed findings, with positive changes supporting my theoretical predictions and hypotheses in the case of sepsis, but no changes detected in support for my theoretical predictions and hypotheses for major joint replacement of the lower extremity.

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Chapter 1

Introduction

The increase in healthcare cost has dramatically outpaced general inflation in the United States (U.S.). Cost and quality of health care delivery remain a focus for the Centers for Medicare and Medicaid Services (CMS) as they attempt to contain healthcare costs. This study examines the impact of the Bundled Payments for Care Improvement (BPCI) initiative on the effectiveness and efficiency of hospital performance. It is aligned with the focus of CMS on effective health care delivery though implementation of the BPCI initiative.

Background

The steady increase in healthcare costs is a major concern for the U.S. economy as these costs continuously outpace the general economy. Total national health expenditures increased dramatically from $255.3 billion in 1980 to $3,337.2 billion in 2016 (Lassman et al., 2017; *Trendwatch: Chartbook 2018: Trends Affecting Hospital and Health Systems*, 2018). The CMS estimates that by 2026, national health spending will reach $5.7 trillion with an average growth rate of 5.5% per year from 2017-2026. Healthcare expenditures were 17.9% of gross domestic product (GDP) in 2016 and are projected to rise to 19.7% by 2026 (*National Health Expenditure Projections 2017-2026*, 2017).

The CMS Office of the Actuary definition of national healthcare expenditures includes all healthcare spending in the U.S. ("National Health Expenditure Accounts Methodology Paper, 2016: Definitions, Sources, and Methods," 2017). According to CMS data from 2017, more than one-third of national healthcare expenditures were for hospital care (42.7% in 1980, 34% in 2016) followed by physician services (20.9% in 2016) (*Trendwatch: Chartbook 2018: Trends Affecting Hospital and Health Systems*, 2018). More than 60% of hospital care expenditures were billed to government health insurance programs: Medicare (47.2%, $182.7 billion) and Medicaid (15.6%, $60.2 billion) (Torio & Andrews, 2013). Medicare is a federal program that provides health coverage for individuals 65 and older and those with severe disabilities regardless of income levels. Medicaid is a state and federal program that provides health coverage to low-income families. Most Medicare expenditures are for hospital care and the program is projected to experience its greatest annual growth of 7.4% in the next few years, largely driven by Medicare enrollment growth and an aging population (Cuckler et al., 2018).

Two of the greatest hospital costs are for treatment of major joint replacement of the lower extremity (MJRL) and sepsis (Torio & Moore, 2006). According to CMS data, MJRL is the most common operation performed in hospitals and sepsis is the most common nonmaternal, non-neonatal principal diagnosis among all conditions and the most expensive condition treated in U.S. hospitals (AHRQ, 2015). In 2011, Medicare was a primary payer for 62% of inpatient bills for sepsis (Torio & Andrews, 2013).

There are several different reimbursement models for health services in the healthcare system. The fee-for-service (FFS) model pays for services separately. It gives an incentive for providers to offer more treatments because payment is dependent on the quantity of care, rather than its quality. Therefore, unnecessary services are often provided and at an increased cost to CMS. With the global capitation model, those making healthcare decisions have a fixed budget. This gives them the incentive to provide quality care within their funding. However, a lack of coordination in episodes of care has resulted in scrutiny of the model (Froimson et al., 2013). There is a middle ground between FFS and global capitation to maximize patient-centered value by aligning payer and provider incentives. It is a bundled payment model known as an episode-based payment (Froimson et al., 2013). In 2011, CMS announced the BPCI initiative under the Affordable Care Act (ACA) to reduce federal spending while maintaining or enhancing the quality of care for Medicare beneficiaries (CMS, 2017).

Evaluating how hospitals response to different reimbursement models is important to health service and policy research. Examining effectiveness and efficiency of the BPCI initiative helps better understand hospital behavior under a new value-based payment model from the federal government. The most recent annual report of the BPCI initiative, Year 5, by the Lewin Group found Medicare payments for MJRL declined significantly under the BPCI initiative Model 2 (CMS, 2018b). This was based on Medicare claims and enrollment data from the fourth quarters of 2011 through 2016 (CMS, 2018b). Research is limited on how a value-based payment model might improve the effectiveness of care for a non-surgical clinical episode such as sepsis. More work is needed to find the most effective alternative payment model to reduce the burden of healthcare expenditures in the U.S. This is particularly relevant for conditions that cause the highest hospital expenditures, MJRL and sepsis.

Purpose of the Study

Given that CMS announced the BPCI initiative under the ACA, the BPCI initiative has been implemented since 2013 and effectiveness of the BPCI initiative needs to be analyzed. The purpose of this study is to examine potential impact of the BPCI initiative on hospital performance in Nevada. This is a quantitative, quasi-experimental study based on secondary data designed to (a) examine the effectiveness of the BPCI initiatives on BPCI-participating hospitals, and (b) examine the efficiency of the BPCI initiatives on these hospitals over the same period.

Research Questions

This study addresses the following research questions:

1. **Does the BPCI initiative have positive effects on the effectiveness of hospital performance for MJRL and care of sepsis?**
2. **Does the BPCI initiative have positive effects on the efficiency of hospital performance for MJRL and care of sepsis?**

Theoretical Framework

This study uses agency theory to understand hospital organizational behavior and performance under the CMS BPCI initiative (Figure 1). Agency theory explains the performance of a hospital under the BPCI initiative on health care delivery for both surgical and non-surgical medical care. In summary, the agency theory is a reflection of the relationships of effectiveness and efficiency with the implementation of the BPCI initiative. There are two hypotheses:

H_a: The BPCI initiative participating hospitals are more likely to improve effectiveness of hospital care than non-participating hospitals.

H_b: The BPCI initiative participating hospitals are more likely to improve efficiency of hospital care than non-participating hospitals.

Significance of the Study

This study uses State Inpatient Databases of Nevada (SIDN) data to provide empirical evidence on the performance of hospitals under the BPCI initiative.

My research addresses several gaps in the literature. First, it determines if the BPCI initiative has affected hospital performance based on a longer pre- and post-intervention period.

Published research results are usually limited to short-term outcomes. There is some evidence, based on short post-implementation of the bundled payment data, that bundled payment reduces the cost of unnecessary or duplicative services and improves care coordination (Dundon et al., 2016; Froemke et al., 2015). Little information is available, however, on the effectiveness of the BPCI initiative over a longer period. Second, this research will add to current literature examining effects of the BPCI initiative for medical care by showing positive effects of the BPCI initiative on hospital performance for sepsis. Third, it will add to the existing literature by providing a more comprehensive picture of the association between the BPCI initiative and quality of hospital performance. Several studies have examined the association between the BPCI initiative and quality of care in terms of readmission, emergency department (ED) visits, length of in-hospital stays (LOS), and mortality (Dundon et al., 2016; Edwards, Mears, & Barnes, 2017; Froemke et al., 2015; Iorio et al., 2016; Navathe et al., 2017). This study expands the examination of complications as a part of the performance measurement. Finally, my study uses the most recent data available. Although the study is based on the data of only one state, Nevada, its findings still improve our understanding of hospital performance responding to a value-based payment model from CMS, the bundled payment.

Summary

This chapter describes the purpose, background, and significance of the study. A summary of the theoretical framework of agency theory, the basis of this research, is also presented. Hospital performance is studied from the aspects of effectiveness and efficiency. Chapter two is a comprehensive literature review of the BPCI initiative and hospital performance on orthopedic surgery and sepsis. Chapter three discusses the conceptual framework, including relationships among the constructs as well as the hypotheses of the framework. Chapter four contains comprehensive information of the methods used in this study, expanding the research questions and hypotheses to include statistical analysis. It also explains the research design and sample, measurements of variables, and analytical approaches. Chapter five presents the results of the study and Chapter six discusses the findings of this study. The last chapter also offers directions for future research, implications for public health policy and interventions, and discusses assumptions and limitations of the study. Terms used in this study are defined in Appendix B.

Chapter 2

Literature Review

Introduction

The purpose of the review is three-fold. First, previous studies on the effects of bundled payments on hospital outcomes are presented. Second, methodological issues pertaining to the existing literature, as well as other literature gaps, are reviewed. Third the review identifies pertinent indicators used in the conceptual framework presented in the next chapter.

To achieve the above purpose, several questions are addressed: (a) Does the BPCI initiative remain effective for a period longer than reported in previous studies? (b) Is the BPCI initiative effective for medical conditions? (c) Does using a different quality indicator support current studies that determined there were no quality changes under the BPCI initiative? (d) If there were any changes in hospital performance under the BPCI initiative, which organizational theory could best explain them? Since Major Joint Replacement of the Lower Extremity (MJRL) and sepsis are chosen as tracer conditions for this study, the chapter begins with descriptions of MJRL and sepsis. The second section reviews health services reimbursement models and the BPCI initiative under the Patient Protection and Affordable Care Act (ACA). The third section explains relationships between the bundled payment reimbursement and hospital performance. The sources used for the literature review were: Pub Med, Google Scholar, Kopernio database, publications listed on the CDC website, and a review of selected journal article citations. Finally, a summary of the major points revealed by the literature review is presented.

The Clinical Procedure and Condition Selected for the Study

Major Joint Replacement of the Lower Extremity.

Major joint replacement of the lower extremity (MJRL) is one of 48 episodes of care covered by the BPCI initiative of CMS (Appendix A). MJRL is total joint arthroplasty (TJA) and includes both total knee arthroplasty (TKA) and total hip arthroplasty (THA). Arthroplasty is a surgical procedure to restore the function of a joint by either resurfacing the bones or by using an artificial joint. TKA either resurfaces a knee damaged by arthritis or uses artificial parts to cap the ends of the bones. It is typically performed on patients with severe knee arthritis (Cram et al., 2012; "Knee Replacement Surgery Procedure," 2018). THA is used to replace a hip joint with an artificial one. TJA is the most common elective surgical procedure in the U.S. and the greatest surgical expenditure for patients with Medicare (Cutler & Ghosh, 2012). In a longitudinal study between 1991 and 2001, Cram et al. (2012) showed a rapid increase of primary TKA both in volume (161.5% increase from 93,232 in 1991 to 243,802 in 2010) and in per capital utilization (99.2% increase, 31.2 procedures per 10,000 Medicare enrollees in 1991 to 62.1 procedures per 100,000 in 2010). The incidence of TKA itself is projected to increase in the U.S. from 500,000 in 2005 to 3.48 million by 2030. The annual incidence of joint replacement procedures is projected to increase considerably among aging "baby boomers" (Nichols & Vose, 2016). A majority of TJA patients are white, female, and 65 or older with Medicare insurance (Molloy, Martin, Moschetti, & Jevsevar, 2017; Nichols & Vose, 2016; Nwachukwu, McCormick, Provencher, Roche, & Rubash, 2015)

There has been a consistent decrease in length of stay (LOS) after TJA surgery (Cram et al., 2012). Two questions have been raised regarding the reduction in LOS, as many U.S. hospitals are adopting the bundled payment reimbursement model. First, there are concerns about an association between shorter LOS and the potential need for more frequent post-discharge care or readmission. One study from a Medicare Part A data file analysis of TKAs between 1991 and 2010, observed a significant decrease in hospital LOS and an increase in hospital readmission rates (Cram et al., 2012). Conversely, Regenbogen et al. (2017) found no evidence among Medicare claims between 2009 and 2012 that a shorter LOS was more likely associated with frequent post-discharge care or readmission. Second, a shorter LOS after surgery might reduce the total cost of care. There are mixed findings in different datasets about cost of care and LOS. One study showed a shorter LOS was associated with lower total surgical payments from analyzing Medicare claims between 2009 and 2012 (Regenbogen et al., 2017). According to Molloy et al. (2017), hospital costs for TJA increased consistently even though LOS decreased. Molloy et al. (2017) used data from National Inpatient Sample from 2002 and 2013 and found a greater increase in mean hospital cost for both TKA (52.4%) and THA (49.8%) and a reduction in LOS from 4.06 to 2.97 days.

There was a change in the trend of patient discharges between 1991 and 2010. More patients were discharged to outpatient rehabilitation in lieu of inpatient rehabilitation (Cram et al., 2012). Post-discharge costs, including readmission costs, are requisite components of the total cost of TJA. In one estimate, initial hospitalization accounted for only about 55% of the total cost, and Medicare spent about $6 billion during the 90-day post-acute period in 2013 (Mechanic, 2015). Bozic et al. (2014) found that post-discharge payments accounted for 36% of total payments. Approximately 49% of patients were transferred to a post-acute care (PAC) facility, such as a skilled nursing facility (SNF), acute rehabilitation facility, or home health services (HHS), which accounted for 70% of post-discharge payments (Bozic, Ward, Vail, & Maze, 2014). Another study supported the finding that using a PAC facility was a significant variable in the total cost of care, as 77.0 % of patients used PAC services following surgery (Snow et al., 2014). Studies on costs associated with patient discharge and 90-day readmission support a substantial variation in costs depending on the care pathway: whether a patient is released to SNF after TJA surgery or readmitted in 90 days (Nichols & Vose, 2016; *Patient Safety Indicators overview*; Tsai et al., 2016). As a result, the most expensive scenario was 1.8 to 2.2 times higher than the lowest cost scenario based on healthcare claims (Nichols & Vose, 2016). The trend to discharge more patients to their homes instead of SNFs after TJA procedure has increased significantly from 15% in 1998 to 35% in 2009 (Ong, Lotke, Lau, Manley, & Kurtz, 2015).

MJRL is a suitable group of surgeries for bundled payment models since it is elective, relatively standardized, and subject to a comparatively low spending variation (Mechanic, 2015). In addition, MJRL varies widely in both cost and quality, though it occurs in high volumes and relatively homogeneous patient populations. Bozic et al. (2014) analyzed 250 Medicare beneficiaries undergoing MJRL at a single hospital over a 12-month period and found bundled payments for MJRL varied depending on patient comorbidities and complications, discharge disposition, and readmission rates. Medicare reimbursements for MJRL are highly variable depending on geographical region, patient volume, health of the patient population, and government ownership of a hospital. These are other important driving forces affecting value-based bundled payments. Based on CMS inpatient charges and reimbursement data, authors found higher reimbursements were correlated with lower patient volume, a healthier patient population, lower cost efficiency, lower quality, and government ownership (Padegimas et al., 2016).

The BPCI initiative classifies joint replacement according to whether or not patients have major complications or coexisting conditions. This classification forms the foundation for the

Medical Severity Diagnosis-Related Groups (MS-DRGs). MS-DRG 469 is for MJRL patients with major complications or coexisting conditions and MS-DRG 470 is for MJRL patients without complications (Appendix A).

Sepsis.

Sepsis is a serious medical condition caused by an overwhelming, life-threatening immune response to infection ("Sepsis," 2018). Sepsis is a substantial burden on the U.S. healthcare system. The mean age of sepsis patients is 65 years (Paoli et al., 2018; Rhee et al., 2017). It is a leading cause of in-hospital death and the most frequent and expensive condition treated in U.S. hospitals. With a continuous increase in the incidence of sepsis, sepsis-associated hospital stays almost tripled between 2005 and 2014 (McDermott, 2017; Stoller et al., 2016). A number of studies were conducted using retrospective databases to examine temporal trends on the incidence of sepsis and in-hospital death. The incidence of sepsis increased, but in-hospital mortality consistently decreased from 2000 to 2012, based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD- 9-CM) codes from National Inpatient Sample data (Stevenson, Rubenstein, Radin, Wiener, & Walkey, 2014; Stoller et al., 2016). However, it is unclear whether the rise in incidence and decrease in in-hospital mortality were true, or whether the reported outcomes were artifacts due to changes in coding and discharge practices. As coding practices became more inclusive, it might have resulted in an increased awareness and diagnosis of sepsis. A reduction of in-hospital mortality may be an outcome of discharging patients to long-term acute care facilities prior to in-hospital death. However, concerns over the reliability of studies based on claim data were reduced when studies using clinical data sets reported the same trends of decreasing in-hospital mortality for sepsis (Rhee et al., 2017; Stevenson et al., 2014).

There was a decrease in LOS from 17.3 to 7 days over the 12-year period from 2000–2012, and home discharges have increased steadily since then, regardless of the severity of sepsis (Paoli, Reynolds, Sinha, Gitlin, & Crouser, 2018; Stoller et al., 2016). Studies also have reported that more than 40% of patients are discharged to SNFs or intermediate care facilities rather than home or HHS (Rhee et al., 2017; Stoller et al., 2016). There has been a slight increase in home discharge but discharge to SNFs remains the same. Different from surgical conditions, studies found that increased LOS for medical conditions was highly associated with reduced rates of early hospital death and fewer readmissions (Eapen et al., 2013; Southern & Arnsten, 2015; Stukel et al., 2012).

Sepsis differs from MJRL in that it is not diagnosed until after admission. There is also more than one therapeutic intervention for sepsis, which must target different pathways due to variability in the pathogenesis of sepsis (Khan & Divatia, 2010; Paoli et al., 2018). Early Goal-Directed Therapy (EGDT) is a protocol that manages sepsis during the six hours following diagnosis. Rivers et al. (2001) found significant benefits in outcomes for patients with sepsis assigned to EGDT. Timing of the diagnosis of sepsis and early treatment are critical to clinical outcomes and financial burdens. When sepsis was not diagnosed on hospital admission, the total cost of sepsis treatment was much higher: $51,022 if undiagnosed compared to $18,023 when diagnosed on admission (Paoli et al., 2018). The Institute for Healthcare Improvement and CMS proposed sepsis care bundles based on EGDT in 2004. The goal was to improve uniformity and universality of sepsis treatment by reducing the variability in clinical practice (Jozwiak, Monnet, & Teboul, 2016; Khan & Divatia, 2010; Paoli et al., 2018). Bundled care processes established a shared clinical baseline, standardizing interventions to reduce variation among clinicians (Miller et al., 2013). A sepsis care bundle is a group of therapies built around evidence-based guidelines rather than individual therapies. Numerous studies have shown the effectiveness of these bundles (Khan & Divatia, 2010; Levy et al., 2004) as in-hospital mortality and LOS have decreased (Castellanos-Ortega et al., 2010; Girardis et al., 2009; Levy et al., 2015; Miller et al., 2013; Noritomi et al., 2014). Additionally, the cost of care per patient has decreased as the condition of patients improved (Noritomi et al., 2014). However, the use of sepsis care bundles is low, with a compliance of about 5% (Jozwiak et al., 2016). Therefore, including sepsis in the BPCI initiative was in line with its goal: to produce higher quality, more coordinated care at a lower cost to Medicare.

The BPCI initiative classifies sepsis in three categories depending on use of mechanical ventilation and the presence of complications. MS-DRG 870 is septicemia or severe sepsis and the use of mechanical ventilation for more than 96 hours. MS-DRG 871 is septicemia or severe sepsis, using mechanical ventilation for more than 96 hours, plus major complications or comorbidity. MS-DRG 872 is septicemia or severe sepsis without using mechanical ventilation for more than 96 hours and without major complications or comorbidity (Appendix A).

Bundled Payments Mechanism and the CMS Initiative

Bundled payments.

Bundled payments, or episode of care payments, are value-based payment models. The payer makes a single payment to providers and healthcare facilities for all the healthcare services performed to treat a patient for a certain condition within a defined period of time. Bundled payments are an incentive to provide quality-of-care services and move away from an emphasis on quantity of care. Providing care within a single payment per patient can reduce unnecessary tests and procedures. Ways of reducing excessive spending may include reducing factors that lead to prolonged inpatient stays and omitting redundancy and waste of medical supplies and employee time (Mechanic, 2015; Tsai et al., 2016). Conventionally, Medicare uses a FFS payment model that makes separate payments to providers for each service they perform during a course of treatment. The FFS approach rewards quantity of services rather than quality of care, resulting in duplicate and unnecessary diagnostic procedures (Tsai & Miller, 2015). Alternatively, bundled payments set a fixed reimbursement amount to be shared among all providers: physicians, allied health professionals, hospitals, and other facilities. This approach prevents fragmented care, provides minimal coordination across health care settings, and requires hospitals and physicians to work collaboratively to manage costs and processes from a single pool of resources.

Surgical inpatient care is about 40% of all hospital and physician bills to Medicare. With a prospective payment system, hospitals and their physicians continue to be paid for each unit of service for any adverse outcomes after the surgery, in addition to fixed payments from Medicare. Analysis of Medicare data for four of the most common types of inpatient surgical care, including hip surgery, showed hospital payments provided the greatest variability and were responsible for the biggest share of payments overall among hospitals (Birkmeyer et al., 2010).

CMS episode-based Bundled Payment Programs.

Acute Care Episode (ACE) Demonstration: 2009 – 2012.

The Inpatient Prospective Payment System and Medicare Physician Fee Schedule are the payment systems CMS uses for hospitals (Part A) and physicians (Part B) during an inpatient stay. In the Medicare Physician Fee Schedule, a number of relative value units for each procedure determine a payment level for each procedure. Physician work is the largest component of a relative value unit and it's defined as the time, intensity, and skill required to perform a service (Urwin et al., 2019).

In 2009, Medicare introduced the ACE Demonstration project under section 646 of the Medicare Prescription Drug, Improvement, and Monetization Act of 2003. Its purpose was to test the use of a bundled payment for inpatient episodes of care for orthopedic and cardiovascular surgery (CMS, 2010). Under the ACE Demonstration, Medicare made a single payment to hospitals for both hospital and physician services provided during an inpatient day. Specifically, ACE Demonstration tested the effect of bundling Part A and Part B payments for episodes of acute care. It was a three-year pilot program limited to five sites in four states: Texas, Oklahoma, New Mexico, and Colorado. In terms of gainsharing, Medicare shared savings up to a maximum of the annual Part B premium with beneficiaries who participated in the ACE Demonstration. Medicare also shared savings with participating hospital-physician partnerships if profits were realized. To be able to gainshare, hospital-physician partnerships agreed to an average 5% discount in DRG payments from CMS (Rana & Bozic, 2015).

In summary, the ACE Demonstration was a pilot program to test bundling hospital (Part A) and physician (Part B) payments for episodes of acute care. However, post-acute care payments were not included in the ACE Demonstration. With this program, most of the studies showed a decrease in the overall cost per orthopedic surgery episode by reducing LOS and implant prices, and gainsharing with physicians was possible (CMS, 2010; Davis, 2010; Rana & Bozic, 2015). The CMS final evaluation report on ACE Demonstration stated reduction in cost of care and LOS with containing quality of care (Urdapilleta et al., 2013).

Bundled Payments for Care Improvement (BPCI) Initiative: 2013 –2018.

In 2011, CMS announced the BPCI initiative under section 3021 of the Patient Protection and ACA with an emphasis on efficiency and quality of care, by shifting FFS Medicare payment models toward value-based models (Dundon et al., 2016; Perla et al., 2018; Tsai, Joynt, Wild, Orav, & Jha, 2015). The Initiative is a voluntary participation that allows participants to choose among different models as well as among 48 clinical episodes (Appendix A). The Medicare Severity-Diagnosis Related Group (MS-DRG) of qualifying hospitalization defined the clinical episodes. The initiative has included 1,201 hospitals and the most popular episode among participating hospitals was MJRL. The BPCI initiative began in 2013 and providers could terminate their participation at any time. One of the objectives of the BPCI initiative was to make hospitals and physicians financially accountable not only for inpatient care but also for post-discharge care, and allow gainsharing between hospitals and physicians across services by aligning stakeholders' incentives (Rana & Bozic, 2015).

The BPCI initiative is a three-year program composed of four innovative models defined by different episodes of care (Table 1). In Model 1, the episode of care includes all MS-DRGs for the inpatient stay in an acute care hospital, like the ACE Demonstration. Medicare paid a reduced amount to hospitals based on rates from the original Medicare program's Inpatient Prospective Payment System. Physicians were paid by Medicare based on the Medicare Physician Fee Schedule (CMS, 2017a). The first and second cohort of Awardees in Model 1 began in April 2013 and January 2014 and concluded on March 31, 2016 and December 31, 2016, respectively. Models 1, 2, and 3 involved a retrospective bundling model that reconciled actual payments against a target price (CMS, 2017b, 2017c; Kivlahan et al., 2016; Mechanic, 2015; Rana & Bozic, 2015; Tsai et al., 2015). For Model 2, the target price for each selected episode was set at a two- to 3-percent discount based on three years of Medicare claims data for the participants (Tsai et al., 2015). Two percent was applied to 30- and 60-day bundles and three percent was applied to 90-day bundles. BPCI initiative participating hospitals could determine their recalculated target prices at the end of each quarter (Mechanic, 2015). A participant would receive additional payments as an incentive if actual payments were less than the target price; otherwise participants were responsible for refunding the excess to CMS as a penalty. An episode of care in Model 2 included a Medicare beneficiary's inpatient stay in an acute care hospital, post-acute care, and all related services during the episode of care. This period ended 30, 60, or 90 days after hospital discharge based on the 48 different clinical episodes. Section 1861(i) of the Social Security Act includes a 3-day inpatient hospital stay prior to receiving SNF services covered by Medicare Part A. For Model 2 participants, this requirement was waived upon a hospital's request (CMS, 2017b; Nichols & Vose, 2016). The first cohort of BPCI participants began on October 1, 2013 and the second on January 1, 2014. Additional cohorts began on January 1, April 1, and July 1, 2015, and the BPCI initiative was extended until September 30, 2018 for Models 2, 3, and 4. As of July 1, 2018, 253 acute-care hospitals and 152 physician group practices had participated in BPCI initiative Model 2. Model 3 involved only the post-acute period following discharge from the hospital for selected DRGs (Table 1). It covered SNF, HHS, inpatient rehabilitation facilities, physician group practices, and long-term-care hospitals (CMS, 2017c). Model 4 was a single, prospective, bundled payment for both hospital and physicians. It covered the acute inpatient stay and related 30-day readmissions after hospital discharge for selected DRGs. The first cohorts of participants in Models 3 and 4 began in

October 2013. As of July 1, 2018, the BPCI Model 4 had two participants in Phase 2.

There were two phases of the BPCI initiative for Models 2, 3, and 4. Phase 1 was the preparation period where CMS and its participants plan implementation of the BPCI and accept the financial risk. To remain in the BPCI, a participating organization must transit at least one clinical episode among the 48 to Phase 2 by July 1, 2015. Phase 1 ended on September 30, 2015 and the transition to Phase 2 of all clinical episodes for all participants was completed. Phase 2 was a risk-bearing phase. It was a three-year period of performance for each clinical episode. Phase 2 was extended until September 30, 2018, allowing awardees to extend their period of performance for all clinical episodes for up to two years. As of July 2018, Phase 2 of the BPCI initiative had 1,025 participants composed of 206 Awardees and 819 Episode Initiators (CMS, 2017d). MJRL was the most common condition among hospitals that participated in Phase 2 of the BPCI initiative (Tsai et al., 2015).

BPCI Initiative Model 2

An episode payment is defined by the length of time covered and range of providers and services included for a single episode of care (CHQPR, 2015). The BPCI initiative Model 2 has the most comprehensive bundle, including all related providers and services for a single patient for a single episode of care, from the starting point to up to 90 days after discharge. Model 2 includes four different time stages: pre-admission, hospitalization, post-acute care, and readmission or complication from the same episode of care up to 90-days following discharge from the hospital (Figure 2) (CHQPR, 2015). The episode starts when a beneficiary is admitted to or visited by an episode-initiating acute-care hospital or a physician. All related professional services provided by a primary care physician (PCP), surgeon or other specialist, in addition to imaging services and drugs, are included in the pre-admission stage. For example, a Medicare beneficiary visits a PCP for hip pain and the PCP refers him or her to an orthopedic specialist. The orthopedic surgeon or the PCP orders imaging and blood tests and the patient is prescribed drugs to ease the pain. If the orthopedic surgeon determines the patient needs a MJRL and the patient agrees to the surgery, the patient is admitted to a hospital. During hospitalization, an anesthesiologist, orthopedic surgeon, radiologist, and hospital staff are involved in the surgical intervention. Implants, blood transfusion, other devices, and drugs used in surgery are services included during hospitalization. If the patient is discharged to a PAC facility, such as a rehabilitation facility, plus long-term care after the MJRL procedure, expenses for other specialists and related staff are also covered under the Model 2 bundled payments. Home care and a PCP care manager, plus services provided during the PAC such as imaging and drugs, are included in the Model 2 bundled payments. Since the BPCI initiative Model 2 extends for 90 days, if the patient is readmitted to the hospital for the same MJRL-related care, all expenses during readmission are included in a bundled payment.

According to the Lewin Group (CMS, 2018b) analysis of Awardee-submitted data, physicians, physician group practices, hospitals, institutional PACs, and home health agencies are the most common gainsharing partners to receive net payment reconciliation and internal cost savings under Model 2. Physicians receive 88.3% of a gainsharing distribution. Of these, most are orthopedic surgeons. From Quarter 4, 2013 through Quarter 2, 2017, each orthopedic surgeon received $23,005 in net reconciliation and averaged $15, 087 in internal cost savings. The amount of the payments received by the different providers under Model 2 is unknown, since their financial arrangements are specified in each “Awardees” agreement with CMS. To ensure quality of care, CMS assesses the patient’s experience of the care and health outcomes by analyzing claims and quality reporting from the Awardees, including surveys and patient-assessment tools. In order to examine the effects of bundled payments, assessment and monitoring activities and data collection efforts are required for BPCI initiative participating hospitals. Number of ED visits, mortality, and readmissions are used to determine quality of care by the CMS Annual report on the BPCI initiative (CMS, 2018b).

Relationship between Bundled Payments and Hospital Performance

In the most recent annual report for the BPCI initiative Year 5, the Lewin Group (CMS, 2018b) found Medicare payments under the BPCI initiative Model 2 declined considerably for 24 of the 32 hospital-initiated clinical episodes analyzed, with little changes in quality of care. This report used a Difference-in-Differences (DiD) method based on Medicare claims and enrollment data from the baseline period, Quarter 4, 2011, through Quarter 3, 2012, to the intervention period, Quarter 4, 2013, through Quarter 4, 2016. Declines in the use of PAC facilities were primarily attributed to Medicare payment reductions. Savings for the Medicare program under Initiative Model 2, however, were not realized overall after reconciliation payments were made to the other participants. Under Model 2, the Initiative resulted in a net loss to Medicare of $202.1 million from Quarter 4 2011 to Quarter 4 2016.

Bundled payments and episodes of care.

Joynt Maddox et al. (2018) examined the effect of five medical conditions in the BPCI initiative: congestive heart failure, pneumonia, chronic obstructive pulmonary disease (COPD), sepsis, and acute myocardial infarction. Based on Medicare claims from 2013 through 2015, they found no significant changes in Medicare payments, LOS, ED use, 30- or 90-day hospital readmissions, or mortality for these five medical conditions. Their finding supports earlier studies on the efficacy of BPCI intervention for COPD by Bhatt et al. (2017). The Medicare BPCI initiative did not reduce overall costs or 30-day readmission rates even though COPD patients under the initiative were more likely to receive effective hospital care through regular follow-up calls and pulmonary clinic visits than COPD patients treated at non-participating hospitals (Bhatt et al., 2017). Early results from the Lewin Group reported similar financial outcomes for the cardiovascular surgery episode between October 2013 and September 2014.

The Lewin Group (CMS, 2018b) reported no significant changes for inpatient hospital LOS or for patients discharged to PAC facilities across all clinical episodes during the BPCI initiative. Regarding discharge locations among patients receiving PAC, the use of institutional PAC declined significantly for 13 clinical episodes: cardiac valve replacement; coronary artery bypass graft; esophagitis, gastroenteritis and other digestive disorders; fractures of the femur, hip or pelvis; MJRL; nutritional metabolic disorders, other reparatory, revision of MJRL; sepsis; simple pneumonia and respiratory infections; transient ischemia; and urinary tract infection.

Quality of care did not change under Model 2 according to the Lewin Group (CMS, 2018b). The mortality rate declined for more than half of the clinical episodes in BPCI-participating hospitals, except for coronary artery bypass grafts. The use of EDs during the 90 days after discharge from the hospital decreased significantly for major joint replacement of the upper extremity, stroke, syncope, and collapse. The results for 90-day readmission rates were mixed. Compared to the baseline period, there was an increase in readmission rates among clinical episodes for: fractures of the femur, hip or pelvis, and revisions of the hip or knee; gastrointestinal obstruction; and percutaneous coronary intervention. There were two episodes of care with a statistically significant decrease in the 90-day readmission rates: esophagitis, gastroenteritis and other digestive disorders; and spinal fusion.

Bundled payments and orthopedic surgery.

Cost of care.

Many studies show positive financial outcomes for the BPCI initiative Model 2 and the MJRL episode of care. The recent BPCI initiative Year 5 annual report by the Lewin Group (CMS, 2018b) found that Medicare payments for MJRL declined significantly under Model 2. The Group used the DiD method based on Medicare claims and enrollment data from Quarter 4, 2011 through Quarter 4, 2016. Declines in PAC were the main contribution in reducing Medicare payments. Dummit et al. (2016) evaluated the association between hospitals participating in the BPCI initiative and Medicare payments for quality of care. For the baseline period from October 2011 to September 2012 and an intervention period from October 2013 to June 2015, they estimated the difference in outcomes for Medicare FFS beneficiaries. Results showed that Medicare payments were $1,166 lower for BPCI-participating hospitals. These savings were primarily due to a reduction in institutional PAC, with no important change in readmissions, ED visits, or mortality. Another study of CMS claim data for a single hospital from the first and second quarter of 2013 showed a 10% Medicare cost reduction under the BPCI initiative compared to the July 2009 to June 2012 baseline period and the target price (Iorio et al., 2016). Edwards and et al. (2017) studied the same Medical claim data for a three-year baseline period, 2009 to 2012. Costs were usually greater for revision TJAs than primary TJAs, mainly because of a mixed patient population, more complications, and a greater complexity of surgical interventions. Courtney and others (2016) compared revision TJA patients in bundled and nonbundled groups from one hospital system using CMS data between October 2013 and March 2015. There were no differences in total costs to CMS, however, between revision TJA before or after the BPCI initiative (Courtney, Ashley, Hume, & Kamath, 2016).

Post-acute care and hospital readmissions are two prime areas of opportunity for meaningful cost reductions (Kivlahan et al., 2016). CMS claims data for 27 BPCI initiative-participating teaching hospitals showed that PAC (SNF, home health agency, inpatient rehab, and inpatient psych) comprised 67% of post-discharge payments for the MJRL episode of care with 22% attributable to readmissions (Kivlahan et al., 2016). The average Medicare payment per episode for inpatient rehabilitation (IP Rehab) dropped from $5,000 and $8,000 during the baseline years of 2009 to 2012, to about $1,000 after participating in the BPCI initiative from 2013 to 2014. A steady increase in home health use was credited with the rapid decrease in the use of IP Rehab. Results from the CMS final reports were similar. The Lewin Group reported that lower PAC payments and increased HHA payments led to reductions in total Medicare payments for MJRL (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018).

Blue Cross Blue Shield of North Carolina was a payer employed in a value-based reimbursement model for MJRL. The MJRL bundle included hospital admission, surgery, anesthesia, physician fees, the implant device, facility fees, lab tests, care coordinator, and all PAC up to 90-days. The payer reported 8–10% savings from bundling in 2011. Unbundled MJRL costs were between $25,000 and $43,000 and decreased to $22,000 to $30,000 when the total costs were bundled (*Action Plan for Bundled Payments*, 2015).

Length of in-hospital stay.

The 2018 annual report on the BPCI initiative supports other studies on the effect of Model 2 on LOS for MJRL (Dundon et al., 2016; Edwards et al., 2017; Iorio et al., 2016). The report indicates reductions in LOS among Model 2-participating hospitals compared to non-participating hospitals (CMS, 2018b). Iorio and et al. (2016) found that LOS decreased from 4.27 to 3.38 days in a single hospital based on Medicare data. Another study also reported a decrease in LOS from 3.81 to 2.57 days using the same Medicare claims data but analyzing a longer intervention period, from October 2013 to September 2014. A reduced LOS from 5.27 to 4.02 days also occurred among patients who had revision MJRL surgeries (Courtney et al., 2016).

Outcome of care.

Many studies have indicated that the BPCI initiative reduced payments for the MJRL episode with no changes in quality of care ((Doran & Zabinski, 2015; Dummit et al., 2016; Edwards et al., 2017; Iorio et al., 2016; Siddiqi et al., 2017). With a significant reduction in LOS among Model 2-participating hospitals, there were concerns of an increase in PAC discharge and readmission rates in exchange for shorter hospital stays. However, earlier studies on the BPCI initiative showed a reduction in LOS was not associated with SNF discharge and readmission rates. A study comparing the first and third years of the Initiative at a single academic hospital from 2013 to 2015 found reduced rates of discharging patients to inpatient facilities and a reduction in readmissions (Dundon et al., 2016). Discharges to home health care increased by 23% along with an 88% cost reduction in IP Rehab. Iorio and et al. (2016) found a reduction in discharges to inpatient facilities. Their study showed a higher portion of readmitted patients were those discharged to facility-based settings rather than patients discharged to home health assistance or self-care (Iorio et al., 2016). Edward et al. (2017) reported a decrease in 90-day readmissions from 16 to 10%, with a 23% reduction in the average cost of readmissions (Edwards et al., 2017). The Lewin Group report also supported the current findings of a PAC discharge reduction for MJRL under initiative Model 2 (CMS, 2018b). However, findings from different studies were mixed regarding quality of care and outcomes such as ED use and mortality rate. The Lewin group found no significant changes in these measures under Model 2.

Navathe and et al. (2018) provided a more complete view of the effects of the Model 2 BPCI initiative on cost reduction by comparing it to the ACE Demonstration. ACE and the BPCI initiative are both bundled payment reimbursement models, except ACE doesn't include post-acute care. Their study analyzed Medicare claims and internal cost data from a healthcare system that participated in both ACE and the BPCI initiative. Hospitals participating in both ACE and the BPCI initiative had a decrease in LOS and in the cost for both DRG 469 and DRG 470. There were no major differences in the number of ED visits or 30-day readmissions after the surgery. However, only BPCI initiative-participating hospitals had a decline in average PAC spending of $2,442.12, or 27% per case (Navathe, Liao, Polsky, et al., 2018).

Bundled payment and sepsis.

Cost of care.

A study by Joynt Maddox et al. (2018) examined effects of the BPCI initiative on the individual components of payment that included total 90-day Medicare payments, payments for readmissions, skilled nursing, IP Rehab, long-term care hospitals, home health agencies, physician fees, and non-physician outpatient fees for sepsis. From DiD analyses of Medicare claims from 2013 through 2015, they found no significant changes in Medicare payments at

BPCI-participating hospitals compared with comparison (non-participating) hospitals (Joynt Maddox, Orav, Zheng, & Epstein, 2018). Findings from the Lewin Group reported no marked changes in total Medicare payments at BPCI-participating hospitals although there was a sizable decrease in Medicare payments for SNF (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018).

A non-research article reported a successful Medicare bundle for sepsis at the St. Joseph Health System in South Bend, Indiana (Meyer, 2018). St. Joseph adopted evidence-based clinical pathways for sepsis that allowed better ED and inpatient care during the first six hours after sepsis was diagnosed. As a result, patients were more likely to be directly discharged to home rather than to a SNF. With a decrease in the use of SNFs, St. Joseph was able to cut costs and meet the bundled payment target.

Length of in-hospital stay.

The BPCI 2018 annual report from the Lewin Group supported Joynt Maddox's findings that there was no significant changes in LOS for sepsis at BPCI-participating hospitals relative to non-participating hospitals comparing before and after the BPCI initiative (CMS, 2018b; Joynt Maddox et al., 2018).

Outcome of care.

Two empirical studies on effects of the BPCI initiative for sepsis measured changes in outcomes of ED use, readmissions, and mortality between BPCI-participating and comparison hospitals. Joynt Maddox and et al. (2018) and the Lewin Group (CMS, 2018b) observed no differences in ED use, hospital readmissions, or mortality between participating and non-participating hospitals, before and after the BPCI initiative.

Summary and Literature Gap

Numerous studies of the early BPCI initiative have shown the effectiveness and efficiency of bundled payments for MJRL. The BPCI initiative was associated with decreases in LOS, mortality, discharging patients to SNF, and Medicare payments without changes in quality of care at BPCI-participating hospitals compared with non-participating hospitals (Carroll, Chernew, Fendrick, Thompson, & Rose, 2018; Dummit et al., 2016; Dummit et al., 2018; Dundon et al., 2016; Froemke et al., 2015; Iorio et al., 2016; Kivlahan et al., 2016; J. M. Zhu, Patel, Shea, Neuman, & Werner, 2018). However, a few studies on sepsis reported no significant effects of the BPCI initiative on hospital performance (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018; Joynt Maddox et al., 2018).

My study will contribute to four aspects of the literature. First, it will contribute to literature that examines the effects of the BPCI initiative using a short baseline and intervention period. For example, most of studies for MJRL were based on CMS Medicare claims data using a short baseline period (2 to 36 months) and intervention (3 to 20 months) (Dummit et al., 2018; Edwards et al., 2017; Froemke et al., 2015). For sepsis, Joynt Maddox and et al. (2018) used a 6-month baseline period and a 9-month intervention period (Joynt Maddox et al., 2018). To the best of my knowledge, my study is the first to address effects of the BPCI initiative on hospital performance for MJRL and sepsis based on a longer pre-intervention period (27 months) and post-interventions period (27 to 30 months) using the most current data.

Second, this study will contribute to literature that uses DiD analyses to determine effects of the BPCI initiative. For example, the Lewin Group report used DiD analyses, but there were large differences in baseline periods of the outcome between BPCI and matched comparison group (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018). Therefore, results could have been biased. A study by Joynt Maddox and et al. (2018) showed parallel baseline trends, yet they used a relatively short baseline period. To address the validity of DiD, my study will test the significance of differences in the average trend in outcomes in the treatment and comparison groups over the period of time leading up to the BPCI initiative (McCoy, McDonough, & Rochowdhury, 2017).

Third, this study will contribute to literature that examines factors that determine quality of care. For example, most studies on the BPCI initiative use mortality, ED use, and hospital readmission as quality measures (Dundon et al., 2016; Edwards et al., 2017; Froemke et al., 2015; Joynt Maddox et al., 2018). To the best of my knowledge, my study is the first to use Patient Safety Indicators (PSIs) to determine complications following procedures.

Fourth, this study will contribute to literature that examines effects of the BPCI initiative for sepsis, since only a limited number of studies are available. For example, Joynt Maddox et al. (2018) and a report from the Lewin Group (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018) are the only two empirical studies on the BPCI initiative for sepsis.

Therefore, my project will help fill literature and research gaps by comparing effects of the BPCI initiative for MJRL and sepsis on hospital performance based on state inpatient discharge data with longer baselines and intervention periods. The purpose of this study, therefore, is to examine the effectiveness and efficiency of the BPCI initiative on hospital performances for MJRL and sepsis in Nevada.

Chapter 3

Conceptual Framework

The rationale for this study and the associated literature review are based on a theoretical agency framework. My goal is to understand how incentives of the BPCI initiative influence hospital effectiveness and efficiency of care. I also address historical development and constructs.

Agency Theory

An open-system view of organizational structure was expanded by the relational concept of organizations as a nexus of contracts (Jensen & Meckling, 1976; Scott, 2003). Agency theory describes the relationship between a principal and an agent; the principal delegates work to the agent and the agent performs that work (Figure 3) (Jensen & Meckling, 1976; Mitnick, 1975; Ross, 1973). In the 1960s, economists identified a problem among cooperating parties with different attitudes towards sharing risk. As early as 1973, scholars included risk sharing as an agency problem within the agency theory (Jensen & Meckling, 1976; Ross, 1973). Eisenhardt (1988, 1989) addressed the agency problem and the problem of risk sharing as part of agency relationships. An agency problem occurs when the goals of the principal conflict with those of the agent, and when the principal doesn't have enough information about the agent's work. The goal of agency theory, therefore, is to develop the most effective contract between the principal and their agent.

Agency theory has been applied to different fields of research including economics, finance, accounting, political science, organizational behavior, and sociology. Some have criticized it as not clearly addressing the problem of organization (Jensen, 1983; Perrow, 1986), but Jensen (1983) considered agency theory as "the foundation for a powerful theory of organizations." In the controversy over agency theory, Eisenhardt (1989) discovered two contributions of the theory to organizational perspective. First, by treating information as a commodity in agency theory, organizations are able to invest in information systems and constrain the agent's self-interest. The implication of risk is the second contribution of agency theory. Outcome uncertainty is perceived as a risk-award trade-off, rather than just a risk. Therefore, contracts between principals and agents are affected by a willingness between principals and agents to take risks.

The agency structure is valid in diverse settings, including macro- to micro-level dyad phenomena. Agency theory has been applied to various aspects of organizations including compensation and incentives (Sappington, 1991), ownership and board relations, and when and how to diversify, among other factors. The application of agency structure to the healthcare system is a diverse, complex principal-agent relationship (Figure 4) (Casalino, 2001). For example, a medical group acts as an agent of a health plan, and simultaneously as a principal to a physician and a patient. According to Eisenhardt (1989):

> Overall, the domain of agency theory is relationships that mirror the basic agency structure of a principal and an agent who are engaged in cooperative behavior, but have differing goals and differing attitudes toward risk (p59).

There are two lines of agency theory: positivist and principal-agent (Jensen, 1983). Using the positivist agency theory, potential conflicting goals between the principal and their agent are identified, and then ways to reduce the agent's self-interest are proposed. It is especially effective if the principal is able to monitor the agent’s performance. It has been suggested that an agent is more apt to act in the interest of the principal if the contract is based on outcomes (Eisenhardt, 1998). Conversely, the principal-agent theory is behavior-based. It seeks to forge the contract that best satisfies both the principal and the agent and this occurs when the principal can determine the agent’s actions by measuring the outcomes (Demski, 1978). This is especially valid if a moral hazard and lack of information about the outcome are added. Eisenhardt (1989) developed eight propositions based on the principal-agent theory to determine the most effective contract between behavior (e.g., salaries) and outcome-based (e.g., commissions) contracts (Figure 5).

The outcomes of contracts often depend on uncontrolled variables, such as policies, competitor actions, and the economic climate, in addition to an agent’s behavior. When the uncertainty of an outcome is high, the costs of shifting risk to the agent are high and behavior-based contracts are more attractive than outcome-based contracts. A conflict of goals between principal and agent can exist in outcome-based contracts. If a conflict exists, the agent is not likely to behave as the principal desires and monitoring the agent will be necessary for establishing outcome-based contracts.

Agency problems in the healthcare setting also occur. Dranove and White (1987) illustrated the agency relationship between patients, physicians, and hospitals from the agency perspective in a metaphor of FFS and Health Maintenance Organizations. Behavior within the FFS system that led to the creation of alternate payment models was explained by the asymmetry of information between the physician and patient. Under the FFS system, physicians tend to overuse medical services as they have more information about illnesses and courses of treatment than patients do. As a result, increased cost pressures on FFS insurers led to different types of contracts, such as Health Maintenance Organizations, that share risks with their providers.

Casalino (2001) discussed the agency relationship in healthcare relative to uncertainty. For example, uncertainty of the patients' ability to pay for health care was reduced with creation of the public health care programs, Medicare and Medicaid. At the same time, however, uncertainty of the physicians' quality and cost of care increased. Casalino viewed FFS and managed care through a lens of uncertainty as, "patient uncertainty about the ability to afford care; patient, purchaser, and payer uncertainty about the quality of care; and purchaser and payer uncertainty about the cost of care" (Casalino, 2001).

Principal-agent theory has been used to examine behavior of health care organizations in previous studies. DeBrock and Arnould (1992) discussed capitation as a risk-sharing arrangement in the physician-insurer relationship to alleviate moral hazard (Debrock & Arnould, 1992). The physician was considered a double agent for the hospital and the patient in the study by Ellis and McGuire (1986). An empirical study by Schneider and Mathios (2006) evaluated physician behavior under different payment systems using a principal-agent framework.

In summary, agency theory serves as a foundation and justification for analyzing hospital performance in the BPCI initiative. The agency theory defines the goal and focus of my study. It provides a conceptual and theoretical framework for understanding the relationships among the constructs of the model, measured by variables used in the study. The agency theory also provides a context for interpreting the study results.

Organizational Effectiveness

The effectiveness of an organization is determined by its organizational structure (Scott, 2003). Different criteria for effectiveness also determine the success of an organization. From the open-system perspective, profitability, adaptability, and flexibility are important criteria because organizations and their environments are highly interdependent in an open system. Weick (1977) said one of the characteristics of effective organizations was, "structural units that are loosely articulated so as to maximize sensitivity to the environment and diversity of response."

The level of analysis is another important source of variation among effectiveness criteria. Researchers have described the predictable behavior of organizations by using different developmental stages. Lyden (1975) suggested that organizations emphasized different functional problems at different organizational stages of developmental. Initially, organizations focused on adaptation to the external environment, followed by resource acquisition and the development of workflow procedures. The emphasis of organizations then changed to goal attainment, efficient outcomes, and in the last stage moved to maintenance and institutionalization of the structure.

Quinn and Cameron (1983) developed a lifecycle-effectiveness model where different criteria of effectiveness were needed to determine the different stages of the organizational lifecycle. Based on the Quinn and Rohrbaugh model (1983), Quinn and Cameron determined that criteria from various models were of greater importance when used to evaluate the effectiveness of organizational development at various stages. The open-systems criteria of effectiveness, for example, are more important in the entrepreneurial stage, where flexibility, readiness, and resource acquisition are critical. In the formalization and control stages of organization, the rational goal model is more appropriate as it includes goal accomplishment, productivity, and efficiency.

Conceptual Framework of the Study

Agency theory, one of the main theories for organizational behavior, explains the probable effects of an outcome-based contract on hospital performance (Figure 1). I based this study on the positivist and principal-agent theories to postulates a strong conceptual and theoretical framework for understanding the associations between the study variables: the association between the BPCI initiative and hospital performance. This study uses the metaphor of the BPCI initiative to illustrate the relationship between CMS and a hospital (Keeley, 1980). The principal in this study is CMS, delegating work to an agent (hospital) under a new outcome-based contract (the BPCI initiative) to govern their relationship. Since participation in this initiative is voluntarily and hospitals need to apply to participate, the BPCI initiative is considered as a contract between the hospital and CMS rather than a regulation. Based on positivist agency theory, I describe the effectiveness of the BPCI initiative as a governance mechanism to control the self-interest behavior of the hospital. One of the main problems in accelerated healthcare costs are the conflicting goals between providers (agents) and payers (principals). A hospital has an incentive to overuse services while the goal of CMS is to reduce the cost of care and increase its quality—value-based care. To limit overuse by the hospital while increasing quality of care, CMS initiated an episode-based payment called the BPCI initiative in 2011. The initiative included all related services for a single patient for a given diagnosis. Under the BPCI initiative, the hospital is expected to offer financial inducements that lead to efficient, effective results, and not to the number of services that can be performed.

Principal-agent theory explains the BPCI initiative as a solution to control a hospital's moral hazard behavior. For example, hospital use is so complex that CMS cannot detect what the hospital is actually doing. The hospital may overuse its services against the interest of CMS.

Under the BPCI initiative Model 2, CMS uses an information system that sets a target price for each episode of care and for each participating hospital. The purpose is to encourage the hospital to align its performance with the interests of the principal (CMS) and reduce moral hazard. Since CMS can verify the hospital's performance by comparing it to the target price calculated by CMS, the hospital is motivated to restrain hospital use.

According to principal-agent theory (Eisenhardt, 1989), it is important to note that the BPCI initiative is an outcome-based, not a behavior-based contract. First, hospital uses are not programmed tasks. Programmed tasks are behaviors that can be specifically defined (Eisenhardt, 1988, 1989). The hospital check-in desk is a highly programmed service that requires a small set of well-defined behaviors, such as regularity and properly executing administrative work; the outcome behavior is easy to evaluate. Conversely, hospital services for an episode of care are not precisely defined. For example, different hospitals may have different implant costs and care coordination programs for MJRL. Therefore, an outcome-based contract motivates hospitals to behave in the interest of the CMS, though their actual behaviors are not clearly evaluated by CMS. Second, the outcomes of hospital performance are measurable in terms of effectiveness and efficiency. LOS, discharge location after an episode of care, in-hospital mortality, complications, total charges, and average charge per hospital day are readily measured as outcomes, so the outcome-based contracts of the BPCI initiative are more attractive. Third, as CMS becomes more risk averse in healthcare cost, it becomes more attractive to pass risk to the hospital through gainsharing and penalties contained in an outcome-based contract. For this study, I adopted two propositions from Eisenhardt (1989) to examine the behavior of a hospital in the context of the outcome-based contract of the BPCI initiative Model 2 (Figure 6):

Proposition 1. When the contract between the principal and agent is outcome based, the agent is more likely to behave in the interests of the principal.

Proposition 2. When the principal has information to verify agent behavior, the agent is more likely to behave in interests of the principal.

(Eisenhardt, 1989)

Summary of Predictions from the Theoretical Model

In summary, agency theory provides a conceptual framework of organizational behaviors that enables us to study potential effects of the BPCI initiative on hospital performance. CMS established the BPCI initiative to minimize conflicts of interests between CMS and hospitals by aligning the hospital's incentive with that of CMS: value-based care. To test effects of the contract (the BPCI initiative) governing the relationship between principal (CMS) and agent (hospital) in conflicting goals, my study measures the agent's performance in terms of effectiveness and efficiency in response to the outcome-based contract (Figure 7).

Further, my study evaluates if the agent behaves differently for surgical care versus non-surgical medical care when responding to the same contract. Based on agency theory, four hypotheses are formed to examine the hospital performance for surgical (MJRL) and medical care (sepsis) under the BPCI initiative (Figure 8).

Hypothesis 1. BPCI initiative-participating hospitals are more likely to improve the effectiveness of hospital performance than non-participating hospitals.

- H_{1a}. BPCI initiative-participating hospitals are more likely to improve the effectiveness of surgical care than non-participating hospitals.

- H_{1b}. BPCI initiative-participating hospitals are more likely to improve the effectiveness of medical care than non-participating hospitals.

Hypothesis 2. BPCI initiative-participating hospitals are more likely to improve the efficiency of hospital performance than non-participating hospitals.

- H_{2a}. BPCI initiative-participating hospitals are more likely to improve the efficiency of surgical care than non-participating hospitals.
- H_{2b}. BPCI initiative-participating hospitals are more likely to improve the efficiency of medical care than non-participating hospitals.

Chapter 4

Methods

This chapter introduces the research design, followed by a discussion of the data and sample being used in this study. Finally, the measurement of variables is described and the analytical approaches used to test hypotheses are explained.

Research Design

The purpose of this study was to examine the impact of the BPCI initiative on hospital performance in Nevada. The study design enables me to investigate associations between the independent and dependent variables.

This study was based on a quasi-experimental design. It was a pre- and post-study with both non-randomized intervention and comparison groups. The intervention was the implementation of the bundled payment approach. The intervention group included discharges from hospitals that participated in Phase 2 of the BPCI initiative Model 2 for MJRL and sepsis episodes of care. The comparison group included discharges from those hospitals that did not participate in Phase 2 of the BPCI initiative Model 2. The unit of analysis was hospital discharge. Hospitals that only participated in Phase I were included in a comparison group. Under the BPCI initiative Model 2, eight awardees representing ten hospitals in phase I participated in the risk-bearing phase of the initiative, Phase II. The analysis included eight hospitals present during both pre- and post- intervention periods. From SIDN data files, this study identified nine acute care hospitals that did not participate in the BPCI initiative in Nevada. This allowed the same cohort to be followed over the course of the study.

SIDN was used for several reasons: (a) it is the only Nevada state representative database that contains discharge information, (b) it includes a diverse sample of participants, (c) it provides a range of hospital care information such as diagnoses and procedures, and (d) it consists of variables that can be used to measure efficiency and effectiveness of hospital use.

Data

State Inpatient Database of Nevada.

The SIDN was mainly used for this study. It includes inpatient discharge records from all non-federal community hospitals in Nevada. For each hospital discharge, the SIDN contains information such as one principal diagnosis, 25 secondary diagnoses, 15 procedures, admission and discharge status, patient demographics characteristics, expected payment source, total charges, and LOS. The SIDN data also contain some hospital-level variables. The SIDN are calendar-year files based on discharge date. For this study, SIDN data were obtained from the Center for Health Information Analysis for Nevada. All patient identifiers were removed from the SIDN (HCUP, 2018).

Sample.

This study used 2013–2017 SIDN data. The 2017 data were the latest publicly available at the time of the study. The unit of analysis was hospital discharge.

The BPCI initiative in Nevada.

In Nevada, 15 health care facilities participated in the BPCI initiatives Model 2 and

Model 3 (CMS, 2017f). As of July 1, 2018, 11 acute care hospitals and one physician group practice participated in Model 2, and three inpatient rehabilitation facilities and one hospitalist participated in Model 3 (CMS, 2018a). There were no BPCI initiative Model 1 participants in Nevada. For the BPCI initiative Model 2, all 10 acute care hospitals participated in Phase1 for the MJRL and sepsis episodes of care in March 7, 2014 or June 20, 2014. Phase I ended September 30, 2015. Two of 10 initiating acute care hospitals did not transit to Phase 2, which is comparable to a CMS report that about 20% of hospitals that began the Phase 1 Model 2 withdrew completely from the BPCI initiative (CMS, 2018b). Seven BPCI initiative participants began Phase 2 in the MJRL episode of care either on April 1 or October 1, 2015. For sepsis, four acute care hospitals began Phase 2 either on April 1 or July 1, 2015. Phase 2 ended September 30, 2018. The episode of care included all related services during the care and 90 days following hospital discharge. All the BPCI initiative Model 2 participants in Nevada negotiated the target price at a two percent discount rate based on three years of Medicare claims data for the participants (CMS, 2018a). Three participants used the three-day hospital waiver for Medicare SNF coverage (CMS, 2017e).

***BPCI initiative Model 2 participating hospitals*.**

This study obtained publicly available lists from CMS of hospitals participating in the BPCI initiative. The lists included names of hospitals participating in the BPCI initiative Model 2, the episodes of care each hospital participated in, their start date, and the date they planned to terminate participation in Phase 1 and Phase 2. From these lists, the study identified hospitals enrolled in Model 2 by April 1, 2015 for the MJRL and sepsis episodes of care in Nevada (Table 2). Model 2-participating hospitals in Nevada included profit and nonprofit acute care hospitals.

The primary interest of this study was in hospitals that agreed to participate in Phase 2 of the BPCI initiative Model 2. Phase 2-participating hospitals entered into risk-bearing agreements with CMS instead of terminating the BPCI initiative after the Phase 1 preparation phase. Model 2 included all related hospital (parts A) and physician (part B) payments, allowing for the broadest definition of an episode of care (Tsai et al., 2015). For simplicity, this study referred to the analytic sample of hospitals participating under Phase 2 of Model 2 simply as "the BPCI initiative participants."

This study selected conflicting definitions for the two phases. Phase 1, non-risk-bearing hospitals that chose not to join Phase 2 were classified as non-participating hospitals. Phase 1- and Phase 2-participating hospitals were classified as participating hospitals. Of these two main groups in our analytic sample the participants included three nonprofit and five for-profit acute care hospitals, and the nonparticipants included six for-profit, two nonprofit acute hospitals, and one county hospital (Table 2). In my study, the BPCI initiative participating hospitals, BPCI-participating hospitals, and participating hospitals were interchangeably used to indicate the BPCI initiative Model 2 Participating Hospitals.

Comparison hospitals.

This study identified comparison hospitals from the publicly available lists of CMS and SIDN data. All hospitals that received payments from CMS for MJRL (DRG 469 and 470) and sepsis (DRG 870, 871, and 872) were selected, except BPCI-participating hospitals in Nevada. This study included 10 comparison hospitals for MJRL and 13 hospitals for sepsis (Table 3).

Study period.

The study period covered the 27 to 33 months before each hospital started the bundled payment, with the intervention period beginning immediately after the start date (Table 2). The post-intervention period ranged from 29 to 33 months depending on the Phase 2 BPCI initiative Model 2 enrollment date. For MJRL, hospitals that started the Phase 2 BPCI initiative in April 2015 had a 33-month intervention period; those that started in October 2015 had a 27-month intervention period. For sepsis, the BPCI initiative participating hospitals had a 33-month or 30-month intervention period depending on whether the hospital started the Phase 2 BPCI initiative in April 2015 or July 2015, respectively (Table 2). It should be noted that the pre- and post-intervention period varied between MJRL and sepsis as well as across hospitals in the intervention group. Table 2 describes details of the start and end dates for both MJRL and sepsis episodes of care for each participating hospital.

First, this study excluded samples between different intervention periods across hospitals for both MJRL and sepsis in order to limit the number of different pre- and post-intervention periods. For MJRL, samples between April 1, 2015 and October 1, 2015 were excluded (Figure 8). October 1, 2015 was regarded as the intervention period for MJRL across hospitals in the intervention and comparison groups. For sepsis, samples between April 1, 2015 and July 1, 2015 were removed (Figure 9). This study used July 1, 2015 as the intervention period for sepsis.

Second, different time intervals were examined for MJRL and sepsis. For sepsis, this study examined the entire time period, from 33 months before to 30 months after the BPCI initiative. For MJRL, a narrow interval (24 months before and after the BPCI initiative) around the treatment was tested to show the significant effect of the treatment. Since the BPCI initiative was not randomly assigned, minimizing the chances of other unobserved differences affecting outcome variables by the narrowing interval would have shown the significance of a treatment effect.

Patient selection and sample size.

Discharges were identified for MJRL by the MS-DRG codes 469 and 470 and for sepsis by the MS-DRG codes 870–872. Specifically, MJRL was defined as a set of diagnosis-related group (DRG) codes with major complications or comorbidity (MCC) (DRG469) and MJRL without MCC (DRG470) (Appendix A). Sepsis was defined as a set of DRG codes for septicemia or severe sepsis with mechanical ventilation for 96+ hours (DRG 870), septicemia or severe sepsis without mechanical ventilation for 96+ hours w/ MCC (DRG 871), and septicemia or severe sepsis without mechanical ventilation for 96+ hours without MCC (DRG 872), as identified by CMS (Appendix A).

Figure 9 illustrates steps of the sample selection process for this study. A total of 285,250 discharges were identified from SIDN as Medicare Beneficiaries from 2013 to 2017. Patients were included in the data analysis if they were diagnosed with either MJRL or sepsis, according to the MS-DRGs. A total of 10,006 episodes of MJRL and 18,360 episodes of sepsis were identified and included in the data analysis. This study excluded patients who were treated between the two different implementation dates. For example, some hospitals implemented the BPCI initiative for MJRL on April 1, 2015 and some began on October 1, 2015. This left 8,870 discharges for MJRL and 17,356 discharges for sepsis episode of care. I further excluded outliers of LOS (if LOS was longer than 60 days) and total charge/costs (if total charge/costs was $0) from both MJRL and sepsis. A total of 13 and 89 discharges from MJRL and sepsis were removed, respectively. The final study sample of 8,870 for MJRL and 17,356 for sepsis were included in the data analysis. The unit of analysis was the discharge.

Measurement of Variables

Variables were carefully selected according to the conceptual framework (Figure 1) and scientific literature. There were three groups of variables: (a) dependent variables of effectiveness, (b) dependent variables of efficiency, and (c) independent variables. Control variables functioned as independent variables in the regression models, but were not specified in the conceptual framework; no testable hypotheses were suggested for the control variables. Table 4 lists the definitions and type of variables used in this study.

Dependent variables: effectiveness measures.

According to Scott (2003), organizational structure determines the effectiveness of an organization in terms of profitability, adaptability, and flexibility. In my study, discharge locations, in-hospital mortality, and complications were selected to measure the effectiveness of hospital performance responding to an outcome-based contract, the BPCI initiative, since outcomes of these variables were highly associated with coordinated and collaborative hospital care (CMS, 2018b; Dummit et al., 2016; Dundon et al., 2016; Edwards et al., 2017; Froemke et al., 2015; Iorio et al., 2016).

Discharge location.

Discharge location was commonly considered in studying the effectiveness of hospital performance, since discharge location was not an end point of hospital care, but rather a transitional care that required an integration of care (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018; Dundon et al., 2016; Figueroa, Zhou, & Jha, 2019; Froemke et al., 2015; Siddiqi et al., 2017;

Waring et al., 2014). Transitional care has often been decided by a physician, without hospital input. Home discharge has been encouraged not only to reduce health care cost, but also to increase value of care. The National Inpatient State (NIS) database defines home discharge as a routine disposition outcome since going home is a desirable end point of hospital care (Sharma, Sonig, Ambekar, & Nanda, 2014; Sonig, Khan, Wadhwa, Thakur, & Nanda, 2012). It has been found that discharge to a SNF for MJRL was associated with higher complications and higher readmissions than home discharge, which generally reflects an undesirable outcome of care (Iorio et al., 2016; McLawhorn & Buller, 2017). Enhancing patient empowerment started in-hospital is an important factor for discharging patients to home, but it is only possible with improved care coordination (Braet, Weltens, & Sermeus, 2016; Waring et al., 2014). Developing a care-coordination program for MJRL has had a positive association with home discharge rather than discharging patients to SNF (Dundon et al., 2016). Further, studies have shown that including physicians in developing an effective clinical pathway is highly associated with home discharges (Froemke et al., 2015; McLawhorn & Buller, 2017; Siddiqi et al., 2017).

Therefore, my study evaluated discharge location to measure the effectiveness of hospital performance using the variable “home” since this discharge requires an effective organizational structure to streamline value-based care. The variable was recoded as dichotomous, with a discharge location to home coded “1” and a patient discharge to other locations coded zero.

In-hospital mortality.

In-hospital mortality is a validated outcome to measure effectiveness of hospital performance. Jha et al. (2007) showed higher hospital performance was associated with lower mortality (Jha, Orav, Li, & Epstein, 2007). For example, early diagnosis and immediate treatment are especially important in reducing hospital deaths for patients treated with sepsis. However, even with the structure of mandated protocols, more rapid completion of a sepsis care bundle and administration of antibiotics are highly associated with reducing in-hospital mortality (Seymour et al., 2017). In order to deliver time-sensitive treatment such as a sepsis care bundle, education of all stakeholders involved in sepsis treatment and an effective organizational structure are required. Studies have shown a decrease in in-hospital mortality at the BPCI initiative participating hospitals after a MJRL procedure (CMS, 2018b; Dummit et al., 2016; Dundon et al., 2016; Edwards et al., 2017; Froemke et al., 2015; Iorio et al., 2016; Joynt Maddox et al., 2018). However, there has been a concern that lower mortality might be associated with an increase in discharging high-risk patients; hospitals might be able to lower in-hospital mortality by discharging high-risk patients to other facilities. This variable was recoded as dichotomous, with in-hospital mortality coded as "1" if a patient died during hospitalization and zero if the patient did not.

***Complications*.**

Reducing complications is important in increasing the effectiveness of hospital care (DesHarnais, McMahon, Wroblewski, & Hogan, 1990). However, categories of complication vary depending on the type of care patients received and how each complication was linked to each procedure (Romano, Chan, Schembri, & Rainwater, 2002). For example, some studies measured postoperative complications identified by the Complication Screening Project, which includes postoperative infection, urinary and renal infection, pulmonary embolism, and blood transfusion to measure complication after an MJRL procedure (Froemke et al., 2015; Nichols &

Vose, 2016; Regenbogen et al., 2017). The CMS uses heart attack, pneumonia, sepsis, and mechanical complications to measure the complication rate for MJRL (Medicare.gov, 2018).

The CMS developed a set of indicators called Patient Safety Indicators (PSIs) to provide information about potential hospital complications following procedures (AHRQ, 2017d). To my knowledge, few studies have used PSIs to determine complications. However, a recent CMS bundled payment model rationalizes using PSIs to measure complication of care. The next-generation CMS bundled payment model following the BPCI initiative, BPCI-Advanced, includes PSIs as mandatary outcome measurements. My study used PSI 03, PSI 08, and PSI 13. PSI 03 is a pressure ulcer rating applied to both medical and surgical discharge and defined by a specific MS-DRG (AHRQ, 2017a). MS-DRG 469 and 470 for MJRL and MS-DRG 870–872 for sepsis were included. Pressure ulcers are caused by pressure over a bony prominence causing a localized area of tissue damage. A major risk factor for developing pressure ulcers is reduced mobility, leaving a patient in one position for a long period of time for example (Wake, 2010).

Therefore, the incidence of pressure ulcers is often considered one of many aspects of patient care that involves nurses and physicians (Wake, 2010). There is a limitation to using PSI 03 to measure potential complications for sepsis. Earlier studies on sepsis have shown that the most serious complication of a pressure ulcer is sepsis (Galpin, Chow, Bayer, & Guze, 1976; Lyder, 2010). Therefore, in my study I identified a pressure ulcer not as a primary diagnosis, but measured it as a complication variable for both MJRL and sepsis. PSI 08 is the incidence of hospital falls with a resulting hip fracture as defined by specific MS-DRGs, including DRG 469 and 470 (AHRQ, 2017b). PSI 13 indicates a postoperative sepsis rate for surgical discharge defined by specific MS-DRGs including MS-DRG 469 and 470 (AHRQ, 2017a, 2017c). PSI total indicates the incidence of PSI 03, PSI 08, or PSI 13. All PSIs are defined by ICD-9-CM and

ICD-10-CM diagnosis codes. For my study, incidence of pressure ulcer (PSI 03) was measured for sepsis-related complications and the PSI total was used to measure complications in cases of MJRL. Appendix D lists ICD-9-CM and ICD-10 codes for each PSI. Complication variables, PSI 03, PSI 08, or PSI 13 and PSI total were recorded as dichotomous, with a value of "1" if yes, zero if otherwise.

Dependent variables: efficiency measures.

Efficiency is defined as the time and resource consumption required for patients to recover. It is measured by the average length of stay, total patient charges per discharge, and average patient charge per day.

Length of in-hospital stay.

The length of in-hospital stays is often used to measure efficiency of hospital care since a shorter LOS is highly associated with reducing the hospital cost per discharge (Froemke et al., 2015; Iorio et al., 2016; Regenbogen et al., 2017; Siddiqi et al., 2017). However, a shorter LOS may result in other adverse effects. More patients could be directed to a SNF from early discharge, which leads to an increase in cost of care. A reduction in discharging patients to a SNF was found to be a large portion of cost reduction in the BPCI initiative (CMS, 2018b; Dundon et al., 2016; Iorio et al., 2016). Since the Model 2 BPCI initiative includes all costs of care including PAC, I assume LOS will be a valid efficiency indicator to measure the effect of the BPCI initiative. The variable LOS is measured in days. This study excluded any patients with a LOS longer than 60 days.

Total charge per discharge.

Total cost has been used as a main indicator to measure efficiency of hospital performance (Jha, Orav, Dobson, Book, & Epstein, 2009; Russo & Adler, 2015). Lower total costs, with an assumption of the same quality of care, indicate hospitals are providing efficient care. Most studies of the BPCI initiative have reported a reduction in total cost of Medicare payments at BPCI initiative participating hospitals for MJRL using a standardized care pathway, but not for sepsis (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018; Courtney et al., 2016; Dummit et al., 2016; Edwards et al., 2017; Joynt Maddox et al., 2018). However, these studies used total claimed bills (total charge) from insurance claim data as a proxy for cost instead of measuring cost directly (Finkler, 1982; Shen et al., 2018; Stoller et al., 2016). The charge represents the amount billed to the payer but does not reflect the actual cost for hospital services. Finkler (1982) argued that use of charges as a proxy for economic cost may lead to unjustified conclusions about efficiency of care (Finkler, 1982). Since use of charge as a proxy for cost has been viewed as inadequately estimating the economic cost of care (Ashby, 1992; Finkler, 1982), my study measured total charges from the SIDN database to evaluate efficiency of hospital performance. The hospital total charge was adjusted to the annual hospital inflation rate (Martin, Hartman, Washington, & Catlin, 2019), but was not converted to cost. Analysis of total charges is important since that is the amount being claimed to Medicare (Finkler, 1982). The variable Total Charge is measured in dollars. This study excludes patients with no charges.

Average charge per hospital day.

Average charge per day is a relevant measure of the efficiency of hospital performance since it's a composite measure of two variables of efficiency measurement: LOS and total charge (Butler, 1995). The average charge per day is determined by dividing total charge by LOS. Therefore, average charge per day decreases when LOS increases with the same total charge, or when total charge decreases with the same LOS. Reductions of both total charge and LOS are the most desirable scenario for decreasing the average charge per hospital day. To the best of my knowledge, this is the first study to examine effects of the BPCI initiative on average charges per day. Average charge is determined by dividing total charge by LOS for each discharge. The variable Average Charge is measured in dollars.

Independent variables: the BPCI initiative.

A contract was measured by the implementation of the BPCI initiative. It is a binary variable with the value of "1" if a given patient was treated after the BPCI initiative was implemented and zero if the patient was not.

Control Variables.

Since this study was not an experimental design based on randomization, using control variables was important to consider potential confounding factors in data analysis. Several patient- and hospital-level variables frequently used in prior studies are included in the multivariable analysis. First, patient and hospital characteristics before the BPCI initiative might have been different than after the BPCI initiative. Second, even though the relevant patient and hospital characteristics did not change, by including them the error of variance may be reduced, leading to a smaller standard error (Wooldridge, 2015). The patient-level variables, or patient characteristics, include age, sex, race/ethnicity, and comorbidities. Hospital-level variables or hospital characteristics include hospital size (measured by the number of beds) and hospital ownership (i.e., for-profit private, non-for-profit, and public). Teaching hospital status was not included in the data analysis as it is highly correlated with hospital ownership status. Hospital rural/urban status was not included in the data analysis because there were no rural hospitals participating in the BPCI initiative.

Patient characteristics.

The set of variables that represent patient characteristics included age, sex, race/ethnicity, and comorbidities. These variables are important in adjusting patient mix when multivariable analyses are performed.

Age.

Age is closely related to clinical process and outcome (DesHarnais et al., 1990; Figueroa et al., 2019). The mean age of Medicare beneficiaries who underwent MJRL was 75 years (Navathe, Liao, Dykstra, et al., 2018). From a DiD analysis of 2011–2015 Medicare claims, Navathe et al. (2018) showed a 0.23% reduction in patients over 85 years old in BPCI-participating hospitals (Navathe, Liao, Dykstra, et al., 2018). Patient-level independent variables were derived from SIDN and included the following: 64 years old and younger, 65–74, 75–84, and 85 and older.

Sex.

Sex is a commonly used variable that relates to health care outcomes, including hospital care (DesHarnais et al., 1990; Figueroa et al., 2019). Among Medicare beneficiaries, women

(64%) were more likely receive MJRL than men (Froemke et al., 2015; Navathe, Liao, Dykstra, et al., 2018). However, fewer women received MJRL at BPCI-participating hospitals than non-participating hospitals. The patient-level independent variables, Male and Female, were derived from the SIDN.

Race/ethnicity.

Racial/ethnic disparities exist in healthcare across a variety of clinical conditions and procedures (DesHarnais et al., 1990; Figueroa et al., 2019). Navathe et al. (2018) observed that 95% of Medicare beneficiaries who had MJRLs were of nonblack race/ethnicity according to 2011–2015 Medicare claims (Navathe, Liao, Dykstra, et al., 2018). Navathe et al. (2018) also showed a small reduction of black patients (-0.14%) at BPCI-participating hospitals after BPCI implementation. Patient-level independent variables were derived from SIDN and included the following: Native American, Asian, Pacific Islander, Black, White, Hispanic, Others (unknown).

Comorbidities.

Risk adjustment taking into account patient sociodemographics and comorbidities is crucial in outcome research. Comorbidities are often negatively related to outcome (DesHarnais et al., 1990; Navathe, Liao, Dykstra, et al., 2018). Navathe et al. (2018) found there was a small reduction in most comorbidity for MJRL at BPCI-participating hospitals except for alcohol use, depression, and psychoses (Navathe, Liao, Dykstra, et al., 2018). Tested comorbidities were: high complexity (-0.15%), obesity (-0.12%), diabetes (-0.22%), diabetes with complications (-0.13%), coronary artery disease (-0.21%), and congestive heart failure (-0.07%) (Navathe, Liao, Dykstra, et al., 2018). Based on Quan et al. (2005), comorbidities were defined in ICD-9-CM and ICD-10 codes and patient-level independent variables were derived from SIDN, including the following: diabetes, diabetes with complications, hypertension, congestive heart failures, COPD, depression, and obesity (Quan et al., 2005). Appendix C lists ICD-9-CM and ICD-10 codes for each comorbidity.

Hospital characteristics.

The set of variables that indicate hospital characteristics includes hospital size and ownership of the hospital. The variables were highly associated with participation in the BPCI initiative Model 2. Since all hospitals included in this study were urban, a variable differentiating rural hospitals was not included.

Hospital size.

Hospital size is commonly considered in studying hospital behavior and performance (Liao et al., 2019; Tsai et al., 2015). With BPCI, studies have found that BPCI-participating hospitals were generally larger than non-participating hospitals (Joynt Maddox et al., 2018; Tsai et al., 2015). Tsai et al (2015) reported 35.5% of BPCI hospitals had more than 400 beds while 11.6% of non-BPCI hospitals had the same number of beds (Tsai et al., 2015). Dummit et al. (2016), Navathe et al. (2018), and Joynt Maddox et al. (2018) supported the association between BPCI-participating hospitals and hospital size. BPCI hospitals had a greater number of beds than non-BPCI hospitals for both MJRL and medical conditions (mean number of beds, 324 vs 213, respectively) (Joynt Maddox et al., 2018; Navathe, Liao, Dykstra, et al., 2018).

For this study, number of beds was derived from the American Hospital Association file. Hospital-level independent variables were derived from SIDN and included the following: small (less than 100 beds), medium (between 100 and 300 beds), and large (more than 300 beds).

Ownership of the hospital.

Many studies have shown that hospital behavior and performance vary among hospitals with different types of ownership (Liao et al., 2019; Tsai et al., 2015). Hospital ownership is generally classified into three types: for-profit, nonprofit, and public. Studies have found associations between the BPCI initiative participating hospitals and hospital ownership. BPCI hospitals were more likely than non-BPCI hospitals to be nonprofit (Joynt Maddox et al., 2018; Navathe, Liao, Dykstra, et al., 2018; Tsai et al., 2015). Based on April 2014 Medicare claims, 82.2% of BPCI hospitals and 58.1% of non-BPCI hospitals were nonprofit (Tsai et al., 2015). Another study reported a 2.3% increase in patients who were treated in nonprofit hospitals after BPCI (Dummit et al., 2016). Hospital-level independent variables were derived from SIDN and included the following structural variables: profit, nonprofit, or county.

Analytical Approaches

The difference-in-differences (DiD) method was the core analytical approach used in this study.

The Difference-in-differences method.

To evaluate the impact of policy implementation, pre-post policy and participant-nonparticipant approaches are often used. Pre-post assessment compares changes of outcomes from the same individuals or communities before and after policy implementation. Participant-nonparticipant comparisons compare outcomes of participants in the policy to nonparticipants.

However, there were important limitations to consider. First, developments not related to a change in policy may be present. For example, if changes in a factor like patient outcomes were in the process of improving before implementation of the new policy, a pre-post study may wrongly conclude that the improvement was due in part to the new policy. Second, selection bias may exist. The Difference-in-Differences (DiD) method addresses these limitations by using a comparison group not exposed to the policy change but experiencing the same time trends (Dimick & Ryan, 2014; Wooldridge, 2015)

The DiD method compares outcomes of pre-post policy implementation between treatment and comparison groups to minimize the bias of unobserved factors that could affect outcomes and that change with the treatment. Therefore, differences in outcomes pre- and post-policy implementation in the group exposed to the policy (treatment group) and in the group not exposed the policy (comparison group), are changes in outcomes related to the policy implementation without the effect of unobserved time trends. If unobserved factors also affected the comparison group, then double-differencing can remove the bias and isolate the treatment effect. Therefore, policy effect is estimated by DiD.

The DiD estimator (δ) is:

$$\delta = (\bar{Y}_{post}^{treatment} - \bar{Y}_{pre}^{treatment)}) - (\bar{Y}_{post}^{comparison} - \bar{Y}_{pre}^{comparison}) \quad (1)$$

Where,

- δ represents effect of policy of the average outcome of Y,
- $\bar{Y}$ shows average outcomes,
- *treatment* represents a group exposed the policy,

- *comparison* represents a group did not exposed to the policy,
- *pre* represents before policy implementation,
- *post* represents after policy implementation.

The DiD estimate is equal to zero if there is no association between policy implementation and subsequent outcomes (Figure 10A). If there is an association, the DiD estimate will show an improvement in the treatment group (Figure 10B).

According to the PubMed database, more studies in health policy and medicine are using the DiD method (Ryan, Burgess, & Dimick, 2015). These studies include: the impact of health insurance expansions under the affordable care act (Zhu, Brawarsky, Lipsitz, Huskamp, & Haas, 2010), payment policy changes and financial incentives (Song et al., 2011), impact of the American College of Surgeons National Surgical Quality Improvement Program on clinical outcomes (Rajaram et al., 2014), implementation of an electronic health record (McCullough, Christianson, & Leerapan, 2013), and the Massachusetts Health Reform on Joint Replacement Use (Hanchate et al., 2015). A DiD study was also used to identify the impact of the BPCI initiative implementation (CMS, 2018b; Dummit et al., 2016; Joynt Maddox et al., 2018; Navathe, Liao, Dykstra, et al., 2018).

Regression models are used to test the significance of DiD estimates rather than simple subtraction as they adjust for control variables (patient demographics or hospital characteristics) that may differ among groups (Ryan et al., 2015; Wooldridge, 2015). In addition to standard statistical assumptions, “common shocks” and “parallel trends” assumptions need to undergo DiD analysis (Angrist & Pischke, 2008; Mazurenko, Shen, Shan, & Greenway, 2018; Ryan et al., 2015; Wooldridge, 2015). The common shock hypothesis assumes that the treatment and comparison groups will be similarly affected by events occurring before, during, or after treatment. Parallel trends, however, assumes that pretreatment outcomes between the treatment and comparison groups will be similar (Figure 10). This leads to the assumption that any outcomes between the two groups that differ must be due to the new policy. Another important assumption is that the composition of the two groups must remain stable (Ryan et al., 2015).

Econometric frameworks.

To evaluate the agent's behavior or performance, this study applied "micro-level" DiD in which data exist at a lower level nested within the treatment unit (e.g., individual-level variables) within the agent (i.e., organization) (Ryan et al., 2015). For individual *i* in organization *j* at time *t* with two groups (treatment and comparison group) and two time periods (pre- and post), baseline DiD models of this study take the form:

$$Y_{ijt} = \beta_0 + \beta_1 Post_{it} + \beta_2 Treat_{ij} + \beta_3 \, (Treat_{ij} \times Post_{it}) + X_{ijt} + \varepsilon_{ijt} \qquad (2)$$

Where,

- Y_{ijt} represents an outcome variable for a dependent variable for individual © of organization *j* in time *t*,
- $Post_{it}$ is a dummy variable for whether an individual occurred in the post-BPCI period,
- $Treat_{ij}$ is a dummy variable indicating the value of one if an individual is getting treated in the BPCI-hospitals, zero otherwise,
- β_3 represents impact of the BPCI initiative on changes in outcomes,
- X_{ijt} is a vector of control variables for sex, race, age, and comorbidity,

- ε_{ijt} is the idiosyncratic error term.

This study has multiple treatment and comparison hospitals in the treatment and comparison groups. Therefore, estimated differences in the treatment (or comparison) group before and after the BPCI initiative could be due to a single hospital with substantially more observations if all the treated or control hospitals were viewed as one hospital (2). In order to estimate before and after changes "within" hospitals and then determine an average, this study replaces the variable "Treat" with a complete set of dummy variables for each hospital (e.g., hospital fixed effects) (3).

$$Y_{ijt} = \beta_0 + \beta_1 Post_{it} + \beta_3 \left(Treat_{ij} \times Post_{it}\right) + X_{ijt} + \mu_j + \varepsilon_{ijt}, \qquad (3)$$

where μ_j is a vector of organization fixed effects. Likewise, it is common to allow a more flexible fitment of the variable "post" by replacing it with a complete set of time-fixed effects (4). Therefore, the main framework was a DiD specification:

$$Y_{ijt} = \beta_0 + \beta_3 \left(Treat_{ij} \times Post_{it}\right) + X_{ijt} + \mu_j + T_t + \varepsilon_{ijt}, \qquad (4)$$

where the outcome variable was one of the following variables: $Home_{ift}$, a dummy variable that equals "1" if the patient is discharged to home, or zero if otherwise; HHS_{ijt}, a dummy variable that equals "1" if the patient is discharged to home under home health services, or zero if otherwise; SNF_{ijt} is a dummy variable that equals "1" if the patient is discharged to skilled nursing facility, or zero if otherwise; $mortality_{ijt}$ is a dummy variable that equals "1" if the patient is deceased in the hospital, or zero if otherwise; LOS_{ijt} is a continuous variable of the number of days the patient stays in the hospital after the episode of care; $PSI03_{ijt}$ is a dummy variable that equals "1" if the patient has a pressure ulcer after the episode of care, or zero if otherwise; $PSI08_{ijt}$ is a dummy variable that equals "1" if the patient has an in-hospital fall with hip fracture after the episode of care, or zero if otherwise; $PSItotal_{ijt}$ is a dummy variable that equals "1" if the patient has either a pressure ulcer or in hospital fall with hip fracture after the episode of care, or zero if otherwise; $TotalCharge_{ijt}$ is a continuous variable that measures the average total charge for the patient; $AverageCharge_{ijt}$ is a continuous variable that measures the average charge per hospital day for the patient.

Here, $Treat_{ij}$ was an indicator variable set equal to "1" for any individual in our sample treated in the BPCI initiative participating hospital, and zero if otherwise. $Post_{it}$ was an indicator variable set equal to "1" for any individual in our sample that was treated after the implementation of the BPCI initiative. Further, μ_j was a set of hospital fixed effects and T_t was a complete set of month-year fixed effects. And then, X_{ijt} was a set of demographic controls that included the following characteristics: age categories (less than 65 years old, 75–84, 85 and older, and 65–74 were omitted); a binary variable indicating if the patient was male; and a set of categorical variables indicating the patient's race/ethnicity (Black, Hispanic, Asian, and others; White was the omitted category); a dummy variable that equals "1" if the patient was diagnosed with diabetes without complications; a dummy variable that equals "1" if the patient was diagnosed with diabetes with complications; a dummy variable that equals "1" if the patient was diagnosed with hypertension; a dummy variable that equals "1" if the patient was diagnosed with congestive heart failure; a dummy variable that equals "1" if the patient was diagnosed with COPD; a dummy variable that equals "1" if the patient was diagnosed with depression; and a dummy variable that equals "1" if the patient was diagnosed with obesity. This study used the OLS model for the impact on home, mortality, LOS, PSI 03, PSI 08, PSI 13, PSI total, total charge, and average charge.

The parameter β_3, which is the parameter of interest, is the coefficient estimate of the treatment group post the BPCI initiative interaction term. It estimates the effect of the BPCI initiative on the average outcome of Y_{ijt}. The term β_3 is estimated by computing the differences in average among the treatment (5-7) and comparison groups (8-10) in each time period, and then differences in the results over time (11,12).

$$Y_{ijt} = \beta_0 + \beta_3 \left(Treat_{ij} \times Post_{it}\right) + X_{ijt} + \mu_j + T_t + \varepsilon_{ijt} \quad (4)$$

Changes in Treatment Group

$$= E\left(Y_{ijt} \middle| Treat_j = 1, Post_t = 1\right) - E(\left(Y_{ijt} \middle| Treat_j = 1, Post_t = 0\right) \quad (5)$$

$$= (\beta_0 + \beta_3) - (\beta_0) \quad (6)$$

$$= \beta_3 \quad (7)$$

Changes in Comparison Group

$$= E\left(Y_{ijt} \middle| Treat_j = 0, Post_t = 1\right) - E(\left(Y_{ijt} \middle| Treat_j = 0, Post_t = 0\right) \quad (8)$$

$$= \beta_0 - \beta_0 \quad (9)$$

$$= 0 \quad (10$$

Therefore, DiD estimates = (7) – (10)

$$= \beta_3 - 0 \quad (11)$$

$$= \beta_3 \quad (12)$$

This study will make several estimated variations of the pre-BPCI initiative to check for robustness (Navathe, Liao, Dykstra, et al., 2018): a generalized linear regression including patient demographics (age, race, sex, comorbidities) and hospital characteristics (ownership, hospital size) as controls, and time and hospital as fixed effects.

Difference-in-differences assumptions.

Based on the DiD checklist proposed by Ryan et al. (2015) in Table 4, three assumptions were tested. First, this study used data on the outcomes from both treatment and comparison groups before and after the interventions were implemented. Second, pre-trends in outcomes between treatment and comparison groups were tested. Since the BPCI initiative was not randomly assigned, this study could not explicitly test parallel trends between BPCI-hospitals and non-BPCI hospitals prior to intervention. This study, however, could test if the trends in outcomes leading up to the BPCI initiative statistically differed between the treatment and the comparison groups (McCoy et al., 2017). This study confined its attention to individual samples *before* the BPCI initiative and constructed *Months Since* $BPCI_{ijt}$ to represent the number of months from each patient *i* treated date to BPCI implementation date. This study estimated variants of:

$$Y_{ijt} = \alpha_0 + \alpha_1 Treat_{ij} + \alpha_2 \cdot Months\ Since\ BPCI_{ijt}$$
$$+ \alpha_3 \cdot Treat_{ij} \cdot Months\ Since\ BPCI_{ijt}$$
$$+ X_{ijt} + \mu_j + T_t + \varepsilon_{ijt}\ , \quad (13)$$

The coefficient of interest for the pre-trend test was derived from:

Changes in Treatment Group: $Treat_{ij} = 1$

$$\frac{\Delta\, y}{\Delta\, Months\ Since\ BPCI_{ijt}}\ |_{T=1} = \alpha_2 + \alpha_3$$

Changes in Comparison Group: $Treat_{ij} = 0$

$$\frac{\Delta\, y}{\Delta\, Months\ Since\ BPCI_{ijt}}\ |_{T=0} = \alpha_2$$

Therefore, differences in the average trend in outcomes between the treatment group and comparison group over the period of time leading up to the BPCI initiative = (14) – (15)

$$= (\alpha_2 + \alpha_3) - \alpha_2$$

$$= \alpha_3$$

This coefficient of α_3 estimate should be statistically insignificant if the pre-trends assumption holds. This study reports the significance of α_3 for each outcome. Third, composition of the treatment and comparison groups was examined through observed covariates between them before and after the intervention.

General operationalized conceptual framework of agency theory.

A goal of the BPCI initiative is to align stakeholders' incentives by shifting the volume of services towards a more coordinated and value-based care. According to agency theory, a hospital (agent) is more likely to behave in the interest of the principal (CMS) in the context of a BPCI initiative (outcome-based contract) that sets a target price for each episode of care. Further, a hospital is more likely to behave under value-based care since CMS has the information to measure hospital performance. To evaluate potential changes in how a hospital's behavior responds to the BPCI initiative, my study measured changes in the effectiveness and efficiency of hospital performance by analyzing the following variables in patient level: home, mortality, complications, LOS, total charge, and average charge (Figure 11).

Agency theory leads to six key predictions that can be tested with an empirical model (Figure 11). First, patients of BPCI-participating hospitals are more likely to be discharged to home than patients of non-participating hospitals. Second, patients at BPCI-participating hospitals are more likely to have lower in-hospital mortality than patients at non-participating hospitals. Third, patients at BPCI-participating hospitals are less likely to have complications than patients at non-participating hospitals. Fourth, patients at BPCI-participating hospitals are more likely to have a shorter LOS than patients at non-participating hospitals. Fifth, patients at BPCI-participating hospitals are more likely to have lower total charges/costs than patients at non-participating hospitals. Fifth, patients at BPCI-participating hospitals are more likely to have lower total charges/costs than patients at non-participating hospitals. And finally, patients at BPCI-participating hospitals are more likely to have lower average charges than patients at non-participating hospitals.

Difference-in-differences analyses for discrete variables.

To evaluate the behavior or performance of the agent with an outcome-based contract from the principal, as shown in Figures 6 and 7, the conceptual framework was operationalized and displayed in Figure 9. When an evaluation of the agent's behavior focused on effectiveness, measured by three dichotomous variables, the DiD model on discrete dependent variables was performed to test the hypotheses of this investigation. According to Figure 10 and Equation (2), the general empirical DiD regression model, each of the indicators had its own equation as listed below. The detailed relationships among variables are displayed in Figure 12.

Agent (Effectiveness) = f (Contract with Principal, Control Variables)

Hospital (Discharge Location) = f_1 (BPCI, Control Variables)

Hospital (In-hospital Mortality) = f_2 (BPCI, Control Variables)

Hospital (Complication) = f_3 (BPCI, Control Variables)

Accordingly, the operationalized hypotheses are as follows:

- H_{1a}1a. Patients with MJRL in the BPCI initiative participating hospitals were more likely to be discharged to home than their counterparts in non-participating hospitals.
- H_{1a}1b. Patients with MJRL in the BPCI initiative participating hospitals were more likely to be discharged to HHS than their counterparts in non-participating hospitals.
- H_{1a}1c. Patients with MJRL in the BPCI initiative-participating hospitals were less likely to be discharged to SNF than their counterparts in non-participating hospitals.
- H_{1a}2. Patients with MJRL in the BPCI initiative participating hospitals were less likely to die in hospital than their counterparts in non-participating hospitals.
- H_{1a}3. Patients with MJRL in the BPCI initiative participating hospitals were less likely to have complications than their counterparts in non-participating hospitals.
- H_{1b}1a. Patients with sepsis in the BPCI initiative participating hospitals were more likely to be discharged to home than their counterparts in non-participating hospitals.
- H_{1b}1b. Patients with sepsis in the BPCI initiative participating hospitals were more likely to be discharged to HHS than their counterparts in non-participating hospitals.
- H_{1b}1c. Patients with sepsis in the BPCI initiative participating hospitals were less likely to be discharged to SNF than their counterparts in non-participating hospitals.
- H_{1b}2. Patients with sepsis in the BPCI initiative participating hospitals were less likely to die in hospital than their counterparts in non-participating hospitals.
- H_{1b}3. Patients with sepsis in the BPCI initiative participating hospitals were less likely to have complications than their counterparts in non-participating hospitals.

The DiD analysis on discrete variables was conducted using general regression, OLS, in STATA, version 15.1.

Difference-in-differences analyses for continuous variables.

When the evaluation of the agent's behavior focused on efficiency, as measured by two continuous variables, the DiD model on continuous dependent variables was performed to test the hypotheses of this investigation. According to Figure 12 and Equation (2), the general empirical DiD regression model, each of the indicators had its own equation, as listed below. The detailed relationships among variables were displayed in Figure 9.

Agent (Efficiency) = f (Contract with Principal, Control Variables)

Hospital (LOS) = f_4 (BPCI, covariates)

Hospital (Total Charge/Cost) = f_5 (BPCI, covariates)

Hospital (Average Charge) = f_6 (BPCI, covariates)

Accordingly, the operationalized hypotheses are as follows; on average,

- $H_{2a}4$. Patients with MJRL in the BPCI initiative participating hospitals were more likely to have shorter LOS than their counterparts in non-participating hospitals.
- $H_{2a}5$. Patients with MJRL in the BPCI initiative participating hospitals were more likely to have lower total charges than their counterparts in non-participating hospitals.
- $H_{2a}6$. Patients with MJRL in the BPCI initiative participating hospitals were more likely to have lower average charges than their counterparts in non-participating hospitals.

- $H_{2b}4$. Patients with sepsis in the BPCI initiative participating hospitals were more likely to have shorter LOS than their counterparts in non-participating hospitals.
- $H_{2b}5$. Patients with sepsis in the BPCI initiative participating hospitals were more likely to have lower total charges than their counterparts in non-participating hospital.
- $H_{2b}6$. Patients with sepsis in the BPCI initiative participating hospitals were more likely to have lower average charges than their counterparts in non-participating hospitals.

The DiD analysis on continuous variables was conducted using general regression, OLS, in STATA, version 15.1.

Summary

This chapter detailed the study design, data sources, variable measurements, and analytical approaches used in this investigation. The SIDN is a relatively rich database for studying patient care outcomes and hospital performance and includes all community hospitals in Nevada. The SIDN data were logically cleaned and able to be used for secondary analysis. MJRL and sepsis were good representatives of clinical procedures and conditions for studying the potential effects of bundled payment. The DiD modeling was applied to test the study hypotheses and answer the two research questions posed for the study.

Chapter 5

Results

Characteristics of the Study Population

During the 2013–2017 study period, a total of 4,470 patients underwent MJRL at the eight hospitals that participated in the BPCI initiative for the MJRL episode of care (Figure 9). These participating hospitals (treatment) were compared with nine non-participating hospitals (comparison) that treated 4,400 MJRL patients (Table 2). For sepsis, a total of 4,087 patients were treated at the four hospitals that participated in the BPCI initiative for sepsis episode of care (Figure 9). These participating hospitals were compared with 13 comparison hospitals that treated 13,269 patients for sepsis during the study period. The characteristics of MJRL and sepsis for the treatment and comparison groups, both before and after implementation of the BPCI initiative, are shown in Tables 6 and 7, respectively.

Patient characteristics.

The characteristics of patients at BPCI initiative participating hospitals were similar to the characteristics of patients seen at comparison hospitals for MJRL procedures (Table 6). A large proportion of patients in the treatment and comparison groups were between ages 65–74 (55% and 45%, respectively) followed by the 75–84-year-old groups (28% and 31%, respectively) (Table 5). Both treatment and comparison groups had a higher proportion of female (61.6% vs 61.0%, respectively) and white patients (84.3% vs 80.9%, respectively). The proportion of patients with individual comorbidities at the BPCI initiative participating and comparison hospitals were similar. Both BPCI-participating and non-participating hospitals had a higher proportion of hypertensive (66.6% vs 61.9%, respectively) and diabetic patients (18.4% vs 17.8%, respectively).

For sepsis, patients' characteristics at treatment and comparison hospitals were also similar. A large proportion of patients in treatment and comparison hospitals were between65–74 years old (34.5% vs 33.9%, respectively) and 75–84 years old (29.9% vs 29.3%, respectively). The BPCI initiative participating hospitals and comparison hospitals had about the same portion of male and female patients (53.1% of males in treatment vs 49.8% of females in comparison, respectively), and both groups had a higher proportion of white patients (66.8% for treatment vs 72.6% for comparison). In terms of individual comorbidities, comparison hospitals had a higher proportion of patients with hypertension (35.9% vs 42.3%) and COPD (28.8% vs 30.9%), respectively, than BPCI initiative participating hospitals.

Characteristics of patients in the pre- and post-BPCI initiative were similar for both treatment and comparison groups for MJRL procedures and sepsis, except for the proportion of patients with individual comorbidities for sepsis. Both treatment and comparison hospitals had a higher proportion of diabetes with complications (25.2% vs 19.3%, respectively) and congestive heart failure patients (24.3% vs 20.6%, respectively) after the BPCI initiative compared to before the BPCI initiative period.

Hospital characteristics.

Since the BPCI initiative is a voluntary participation program, comparing hospital characteristics between BPCI-participating and non-participating hospitals is important. Both the BPCI initiative participating and non-participating hospitals for MJRL were more likely to be medium-size hospitals (89.4% of the treatment and 63.8% of the comparison hospitals with 100–

300 beds). Compared with the comparison hospitals, those participating in the BPCI initiative for MJRL were more likely to be non-profit (55.5% of the treatment vs 23.9% of the comparison) and non-teaching hospitals (0.0% of the treatment vs 5.9% of the comparison). Results were similar for sepsis, except both the BPCI initiative participating and non-participating hospitals were more likely to be profit hospitals (64.6% vs 67.0%, respectively).

The composition of hospital characteristics of treatment and comparison groups did not change over the course of the study for MJRL, except for changes of the BPCI initiative participating hospitals in hospital ownership. After the BPCI initiative, more profit hospitals among the BPCI initiative participating hospitals operated MJRL procedures compared to before the-BPCI initiative period (44.6% of treatment during pre-BPCI and 78.7% of treatment during post-BPCI). Results were similar for sepsis in that those hospital characteristics for the treatment and comparison groups did not alter before or after the BPCI initiative.

Means and standard deviations for dependent variables.

Tables 8 and 9 describe the means and standard deviations for dependent variables in treatment and comparison hospitals, pre- and post-BPCI initiative for MJRL and sepsis.

Pre-Trend Tests

Significances of outcomes from pre-trend tests for each dependent variable indicated the validity of DiD analyses used in this study (Table 10). For MJRL, differences in the average trend in outcomes of all dependent variables in the treatment group and comparison group over the period of time (-24 to 24 months) leading up to the BPCI initiative were not statistically significant at 10% except home discharge at 5%. Results were the same for sepsis from 33 months before to 29 months after the BPCI initiative at 10% significance. Therefore, my study used two different time periods to examine effects of the BPCI initiative on hospital performance for MJRL and sepsis. For MJRL, 24 months before and after the BPCI initiative on October 1, 2015 were examined. For sepsis, 33 months before and 30 months after the BPCI initiative on July 1, 2015 were examined.

Effectiveness of Hospital Behaviors and Performance

Discharge location.

Some changes were observed in discharging patients to home for sepsis at the BPCI initiative participating hospitals compared to the comparison hospitals during the post-BPCI versus pre-BPCI periods. DiD estimates of 0.042 (significant at 5%) indicated that patients in the treatment group for sepsis experienced an additional 0.042 increase on average in the probability of being discharged to home following the BPCI initiative, as compared to the patients in the comparison group (Table 11). The average probability of home discharge in the treatment group during the pre- period was 0.169 (Table 9) and the pre-policy probability was estimated to increase by 0.042. Therefore, effects of the BPCI initiative led to an estimated 25% (i.e., 0.042/0.169=0.249) increase in the probability of a home discharge for sepsis. More specifically, patients younger than 64 years of age (0.06; 35.5% average increase) and patients with hypertension (0.047; 27.8% average increase) were associated with a statistically significant increase in home discharge (Table 11). Hispanic (coef. =0.074, $P<.01$) and Asian patients (coef. =0.037, $P<.05$) were significantly associated with an increase in home discharge for sepsis. However, my study did not find this level of home discharge for MJRL (*p*-value from pre-trend test = 0.059) (Table 10).

In short, the results of my study supported the hypothesis that patients with sepsis in the BPCI initiative participating hospitals were more likely to be discharged to home than their counterparts in non-participating hospitals (H_{1b}1a). However, the study did not support the assumption that patients with MJRL in the BPCI initiative participating hospitals were more likely to be discharged to home than their counterparts in non-participating hospitals (H_{1a}1a).

In-hospital mortality.

There were no apparent differences in hospital deaths related to MJRL between patients treated in BPCI-participating and non-participating hospitals before and after the BPCI initiative (Table 12). However, results were different for sepsis with a DID estimate of -0.053 (significant at 1%). In the treatment group during the pre- period, the probability of in-hospital mortality was 0.248 (Table 8) and pre-policy probability was estimated to be reduced by -0.053 to 0.195 (i.e., 0.248 – 0.053 = 0.195), which implied that the average mortality rate for patients treated at BPCI-participating hospitals decreased by about 21.4% following the BPCI initiative relative to the patients treated at non-participating hospitals. (i.e., (0.195 – 0.248)/0.248 = - 0.214 or simply (-0.053 /0 .248 = - 0.214). Patients younger than 64 years old (-0.051 with a significance of 1%) and with comorbidities (specifically diabetes with complications, hypertension, depression, and obesity) were highly associated with a decrease in hospital death for sepsis.

Complications.

A decrease in occurrence of complications among patients with sepsis was observed between the BPCI initiative participating hospitals and the non-participating hospitals. My study observed an average 0.036 decrease (5% significance) in the probability of pressure ulcers among patients treated for sepsis at the BPCI-participating hospitals relative to patients treated at non-participating hospitals for the same condition (Table 13). The average probability of pressure ulcers in the treatment group in the pre- period was 0.173 (Table 9). Therefore, the BPI initiative reflected a 20.8% (i.e., -0.036/0.173) decrease in the incidence of pressure ulcers among patients treated for sepsis in the treatment group compared with the comparison group. However, the results were different for MJRL in that no significant changes in complications were observed. My results showed no significant changes in the incidence of pressure ulcers, hospital falls, or postoperative sepsis among patients treated for sepsis at BPCI-participating hospitals compared to patients in the comparison hospitals (Table 13).

Efficiency of Hospital Behaviors and Performance

Length of hospital stay.

Changes in LOS with the episode of care for sepsis were detected with DiD estimates of -0.5 (significant at 5%), which indicated that patients in the treatment group experienced an average 0.5-day decrease in LOS following the BPCI initiative compared to their counterparts in the comparison group (Table 14). Average LOS before the policy for the treatment group was almost 8 days (7.91 days, on average) (Table 9) and the pre-BPCI initiative probability was estimated to be reduced by -0.5, or just over 7 days (e.g., 7.91 - 0.5 = 7.41), representing an estimated 6.75% reduction in LOS (e.g., (7.41–7.91)/7.91 = - 0.0675). Therefore, the BPCI initiative led to a half-day decrease (6.8%) in LOS among patients treated for sepsis at BPCI-participating hospitals compared to patients treated at non-participating hospitals. This study found no statistically significant results for sepsis among patients older than 85 years or patients with diabetes, diabetes with complications, hypertension, congestive heart failures, COPD, or obesity. The BPCI initiative led to a decrease in LOS of almost a full day (coef. = -0.708, P<0.01) for patients older than 85 years. A decreased LOS was also present among patients with diabetes by 4.4% (coef = -0.346, P<0.01) and hypertension by 9.6% (coef = -0.762, P<0.01). However, patients with DWC, CHF, COPD, and obesity showed a probability for an increase in LOS by a half-day.

The results, however, were different for MJRL. My study observed no significant changes in LOS among patients who had MJRL procedures at BPCI-participating hospitals relative to patients at comparison hospitals for the same procedure.

Total charge per hospital discharge.

The effects of the BPCI initiative on total charges were detected for sepsis but not for MJRL. My study showed a $13,092.85 decrease (significant at 5%) in total charges, on average, among patients treated for sepsis by the treatment group compared to the comparison group after the BPCI implementation (Table 15). The average total charges in the treatment group in the pre-period was $142,782 (Table 9) and the pre-policy total charge was estimated to be reduced by $13,092.85, to $129,690. Therefore, the BPCI initiative led to a $13,092.85, or 9.2% decrease in total charges, on average, at the BPCI initiative participating hospitals relative to non-participating hospitals following the BPCI initiative. Effects of the BPCI initiative on a decrease in total charges for sepsis were significantly associated with patient characteristics. First, this study indicated a significant decrease in total charges for ages 75—84, and older than 85. There was an average decrease of $8,351 (significant at 1%) and $23,114 (significant at 1%) in total charges among patients 75—84, and older than 85, respectively. Second, patients in the treatment group with diabetes and hypertension were significantly associated with an average total charge reduction of 3.1% ($4,465 decrease, 5% significance) and 13% ($18,618 decrease, 1% significance), respectively.

My study showed no significant changes in total charge, on average, for patients with MJRL procedures at BPCI-participating hospitals compared with patients treated at non-participating hospitals.

Average charge per hospital day.

There were no statistically significant changes in average charges per hospital day among patients treated for MJRL at the BPCI initiative participating hospitals compared with patients treated at non-participating hospitals, in the pre- versus post-BPCI initiative periods (Table 16). The results were the same for patients with sepsis.

Answers to Research Questions

The first research question asked was if the BPCI initiative would show positive effects on the effectiveness of hospital performance for MJRL and sepsis. My study found that that the BPCI initiative positively affected the effectiveness of hospital performance for sepsis but not for MJRL. The likelihood of patients with sepsis in the BPCI initiative participating hospitals being discharged to home increased more than that of their counterparts in non-participating hospitals. Similar findings were found in regard to in-hospital mortality; the level of mortality was lower among patients in the BPCI-participating hospitals than those in non-participating hospitals after the BPCI implementation. Regarding complications, patients with sepsis in the BPCI initiative participating hospitals were less likely to have pressure ulcers than patients in non-participating hospitals. The results, however, were different for MJRL. Patients with MJRL procedures showed no significant changes in mortality or complications at BPCI-participating hospitals compared to non-participating hospitals.

The second research question asked was if the BPCI initiative would show positive effects on the efficiency of hospital performance for MJRL and sepsis. This study revealed some positive effects of the BPCI initiative on improving the efficiency of hospital performance for sepsis but not for MJRL. Regarding sepsis, patients in the BPCI initiative participating hospitals tended to have shorter LOS and lower total charges than their counterparts in non-participating hospitals. In contrast, the BPCI initiative did not affect the efficiency of hospital performance in the case of MJRL.

Summary

Results of the data analyses using the SIDN showed that the BPCI initiative was associated with improving the effectiveness and efficiency of hospital performance for sepsis but not for MJRL. My study showed an average 25% increase in the probability of a home discharge, an average 21.4% decrease in likelihood of mortality, an average 12% decrease in likelihood of complications, an average 6.8% decrease in LOS, and an average 9.2% reduction in total charge for sepsis patients treated at the BPCI-participating hospitals compared to patients treated at non-participating hospitals due to the BPCI initiative (Table 17). The two research questions and five of the six hypotheses tested for hospital performance on sepsis demonstrated marked changes, supporting the BPCI initiative participating hospitals as more likely to improve the effectiveness and efficiency of medical care than non-participating hospitals (Table 18). However, none of the six hypotheses tested for hospital performance on MJRL were significant in supporting that BPCI initiative participating hospitals were more likely to improve the effectiveness and efficiency of surgical care than non-participating hospitals. I found no differences in changes in home discharge, mortality, complications, LOS, or total charges for MJRL patients at BPCI-participating hospitals and non-participating hospitals. The results of this study were validated by a pre-trend test (Table 10). A further discussion of the findings, comparison with other BPCI-related studies, and directions for future research, policy implication, and the limitations of this study are discussed in Chapter 6.

Chapter 6

Discussion

Introduction

The high cost of healthcare in the United States presents one of its most formidable challenges. A large body of research on reducing healthcare expenditure suggests a strong relationship between the behavior of health care providers and reimbursement models. The objective of this study was to examine the association between health care outcomes and a value-based financial incentive reimbursement model, the BPCI initiative from CMS, regarding the effectiveness and efficiency of hospital performance. This study makes several contributions to the literature. To our knowledge, this is the first study that addresses effects of the BPCI initiative on hospital performance based on a relatively long pre- and post-intervention period and relying on the most recently available data. Little is known about the potential effects of the BPCI initiative on medical care. This study adds new empirical evidence to the existing literature by examining the association between the BPCI initiative and outcomes of sepsis, which focused on non-surgical medical care. Further, our study, for the first time, expands the measurement of outcomes to clinical complications among the AHRQ's Patient Safety Indicators (PSIs) by studying the bundled payment policy; we examined pressure ulcers, patient falls, and postoperative sepsis. Next, this study adds to our knowledge of the bundled payment through the BPCI initiative. It showed there were no significant changes between intervention and comparison hospitals during the pre-intervention period (McCoy et al., 2017). An earlier report on the BPCI initiative did not explicitly confirm this parallel in pre-intervention trends—a major assumption of DiD analysis (Dimick & Ryan, 2014; Dummit et al., 2018). Finally, this study compared the effects of bundle payments on hospital performance between surgical and medical care. The following sections discuss key findings, directions for future research, public policy implications and interventions, and limitation of the study.

Key Findings

Effectiveness of hospital care under the BPCI initiative.

Findings from this study indicated that the BPCI initiative was associated with improving the effectiveness of hospital performance for medical care, specifically non-surgical medical care for sepsis, but not for surgical care for MJRL.

Discharge location.

Earlier studies on the BPCI initiative reported a shift of discharging location from SNFs to home following MJRL procedures. Froemke et al. (2015) showed an increase in discharging patients to SNFs from 10.5 to 18.3%, while home discharge increased from 54 to 63.7% (Froemke et al., 2015). Iorio and et al. (2016) studied CMS claim data from one academic hospital and found increased discharges to home following implementation of the BPCI initiative (Iorio et al., 2016). Doran and Zabinski (2015) examined effects of the BPCI initiative on Medicare and non-Medicare patients at a community hospital, and reported an increase in home discharge among Medicare patients (Doran & Zabinski, 2015). Unlike earlier studies, however, my study did not find positive changes in outcomes for home discharge. This may have been due to implementation of another CMS outcome-based contract prior to the BPCI initiative. The CMS announced the Hospital Readmissions Reduction Program (HRRP) for three medical conditions (myocardial infarction, heart failure, and pneumonia) in 2010 and it was expanded to include a surgical condition, MJRL in 2013 (Chhabra, Ibrahim, Thumma, Ryan, & Dimick, 2019). My study did not measure hospital readmissions due to limited data availability. However, preventing hospital readmission was being enforced by HRRP in 2013, which was the same year as the voluntary participation in the BPCI initiative began, and this may have influenced the discharge of patients to home for MJRL. Ali et al. (2017) reported that the comorbidities of individual patients were significantly associated with 30-day readmission after a THA procedure (Ali, Loeffler, Aylin, & Bottle, 2017). Yao et al. (2017) identified risk factors of unplanned readmission among patients discharged to home after MJRL. They found older patients and patients with diabetes, chronic heart failure, hypertension, or pulmonary disease were strong predictors for hospital readmission following the home discharge of MJRL patients. My study showed patients older than 85 years (coef = -0.130, $P<0.01$) and with comorbidities at BPCI-participating hospitals were associated with a reduction in patients discharged to home. Note that readmission is included in Model 2 of the BPCI initiative. Therefore, I speculate that BPCI-participating hospitals may have responded differently to the BPCI initiative in addition to the earlier HRRP contract. Regardless of BPCI participation, both participating and non-participating hospitals may have changed their practices in response to HRRP. However, BPCI-participating hospitals would have a double incentive to reduce readmission in response to another contract—the BPCI initiative. Therefore, BPCI-participating hospitals were less likely to discharge high-risk patients to home in response to the BPCI initiative and HRRP, particularly for elderly patients and patients with comorbidities, thus preventing hospital readmission.

My study demonstrated that patients with sepsis in BPCI initiative participating hospitals were more likely to be discharged to home than their counterparts in non-participating hospitals after the BPCI implementation. These results differed from some existing studies. Two empirical studies on sepsis reported no effects of the BPCI initiative on discharges to home (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018; Joynt Maddox et al., 2018). However, one non-peer-reviewed report showed an increase in home discharge after implementing a clinical pathway for sepsis treatment. This report was supported by other studies on the implementation of sepsis care bundles and an increase in discharging patients to home (Han et al., 2018). Sepsis care bundles are "a group of best evidence based interventions which when instituted together, gives maximum outcome benefits" (Khan & Divatia, 2010). To implement sepsis care bundles, engagement of all stakeholders in the care of sepsis (e.g., physicians, nurses, laboratory operations, pharmacists) and development of management strategies to ensure compliance, is necessary. Therefore, BPCI-participating hospitals are more likely to improve their internal structure of care delivery to increase home discharge in response to the BPCI initiative.

In-hospital mortality.

My study did not detect differences in changes in hospital mortality for MJRL between the BPCI-participating and non-participating hospitals before and after the BPCI initiative. This was consistent with findings from other studies that used Medicare claims to examine the 90-day post-procedure mortality (CMS, 2018b; Dummit et al., 2016). My result also fits the temporal trend of in-hospital mortality. There has been a trend of declining in-hospital mortality after MJRL procedure over the last few decades. Studies have identified that the decreasing trend of MJRL mortality is associated with initiation of multi-disciplinary pre-operative assessment, as well as improved surgical safety and post-operative care (Berstock, Beswick, Lenguerrand, Whitehouse, & Blom, 2014; Hunt et al., 2013). Therefore, the findings of my study do not support the hypothesis that patients with MJRL in the BPCI initiative participating hospitals are less likely to die in hospital than their counterparts in non-participating hospitals ($H_{1a}2$).

In contrast, the findings of my study supported that patients with sepsis in the BPCI initiative participating hospitals were less likely to die in the hospital than their counterparts in non-participating hospitals ($H_{1b}2$). This finding differs from other existing studies that, based on Medicare claims, reported no difference in changes in mortality of sepsis between BPCI-participating hospitals and non-participating hospitals (CMS, 2018b; Joynt Maddox et al., 2018). Earlier diagnosis and immediate treatment are imperative actions to reduce hospital death for patients with sepsis. To enforce early diagnosis and rapid initiation of treatment for sepsis, CMS implemented a new sepsis core measure, SEP-1, in 2015 and CMS now recommends sepsis bundle compliance with an ongoing increase in mortality and costs of sepsis (Medicare, 2018). Another study found a significant decrease in in-hospital mortality after implementation of the SEP-1 measure (Ramsdell, Smith, & Kerkhove, 2017). I have no direct information about whether or not BPCI-participating hospitals have implemented CMS sepsis bundle compliance. From the findings of my study, however, I assume that BPCI-participating hospitals were more likely to implement the scientifically proven CMS sepsis bundle compliance responding to BPCI initiative than the non-participating hospitals.

Complications.

To the best of my knowledge, no study has examined the potential effects of the BPCI initiative on changes in complications. Most existing studies focus on LOS and total cost (Nichols & Vose, 2016; Regenbogen et al., 2017). My study, in the case of MJRL, did not detect differences in changes in the incidence of pressure ulcers, patient falls with hip fracture, or postoperative sepsis between BPCI-participating and non-participating hospitals. There is a possible explanation. In 2008, CMS started a No-Pay policy on hospital-acquired conditions that included hospital falls, pressure ulcers, and surgical-site infections. Fehlberg et al. (2017) showed nurses were about twice as likely to perform fall-related interventions after the CMS No-Pay policy (Fehlberg et al., 2017). On the other hand, rates of hospital-acquired pressure ulcers remained unchanged following initiation of the No-Pay policy in 2008 (Meddings et al., 2015). The CMS No-Pay policy on hospital-acquired conditions in 2008 may have already improved these conditions at both BPCI-participating and non-participating hospitals before the BPCI initiative started in 2015. In the context of agency theory, hospitals (agents) have already improved their performance by decreasing hospital falls, pressure ulcers, and surgical-site infections in response to other outcome-based contracts (e.g., No-Pay policy on hospital-acquired conditions in 2008) before the BPCI initiative started in 2015. As a result, the BPCI initiative could not further change the performance of BPCI-participating hospitals to reduce complications compared to non-participating hospitals. Therefore, my findings do not support the hypothesis that patients with MJRL in the BPCI initiative participating hospitals were less likely to have complications than their counterparts in non-participating hospitals ($H_{1a}3$).

Conversely, my study showed a greater decrease in incidents of pressure ulcers for patients with sepsis in BPCI-participating hospitals compared to those in non-participating hospitals. To my knowledge, this is the first study that detects a positive association between the BPCI initiative and complications from sepsis. The presence of pressure ulcers is associated with an increase in discharging patients to SNFs, mortality, LOS to 7 days, and costs (Bauer, Rock, Nazzal, Jones, & Qu, 2016). Therefore, the agent (hospital) is more likely to develop a coordinated organizational structure to decrease the incidence of pressure ulcers and align with the interest of the principal (CMS). This alignment is an effort to contain costs and improve the overall quality of care in response to outcome-based contracts (the BPCI initiative), bundled payments.

Efficiency of hospital care under the BPCI initiative.

Results of my study demonstrated that the BPCI initiative was associated with enhancing hospital efficiency for medical care of sepsis, but did not enhance the effectiveness of surgical care for MJRL.

Length of in-hospital stay.

There were no substantial differences in changes in LOS for MJRL between participating and non-participating hospitals after BPCI implementation. These results were inconsistent with findings from the BPCI initiative literature, which found a significant decrease in LOS. A recent analysis of the National Inpatient Sample data showed a LOS reduction from 4.06 days in 2002 to 2.97 days in 2013 (Molloy et al., 2017). Another study showed an 18% reduction in average LOS after standardizing a care pathway for MJRL in response to the BPCI initiative (Froemke et al., 2015). This reduction was mainly due to improvements in pain management protocols, implants, anesthesia procedures, and surgical techniques. Findings of my study may be explained by proactive behaviors at non-participating hospitals. According to Chhabra (2019), “Proactive behavior is a behavior of taking initiative in improving current circumstances rather than passively adapting to present conditions” (Chhabra et al., 2019). MJRL is the most common elective surgery in the U.S. and a best-fit episode of care for a bundled payment model; CMS’ alternative payment model has mainly focused on MJRL. The ACE demonstration program in 2009, BPCI initiative in 2012, and Comprehensive Care for Joint Replacement Model (CJR) in 2016 are different bundled payment models that CMS established in a process of developing the most effective reimbursement model. Further, private insurance might be proactive and design its reimbursement model based on the CMS bundle payments since the MJRL episode of care is at the forefront of a value-based payment model. Therefore, hospitals that do not participate in the BPCI initiative may still want to prepare for the bundled payment model because private payers typically add new methodologies to their provider contracts. BPCI non-participating hospitals might have proactively redesigned the care pathway for MJRL as BPCI-participating hospitals have done. As a result, regardless of the BPCI initiative participation, all hospitals are more likely to improve LOS for MJRL. The results of my study did not support the hypothesis that patients with MJRL in the BPCI initiative participating hospitals were more likely to have shorter LOS than their counterparts in non-participating hospitals ($H_{2a}4$).

Regarding sepsis, LOS at BPCI-participating hospitals decreased compared to non-participating hospitals. My study supported the hypothesis that patients with sepsis in BPCI initiative participating hospitals were more likely to have a shorter LOS than their counterparts in non-participating hospitals ($H_{2b}4$). There are several explanations for this finding. First, a significant decrease in complications at the BPCI-participating hospitals in my study might have contributed to a significant reduction in LOS. Second, the literature on sepsis shows that it is possible to decrease LOS using evidence-based guidelines. For example, implementation of a machine learning-based sepsis prediction algorithm decreased LOS by 9.55% and mortality by 60.24% and the same results were repeated with the SEP-1 measure (McCoy & Das, 2017; Ramsdell et al., 2017). Therefore, the findings of my study may indicate that BPCI-participating hospital were more likely to implement evidence-based guidelines in response to the BPCI initiative.

In the context of agency theory, the agent (hospital) is more likely to implement a behavior that decreases LOS for sepsis to align with the goal of the principal (CMS), and to control cost of care in response to an outcome-based contract (the BPCI initiative). Non-participating hospitals may have behaved differently, however, since they have no incentives to decrease LOS. In fact, without effective contracts that could govern the relationship between principal and agent, an agent (non-participating hospital) is more likely to increase LOS to receive more payments. Therefore, conflicts of interest still exist between the principal (CMS) and agent (hospitals) without an outcome-based contract, such as the BPCI initiative.

Total charge per hospital discharge.

The results of my study did not support that patients with MJRL in BPCI initiative participating hospitals were more likely to have lower total charges than their counterparts in non-participating hospitals ($H_{2a}5$). Unlike my findings, earlier studies on the BPCI initiative show significant reductions in total costs and Medicare payments for MJRL (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018; Froemke et al., 2015). The common focus of hospitals seeking to contain costs is a reduction in LOS. With insignificant changes in LOS and complications at BPCI-participating hospitals for MJRL, it is not surprising to see insignificant changes in total charge.

My study supported the hypothesis that patients with sepsis in the BPCI initiative participating hospitals were likely to have lower total charges than their counterparts in non-participating hospitals ($H_{2b}5$). To my knowledge, this is the first empirical study to show effects of bundled payments on the efficiency of hospital care regarding sepsis. First, in this study a significant reduction in total charge for sepsis was expected with significant reductions in LOS and complications. Second, as mentioned earlier, adherence to sepsis bundled care is important in decreasing sepsis-related costs. Therefore, my findings may indicate that the agent (hospital) will more likely act to decrease total charges and align with the goal of the principal (CMS); they will try to restrain the cost of care in response to the outcome-based contract (the BPCI initiative), which passes financial risk to the hospital via gainsharing and penalties. Conversely, non-participating hospitals without an outcome-based contract may behave differently. These agents (hospitals), according to the agency theory, are more likely to perform more treatments to receive more payments. Since the principal (CMS) has asymmetrical information about the agent's work, the agent has more incentive to provide more treatments. Therefore, the agent may tend to increase total charges in opposition to the interest of the principal, which encourages value-based care.

Average charge per hospital day.

This study found no significant changes in average charges per hospital day for MJRL or sepsis at BPCI initiative participating hospitals relative to non-participating hospitals. Even though findings of this study did not support that patients with MJRL and sepsis in the BPCI initiative participating hospitals were more likely to have lower average daily charges than their counterparts in non-participating hospitals ($H_{2a}6$, $H_{2b}6$), the study provided a different perspective on hospital performance under the BPCI initiative, especially for sepsis. As expected, there were no changes in average daily charges for MJRL as there were no changes in LOS and total charge between the treatment and comparison groups for this study, following the BPCI initiative (Table 17). For sepsis, however, I expected a decrease in average daily charges with the reduction in LOS and total charge. No changes in average daily charges reflect that the intensity of care has not changed. I suspect the reduced total charge might be due to mainly in a decrease in LOS, but not by altering the concentration of care per patient's stay. This explains how agents (BPCI-participating hospitals) are more likely to perform value-based care in responding to the contract (BPCI initiative) by decreasing total charge by reducing LOS while the intensity of care remains the same.

Hospital Care under the BPCI Initiative based on Agency Theory

Figure 13 illustrates changes in hospital behavior in responding to the BPCI initiative for MJRL and sepsis. My study indicated that hospitals performed differently in response to the outcome-based contract, the BPCI initiative, for surgical and medical care. For sepsis, BPCI-participating hospitals are more likely to improve their organizational structure, incorporating evidence-based guidelines such as sepsis care bundles, in response to the BPCI initiative. By increasing routine home discharges and decreasing the negative outcomes of in-hospital mortality and complications, the incentives of BPCI-participating hospitals (agent) regarding sepsis seemed to shift toward value-based care. Conversely, non-participating hospitals may have behaved differently because they had no incentives to invest in improving organizational structure. Therefore, the results of my study supported that an agent in an outcome-based contract with a principal is more likely to behave in the interests of the principal by improving its effectiveness in the medical care of sepsis.

The BPCI initiative also has effects on governing relationships between principal and agent in terms of its efficiency in sepsis care. My study showed an agent was more capable of restrain total charges and reducing length of hospital stay under an outcome-based contract since the agent had stronger incentives to do so under the outcome-based contract (the BPCI initiative); the financial risk was passed on to the hospital through gainsharing and penalties. Conversely, non-participating hospitals may feel less compelled to increase their efficiency without an outcome-based contract. Therefore, the conflicting goals between principal (CMS) and agent in non-participating hospitals still exist.

For MJRL, my study found no improvement in efficiency for participating hospitals versus non-participating hospitals in responding to the BPCI initiative. This could be interpreted in two ways. First, both participating and non-participating hospitals may have increased the efficiency of their performance regardless of the BPCI initiative. Second, neither participating nor non-participating hospitals were able to improve their efficiency, even under the BPCI initiative. MJRL is an elective procedure with large variations in cost of care and a relatively simple clinical pathway. For example, the cost of surgical implants has a wide price range depending on a physician's choice. Earlier studies on the BPCI initiative have shown that a reduction in implant cost is one of the first objectives in lowering total charges for MJRL (Doran & Zabinski, 2015; Navathe et al., 2017). Studies also have shown that physician-led standardization of care reduced the cost of implants, prescriptions, and laboratories (Froemke et al., 2015; Siddiqi et al., 2017). Since hospitals and physicians are both financially accountable for inpatient care, it seems that participating hospitals would be more likely to focus on physician engagement to coordinate and standardize a clinical pathway for MJRL. Nevertheless, my study did not produce the anticipated findings. Therefore, I speculate that both participating and non-participating hospitals have improved their efficiency of care. There are three major healthcare systems in Nevada. All three systems that include 10 hospitals participated in Phase 1 (preparation stage) Model 2 of the BPCI initiative for MJRL care. While transitioning to Phase 2, one hospital system terminated their participation, leaving seven participating hospitals moving into Phase 2 of the BPCI initiative. Further, there are a limited number of orthopedic physicians in Nevada and they often work in different healthcare systems. Considering all aspects of these unique healthcare delivery systems and infrastructures in Nevada, I speculate that non-participating hospitals are also able to engage with physicians to streamline health care pathways and improve outcomes.

My study did not support agency theory on the effectiveness of hospital care for MJRL under the BPCI initiative since no significant differences in changes in home discharge, mortality, or complications were evident between participating and non-participating hospitals. However, agency theory explains the agents' (both participating and non-participating hospitals) behavior in responding to another outcome-based contract (CMS No-Pay policy on hospital-acquired condition) in 2008. Therefore, a conflict of interest between CMS and its agents may have started to resolve before the BPCI initiative was implemented in Nevada in 2015.

Summary of the Findings

Based on the agency theory, I examined the effectiveness and efficiency of hospital performance for MJRL and care of sepsis in response to the outcome-based contract, the BPCI initiative.

The findings of this study did not support the hypothesis that BPCI initiative participating hospitals were more likely to improve the effectiveness and efficiency of hospital performance for surgical care (MJRL) than non-participating hospitals in response to the BPCI initiative (H_{1a} and H_{2a}). Conversely, this study's findings support that BPCI initiative participating hospitals were more likely to improve the effectiveness and efficiency of their performance for medical care (sepsis) than non-participating hospitals responding to the BPCI-initiative (H_{1b} and H_{2b}). There are several explanations for this finding. First, baseline outcomes of the BPCI-participating hospitals were much higher than comparison groups for sepsis. For example, mean total charge in the treatment group was much higher ($142,782) than mean total charge in the comparison group ($116,990) during the pre-BPCI initiative period for the care of sepsis (Table 9). Since target prices for the BPCI initiative are based on a hospital's improvement over its own past performance and are used to determine their gainsharing, hospitals with higher baseline outcomes such as higher total charge have more room to improve their hospital performance. This suggests there might be a potential participation bias that could have led to changes in the different outcomes between treatment and comparison groups, before and after the BPCI initiative. Second, proactive effects may explain insignificant changes in hospital performance for MJRL. In addition to the BPCI initiative, CMS announced the CJR model in 2015. Unlike the BPCI initiative, the CJR model created regional competition since the target price of the CJR model was based on regional claims data and participating hospitals' own data from previous years (McLawhorn & Buller, 2017). Therefore, hospitals not participating in the BPCI initiative still want to prepare for the bundled payment model to be compatible with their own region. Third, findings on early bundled payments for MJRL from existing studies were highly positive. Many studies reported a significant decrease in cost for MJRL by reconstructing the care pathway. Therefore, hospitals that were not participating in the BPCI initiative may have participated in developing a care pathway to improve effectiveness and efficiency of care. Table 18 summarizes the general results of my hypothesis testing.

Directions for Future Research

The evaluation of alternative payment models on hospital care improvement is not complete. My focus on the BPCI initiative suggested some positive effects of a financial, outcome-based contract on hospital performance for MJRL and care of sepsis. There is one more year of SIDN data to be evaluated (Phase II BPCI Model 2 ended in September 30, 2018). However, additional data might not enable a much more in-depth analysis of the BPCI initiative since there are limited baseline episode payments to reduce episode spending. Additional research is needed to determine types of financial incentives and health care outcomes that will motivate hospitals to better manage resources, coordinate care, and thus reduce total charges and costs. Furthermore, different episodes of care may require different types of outcome measurements in addition to financial incentives. For example, adherence to sepsis bundle compliance is an essential element in reducing mortality and the cost of care for sepsis. Therefore, including the SEP-1 measure should be one of the outcome measurements for sepsis in future bundled payments.

A qualitative study merits inclusion in future research on bundled payments to examine providers' perceptions on the BPCI initiative. According to the resource dependence theory, managerial and organizational decision-making become important when resources are limited, as with a bundled payment. For example, physician engagement and care coordination are essential elements for successful implementation of the BPCI initiative. Therefore, operational perspectives on merits and barriers of the BPCI initiative implementation will be beneficial to advance the designing of alternative reimbursement models. Operational perspectives from non-participating hospitals need to be conducted as well. Sampling of the qualitative study needs to include chief executive officers, chief operating officers, chief financial officers, medical directors, and operational directors for each episode of care.

Patient-level information for each procedure is needed to further understand the effects of bundled payments on hospital performance. First, current available data only allow researchers to analyze effects of the BPCI initiative on total charges and costs and on total Medicare payments without knowing the components of the total charges and costs. For example, total charges and costs include those for radiology, laboratory services, ED and ICU use, cardio, respiratory system, blood utilization, pharmacy, operating room, and more. Further, different episodes may have different categories of total charges and costs. Therefore, an examination of electronic health records needs to be conducted to understand the effects of bundled payments on a specific category, whether the total cost is reduced or not. This may allow hospitals and the CMS to develop different strategies for different episodes of care and target the cost of different categories. Other aspects of in-hospital complications that need to be examined include transient hypotension, urinary retention, and transfusion rate.

Since the BPCI initiative ended in September 2018, CMS has announced another bundled payment model called BPCI-Advanced started on October 1, 2018. BPCI-Advanced is a voluntary model with a few different approaches from the BPCI initiative. The BPCI-Advanced is a more outcome-based model than the BPCI initiative since payment of BPCI-Advanced is tied to performance on quality measures rather than just target price. BPCI-Advanced adopted seven administrative, quality-measure fact sheets for each episode of care. The quality measures for MJRL include: perioperative care; hospital-level, risk-standardized complication rates; readmission measures; and PSIs. In addition, BPCI-Advanced provides preliminary target prices to participating hospitals each year. Therefore, research will be needed to determine how BPCI-Advanced affects hospital performance with these more specific outcome-based contracts.

Implications for Health Care Policy and Interventions

Many policy makers believe in strengthening financial and other incentives to improve hospital performance (Peck, Usadi, Mainor, Fisher, & Colla, 2019). My findings supported the observation that hospitals were more likely to act in the interest of the CMS when their relationship was founded on an outcome-based contract with incentives (Figure 1). Importantly, my findings for the bundled payment with sepsis showed the feasibility of a total charge reduction without compromising the quality of medical care. Even though there is limited research supporting my findings, the positive outcomes were a strong indicator for including non-surgical care when developing an alternative payment model and mechanisms. CMS has developed different bundled payment models as alternative payment methods to align itself with the interests of providers as it moves away from FFS. As bundled payment models evolve, the effect of the BPCI initiative shows we are moving closer to value-based care. However, more improvements in these models are needed. So far, the CMS model has focused on the total cost of care. Even quality of care was indirectly monitored by total cost, since any charges for readmission and post-care services were all included in their bundle. However, there is a limit to how much cost can be reduced after approaching a "floor." Therefore, future developments in the bundled payment model need to be based on more than a target price. The absence of direct quality measurement is another limitation of the current model. It is evident that the same quality measurement should not be applied to different episodes of care. For example, the quality of measure for sepsis may include compliance with SEP-1, which has had an important role in reducing mortality and readmissions. While effective for sepsis, this measure was not effective for MJRL. Therefore, it may be time to expand the incentives in bundled payment plans, in addition to the existing financial incentives based on episode-specific and evidence-based outcome measurements.

Savings in episode payments made to the Medicare program through the BPCI initiative were lost in reconciliation payments to the participants (*CMS Bundled Payments for Care Improvement Initiative Models 2-4: Year 5 Evaluation & Monitoring Annual Report*, 2018). There is more room to improve savings to the CMS, however, especially for surgical care. The Medicare Physician Fee Schedule is the payment system CMS uses for physician reimbursement during inpatient stays. Accuracy of the Medicare Physician Fee Schedule is important since payments of Medicare's FFS, and most commercial insurers, are based on this fee schedule, including alternative payment models like bundled payments (Urwin et al., 2019). Physician time is one indicator of a physician's work in the Medicare Physician Fee Schedule. This schedule includes preparation time for the operation, operation time, and postoperative time of the hospital and the physician's office. A recent empirical study found that the Medical Physician Fee Schedule significantly overestimates operating times for MJRL by 18–23 %, and that of revisions by 48–61% (Urwin et al., 2019). The current Medicare Physician Fee Schedule is not responsible for other related aspects of care, such as pre-op, post-op, and quality of care. Figure 14 illustrates that 88.36% of gainsharing distributions go to physicians. To reduce Medicare payments, therefore, the bundled payment system should be modified based on an updated Medical Physician Fee Schedule, and then enforced.

Assumptions and Limitations

This study had several limitations. First, findings may have limited generalizability since the study sample was limited to hospitals in Nevada. Second, effects of the BPCI initiative might not represent the effectiveness and efficiency of a value-based payment model accurately since its implementation was voluntary. For example, the BPCI initiative participating hospitals tended to have higher baselines for their episode payments than non-participating hospitals. However, pre-trend tests and the consistency of patient characteristics between the BPCI initiative participating hospitals and comparison hospitals supported the validity of this study. Third, selection of a comparison group might have been biased. Due to limited data availability, this study did not select comparison hospitals using propensity scores based on hospital and market characteristics and baseline outcome measurements (Dimick & Ryan, 2014; Joynt Maddox et al., 2018). However, non-significance changes (p-value larger than 0.5) for all outcome measurements between the treatment and comparison groups leading up to the BPCI initiative supported the validly of this study (Table 10). Fourth, limited data resources also affected the measure of quality care in this study. Post-discharge data such as hospital readmission, ED use, and PAC were therefore not included. However, the recent bundled payment model by CMS, BPCI-Advanced, supported analyses of PSI as a quality measurement. BPCI-Advanced includes PSI 03, pressure ulcers, and PSI 08, hospital falls, in quality-measurement sheets for MJRL and sepsis. Fifth, using pressure ulcers to measure complications of sepsis may raise questions about the validity of measurement. Sixth, the SIDN database does not contain patient-level data, such as smoking, that could influence outcomes of MJRL. In addition, procedural characteristics like blood transfusion or operative time that may have influenced outcomes were not available in the SIDN database. Finally, total charges were not translated into total costs. The analyses of total charges were important, however, since these were the amount being claimed to Medicare.

Conclusions

To date, bundled payment models have primarily focused on surgical care, such as MJRL.

This study provided results that suggest hospitals could achieve improved outcomes in the medical care of sepsis in response to the BPCI initiative. The recognition that the BPCI initiative was associated with improving the effectiveness and efficiency of hospital performance in the case of sepsis, provides new opportunities for developing an outcome-based reimbursement model that extends to other medical care episodes. The agency theory was a well-suited conceptual framework, describing changes in hospital performance in response to an outcome-based contract, the BPCI initiative. In the context of agency theory, the BPCI initiative participating hospitals were more likely to improve the effectiveness and efficiency of hospital performance than non-participating hospitals because of this outcome-based contract, the BPCI initiative. The empirical results of this study suggested that the BPCI initiative increased home discharge, decreased complications, LOS, and total charges for medical care of sepsis, specifically, but not for surgical care of MJRL.

The outcome-based reimbursement model was effective in improving hospital performance, suggesting that public policies are needed to incentivize hospitals to be more effective and efficient. Overall, the BPCI initiative appears to be a step towards reducing health care expenditures for different episodes of care without compromising outcomes and quality of care.

Table 1. BPCI Initiative Models

	Model 1	Model 2	Model 3	Model 4
Episode	All DRGs; all acute patients	Selected DRGs; hospital plus post-acute period	Selected DRGs; post-acute period only	Selected DRGs; hospital plus readmissions
Payment	Retrospective	Retrospective	Retrospective	Prospective
Episode of Care includes	All Part A services paid as part of the MS-DRG payment	All non-hospice Part A and B services during the initial inpatient stay, post-acute period and readmissions	All non-hospice Part A and B services during the post-acute period and readmissions	All non-hospice Part A and B services (including the hospital and physician) during initial inpatient stay and readmission

Resource: CMS (2016)

Table 2. BPCI Initiative Model 2 in Nevada

	Major Joint Replacement of the Lower Extremity (DRG 469, 470)		Sepsis (DRG 870, 871, 872)		Three-Day Hospital Waiver
	Phase 1	Phase 2	Phase 1	Phase 2	
Hospital # 1	6/20/14-9/30/15	4/1/15-9/30/18	6/20/14-9/30/15	-	
Hospital # 2	6/20/14-9/30/15	4/1/15-9/30/18	6/20/14-9/30/15	-	Y
Hospital # 3	6/20/14-9/30/15	4/1/15-9/30/18	6/20/14-9/30/15	7/1/15-9/30/18	Y
Hospital # 4	6/20/14-9/30/15	4/1/15-9/30/18	6/20/14-9/30/15	7/1/15-9/30/18	Y
Hospital # 5	6/20/14-9/30/15	-	6/20/14-9/30/15	7/1/15-9/30/18	
Hospital # 6 (nonprofit)	3/7/14-9/30/15	10/1/15-9/30/18	3/7/14-9/30/15	4/1/15-9/30/18	
Hospital # 7 (nonprofit)	3/7/14-9/30/15	10/1/15-9/30/18	3/7/14-9/30/15	-	
Hospital # 8 (nonprofit)	3/7/14-9/30/15	10/1/15-9/30/18	3/7/14-9/30/15	-	
Hospital # 9	6/20/14-9/30/15	-	6/20/14-9/30/15	-	
Hospital # 10	6/20/14-9/30/15	-	6/20/14-9/30/15	-	
Hospital # 11	-	-	-	-	
Hospital # 12 (county)	-	-	-	-	
Hospital # 13	-	-	-	-	
Hospital # 14	-	-	-	-	
Hospital # 15	-	-	-	-	
Hospital # 16 (nonprofit)	-	-	-	-	
Hospital # 17 (nonprofit)	-	-	-	-	

Note. (-) indicates non-participating hospitals.

Table 3. BPCI-Participating (Treatment) and Non-Participating Hospitals (Comparison)

	BPCI-participating Hospitals (Treatment)		Non-participating Hospitals (Comparison)
		BPCI Implementation Date	
MJRL	7 Hospitals	4/1/15-9/30/18 (4 hospitals) 10/1/15-9/30/2015 (3 hospitals)	10 Hospitals
Sepsis	4 Hospitals	4/1/15-9/30/18 (1 hospitals) 7/1/15-9/30/2015 (3 hospitals)	13 Hospitals

Table 4. List of Variables: Type, Definition, and Coding Value

	Type	Definition	Coding Value
Dependent Variable			
Discharge Location			
Home	Binary	Discharged to home	1=yes; 0=no
Mortality	Binary	Died in hospital after procedure	1=yes; 0=no
Complication			
PSI03	Binary	Pressure Ulcer	1=yes; 0=no
PSI08	Binary	In hospital fall with hip fracture	1=yes; 0=no
PSItotal	Binary	Pressure ulcer or in hospital fall with hip fracture	
LOS	Continuous	Length of hospital stay	Day
Total Charge	Continuous	Total charge	$
Average Charge	Continuous	Charge per Day	$
Independent Variable			
BPCI	Binary	BPCI initiative	1= Post-BPCI 0= Pre-BPCI

Notes. PSI = patient safety indicator; PSI 03= pressure ulcer; PSI 08=in hospital fall with hip fracture; PSI 13=postoperative sepsis; PSI Total = PSI 03 + PSI 08; LOS= length of in-hospital stays

Resource. AHRQ (2017, 2018)

Table 5. Elements of Difference-in-Differences Checklist

Confirm that	How to Test	Check
1. Data exist on study outcomes for at least one observation period among groups exposed and not exposed to an intervention, both before and after the intervention was implemented	Directly observable	Yes
2. Trends in outcome performance prior to an intervention are "parallel" between treatment and comparison groups	Test equivalence of linear trends between treatment and comparison groups prior to intervention by testing the significance of the interaction term between the time trend and the treatment group	Yes
3. Baseline outcome levels are unrelated to expectations for changes in outcomes	For both treatment and comparison groups, test whether baseline outcome is correlated with change in performance across the study period	Not applicable
4. Violations of standard statistical assumptions are appropriately addressed	Test for violations of homoscedasticity of standard errors	Not applicable
5. Events of factors other than treatment, occurring at the time of treatment, do not differentially affect outcomes for treatment and comparison groups	Not directly testable	Not applicable
6. The composition of treatment and comparison groups does not change over the course of the study	Test for difference in observed covariates between treatment and comparison rates before and after the intervention. Test for differential drop-out rates between treatment and comparison groups	Yes
7. Treatment does not "spill-over" from treatment group to comparison group	Test whether comparison group experiences deviation from existing trend concurrent with intervention	Not applicable

Source. Ryan (2015)

Table 6. Characteristics of Patients and Hospitals of the BPCI Initiative Participating Hospitals (Treatment) and Nonparticipating Hospitals (Comparison) for Major Joint Replacement of the Lower Extremity

	Pre				Post			
	Treatment		Comparison		Treatment		Comparison	
N	2,831		1,818		1,639		2,582	
Patient Characteristics	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Age								
< 64	248	8.76	197	10.84	154	9.40	197	7.63
65–74	1,559	55.07	823	45.27	905	55.22	1,374	53.21
75–84	806	28.47	571	31.41	452	27.58	776	30.05
85 and older	218	7.70	227	12.49	128	7.81	235	9.10
Sex								
Male	1,086	38.36	709	39.00	622	37.95	1,027	39.78
Female	1,745	61.64	1,109	61.00	1,017	62.05	1,555	60.22
Race								
White	2,387	84.32	1,470	80.86	1,307	79.74	2,231	86.41
Black	169	5.97	87	4.79	115	7.02	86	3.33
Hispanic	124	4.38	118	6.49	92	5.61	137	5.31
Asian	67	2.37	55	3.03	73	4.45	49	1.90
Others*	84	2.97	88	4.83	52	3.17	79	3.06
Comorbidities								
Diabetes	520	18.37	324	17.82	279	17.02	365	14.14
Diabetes with complications	46	1.62	33	1.82	77	4.70	78	3.02
Hypertensions	1,886	66.62	1,125	61.88	1,009	61.56	1,461	56.58
Congestive Heart Failures	23	0.81	45	2.48	49	2.99	71	2.75
COPD	220	7.77	235	12.93	152	9.27	246	9.53
Depression	368	13.00	186	10.23	179	10.92	202	7.82
Obesity	0	0.00	0	0.00	194	11.84	261	10.11
Hospital Characteristics								
Hospital Size								
Small (<100 beds)	0	0.00	85	4.68	0	0.00	78	3.02
Medium (100–299 beds)	2,531	89.40	1,160	63.81	1,344	82.00	1,901	73.63
Large (> 300 beds)	300	10.60	573	31.52	295	18.00	603	23.35
Hospital Ownership								
Profit	1,262	44.58	1,275	70.09	1,290	78.71	1,720	66.59
Non-profit	1,575	55.48	436	23.93	349	21.29	758	29.35
County	0	0.00	108	5.94	0	0.00	105	4.07
Teaching Hospital	0	0.00	108	5.94	0	0.00	105	4.07

Dependent Variables								
Discharge location								
Home	155	5.48	335	18.43	82	5.00	1,057	40.94
Mortality	12	0.42	10	0.55	3	0.18	4	0.15
Complication								
PSI 03	13	0.46	9	0.49	0	0.00	2	0.08
PSI 08	5	0.18	15	0.83	0	0.00	0	0.00
PSI 13	7	0.25	12	0.66	5	0.31	11	0.43
PSI total	23	0.81	35	1.93	5	0.31	12	0.47
PSI total = 1	21	0.74	34	1.87	5	0.31	11	0.43
PSI total = 2	2	0.07	1	0.06	0	0.00	1	0.04

Notes. *Others in race include Native Americans (0.4%), unknown (0.9%). COPD = chronic obstructive pulmonary disease; PSI= patient safety indicator; PSI 03 is pressure ulcer; PSI 08 is in hospital fall with hip fracture; PSI 13 is postoperative sepsis; PSI total indicates incidence of PSI03, PSI 08, or PSI 13.

Data Source. State Inpatient Database Nevada, 2013-2017

Table 7. Characteristics of Patients and Hospitals of the BPCI Initiative Participating Hospitals (Treatment) and Nonparticipating Hospitals (Comparison) for Sepsis

	Pre				Post			
	Treatment		Comparison		Treatment		Comparison	
N	1,332		4,739		2,755		8,530	
Patient Characteristics	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
Age								
< 64	245	18.39	902	19.03	583	21.16	1,759	20.62
65–74	460	34.53	1,606	33.89	931	33.79	2,772	32.50
75–84	398	29.88	1,387	29.27	791	28.71	2,509	29.41
85 and older	229	17.19	844	17.81	450	16.33	1,490	17.47
Sex								
Male	707	53.08	2,377	49.84	1,363	49.47	4,239	49.70
Female	625	46.92	2,362	50.16	1,392	50.53	4,291	50.30
Race								
White	890	66.82	3,438	72.55	1,864	67.66	5,888	69.03
Black	182	13.66	431	9.09	349	12.67	938	11.00
Hispanic	106	7.96	289	6.10	269	9.76	655	7.68
Asian	83	6.23	230	4.85	136	4.94	477	5.59
Others*	71	5.33	351	7.41	137	4.98	572	6.71
Comorbidities								
Diabetes	413	31.01	1,338	28.23	472	17.13	1,689	19.80
Diabetes with complications	106	7.96	340	7.17	695	25.23	1,649	19.33
Hypertensions	478	35.89	2,002	42.25	1,086	39.42	3,394	39.79
Congestive Heart Failures	113	8.48	392	8.27	670	24.32	1,754	20.56
COPD	383	28.75	1,464	30.89	470	17.06	1,475	17.29
Depression	113	8.48	516	10.89	232	8.42	903	10.59
Obesity	0	0.00	0	0.00	327	11.87	978	11.47
Hospital Characteristics								
Hospital Size								
Small (<100 beds)	0	0.00	148	3.09	0	0.00	192	2.25
Medium (100–299 beds)	917	67.78	2,388	49.84	1,828	66.26	3,730	43.67
Large (> 300 beds)	436	32.22	2,255	47.07	931	33.74	4,620	54.09
Hospital Ownership								
Profit	861	64.64	3,175	67.00	2,313	83.96	6,473	75.89
Non-Profit	471	35.36	1,348	28.44	442	16.04	1,620	18.99
County	0	0.00	216	4.56	0	0.00	437	5.12
Teaching Hospital	0	0.00	216	4.56	0	0.00	437	5.12

Dependent Variables								
Discharge location								
Home	225	16.89	1,138	24.01	642	23.30	2,313	27.12
Mortality	330	24.77	797	16.82	440	15.97	1,153	13.52
Complication								
PSI 03	230	17.27	638	13.46	78	2.83	221	2.59

Notes. *Others in race include Native Americans (0.4%), unknown (0.9%). COPD = chronic obstructive pulmonary disease; PSI= patient safety indicator; PSI 03 is pressure ulcer.

Data Source. State Inpatient Database of Nevada, 2013-2017

Table 8. MJRL: Means and Standard Deviations for Dependent Variables

	Pre		Post	
Dependent Variable	Treatment	Comparison	Treatment	Comparison
N	2,831	1,818	1,639	2,582
Discharge location				
Home	0.055 [0.228]	0.184 [0.388]	0.050 [0.218]	0.409 [0.492]
Mortality	0.004 [0.065]	0.006 [0.074]	0.002 [0.043]	0.002 [0.039]
Complication				
PSI 03	0.005 [0.068]	0.005 [0.070]	0.000 [0.000]	0.001 [0.028]
PSI 08	0.002 [0.042]	0.008 [0.090]	0.000 [0.000]	0.000 [0.000]
PSI 13	0.002 [0.050]	0.007 [0.081]	0.003 [0.055]	0.004 [0.065]
PSI total	0.009 [0.101]	0.020 [0.143]	0.003 [0.055]	0.005 [0.076]
LOS	3.61 [2.47] (1, 42)	3.87 [2.62] (1, 36)	3.39 [2.46] (1, 58)	2.96 [2.50] (1, 46)
Total Charge	112649 [44273] (48245, 791162)	90999 [40663] (24830, 596396)	137906 [46689] (53287, 587694)	95617 [44376] (45557, 631599)
Average Charge	35381 [14111] (2732, 178729)	27692 [14823] (2854, 148029)	48530 [21647] (5835, 243773)	44493 [27749] (7405, 209078)

Notes. Means are reported with standard deviation in brackets. Minimum and max are reported in parenthesis. MJRL=major joint replacement of the lower extremity; LOS=length of stay; PSI=patient safety indicators; PSI 03=pressure ulcer; PSI 08=in hospital fall with hip fracture; PSI 13=postoperative sepsis; PSI total indicates incidence of PSI 03, PSI 08, or PSI 13; Total charge is weighted using the inpatient hospital inflation rate.
Data Source. State Inpatient Database of Nevada, 2013-2017

Table 9. Sepsis: Means and Standard Deviations for Dependent Variables

	Pre		Post	
Dependent Variable	Treatment	Comparison	Treatment	Comparison
N	1,332	4,739	2,755	8,530
Discharge location				
Home	0.169 [0.375]	0.240 [0.427]	0.233 [0.423]	0.271 [0.445]
Mortality	0.248 [0.432]	0.168 [0.374]	0.160 [0.366]	0.135 [0.342]
Complication				
PSI 03	0.173 [0.378]	0.135 [0.341]	0.028 [0.166]	0.026 [0.159]
LOS	7.91 [6.89] (1, 54)	7.39 [6.12] (1, 56)	7.01 [6.43] (1, 57)	6.72 [5.60] (1, 60)
Total Charge	142782 [139256] (15669, 1151320)	116990 [120721] (77, 1545745)	140965 [134555] (2163, 1236934)	119818 [115109] (3089, 1818046)
Average Charge	20548 [12132] (2986, 108137)	17210 [12109] (19, 126669)	23271 [13347] (1176, 166657)	19918 [13334] (1215, 160164)

Notes. Means are reported with standard deviation in brackets. Minimum and max are reported in parenthesis. LOS=length of stay; PSI=patient safety indicators; PSI 03=pressure ulcer; Total charge is weighted using the inpatient hospital inflation rate.
Data Source. State Inpatient Database of Nevada, 2013-2017

Table 10. Significance of Pre-Trend Test

	P [Days x Treat ≠0|Post = 0]			
Dependent Variable	MJRL		Sepsis	
Home	0.000	0.059	0.238	0.442
Mortality	0.974	0.631	0.133	0.288
LOS	0.857	0.362	0.489	0.025
PSI 03	0.047	0.750	0.584	0.301
PSI 08	0.535	0.903	0.886	0.489
PSI 13	0.221	0.176	-	-
PSI total	0.436	0.576	0.576	0.261
Total Charge	0.135	0.585	0.993	0.159
Average Charge	0.655	0.205	0.160	0.238
Sample Size	4,649	3,159	6,071	4,879
Hospital FE	*y*	*y*	*y*	*y*
Time FE	*y*	*y*	*y*	*y*
Patient Demographics	*y*	*y*	*y*	*y*
Hospital Characteristics	*y*	*y*	*y*	*y*
Drop 4/1/15-10/1/15	*y*	*y*	*n*	*n*
Drop 4/1/15- 7/1/15	*n*	*n*	*y*	*y*
Period:				
-36 to 27 months	*y*	*n*	*n*	*n*
-33 to 30 months	*n*	*n*	*y*	*n*
-24 to 24 months	*n*	*y*	*n*	*y*

Notes. MJRL=major joint replacement of the lower extremity; LOS=length of stay; PSI=patient safety indicators; PSI 03=pressure ulcer; PSI 08=in hospital fall with hip fracture; PSI 13=postoperative sepsis; PSI total indicates incidence of PSI03, PSI 08, or PSI 13; Total charge is weighted using the inpatient hospital inflation rate.
Data Source. State Inpatient Database of Nevada, 2013-2017

Table 11. Difference-in-Differences Estimates for Home Discharge

		MJRL		Sepsis	
Sample Size		7,093		17,356	
Dependent Variable					
(a) Home	Treat × Post	-0.080***		0.042**	
		(0.016)		(0.015)	
	P [Days x Treat ≠0|Post = 0]	0.059		0.238	
Hospital FE		*y*		*y*	
Time FE		*y*		*y*	
Patient Demographics		*y*		*y*	
Age					
< 64		-0.013	(0.014)	0.060***	(0.010)
75-84		-0.053***	(0.008)	-0.084***	(0.008)
85 +		-0.130***	(0.011)	-0.161***	(0.009)
Sex					
Male		0.040***	(0.008)	-0.011*	(0.006)
Race					
Black		-0.002	(0.016)	0.019*	(0.011)
Hispanic		-0.036**	(0.014)	0.074***	(0.013)
Asian		0.008	(0.021)	0.037**	(0.014)
Others		-0.014	(0.019)	-0.008	(0.014)
Comorbidities					
Diabetes		-0.016	(0.010)	-0.009	(0.008)
Diabetes w/ complications		-0.089***	(0.014)	-0.026**	(0.009)
Hypertension		-0.007	(0.008)	0.047***	(0.007)
Congestive Heart Failures		-0.046**	(0.023)	-0.065***	(0.009)
COPD		-0.062***	(0.012)	-0.026***	(0.008)
Depression		-0.031**	(0.011)	-0.036***	(0.011)
Obesity		-0.012	(0.016)	-0.022*	(0.013)
Hospital Characteristics		*y*		*y*	
Drop 4/1/15-10/1/15		*y*		*n*	
Drop 4/1/15-7/1/15		*n*		y	
Period: -24 to 24 months		*y*		*n*	
Period: -33 to 30 months		*n*		*y*	

Notes. *** indicates significant at the 1% level; ** 5% level; * 10% level. Robust standard errors are in parenthesis. MJRL=major joint replacement of the lower extremity; COPD=chronic obstructive pulmonary disease.
Data Source. State Inpatient Database of Nevada, 2013-2017

Table 12. Difference-in-Differences Estimates for In-Hospital Mortality

Dependent Variable		MJRL (n=7,093)		Sepsis 17,356	
Mortality	Treat × Post	0.001		-0.053***	
		(0.003)		(0.016)	
	P [Days x Treat ≠0|Post = 0]	0.631		0.133	
Hospital FE		*y*		*y*	
Time FE		*y*		*y*	
Patient Demographics		*y*		*y*	
Age					
< 64		-0.001	(0.001)	-0.051***	(0.007)
75-84		0.003*	(0.002)	0.018**	(0.007)
85 +		0.017***	(0.005)	0.061***	(0.009)
Sex					
Male		0.000	(0.001)	0.023***	(0.006)
Race					
Black		-0.003***	(0.001)	0.002	(0.009)
Hispanic		-0.002	(0.003)	-0.020**	(0.010)
Asian		-0.001	(0.005)	0.003	(0.013)
Others		-0.005***	(0.001)	0.011	(0.011)
Comorbidities					
Diabetes		0.001	(0.002)	-0.013*	(0.007)
Diabetes w/ complications		0.008	(0.007)	-0.015**	(0.008)
Hypertension		-0.002	(0.002)	-0.048***	(0.006)
Congestive Heart Failures		-0.001	(0.007)	0.029***	(0.008)
COPD		-0.002	(0.003)	0.006	(0.007)
Depression		0.001	(0.003)	-0.034***	(0.008)
Obesity		0.000	(0.001)	-0.020**	(0.010)
Hospital Characteristics		*y*		*y*	
Drop 4/1/15-10/1/15		*y*		*n*	
Drop 4/1/15-7/1/15		*n*		y	
Period: -24 to 24 months		*y*		*n*	
Period: -33 to 30 months		*n*		*y*	

Notes. *** indicates significant at the 1% level; ** 5% level; * 10% level. Robust standard errors are in parenthesis. MJRL=major joint replacement of the lower extremity; COPD=chronic obstructive pulmonary disease.

Data Source. State Inpatient Database of Nevada, 2013-2017

Table 13. Difference-in-Differences Estimates for Complication

		MJRL		Sepsis	
Sample Size		7,093		17,356	
Dependent Variable					
PSI 03	Treat × Post	-		-0.036**	
				(0.012)	
		-			
	P [Days x Treat ≠0|Post = 0]			0.584	
PSI total	Treat × Post	0.002		-	
		(0.006)			
	P [Days x Treat ≠0|Post = 0]	0.576		-	
Hospital FE		*y*		*y*	
Time FE		*y*		*y*	
Patient Demographics		*y*		*y*	
Age					
< 64		0.002	(0.004)	-0.005	(0.005)
75-84		0.005	(0.003)	0.001	(0.005)
85 +		0.019*	(0.007)	0.013**	(0.006)
Sex					
Male		0.006	(0.002)	0.013***	(0.004)
Race					
Black		-0.011***	(0.001)	0.003	(0.007)
Hispanic		-0.002	(0.006)	-0.004	(0.007)
Asian		-0.01***	(0.002)	-0.023**	(0.007)
Others		0.014	(0.012)	0.004	(0.008)
Comorbidities					
Diabetes		0.002	(0.004)	0.003	(0.005)
Diabetes w/ Complications		0.006	(0.009)	0.007	(0.005)
Hypertension		-0.004	(0.003)	-0.02***	(0.004)
Congestive Heart Failures		0.009	(0.014)	-0.007	(0.005)
COPD		0.012**	(0.006)	-0.009*	(0.005)
Depression		-0.003	(0.003)	-0.003	(0.006)
Obesity		0.003	(0.004)	-0.003	(0.004)
Hospital Characteristics		*y*		*y*	
Drop 4/1/15-10/1/15		*y*		*n*	
Drop 4/1/15-7/1/15		*n*		y	
Period: -24 to 24 months		*y*		*n*	
Period: -33 to 30 months		*n*		*y*	

Notes. *** indicates significant at the 1% level; ** 5% level; * 10% level. Robust standard errors are in parenthesis. MJRL=major joint replacement of the lower extremity; PSI total=PSI 03 + PSI 08+PSI13; PSI 03 is pressure ulcer; PSI 08 is in hospital fall with hip fracture; PSI 13 is postoperative sepsis; COPD = chronic obstructive pulmonary disease.

Data Source. State Inpatient Database of Nevada, 2013-2017

Table 14. Difference-in-Differences Estimates for Length of In-Hospital Stay

		MJRL		Sepsis	
Sample Size		7,093		17,356	
Dependent Variable					
LOS	Treat × Post	-0.069		-0.500**	
		(0.127)		(0.254)	
	P [Days x Treat ≠0|Post = 0]	0.362		0.489	
Hospital FE		*y*		*y*	
Time FE		*y*		*y*	
Patient Demographics		*y*		*y*	
Age					
< 64		0.013	(0.093)	-0.104	(0.135)
75–84		0.400***	(0.069)	-0.178	(0.113)
85 +		1.217***	(0.122)	-0.708***	(0.124)
Sex					
Male		-0.089	(0.063)	0.131	(0.089)
Race					
Black		0.065	(0.151)	0.238	(0.165)
Hispanic		-0.091	(0.133)	-0.264	(0.184)
Asian		0.035	(0.174)	-0.029	(0.197)
Others		0.017	(0.172)	0.147	(0.190)
Comorbidities					
Diabetes		0.166*	(0.082)	-0.346***	(0.105)
Diabetes w/ complications		0.745***	(0.225)	0.369**	(0.136)
Hypertension		-0.051	(0.060)	-0.762***	(0.091)
Congestive Heart Failures		2.192***	(0.392)	1.38***	(0.136)
COPD		0.454***	(0.113)	0.522***	(0.115)
Depression		0.1094	(0.122)	0.122	(0.139)
Obesity		0.082	(0.114)	0.684***	(0.183)
Hospital Characteristics		*y*		*y*	
Drop 4/1/15-10/1/15		*y*		*n*	
Drop 4/1/15-7/1/15		*n*		y	
Period: -24 to 24 months		*y*		*n*	
Period: -33 to 30 months		*n*		*y*	

Notes. *** indicates significant at the 1% level; ** 5% level; * 10% level. Robust standard errors are in parenthesis. MJRL=major joint replacement of the lower extremity; LOS=length of in-hospital stays; COPD = chronic obstructive pulmonary disease.
Data Source. State Inpatient Database of Nevada, 2013-2017

Table 15. Difference-in-Differences Estimates for Total Charge

		MJRL		Sepsis	
Sample Size		7,093		17,356	
Dependent Variable					
Total Charge	Treat × Post	-2887.61		- 13092.85**	
		(1972.02)		(5021.22)	
	P [Days x Treat ≠0|Post = 0]	0.585		0.993	
Hospital FE		*y*		*y*	
Time FE		*y*		*y*	
Patient Demographics		*y*		*y*	
Age					
< 64		3134.12*	(1896.07)	-3084.80	(2677.82)
75–84		3123.28**	(1024.88)	-8351.23***	(2195.37)
85 +		7843.35***	(1713.77)	-23113.64***	(2387.60)
Sex					
Male		299.15	(947.75)	5343.05**	(1727.77)
Race					
Black		1877.45	(2917.48)	846.24	(3227.10)
Hispanic		-3598.70**	(1793.47)	-6361.94*	(3634.55)
Asian		2051.88	(3072.79)	4608.65	(4332.45)
Others		1889.66	(3166.11)	4660.65	(3638.59)
Comorbidities					
Diabetes		3820.19**	(1353.15)	-4464.81**	(2089.54)
Diabetes w/ complications		17555.36***	(3967.01)	7588.59**	(2677.41)
Hypertension		-1184.22	(972.74)	-18618.23***	(1710.81)
Congestive Heart Failures		31178.89***	(6646.95)	33004.5***	(2699.14)
COPD		8716.89***	(1952.72)	14200.77***	(2205.23)
Depression		724.34	(1540.4 8)	-4036.24	(2486.09)
Obesity		5852.57 **	(2648.76)	18697.04***	(3990.87)
Hospital Characteristics		*y*		*y*	
Drop 4/1/15-10/1/15		*y*		*n*	
Drop 4/1/15-7/1/15		*n*		y	
Period: -24 to 24 months		*y*		*n*	
Period: -33 to 30 months		*n*		*y*	

Notes. *** indicates significant at the 1% level; ** 5% level; * 10% level. Robust standard errors are in parenthesis.; COPD = chronic obstructive pulmonary disease; Total charge is weighted using the inpatient hospital inflation rate. *Data Source.* State Inpatient Database of Nevada, 2013-2017.

Table 16. Difference-in-Differences Estimates for Average Charge

		MJRL		Sepsis	
Sample Size		7,093		17,356	
Dependent Variable					
Average Charge	Treat × Post	-471.40		-64.83	
		(877.91)		(484.72)	
	P [Days x Treat ≠0|Post = 0]	0.205		0.160	
Hospital FE		*y*		*y*	
Time FE		*y*		*y*	
Patient Demographics		*y*		*y*	
Age					
< 64		-237.97	(792.73)	-437.92	(0.135)
75–84		-3473.12***	(461.53)	-780.87***	(0.113)
85 +		-8434.26***	(637.80)	-1474.4***	(0.124)
Sex					
Male		2997.15***	(416.34)	712.31***	(0.089)
Race					
Black		-1877.65**	(807.40)	-477.46	(0.165)
Hispanic		-1717.79**	(806.23)	-168.24	(0.184)
Asian		486.49	(1523.89)	-419.51	(0.197)
Others		35.36	(949.35)	723.11*	(0.190)
Comorbidities					
Diabetes		-588.70	(536.27)	140.09	(0.105)
Diabetes w/ complications		-2689.33**	(1256.66)	-44.13	(0.136)
Hypertension		-41.79	(418.73)	-1061.4***	(0.091)
Congestive Heart Failures		-7056.49***	(141.65)	764.51***	(0.136)
COPD		-2179.38***	(654.37)	571.78**	(0.115)
Depression		-370.90	(650.23)	-1029.5***	(0.139)
Obesity		-1037.59	(775.16)	-210.19	(0.183)
Hospital Characteristics		*y*		*y*	
Drop 4/1/15-10/1/15		*y*		*n*	
Drop 4/1/15-7/1/15		*n*		y	
Period: -24 to 24 months		*y*		*n*	
Period: -33 to 30 months		*n*		*y*	

Notes. *** indicates significant at the 1% level; ** 5% level; * 10% level. Robust standard errors are in parenthesis. COPD = chronic obstructive pulmonary disease. Average charge is weighted using the inpatient hospital inflation rate. *Data Source*. State Inpatient Database of Nevada, 2013-2017.

Table 17. Summary of Results

	MJRL		Sepsis	
	DiD Coefficient	Findings	DiD Coefficient	Findings
Home	-	No findings	0.042**	25% increase
Mortality	0.001	Insignificant	-0.053***	21.4% decrease
Complication	0.002	Insignificant	-0.036**	12% decrease in pressure ulcer
LOS	-0.069	Insignificant	-0.500**	6.8% decrease
Total Charge	-2887.61	Insignificant	-13092.85**	9.2% reduction
Average Charge	-471.40	Insignificant	-64.83	Insignificant

Notes. *** indicates significant at the 1% level; ** 5% level; * 10% level. MJRL= Major Joint Replacement of the Lower Extremity; DiD=difference-in-differences; LOS = length of in-hospital stays; Total charge is weighted using the inpatient hospital inflation rate.

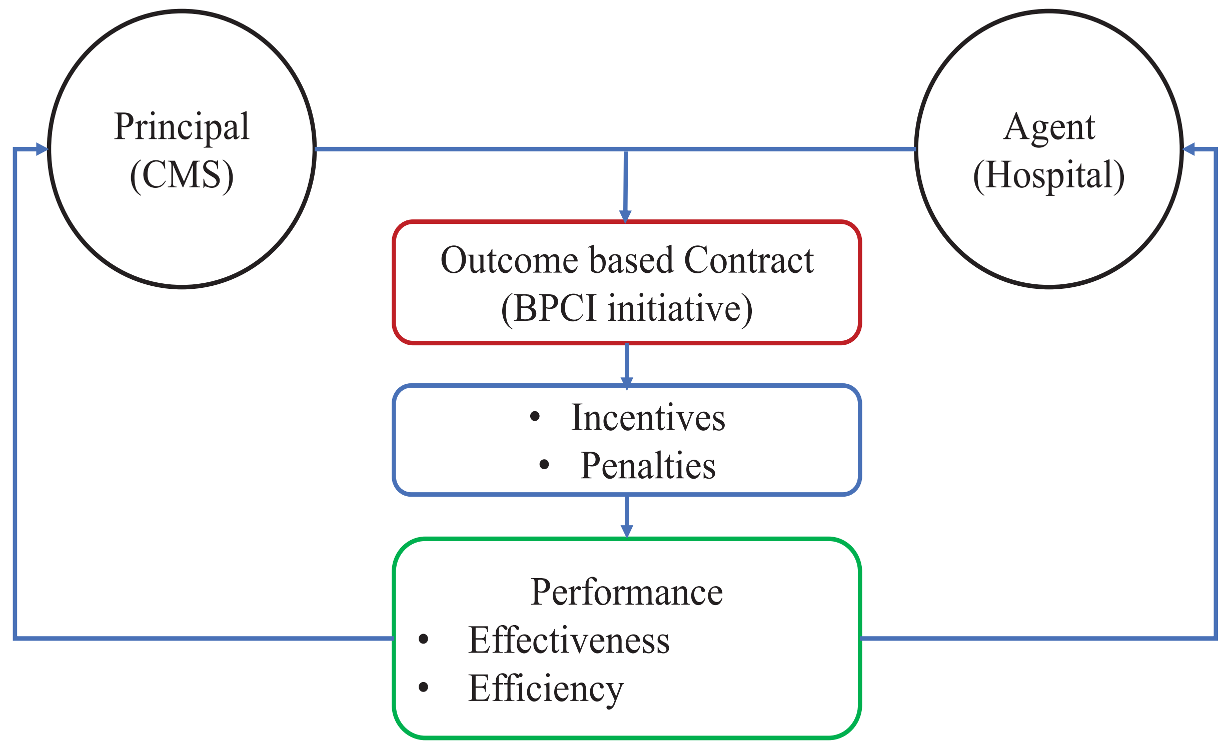
Table 18. Summary of Hypotheses

Hypothesis		Findings
Research Question One. Does the BPCI initiative show positive effects on the effectiveness of hospital performance for MJRL and sepsis?		
Hypothesis 1. BPCI initiative-participating hospitals are more likely to improve the effectiveness of hospital performance than non-participating hospitals.		
H1a. BPCI initiative-participating hospitals are more likely to improve the effectiveness of surgical care than non-participating hospitals.		No
H1a1a.	Patients with MJRL in BPCI initiative participating hospitals are more likely to be discharged to home than their counterparts in non-participating hospitals.	No findings
H1a1b.	Patients with MJRL in BPCI initiative participating hospitals are more likely to be discharged to HHS than their counterparts in non-participating hospitals.	+
H1a1c.	Patients with MJRL in BPCI initiative-participating hospitals are less likely to be discharged to SNF than their counterparts in non-participating hospitals.	-
H1a2.	Patients with MJRL in BPCI initiative participating hospitals are less likely to die in hospital than their counterparts in non-participating hospitals.	NS
H1a3.	Patients with MJRL in BPCI initiative participating hospitals are less likely to have complications than their counterparts in non-participating hospitals.	NS
H1b. BPCI initiative-participating hospitals are more likely to improve the effectiveness of medical care than non-participating hospitals.		Yes
H1b1a.	Patients with sepsis in BPCI initiative participating hospitals are more likely to be discharged to home than their counterparts in non-participating hospitals.	+
H1b1b.	Patients with sepsis in BPCI initiative participating hospitals are more likely to be discharged to HHS than their counterparts in non-participating hospitals.	NS
H1b1c.	Patients with sepsis in BPCI initiative participating hospitals are less likely to be discharged to SNF than their counterparts in non-participating hospitals.	-
H1b2.	Patients with sepsis in BPCI initiative participating hospitals are less likely to die in hospital than their counterparts in non-participating hospitals.	+
H1b3.	Patients with sepsis in BPCI initiative participating hospitals are less likely to have complications than their counterparts in non-participating hospitals.	+
Research Question Two. Does the BPCI initiative show positive effects on the efficiency of hospital performance for MJRL and sepsis?		
Hypothesis 2. BPCI initiative-participating hospitals are more likely to improve the efficiency of hospital performance than non-participating hospitals.		

H2a. BPCI initiative-participating hospitals are more likely to improve the efficiency of surgical care than non-participating hospitals.	No
H2a4. Patients with MJRL in BPCI initiative participating hospitals are more likely to have shorter LOS than their counterparts in non-participating hospitals.	NS
H2a5. Patients with MJRL in BPCI initiative participating hospitals are more likely to have lower total charges than their counterparts in non-participating hospitals	NS
H2a6. Patients with MJRL in BPCI initiative participating hospitals are more likely to have lower average charges than their counterparts in non-participating hospitals.	NS
H2b. BPCI initiative-participating hospitals are more likely to improve the efficiency of medical care than non-participating hospitals.	Yes
H2b4. Patients with sepsis in BPCI initiative participating hospitals are more likely to have shorter LOS than their counterparts in non-participating hospitals.	+
H2b5. Patients with sepsis in BPCI initiative participating hospitals are more likely to have lower total charges than their counterparts in non-participating hospital	+
H2b6. Patients with sepsis in BPCI initiative participating hospitals are more likely to have lower average charges than their counterparts in non-participating hospitals	NS

Notes. NS=not significant; + indicates significantly positive; - indicates significantly negative

Figure 1. Conceptual Framework



<u>Overarching Hypothesis.</u> An agent (hospital) that has an outcome-based contract (BPCI initiative) with the principal (CMS) is more likely to behave in interests of the principal by improving its performance (effectiveness and efficiency).

Figure 2. BPCI Initiative Model 2

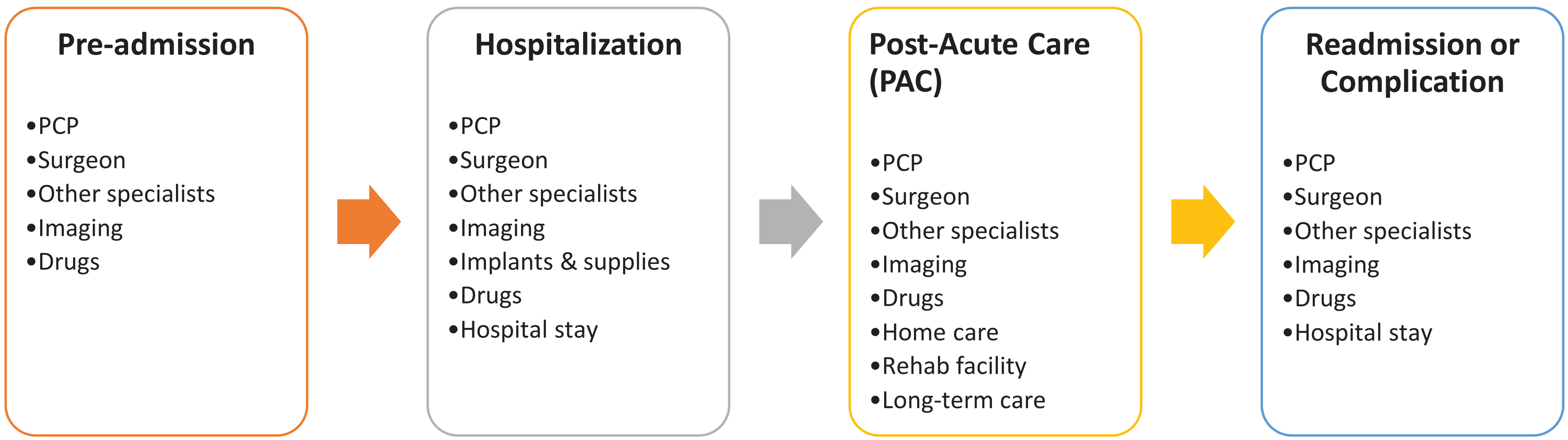


Figure 3. Principal-Agent Relationship in Agency Theory

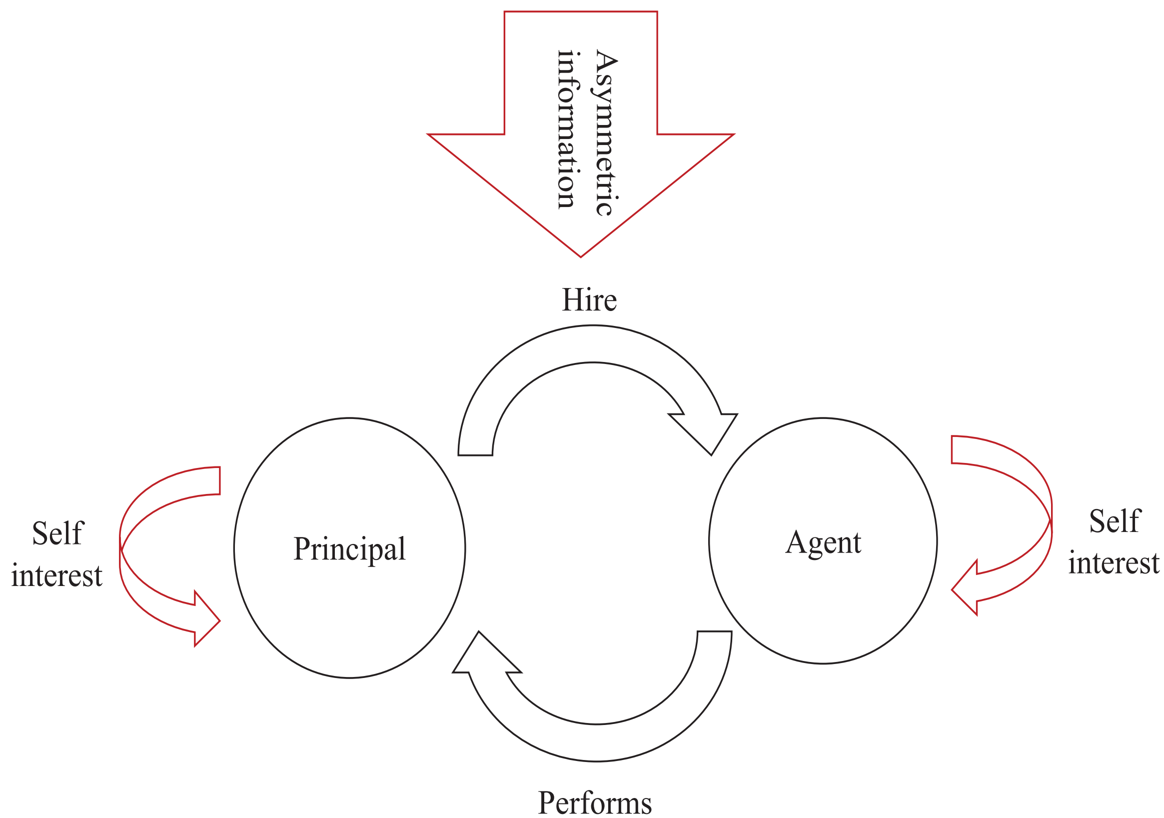
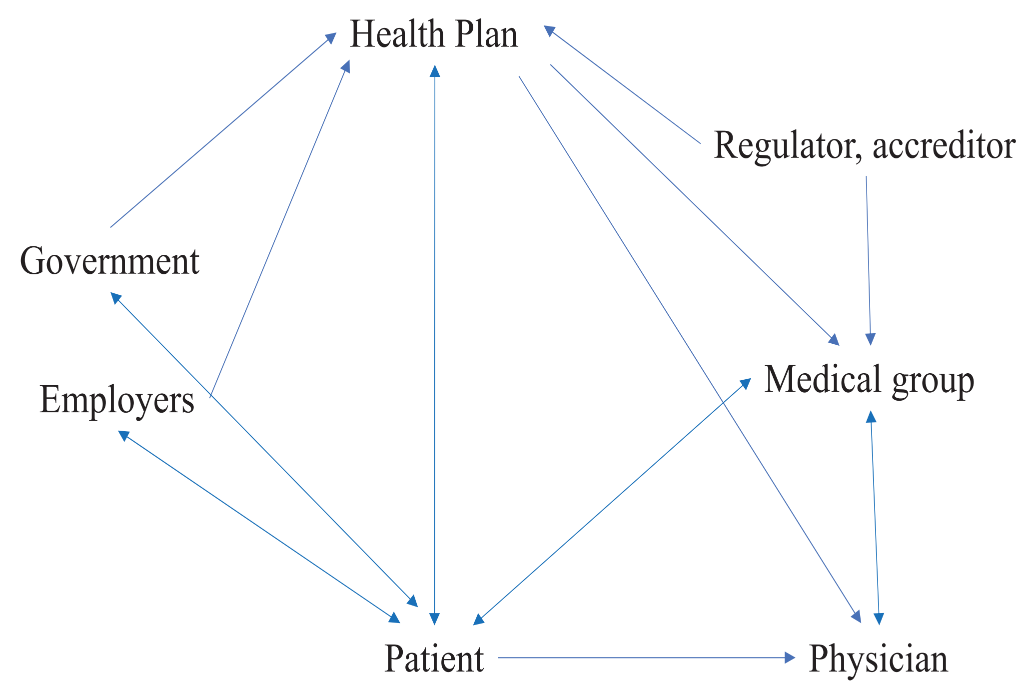
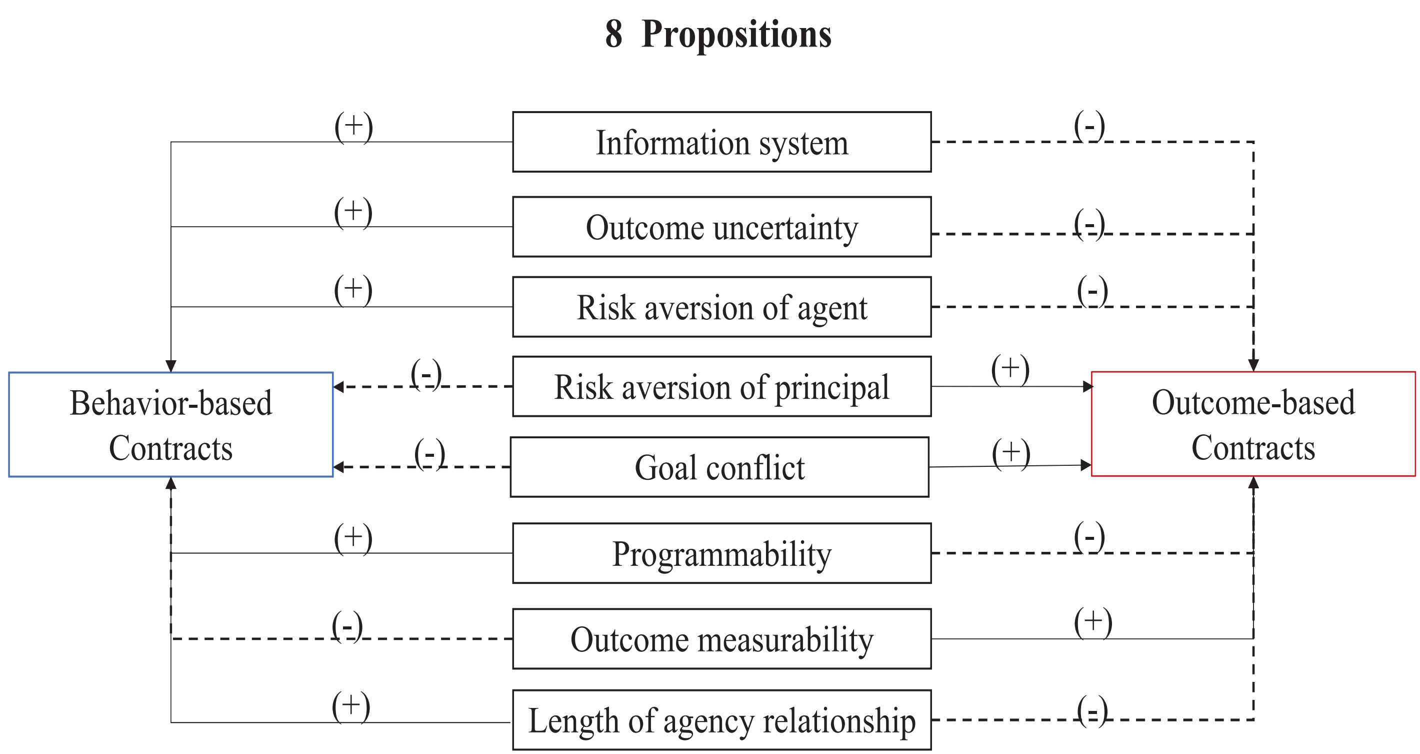


Figure 4. Traditional Principal-Agent Relationships in U.S. Medical Care



(Casalino, 2001)

Figure 5. Determining Behavior or Outcome-based Contracts based on Principal-Agency Theory

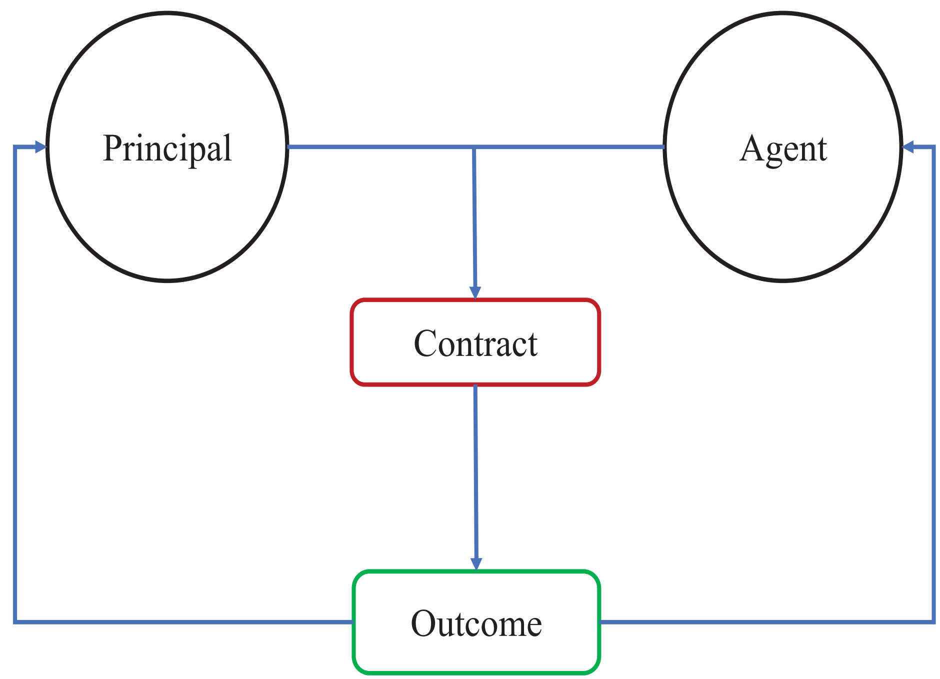


Notes: (+) indicates positively related; (-) indicates negatively related (Eisenhardt, 1989)

Figure 6. Principal-Agent and Outcome Based Contract in Agency Theory

Proposition 1. When the contract between the principal and agent is outcome based, the agent is more likely to behave in the interests of the principal.

Proposition 2. When the principal has information to verify agent behavior, the agent is more likely to behave in interests of the principal.



Eisenhardt (1989)

Figure 7. Conceptual Framework of BPCI Initiative and Hospital Performance

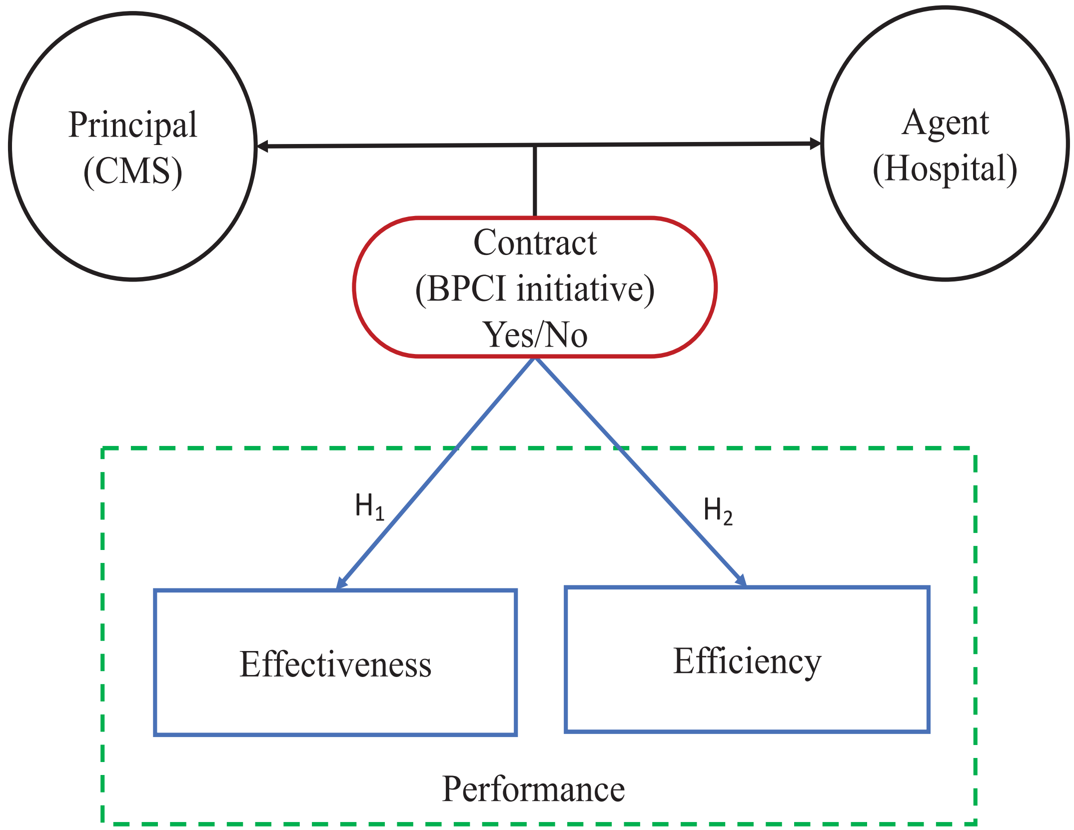


Figure 8. Conceptual Framework of BPCI Initiative and Hospital Performance for Surgical and Medical Care

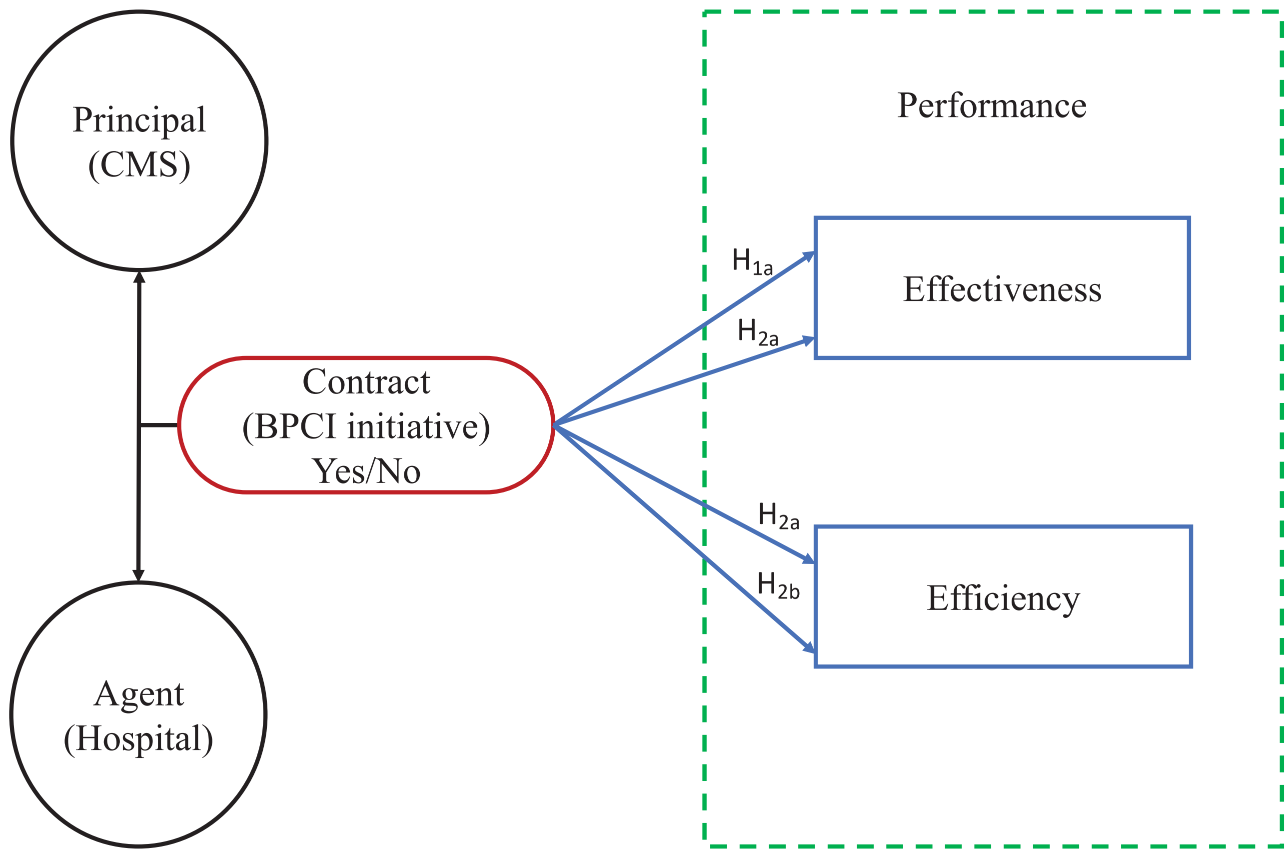


Figure 9. Sample Selection

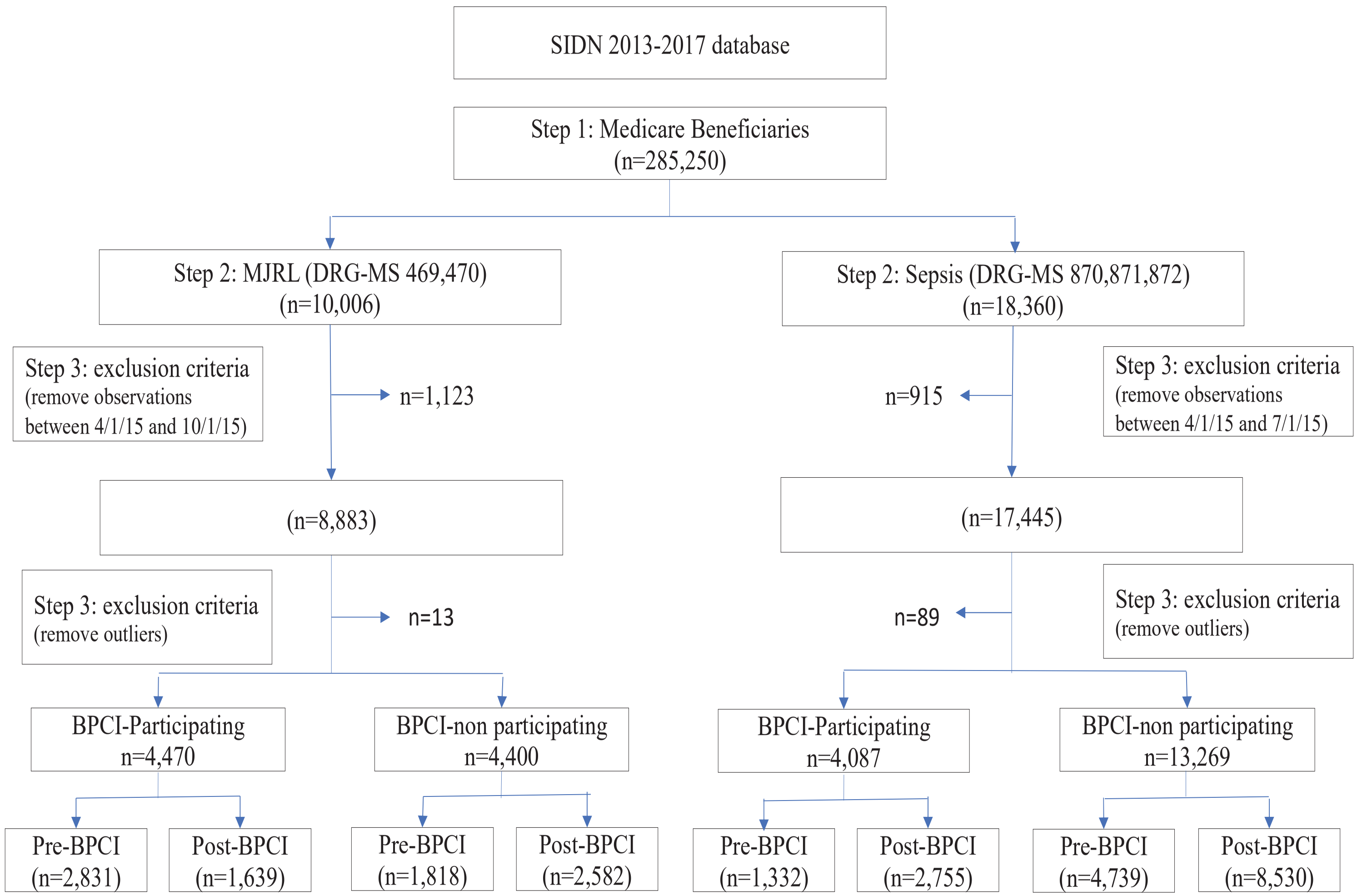


Figure 10A. Conceptual Illustration of a Difference-in-Differences Analysis: No Association

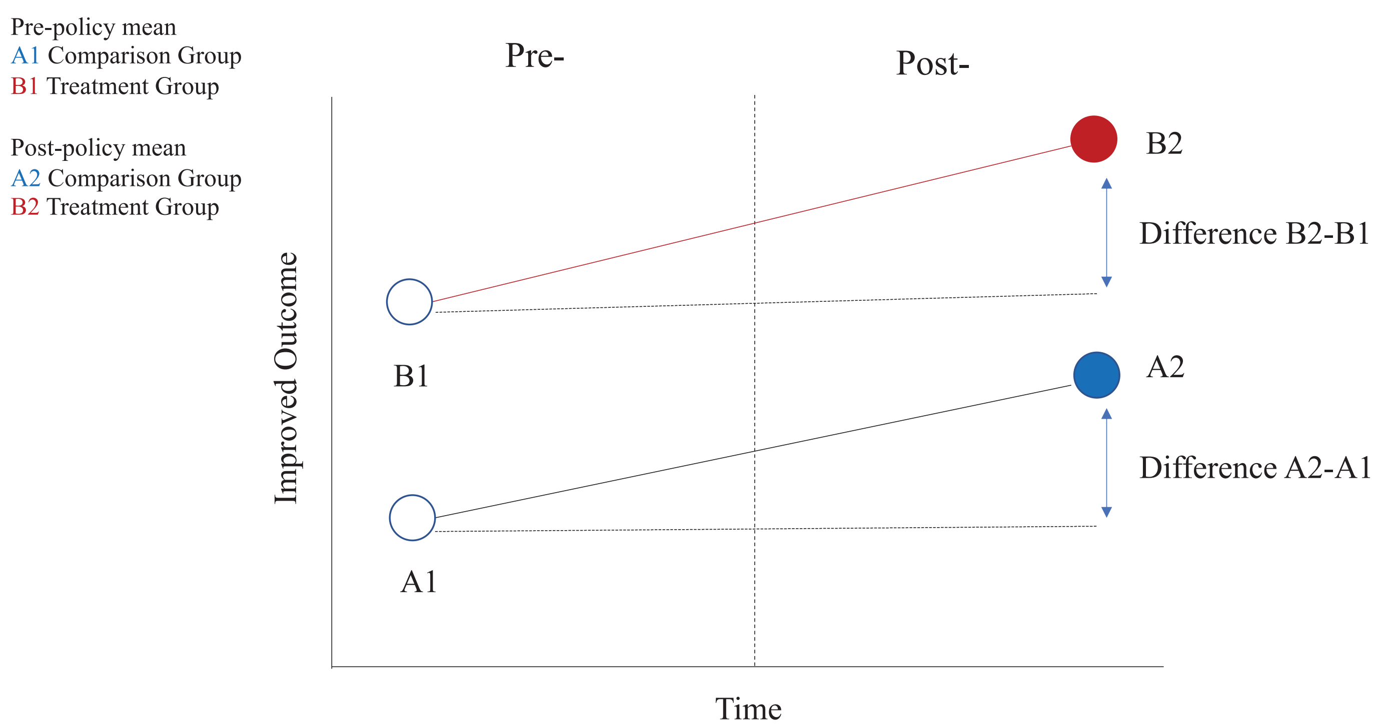


Figure 10B. Conceptual Illustration of a Difference-in-Differences Analysis

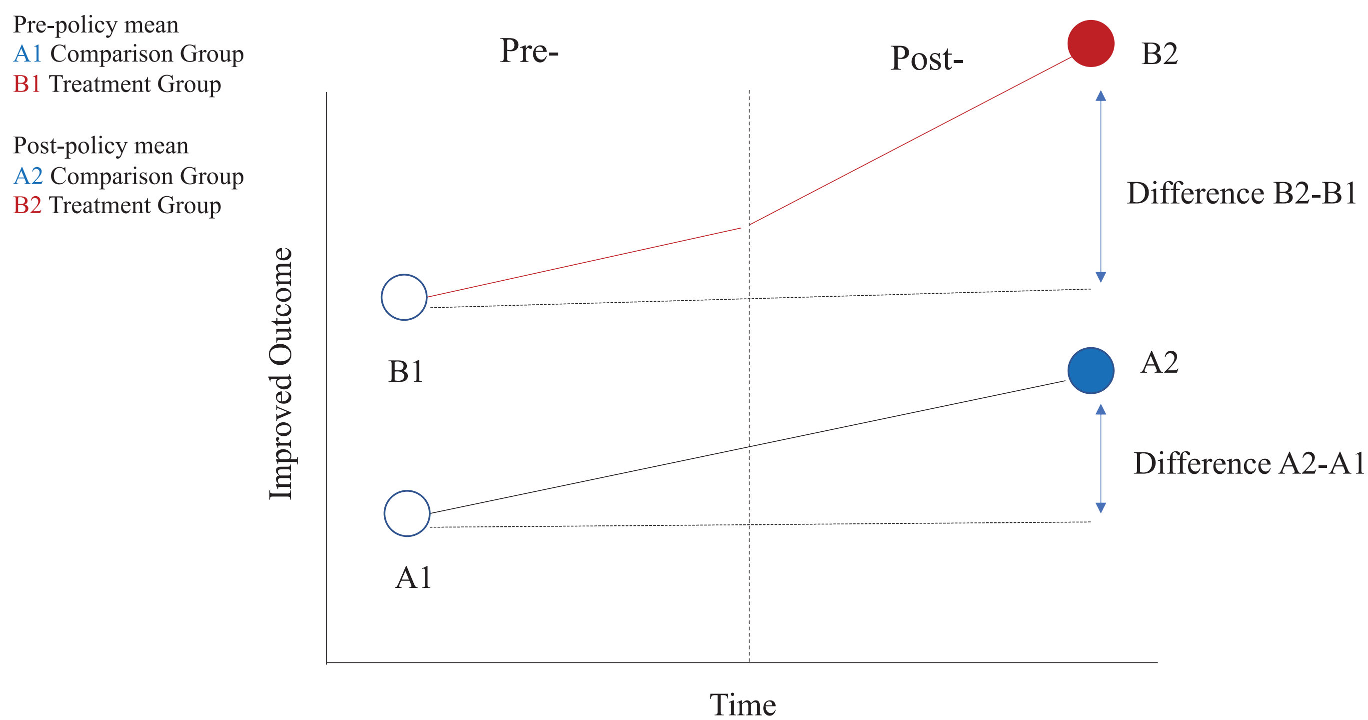


Figure 11. General Operationalized Conceptual Framework of Agency Theory

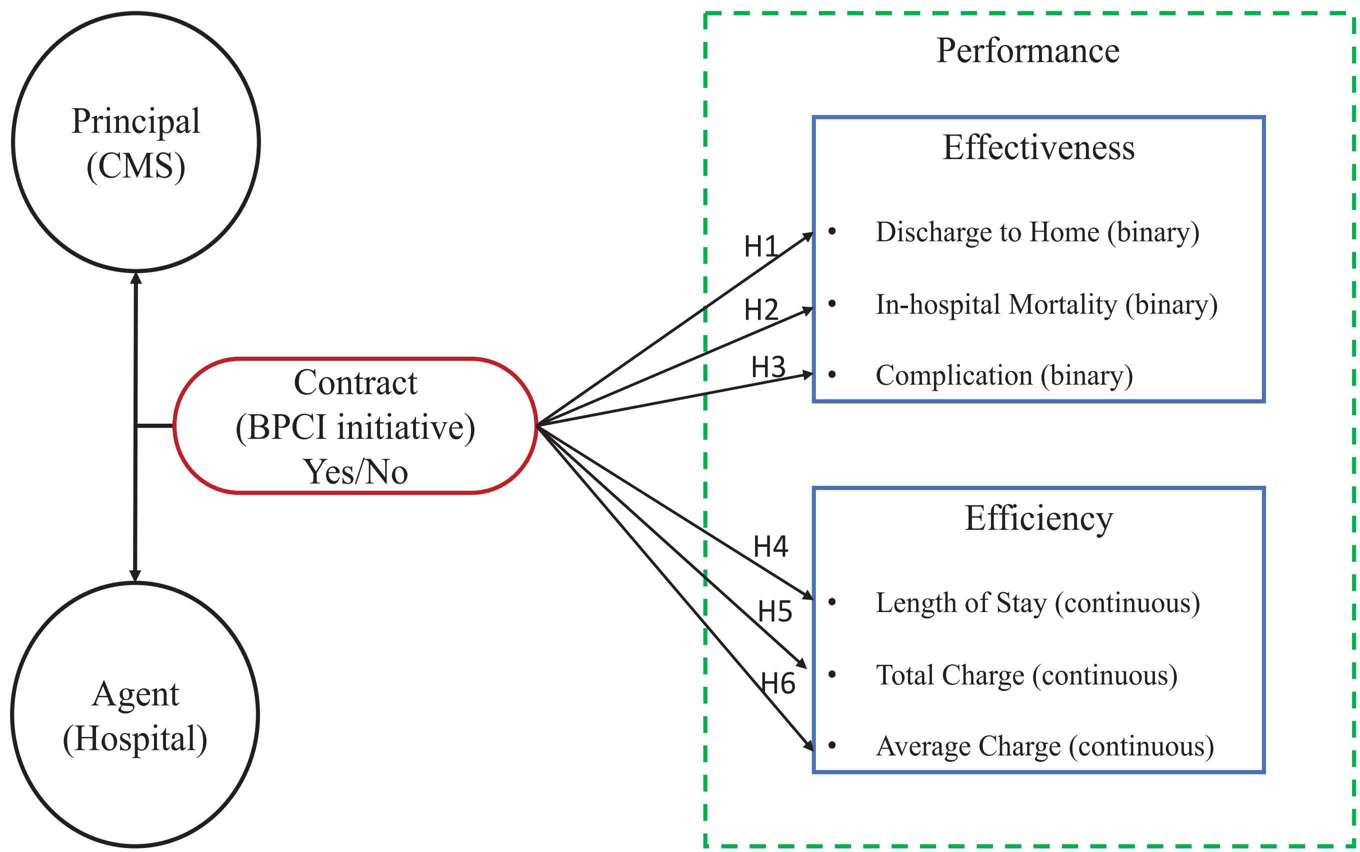


Figure 12. Operationalized Conceptual Framework of the Study

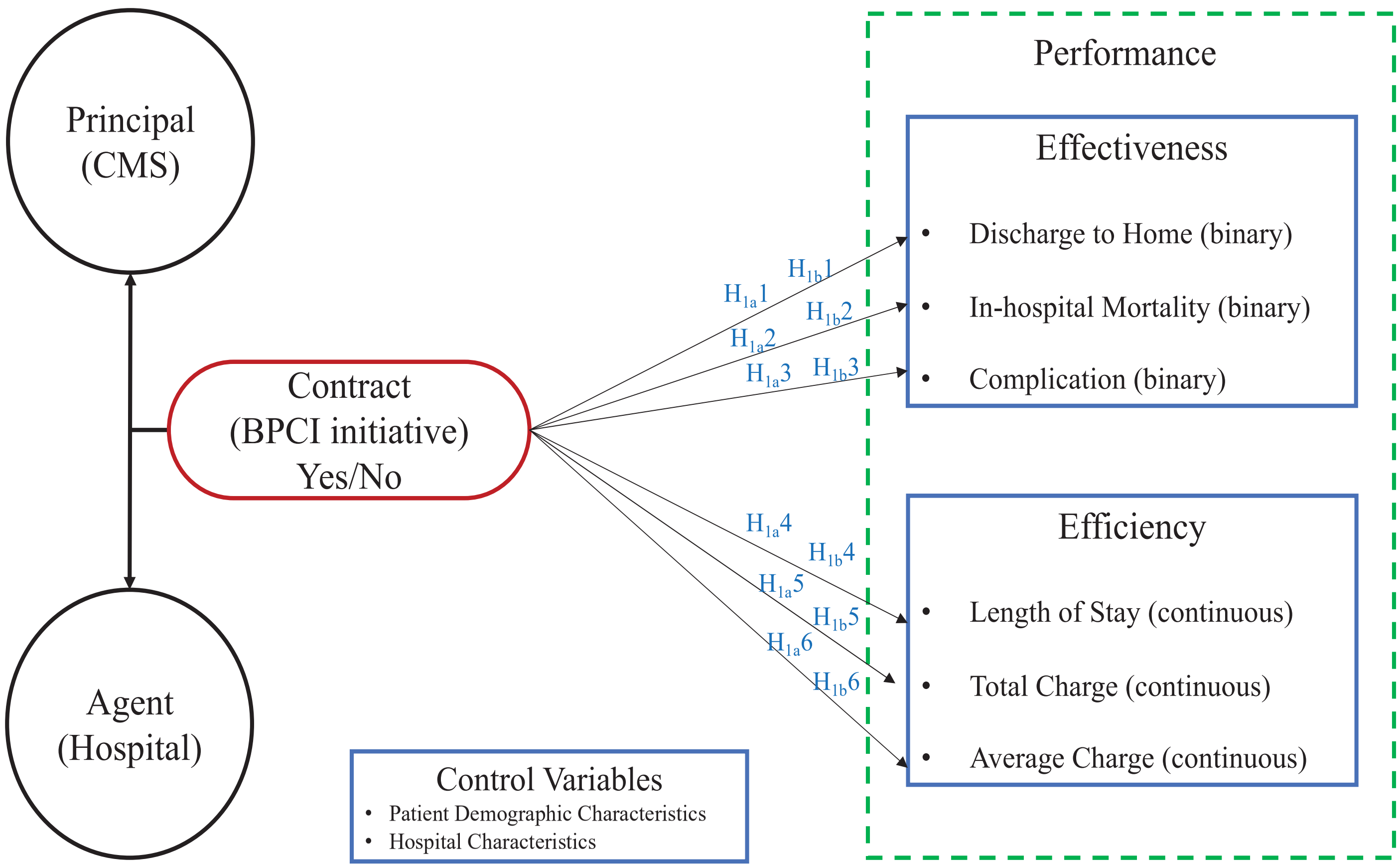


Figure 13. Changes in Hospital Behavior/Performance in Responding to the BPCI Initiative

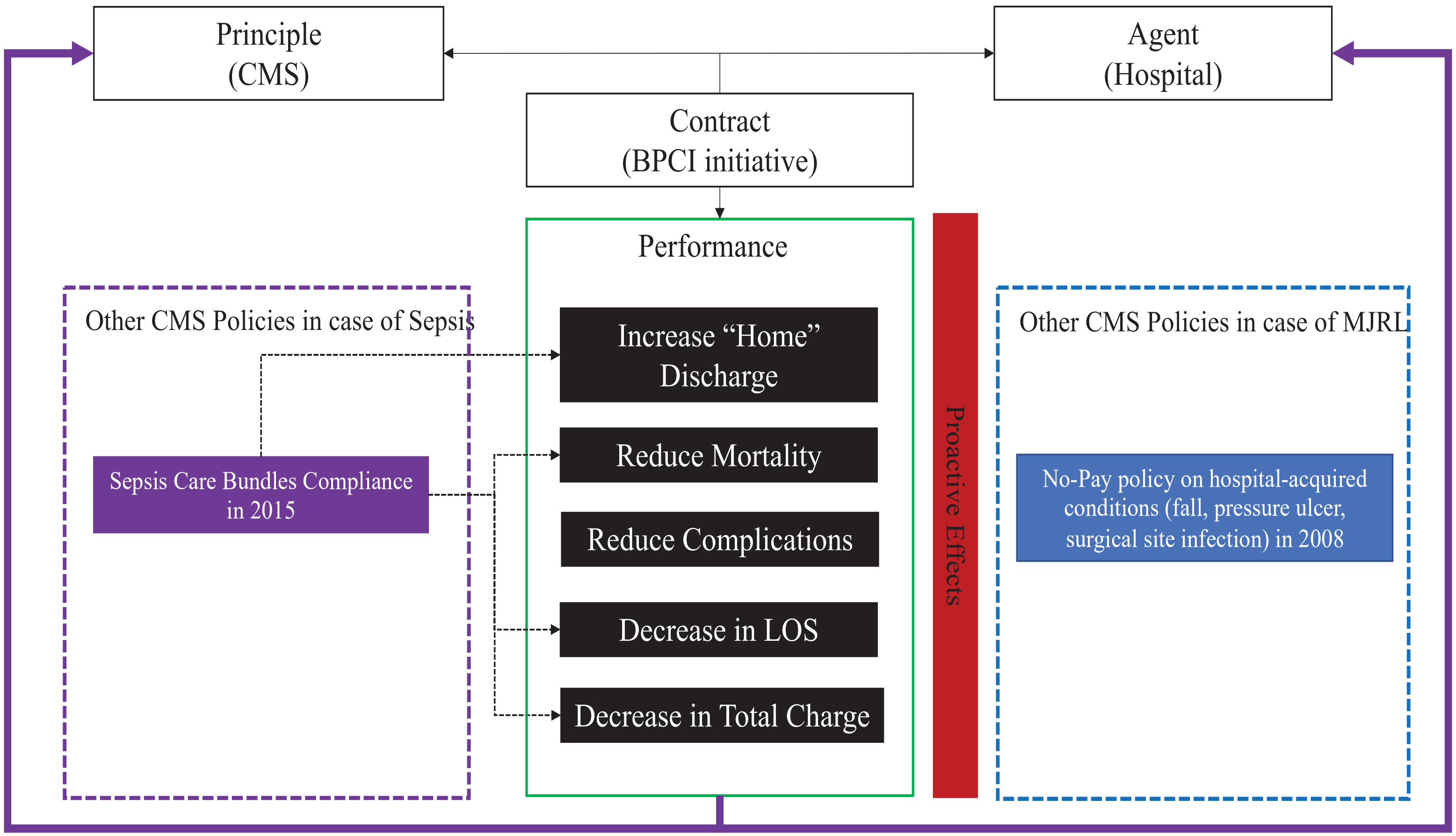
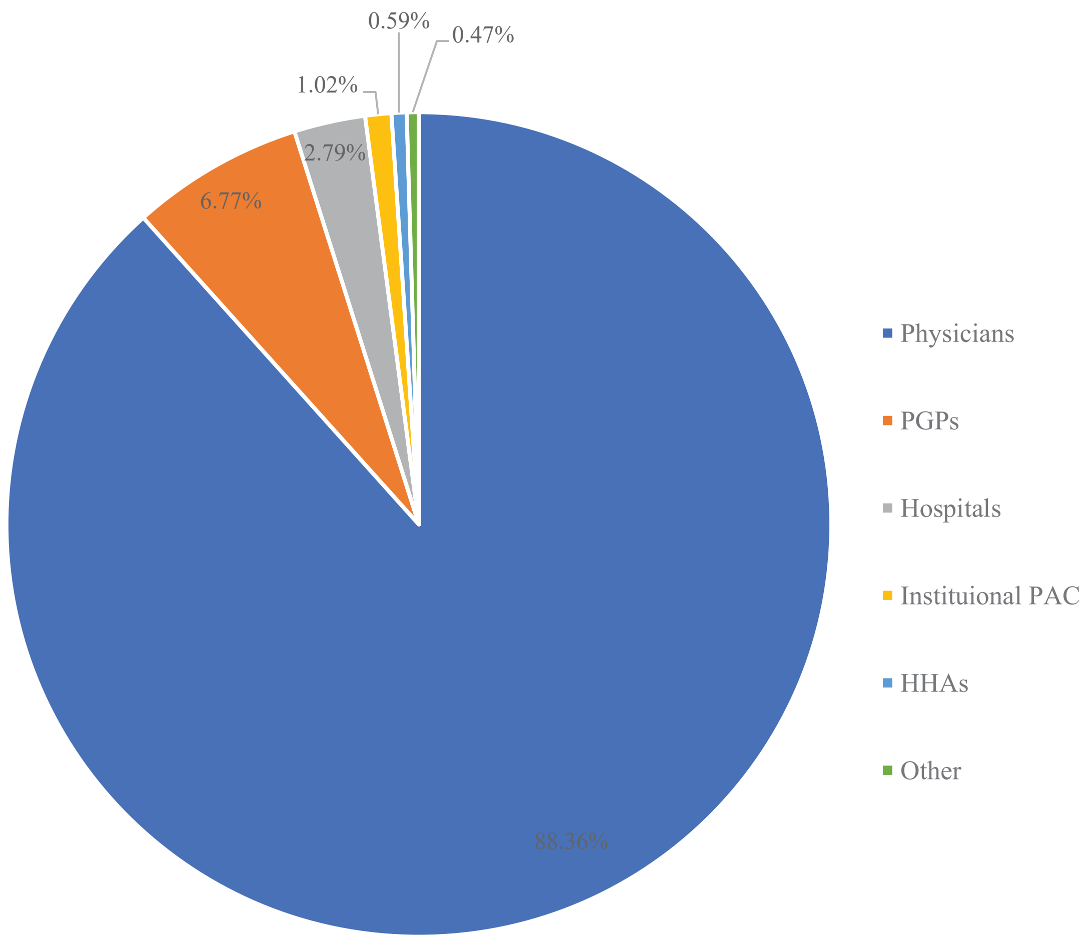


Figure 14. Gainsharing Distributions Received by Partner Type, Model 2, Q4 2013-Q2 2017



Note: PGP=physician group practice. PAC=post-acute care. HHA=home health agency

Resource: Lewin Group (2018)

Appendix A. Bundled Payments for Care Improvement List of Clinical Episodes for All Models

Episode Name	Anchor MS-DRG	MS-DRG Title
Major joint upper extremity	483	Major joint/limb reattachment procedure of upper extremities
Amputation	239	Amputation for circulation system disorders except upper limb and toe with major complications or comorbidities
	240	Amputation for circulation system disorders except upper limb and toe with complications or comorbidities
	241	Amputation for circulation system disorders except upper limb and toe without complications or comorbidities and major complications or comorbidities
	255	Upper limb and toe amputation for circulation system disorders with major complications or comorbidities
	256	Upper limb and toe amputation for circulation system disorders with complications or comorbidities
	257	Upper limb and toe amputation for circulation system disorders without complications or comorbidities and major complications or comorbidities
	474	Amputation for musculoskeletal system and connective tissue disease with major complications or comorbidities
	475	Amputation for musculoskeletal system and connective tissue disease with complications or comorbidities
	476	Amputation for musculoskeletal system and connective tissue disease without complications or comorbidities and major complications or comorbidities
	616	Amputation of lower limb for endocrine, nutrition, and metabolic disease with major complications or comorbidities
	617	Amputation of lower limb for endocrine, nutrition, and metabolic disease with complications or comorbidities
	618	Amputation of lower limb for endocrine, nutrition, and metabolic disease without complications or comorbidities and major complications or comorbidities
Urinary tract infection	689	Kidney and urinary tract infections with major complications or comorbidities
	690	Kidney and urinary tract infections without major complications or comorbidities
Stroke	61	Acute ischemic stroke with use of thrombolytic agent with major complications or comorbidities
	62	Acute ischemic stroke with use of thrombolytic agent with complications or comorbidities
	63	Acute ischemic stroke with use of thrombolytic agent without complications or comorbidities and major complications or comorbidities
	64	Intracranial hemorrhage or cerebral infarction with major complications or comorbidities
	65	Intracranial hemorrhage or cerebral infarction with complications or comorbidities or tPA in 24 hours

	66	Intracranial hemorrhage or cerebral infarction without complications or comorbidities and major complications or comorbidities
Chronic obstructive pulmonary disease, bronchitis/asthma	190	Chronic obstructive pulmonary disease with major complications or comorbidities
	191	Chronic obstructive pulmonary disease with complications or comorbidities
	192	Chronic obstructive pulmonary disease without complications or comorbidities and major complications or comorbidities
	202	Bronchitis and asthma with complications or comorbidities and major complications or comorbidities
	203	Bronchitis and asthma without complications or comorbidities and major complications or comorbidities
Coronary artery bypass graft surgery	231	Coronary bypass with Percutaneous Transluminal Coronary Angioplasty (balloon) with major complications or comorbidities
	232	Coronary bypass with Percutaneous Transluminal Coronary Angioplasty (balloon) without major complications or comorbidities
	233	Coronary bypass with cardiac catheter with major complications or comorbidities
	234	Coronary bypass with cardiac catheter without major complications or comorbidities
	235	Coronary bypass without cardiac catheter with major complications or comorbidities
	236	Coronary bypass without cardiac catheter without major complications or comorbidities
Major joint replacement of the lower extremity	469	Major joint replacement or reattachment of lower extremity with major complications or comorbidities
	470	Major joint replacement or reattachment of lower extremity without major complications or comorbidities
Percutaneous coronary intervention	246	Percutaneous cardiovascular procedure with drug-eluting stent with major complications or comorbidities
	247	Percutaneous cardiovascular procedure with drug-eluting stent without major complications or comorbidities
	248	Percutaneous cardiovascular procedure with non-drug-eluting stent with major complications or comorbidities
	249	Percutaneous cardiovascular procedure with non-drug-eluting stent without major complications or comorbidities
	250	Percutaneous cardiovascular procedure without coronary artery stent or Acute myocardial infarction with major complications or comorbidities
	251	Percutaneous cardiovascular procedure without coronary artery stent or Acute myocardial infarction without major complications or comorbidities
Pacemaker	242	Permanent cardiac pacemaker implant with major complications or comorbidities
	243	Permanent cardiac pacemaker implant with complications or comorbidities
	244	Permanent cardiac pacemaker implant without complications or comorbidities and major complications or comorbidities
Cardiac	222	Cardiac defibrillator implant with cardiac catheter with Acute

defibrillator		myocardial infarction/heart failure/shock with major complications or comorbidities
	223	Cardiac defibrillator implant with cardiac catheter with Acute myocardial infarction/heart failure/shock without major complications or comorbidities
	224	Cardiac defibrillator implant with cardiac catheter without Acute myocardial infarction/heart failure/shock with major complications or comorbidities
	225	Cardiac defibrillator implant with cardiac catheter without Acute myocardial infarction/heart failure/shock without major complications or comorbidities
	226	Cardiac defibrillator implant without cardiac catheter with major complications or comorbidities
	227	Cardiac defibrillator implant without cardiac catheter without major complications or comorbidities
Pacemaker Device replacement or revision	258	Cardiac pacemaker device replacement with major complications or comorbidities
	259	Cardiac pacemaker device replacement without major complications or comorbidities
	260	Cardiac pacemaker revision except device replacement with major complications or comorbidities
	261	Cardiac pacemaker revision except device replacement with cardiac catheterization
	262	Cardiac pacemaker revision except device replacement without complications or comorbidities and major complications or comorbidities
Automatic implantable cardiac defibrillator generator or lead	245	Automatic implantable cardiac defibrillator lead and generator procedures
	265	Automatic implantable cardiac defibrillator lead procedures
Congestive heart failure	291	Heart failure and shock with major complications or comorbidities
	292	Heart failure and shock with cardiac catheterization
	293	Heart failure and shock without complications or comorbidities and major complications or comorbidities
Acute myocardial infarction	280	Acute myocardial infarction, disease/discharged alive with major complications or comorbidities
	281	Acute myocardial infarction, disease/discharged alive with complications or comorbidities
	282	Acute myocardial infarction, disease/discharged alive without complications or comorbidities and major complications or comorbidities
Cardiac arrhythmia	308	Cardiac arrhythmia and conduction disorders with major complications or comorbidities
	309	Cardiac arrhythmia and conduction disorders with complications or comorbidities
	310	Cardiac arrhythmia and conduction disorders without complications or comorbidities and major complications or comorbidities
Cardiac valve	216	Cardiac valve and other major cardiothoracic procedure with card catheter with major complications or comorbidities

	217	Cardiac valve and other major cardiothoracic procedure with cardio catheter with complications or comorbidities
	218	Cardiac valve and other major cardiothoracic procedure with card catheter without complications or comorbidities and major complications or comorbidities
	219	Cardiac valve and other major cardiothoracic procedure without card catheter with major complications or comorbidities
	220	Cardiac valve and other major cardiothoracic procedure without card catheter with complications or comorbidities
	221	Cardiac valve and other major cardiothoracic procedure without card catheter without complications or comorbidities and major complications or comorbidities
	266	Endovascular Cardiac Valve Replacement with major complications or comorbidities
	267	Endovascular Cardiac Valve Replacement without major complications or comorbidities
Other vascular surgery	252	Other vascular procedures with major complications or comorbidities
	253	Other vascular procedures with complications or comorbidities
	254	Other vascular procedures without complications or comorbidities and major complications or comorbidities
Major cardiovascular procedure	237	Major cardiovascular procedures with major complications or comorbidities
	238	Major cardiovascular procedures without major complications or comorbidities
Gastrointestinal hemorrhage	377	Gastrointestinal hemorrhage with major complications or comorbidities
	378	Gastrointestinal hemorrhage with complications or comorbidities
	379	Gastrointestinal hemorrhage without complications or comorbidities and major complications or comorbidities
Major bowel	329	Major small and large bowel procedures with major complications or comorbidities
	330	Major small and large bowel procedures with major complications or comorbidities
	331	Major small and large bowel procedures without complications or comorbidities and major complications or comorbidities
Fractures femur and hip/pelvis	533	Fractures of femur with major complications or comorbidities
	534	Fractures of femur without major complications or comorbidities
	535	Fractures of hip and pelvis with major complications or comorbidities
	536	Fractures of hip and pelvis without major complications or comorbidities
Medical non-infectious orthopedic	537	Sprains, strains, and disease locations of hip, pelvis and thigh with complications or comorbidities and major complications or comorbidities
	538	Sprains, strains, and disease locations of hip, pelvis and thigh without complications or comorbidities and major complications or comorbidities
	551	Medical back problems with major complications or comorbidities
	552	Medical back problems without major complications or comorbidities
	553	Bone diseases and arthropathies with major complications or comorbidities
	554	Bone diseases and arthropathies without major complications or

		comorbidities
	555	Signs and symptoms of musculoskeletal system and connective tissue with major complications or comorbidities
	556	Signs and symptoms of musculoskeletal system and connective tissue without major complications or comorbidities
	557	Tendonitis, myositis and bursitis with major complications or comorbidities
	558	Tendonitis, myositis and bursitis without major complications or comorbidities
	559	Aftercare, musculoskeletal system and connective tissue with major complications or comorbidities
	560	Aftercare, musculoskeletal system and connective tissue with cardiac catheterization
	561	Aftercare, musculoskeletal system and connective tissue without complications or comorbidities and major complications or comorbidities
	562	Fixed area, sprains, strains and disease except femur, hip, pelvis and thigh with major complications or comorbidities
	563	Fixed area, sprains, strains and disease except femur, hip, pelvis and thigh without major complications or comorbidities
Double joint replacement of the lower extremity	461	Bilateral or multiple major joint procedures of lower extremity with major complications or comorbidities
	462	Bilateral or multiple major joint procedures of lower extremity without major complications or comorbidities
Revision of the hip or knee	466	Revision of hip or knee replacement with major complications or comorbidities
	467	Revision of hip or knee replacement with complications or comorbidities
	468	Revision of hip or knee replacement without complications or comorbidities and major complications or comorbidities
Spinal fusion (non-Cervical)	459	Spinal fusion except Cervical with major complications or comorbidities
	460	Spinal fusion except Cervical without major complications or comorbidities
Hip and femur procedures except major joint	480	Hip and femur procedures except major joint with major complications or comorbidities
	481	Hip and femur procedures except major joint with complications or comorbidities
	482	Hip and femur procedures except major joint without complications or comorbidities and major complications or comorbidities
Cervical spinal fusion	471	Cervical spinal fusion with major complications or comorbidities
	472	Cervical spinal fusion with complications or comorbidities
	473	Cervical spinal fusion without complications or comorbidities and major complications or comorbidities
Other knee procedures	485	Knee procedures with primary diagnosis of infection with major complications or comorbidities
	486	Knee procedures with primary diagnosis of infection with complications or comorbidities
	487	Knee procedures with primary diagnosis of infection without

		complications or comorbidities and major complications or comorbidities
	488	Knee procedures without primary diagnosis of infection with complications or comorbidities and major complications or comorbidities
	489	Knee procedures without primary diagnosis of infection without complications or comorbidities and major complications or comorbidities
Complex non-Cervical spinal fusion	456	Spinal fusion except cervical with spinal curve, malignant or 9+ fusions with major complications or comorbidities
	457	Spinal fusion except cervical with spinal curve, malignant or 9+ fusions with complications or comorbidities
	458	Spinal fusion except cervical with spinal curve, malignant or 9+ fusions without complications or comorbidities and major complications or comorbidities
Combined anterior posterior spinal fusion	453	Combined anterior/posterior spinal fusion with major complications or comorbidities
	454	Combined anterior/posterior spinal fusion with complications or comorbidities
	455	Combined anterior/posterior spinal fusion without complications or comorbidities and major complications or comorbidities
Back and neck except spinal fusion	518	Back and neck procedures except spinal fusion with major complications or comorbidities or disc device/neurostimulator
	519	Back and neck procedures except spinal fusion with complications or comorbidities
	520	Back and neck procedures except spinal fusion without complication or comorbidities and major complications or comorbidities
Lower extremity and humerus procedure except hip, foot, femur	492	Lower extreme and humerus procedure except hip, foot, femur with major complications or comorbidities
	493	Lower extreme and humerus procedure except hip, foot, femur with complications or comorbidities
	494	Lower extreme and humerus procedure except hip, foot, femur without complications or comorbidities and major complications or comorbidities
Removal of orthopedic devices	495	Local excision and removal internal fix devices except hip and femur with major complications or comorbidities
	496	Local excision and removal internal fix devices except hip and femur with complications or comorbidities
	497	Local excision and removal internal fix devices except hip and femur without complications or comorbidities and major complications or comorbidities
	498	Local excision and removal internal fix devices of hip and femur with complications or comorbidities and major complications or comorbidities
	499	Local excision and removal internal fix devices of hip and femur without complications or comorbidities and major complications or comorbidities
Sepsis	870	Septicemia with MV 96+ hours
	871	Septicemia without MV 96+ hours with major complications or

		comorbidities
	872	Septicemia without MV 96+ hours without major complications or comorbidities
Diabetes	637	Diabetes with major complications or comorbidities
	638	Diabetes with complications or comorbidities
	639	Diabetes without complications or comorbidities and major complications or comorbidities
Simple pneumonia and respiratory infections	177	Respiratory infections and inflammations with major complications or comorbidities
	178	Respiratory infections and inflammations with complications or comorbidities
	179	Respiratory infections and inflammations without complications or comorbidities and major complications or comorbidities
	193	Simple pneumonia and pleurisy with major complications or comorbidities
	194	Simple pneumonia and pleurisy with complications or comorbidities
	195	Simple pneumonia and pleurisy without complications or comorbidities and major complications or comorbidities
Other respiratory	189	Pulmonary edema and respiratory failure
	204	Respiratory signs and symptoms
	205	Other respiratory system diagnoses with major complications or comorbidities
	206	Other respiratory system diagnoses without major complications or comorbidities
	207	Respiratory system diagnosis with ventilator support 96+ hours
	208	Respiratory system diagnosis with ventilator support <96 hours
	186	Pleural effusion with major complications or comorbidities
	187	Pleural effusion with complications or comorbidities
	188	Pleural effusion without complications or comorbidities and major complications or comorbidities
Chest pain	313	Chest pain
Medical peripheral vascular disorders	299	Peripheral vascular disorders with major complications or comorbidities
	300	Peripheral vascular disorders with complications or comorbidities
	301	Peripheral vascular disorders without complications or comorbidities and major complications or comorbidities
Atherosclerosis	302	Atherosclerosis with major complications or comorbidities
	303	Atherosclerosis without major complications or comorbidities
Gastrointestinal obstruction	388	Gastrointestinal obstruction with major complications or comorbidities
	389	Gastrointestinal obstruction with complications or comorbidities
	390	Gastrointestinal obstruction without complications or comorbidities and major complications or comorbidities
Syncope and collapse	312	Syncope and collapse
Renal failure	682	Renal failure with major complications or comorbidities
	683	Renal failure with complications or comorbidities
	684	Renal failure without complications or comorbidities and major complications or comorbidities

Syncope and collapse	312	Syncope and collapse
Renal failure	682	Renal failure with major complications or comorbidities
	683	Renal failure with complications or comorbidities
	684	Renal failure without complications or comorbidities and major complications or comorbidities
Nutritional and metabolic disorders	640	Nutritional and miscellaneous metabolic disorders with major complications or comorbidities
	641	Nutrition and miscellaneous metabolic disorders without major complications or comorbidities
Cellulitis	602	Cellulitis with major complications or comorbidities
	603	Cellulitis without major complications or comorbidities
Red blood cell disorders	811	Red blood cell disorders with major complications or comorbidities
	812	Red blood cell disorders without major complications or comorbidities
Transient ischemia	69	Transient ischemia
	684	Renal failure without complications or comorbidities and major complications or comorbidities
Esophagitis, gastroenteritis and other digestive disorders	391	Esophagitis, gastroenteritis and miscellaneous digest disorders with major complications or comorbidities
	392	Esophagitis, gastroenteritis and miscellaneous digest disorders without major complications or comorbidities

Source: CMS (2017). *BPCI Initative Episode Analytic File(XLS).* Assessed 8/3/2018 at https://innovation.cms.gov/Files/x/bpcianalyticfile.xlsx.

Appendix B. Glossary of Acronyms Related to this study

Abbreviation	**Meaning**
ACA	Affordable Care Act
ACE	Acute Care Episode
AHRQ	Agency for Healthcare Research and Quality
BPCI	Bundled Payments for Care Improvement
CJR	Comprehensive care for joint replacement
CMS	Centers for Medicare and Medicaid Services
COPD	Chronic Obstructive Pulmonary Disease
DiD	Difference-in-Differences
ED	Emergency Department
EGDT	Early Goal-Directed Therapy
FFS	Fee for Service
HHS	Home Health Service
HRRP	Hospital Readmissions Reduction Program
ICD-9-CM	International Classification of Diseases, Ninth Revision, Clinical Modification
IP Rehab	Inpatient Rehabilitation
LOS	Length of hospital stay
MS-DRG	Medicare Severity-Diagnosis Related Group
NIS	National Inpatient Sample
PAC	Post-Acute Care
PCP	Primary Care Physician
PSI	Patient Safety Indicator
SIDN	State Inpatient Databases of Nevada
SNF	Skilled Nursing Facility
TJA	Total Joint Arthroplasty
THA	Total Hip Arthroplasty
TKA	Total Knee Arthroplasty
MJRL	Major Joint Replacement of the Lower Extremity

Appendix C. ICD-9 and ICD-10 codes for Comorbidities

	ICD-9	ICD-10
Diabetes, uncomplicated	250.0-250.3	E10.0, E10.1, E10.9, E11.0, E11.9, E12.0, E12.1, E12.9, E13.0, E13.1, E13.9, E14.0, E14.1, E14.9
Diabetes, complications	250.4-250.7, 250.9	E10.2-E10.8, E11.2-E11.8, E12.2-E12.8, E13.2-E13.8, E14.2-E14.8
Hypertension	243-244.2, 244.8, 244.9	240.9, 243.x, 244.x, 246.1, 246.8
Congestive heart failure	398.91, 402,11, 402.91, 414.11, 414.13, 414.91, 414.93, 428.x	I90.9, I11.0, I13.0, I13.2, I125.5, I42.0, I42.5-I42.9, I43x, I50x, P29.0
Chronic obstructive pulmonary disease	490-492.8, 493.00-493,91, 494.x-505.x, 506.4	416.8, 416.9, 490.x-505.x, 506.4, 508.1, 508.8
Obesity	278.0	E66.x
Depression	300.4, 301.12, 309.0, 309.1, 311	F20.4, F31,3-F31,5, F32.x, F33.x, F34.1, F41.2, F43.2

Source: Quan et al (2005). Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data.

Appendix D. ICD-9 and ICD-10 codes for Patient Safety Indicators (PSIs)

PSI	ICD-9	ICD-10
PSI 03 (Pressure Ulcer)	7070, 70700, 70701, 70702, 70703, 70704, 70705, 70706, 70707, 70709, 70723, 70725, 70725	L8990, L89009, L89119, L89129, L89139, L89149, L89159, L89209, L89309, L89509, L89609, L89819, L89899
PSI 08 (In Hospital Fall with Hip Fracture)	82000, 82001, 82002, 82003,82009, 82010, 82011, 82012, 82013, 82019, 82020, 82021, 82022, 82030, 82031, 82032, 8208, 8209	S72019A, S72023A, S72026A, S72033A, S72036A, S72043A, S72046A, S72099A, S72019B, S72019C, S72023B, S72023C, S72026B, S72026C, S72033B, S72033C, S72036B, S72036C, S72043B, S72043C, S72046B, S72046C, S72099B, S72099C, S72109B, S72143A, S72146A, S7223XA, S7226XA, S72109B, S72109C, S72143B, S72143C, S72146B, S72146C, S7223XB, S7223XC, S7226XB, S7226XC
PSI 13 (Postoperative Sepsis)	0380, 0381, 03810, 03811, 03812, 03819, 0382, 0383, 03840, 03841, 03842, 03843, 03844, 03849, 0388, 0389, 78552, 99591, 99592, 9980, 99802	A409, A411 A412, A4101, A4102, A403, A414, A4150, A413, A4151, A4152, A4153, A4159, A4189, A419

Source: AHRQ (2017)

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Curriculum Vitae

Pearl C. Kim, Ph.D.

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EDUCATION

Doctor of Philosophy in Public Health **2019**
Department of Health Care Administration and Policy
University of Nevada, Las Vegas

Dissertation Title: *Effects of The Bundled Payments as A Care Improvement Initiative on Hospital Care of Total Joint and Sepsis: A Perspective on Organizational Effectiveness*

Master of Health Care Administration and Policy **2015**
School of Public Health
University of Nevada, Las Vegas

Professional Paper: *Five Rights of Medication Administration Process: Are They Related to Clinical Unit, Drug Class, and Consequences of Medication Errors?*

Bachelor of Science in Microbiology and Molecular Genetics **2001**
University of California, Los Angeles

PROFESSIONAL EXPERIENCE

2015–2019 **Research Assistant** ♦ *University of Nevada, Las Vegas* ♦ LV, NV

- Participated in interdisciplinary research projects working with Dr. Jay Shen, Associate Dean in School of Public Health. Projects are focused on clinical outcomes, socioeconomic disparities in healthcare systems, palliative care, and policy impacts on healthcare services.

2018–2019 **Faculty Opportunity Award Research Assistant** ♦ *University of Nevada, Las Vegas* ♦ LV, NV
Project Title: *Displace or diffuse? The effect of medical and recreational marijuana legalization on opioid abuse and other substance-related crimes.*

2015–2018 **PCORI Project Coordinator** ♦ *University of Nevada, Las Vegas* ♦ LV, NV
Project Title: *Patient-Centered Palliative Care (PCPC).*

- Participated in writing the grant
  Project Title: *Engaging Asian Communities in Palliative Care in Nevada (EACPAC)*
- Developed governance infrastructure and rules of operation
- Developed research project timeline

- Patient-centered research collaborating with stakeholders in palliative care in Southern Nevada developing comparative effectiveness research

05/17–08/17 **Course Instructor** ♦ *University of Nevada, Las Vegas* ♦ LV, NV

- Taught HCA 173, US Health Care System

01/16–08/16 **Graduate Assistant** ♦ *University of Nevada, Las Vegas* ♦ LV, NV

- Teaching Assistant for EAB 173, Biostatistical Methods for Public Health
- Participated with clinical research project collaborating with Lou Ruvo Center for Brain Health

01/15–05/15 **Graduate Administrative Internship** ♦ *Summerlin Hospital Medical Center* ♦LV, NV

Project Title: *Development of Orthopedic Total Joint Replacement Program*

- Participated in xG ProvenCare Training for Joints/Spine Conference
- Participated in bundled payment, clinical variation reduction, and physician engagement for Orthopedic Total Joint Replacement Program.
- Developed crimson data analysis on DRG 469, 470 by surgeons and all payers based on quality and finance indicators.
- Developed survey for Pre-operative Education Class

2002 –Present **Operational and Finance Director** ♦ Pointe North Dental Group ♦ LV, NV

Pointe North Dental, 7321 W. Cheyenne Ave. #3, Las Vegas, NV
North Pointe Dental, 4960 N. Ann Rd. #4, Las Vegas, NV

Managing two dental practices consisting of 20 employees and three doctors. Creating training manual and templates for insurance verification, insurance break down. Create protocols for pre-, peri-, and pro- treatments in both administration and in clinics. Recruiting, terminating, and over-seeing staff. Setting short and long-term goals for each office. In charge of accounts receivable, account payable, and insurance claims with full knowledge of PPO, HMO, and various insurance coverage. Overseeing marketing and public relations.

1999–2002 **Undergraduate Researcher** ♦ *University of California* ♦ Los Angeles, CA

- Project Title: *Signal Transduction identifying G-protein and their role in cancer proliferation.*
- Performing PCR, Gel Electrophoresis, Cell Culture, Assay

PUBLICATIONS

Kim, P.C., Yoo, J.W., Cochran, C.R., Park, S, Chung, S., Lee, Y, and Shen, J.J. (2019). Trends and associated factors of use of opioid, heroin, and cannabis among patients for emergency department visits in Nevada: 2009-2017. *Medicine*. 98(45):e17739. doi: 10.1097/MD.0000000000017739. https://journals.lww.com/md-journal/Fulltext/2019/11220/Trends_and_associated_factors_of_use_of_opioid,.3.aspx

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Kim, P., Yamashita, T., Shen, J., Park, S.M., Chun, S., Kim, S., Hwang, J., Lee, S.W., et al. (2019). Dissociation between the growing opioid demands and drug policy directions among the U.S. older adults with degenerative joint diseases. *Medicine.* 98(28):e16169. doi: 10.1097/MD.0000000000016169. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6641693/

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Shen, J.J., **Kim, P**., et al. (2019). Opioid-use disorders and hospital palliative care among patients with gastrointestinal cancers: Ten-year trend in the U.S. 2005 to 2014. 2019. *Journal of Palliative Medicine.* (under review).

Zhou, W.L., **Kim, P**., Shen J.J., Greenway, J., and Ditmyer, M. (2018). Preventable Emergency Department Visits for Non-Traumatic Dental Conditions: Trends and Disparities in Nevada, 2009-2015. *American Journal of Public Health,* 2018,108:369-371; doi:10.2105/AJPH.2017.304242. https://ajph.aphapublications.org/doi/abs/10.2105/AJPH.2017.304242

Liu, X., Shen, J., **Kim, P**., Park, S., Chun, S., Pan, J., and Yoo, J.W. (2018). Hepatitis C infection screening and management in opioid use epidemics in the United States. *The American Journal of Medicine.* 131(11), 1276-1278. doi: https://doi.org/10.1016/j.amjmed.2018.06.003. https://www.amjmed.com/article/S0002-9343(18)30551-5/abstract

Chen, X., Shen, J., **Kim, P**., Kim, S.J., et al. (2018). Trends in utilizations of life-sustaining procedures and palliative care consultation in dying patients with advanced chronic pancreas illnesses in U.S hospitals: 2005-2014. *Journal of Palliative Care.*

Lee, Y.J., Yoo, J.W., Hua, L., **Kim, P**., Kim, S.J., and Shen, J.J. (2018). Ten-year trends of palliative care utilization associated with multiple sclerosis patients in the United States from 2005-2014. *Journal of Clinical neuroscience*, 58, 13-19. https://www.sciencedirect.com/science/article/abs/pii/S0967586818313043

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procedures, palliative care consultation, and do-not resuscitate status in dying patients with COPD in US hospitals: 2010-2014. *Journal of Palliative Care*. https://journals.sagepub.com/doi/abs/10.1177/0825859718777375

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Kim, P., Shen, J.J., Lee, Y.J., Kim, S.J., Liu, X., and Yoo, J.W. (2017). Alternative trends estimate and stakeout synthetic marijuana use. *The American Journal of Medicine,* 2017,130 (12), e563-e564. https://www.amjmed.com/article/S0002-9343(17)30720-9/abstract.

PRESENTATIONS

Shen, J., **Kim, P**, Yoo, J. Cochran, C., Sotero, M., and Greenway, J. (2018, Jan). *Opioid-Associated Emergency Department Visits and Hospitalizations in Nevada: A Ten-Year Trend from 2008-2017*. [Presentation]. Opioid & Prescription Drug Speaker Series 2018. UNLV Health Law, Las Vegas, NV.

Kim, P., Shen, J., & Dingley, C. (2017, Sept). *Palliative Care for Patients with Life-Limiting Illness: Informal and Formal Caregivers' Experience and Perspectives*. [Poster]. Nevada Public Health Association's 2017 Annual Conference, Reno, NV.

Kim, P., Shen, J., & Dingley, C. (2017, Sept). *Errors Associated with the RIGHTs of Medication Administration: Do Hospital Unit and Drug Type Matter?* [Poster]. Nevada Public Health Association's 2017 Annual Conference, Reno, NV.

Zhou, WL., Shen, J., & **Kim, P**. (2017, Sept). *Temporal Trends and Socioeconomic Disparities in Preventable Emergency Department Visits with Non-Traumatic Dental Conditions in Nevada*. [Poster]. Nevada Public Health Association's 2017 Annual Conference, Reno, NV.

HONORS AND AWARDS

2019 Recipient of 2019 Winter Outstanding UNLV Graduate

2016 Stacy Darling Scholarship Winner

2016 1st Place Winner of Interdisciplinary Research Scholarship
Project Title: *Five Rights of Medication Administration Process: Are They Related to Clinical Unit, Drug Class, and Consequences of Medication Errors?*

2016 PCORI Workshop Scholarship Recipient

2016 API Heritage Month Honoree

- Recognized by the Lieutenant Governor, State of Nevada, for dedication and extraordinary support for and promotion of Korean culture and heritage in Nevada.

2015 Recipient of UNLV School of Community Health Sciences Outstanding Graduate Student 2015

VOLUNTEERING

2002–Present Honorary Director, Korean American Scholarship Foundation
2018–2020 Advisory Council, Engaging Asian Communities in Palliative Care in Nevada
2017–2018 Elected-President, School of Public Health Alumni Chapter
2016–2017 Founder, School of Public Health Alumni Chapter
2015–2017 Cultural Ambassador, Chinese New Year in Desert
2012–2016 Vice President in Board of Directors, Las Vegas Youth Orchestra

AFFILIATION/ Membership

- American College of Healthcare Executives
- Healthcare Financial Management Association
- Medical Group Management Association
- Nevada Public Health Association
- Las Vegas HEALS
- UNLV School of Public Health Alumni Chapter
- UCLA Alumni Chapter, Las Vegas
- Las Vegas Asian Chamber of Commerce