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A Feel for the Whole: Considering State-Specific Quality Measures for Medicare's Value-based Programs in the Context of Social Risk Factors and Population Health

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Healthcare-associated infections (HAIs) are used as a measure for federal value-based payment programs. Using data for 2015, the Centers for Disease Control and Prevention (CDC) developed newer risk adjustment models to calculate the standardized infection ratio (SIR) for various infections occurring in hospitals. New national baselines were set to compare performance among medical facilities and states. Despite adjustments for various facility-level factors that contribute to HAI risk, there are ongoing concerns that SIR calculations do not adequately account for non-hospital risk factors that have been linked to clinical outcomes. This explanatory study evaluates state-level data using simple linear regression to determine relationships between the standardized infection ratio (SIR) for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia and several socioeconomic and geographic factors. Bivariate analysis produced significant correlation between SIR and high school education, with states exhibiting lower SIR relative to the percent of adults who completed high school. Higher SIRs were found relative to the percent of state populations subjected to poverty, obesity, and diagnosis of diabetes. Percent of nonprofit hospitals, adults with bachelor's

degrees, and rural residents were not significantly correlated with state measures of MRSA bacteremia. These findings can help guide efforts to reduce HAIs, improve safety of care, and advance population health efforts. The results from this study reinforce the notion that non-hospital factors may have significant effects on the incidence of MRSA bacteremia events occurring in hospitalized patients. Current risk adjustment models that predict MRSA bacteremia events for quality reporting purposes may not adequately account for these risk factors. The present study highlights some ways that hospitals, patients, and policymakers can work together to address social risk factors as a strategy for promoting better and safer care, and healthier communities. This study investigates aspects of the bigger picture of health care quality, performance measurement, and population health. This "feel for the whole" underscores the implications on state performance in infection prevention in the context of socioeconomic and medical vulnerabilities. The study emphasizes the need for greater multidisciplinary collaboration to address community health needs and reduce social and medical disparities.

DEDICATION

This dissertation is dedicated to my husband, Steven, for his relentless support and encouragement. I would also like to dedicate this work to my sons, Thomas Cole and Clayton Pierce, for their patience and tolerance, and to my mother, Carolyn, whose strength, integrity, and benevolence guide me every day.

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LIST OF ACRONYMS

CAUTI	Catheter-Associated Urinary Tract Infection
CDC	Centers for Disease Control and Prevention
CLABSI	Central Line-Associated Bloodstream Infection
CMS	Centers for Medicare & Medicaid Services
CY	Calendar Year
FY	Fiscal Year
HACRP	Hospital-Acquired Condition Reduction Program
HAI	Healthcare-Associated Infection
HRRP	Hospital Readmissions Reduction Program
HVBP	Hospital Value-Based Purchasing
IPPS	Inpatient Prospective Payment System
IQR	Inpatient Quality Reporting
LabID	Laboratory-identified
MRSA	Methicillin-resistant *Staphylococcus aureus*
NHSN	National Healthcare Safety Network
PPS	Prospective Payment System
SSI	Surgical Site Infection
VBP	Value-Based Purchasing

CHAPTER I

INTRODUCTION

Statement of the Problem

In 1993, Mary Schmidt published an article about the valuable insights that can be derived from alternative sources of knowledge. Schmidt also cautioned about potential adverse consequences of relying on information that is too narrowly-defined, shortsighted, or lacking in diverse perspectives. Certain hospital quality measures involved in Medicare's value-based payment programs have been criticized for failing to adequately account for social risk factors. In this spirit, and to do what Schmidt characterized as gain a "feel for the whole," this study explores standardized infection ratios, aggregated at the state level, for bloodstream infections caused by methicillin-resistant *Staphylococcus aureus*, commonly referred to as MRSA. These infection ratios will be studied in the context of various state-level measures to assess state performance. This will help to assess whether current standardized models adequately depict broader community risks for poor health outcomes.

The shift from fee-for-service to pay-for-performance has been accompanied by a greater emphasis on outcome measures instead of structure and process measures. This transition has also involved additional public reporting of hospital data, and repurposing of surveillance databases for performance measurement and Medicare value-based payment programs. This shift to outcome measures has driven hospitals to identify and

mitigate patient risk factors that contribute to poor outcomes. These risk factors may be present long before patients come to the hospital and persist long after patients have been discharged. Consequently, approaches to improve population health involve more proactive strategies instead of reactive responses to illness or injury. A challenge for hospitals has been deciding where to start to address upstream determinants of health. Some hospitals that manage high-risk patients have been subjected to excess penalties, and hospitals with lower-risk patients have received financial rewards for performance. These incongruities are the impetus for this research.

Significance of the Study

Over the past several years, the Centers for Medicare and Medicaid Services (CMS) has progressively shifted payment incentives to place greater emphasis on outcomes-based measures of performance and value. Economic futurist Ian Morrison calls this a first-curve to second-curve shift (1996). The U.S. healthcare system turned sharply into the second-curve upon passage of the Affordable Care Act (ACA), which mandated that the Centers for Medicare and Medicaid Services (CMS) initiate a pay-for-performance program for hospitals. The Hospital Value-Based Purchasing (VBP) Program was subsequently launched on April 28, 2011, followed by the Hospital-Acquired Condition Reduction Program (HACRP). These programs redistribute Medicare payments to hospitals based on their performance on various quality measures. Data for these measures are collected through the Hospital Inpatient Quality Reporting (IQR) program, which was implemented in 2005. Federal mandates require Medicare-

certified facilities to conduct surveillance and reporting for certain types of healthcare-associated infections (HAIs).

There is a tendency to view HAIs as a function of hospital performance, but many risk factors are beyond direct control of hospitals. An article in *The New England Journal of Medicine* noted that variations in outcomes could be caused by differences in "the total disease burden and the preferences of patients" (Tinetti et al., 2004, p. 2870). As McGinnis and Foege point out in their study of actual causes of death in the United States (1993, p. 2207), "most diseases or injuries are multifactorial in nature," which makes it difficult to sort out "the relative contributions of the various factors." HAI risk factors may include acuity of patient illness, inadequate nurse-patient staffing ratios, resource constraints, or competing demands that interfere with infection prevention efforts (Collins, 2008). Miller (2014) notes that differences in outcomes may be due to factors that are not easily measured or understood. Miller also cautions that "failing to adjust for these factors could unfairly penalize providers who care for disproportionate numbers of patients with these characteristics" (2014, p. 21). "In order to properly align payments and ensure value-based purchasing programs achieve their intended goals, the relationships between social risk and performance on these programs need to be better understood" (ASPE, 2016, p. 7).

Local prevalence of obesity and poverty may impact hospital infection rates. There may be differences between people living in urban and rural areas. Level of education and health literacy are important determinants of health. The number of infections may be associated with the community prevalence of diabetes. Infection

statistics could vary based on the type of hospital ownership. These are specific areas that were explored in this study using state-level data.

Disparities in state infection ratios may be attributable to social determinants of health in combination with the quality (or quantity) of medical care received. "The United States will not achieve high-value health care unless improvement initiatives pursue a broader system of linked goals" (Berwick et al., 2008, p. 760). The goals that Berwick and his colleagues define are: better care; smarting spending; and healthier people – commonly referred to as the 'Triple Aim' (2008). Discussions about the Triple Aim often refer to multiple, interdependent associations among variables and improvement strategies. This interconnectedness presents some challenges to measuring quality and defining value. Moreover, some outcomes-based measures establish a dichotomy of competition and collaboration. This is particularly true for performance metrics involving healthcare-associated infections (HAIs).

Healthcare-associated infections (HAIs) are infections that patients develop while (or immediately after) receiving health care for other conditions. The Centers for Disease Control and Prevention (CDC) estimate that at least 1.7 million healthcare-associated infections occur each year. These infections are estimated to cause at least 99,000 deaths each year in the United States (ASTHO, 2011). The high morbidity and mortality related to these infections have made them a major focus of health care reform efforts in the past several years. HAI statistics are often cited as an indicator of health care quality (Collins, 2008). Using HAI data as a quality measure has some shortcomings, as patient outcomes

can be affected by factors beyond a hospital's control. Additionally, there tends to be a lag between hospital interventions and measurable improvements (Cannon, 2007).

Health care reform in the United States is increasingly focused on measures of value instead of volume of services provided. During the first curve of health reform, some bemoaned how the fee-for-service payment system was not sufficiently coordinated or collaborative. Under fee-for-service, doctors were ordering more tests, and patients were generally receiving more medical services, but outcomes were not improving as much, or as rapidly, as they should. The health care system was doing more, but not getting more done. This fundamental shift in the second curve places greater emphasis on population health and reducing health disparities. Standardized ratios for healthcare-associated infections (HAIs) are outcome measures used in public reporting and payment programs for hospitals.

CHAPTER II

LITERATURE REVIEW

Healthcare-associated infections

To comply with the federal HAI reporting requirements, hospitals must report certain types of healthcare-associated infections (HAIs) to the National Healthcare Safety Network (NHSN), a database managed by the Centers for Disease Control and Prevention (CDC). The CDC uses multivariable regression models to generate a predicted number of infections and compares the predicted number to the actual number of infections reported. The ratio of actual infections to predicted infections is known as the standardized infection ratio (SIR). "The standardized infection ratio (SIR) is a summary measure used to track HAIs at a national, state, or local level over time" (CDC, 2017, p. 4). The CDC's multiple regression models apply several risk adjustments to account for facility differences, but some experts argue that these risk adjustments are inadequate, causing some hospitals to be unfairly penalized (Miller, 2014). The American Hospital Association (AHA) issued a report in 2014 expressing alarm about unfair payment reductions for hospitals that treat medically complex or high-risk patients. "The HAC Reduction Program imposes arbitrary, excessive penalties that disproportionately impact hospitals tending to care for the sickest patients" (AHA, 2014, p. 5).

The use of HAI data to measure variations in health care quality has steadily expanded over the past few years. In fiscal year 2015, the HAI data made up 60% of a hospital's overall HAC score. By fiscal year 2018, the HAC calculations were weighted so that HAI measures constituted 85% of the overall score. Value-based programs strive to improve transparency and provide hospital infection data to the public. However, these datasets need to be enriched by additional information about the populations in the communities served by each hospital. This would help put the raw data into proper context and acknowledge the exceptional challenges and resource limitations faced by some facilities.

The Hospital Inpatient Quality Reporting (IQR) program was mandated by Section 501(b) of the Medicare Prescription Drug, Improvement, and Modernization Act (MMA) of 2003. Section 3008 of the Patient Protection and Affordable Care Act (PPACA), which was signed into law on March 23, 2010, established the Hospital Value-Based Purchasing (HVBP) Program and Hospital-Acquired Condition Reduction Program (HACRP). The PPACA (or ACA for brevity) called for expanded access to health insurance; mechanisms to slow down the rate of growth in Medicare spending; and innovative experiments in payment and delivery system reform (Oberlander, 2010; Cohen et al., 2015).

The ACA was enacted in the wake of the Great Recession that began in December 2007. The economic recession highlighted fundamental flaws and instability in the American health care system. The recession caused many Americans to suffer job losses, decreases in household income, foreclosures, bankruptcies, poverty, and loss of

employer-sponsored health insurance coverage. Through the ACA, policymakers sought to improve access to health care while also controlling costs and placing greater emphasis on prevention of chronic disease and improving public health. These provisions are outlined in Title IV of the ACA (PPACA, 2010, p. 463).

Health care quality improvement is a fundamental objective of the Affordable Care Act (Obama, 2016). The federal government has the unique position as a health care regulator, purchaser, and provider (Corrigan, Eden & Smith, 2003). Individual states have regulatory and oversight mechanisms to support and validate HAI reporting, and to ensure that hospitals are implementing evidence-based infection prevention strategies. Together, federal and state agencies can help validate data reported to NHSN. The current wave of health care reform is inducing "greater coordination and standardization of performance measurement across government programs and throughout the health care sector overall" (Corrigan, Eden & Smith, 2003, p. 75). In April 2017, a report from the Office of Inspector General for the U.S. Department of Health and Human Services emphasized that "collecting and analyzing quality data is increasingly central to Medicare programs that link payments to quality and value" (OIG, 2017, p. 14).

Reducing healthcare-associated infections (HAIs) is a national priority (Gohil et al., 2015). Rates of HAIs may be influenced by how states identify and addresses medical, social, and economic risk factors among their population. Newer health care payment models emphasize value and quality, with patient outcomes as a measure of quality. Experts are concerned that outcome measures may not account for variability in

how patients respond to treatment, especially in the context of confounding medical, social, or economic circumstances (ASPE, 2016). Prior research shows how non-hospital risk factors can influence HAI rates (National Academies, 2016; Gohil et al., 2015; Fiscella, Burstin, & Nerenz, 2014; Buntin & Ayanian, 2017). The current study examines correlations between state HAI levels and various characteristics of the population.

Non-hospital risk factors

There are concerns that HAI measures fail to adequately account for social risks that influence clinical outcomes. In an article published in the *Yale Journal of Health Policy, Law, and Ethics*, Cannon (2007, p. 5) warns that "developing performance measures for complex phenomena is difficult and that inappropriate measures can have significant negative consequences." For instance, some populations may be subjected to greater sources of microorganisms. This could be due to patients' endogenous flora or the prevalence of microorganisms in the environment. Some people are more susceptible to infection. Patients with compromised immune systems, poor overall health status, or prolonged hospitalization are more likely to develop HAIs (Collins, 2008). Although the NHSN risk models adjust for some organizational and hospital unit-based factors, the reporting system does not capture the full range of relevant information about patient-level or social risk factors that may influence outcomes. Some of these risk factors can be evaluated at the state or county level through publicly-available data sources.

Hospitals that treat more socially or economically vulnerable patients may tend to have worse performance on quality measures (Gilman et al., 2015). The various social

factors that contribute to poor health care outcomes should be carefully considered when making value-based payment adjustments so that hospitals are not unduly penalized for serving disadvantaged patients. Medical researchers have found that patients with multiple concomitant medical conditions are at higher risk of MRSA bacteremia (Bassetti et al, 2012).

A Danish study considered the increased risk of *Staphylococcus aureus* bacteremia among diabetic patients (Smit et al., 2016). Bloodstream infections due to MRSA has higher morbidity and mortality for patients with cardiac problems, including patients with prosthetic heart valves, implanted pacemakers, or defibrillators (Cosgrove & Fowler Jr., 2008). Obesity and diabetes are risk factors for cardiovascular disease (Pi-Sunyer, 2009; Guh et al., 2009). Obesity is associated with altered immune response and increased susceptibility to certain infections (Hegde & Dhurandhar, 2013).

A New Zealand report identified income as "the single most important modifiable determinant of health" (National Health Committee, 1998). Poverty can impact infection risk through broader community environmental factors. Poorer communities may have more environmental pollution, reduced access to resources to manage chronic conditions, and food deserts that impact nutrition. "In many communities across the U.S., poverty is a depressingly reliable indicator of health outcomes and health system performance" (Klein and McCarthy, 2014). Levels of health literacy and health numeracy influence many health-related behaviors. "Behavioral disparities are correlated with income and education, and efforts to change unhealthy behaviors have often proven less effective among low-income, less-educated populations" (Hartley, 2004, p. 1676). Higher levels

of educational attainment are associated with improved health outcomes, partly because of higher levels of health literacy and numeracy (Mantwill, Monestel-Umaña, & Schulz, 2015).

Some low-income Medicare beneficiaries are also eligible for Medicaid benefits. This subgroup of Medicare beneficiaries is referred to as dual-eligible. A study by Lied and Haffer (2004) found that dual-eligible beneficiaries tend to have special health needs and risk factors. A Congressional Budget Office report explained that individuals who are dual-eligible were about twice as likely as nondual Medicare beneficiaries to have at least three chronic conditions. Dual-eligible beneficiaries also have significantly higher medical risks because statistics show they are "nearly three times as likely to have been diagnosed with a mental illness" (CBO, 2013, p. 4). These individuals tend to need more extensive medical and social services. A study in 2010 found promising indications that value-based payment programs may help to drive improvements in hospitals that care for poor patients (Jha). However, a subsequent study by the same researcher had a more pessimistic outlook on the ability of Medicare's value-based payment programs to address health disparities (Jha & Zaslavsky, 2014).

Rurality

There is an adage that "all health care is local" (Klein & McCarthy, 2014). People living in rural areas may lack access to certain medical services or specialties. Hospitals in rural communities may have fewer resources to tackle population health challenges. "Rural Americans are a population group that experiences significant health disparities" (Rural Health Information Hub, n.d.). To overcome these challenges, rural

hospitals may participate in cooperative alliances with faith-based organizations, civic groups, and local industry leaders. "Improving outcomes and reducing costs really requires a commitment to capacity building in the community" (Klein & McCarthy, 2014). The second curve of population health accentuates the need for hospitals to collaborate with partners and stakeholders, who "often have access to and trusting relationships with populations often not easily reached by formal health care and public health systems" (Asomugha, Derose, & Lurie, 2011, p. 2). Hospitals must consider how they work synergistically with community partners, such as faith-based organizations, to assess local needs, carry out effective interventions, measure outcomes, and reach underserved populations (Asomugha, Derose, & Lurie, 2011). State and local agencies can provide targeted support to address disparities in health and/or health care. Ultimately, these activities are fundamental to quality improvement activities under value-based programs in health care. When hospitals are penalized for outcomes that are contingent on social determinants, value-based metrics may have the effect of exacerbating health disparities instead of alleviating them.

Eisenberg et al. (2007) examined how the environment influences rates of infectious disease. The burden of infectious disease in an area can depend on social, ecologic, cultural, behavioral, and genetic factors. There are often distinctions between rural and urban areas in terms of population density, infrastructure, water quality, and resident travel patterns that influence the "landscape of human disease" (Eisenberg et all, 2007, p. 1222). Environmental characteristics affect rates of exposure to infectious disease, and the community's ability to manage infection risks.

Traditionally, rural health care was considered a function of access to clinical services. More recently, experts more fully acknowledge the impact of social determinants of health (Hartley, 2004). Clinical outcomes are an expression of complex interactions between healthcare service delivery and various social risk factors. "Social factors are powerful determinants of health" (ASPE, 2016, p. 18, 374). Rural populations are more likely than their urban counterparts to engage in certain behaviors that are harmful to health (Hartley, 2004).

Under value-based programs, some rural hospitals have been subjected to financial penalties. A report to Congress outlined the role of social risk factors in health and health care (ASPE, 2016). The report cautioned about unfair penalties that may be imposed on hospitals that care for a significant number of patients with social risk factors. In these settings, poor health outcomes may be a consequence of elements beyond the quality of care provided (ASPE, 2016). Hospitals are charged with facilitating better health outcomes by mitigating the effects of social and medical risk factors. Rates of healthcare-associated infections (HAIs) are exacerbated by the prevalence of social risk factors in rural areas. Some rural hospitals, along with non-rural hospitals that serve vulnerable populations, have sounded the alarm about receiving disproportionate penalties under value-based payment models (Gilman, 2015). (Lipstein & Dunagan, 2014)

Interdependence

Resource Dependence Theory (RDT) helps to evaluate hospital efforts at improving quality measures – including infection prevention activities – in the

organizational and social context of the second curve of health care. This theory claims that organizational responses are conditioned through competition and interdependence with other organizations (Pfeffer and Salancik, 1978). RDT considers the resources of the organization, and the degree of uncertainty, and the interaction between the organization and the environment. Pfeffer and Salancik propose that organizational strategies toward compliance are motivated by desires to reduce uncertainty, and to ensure the ability obtain and allocate resources in the best way possible. Competition among hospitals, and the power that regulatory agencies exert over healthcare organizations, are dynamics addressed through a resource dependence perspective.

Although Medicare's value-based incentives and penalties are imposed upon individual facilities, hospital outcomes are largely based on interdependent factors. This is because a hospital "does not entirely control all of the conditions necessary for the achievement" of quality outcomes (Pfeffer & Salancik, 2003, p. 40). Hospitals are subjected to both outcome interdependence and behavior interdependence (p. 41). The current study examined aggregate data of healthcare-associated infections (HAIs) for each state in the context of social determinants and population health measures. The researcher sought to determine whether state HAI levels are associated with various social and medical risk factors. This can provide a context for proactive, population-based approaches to managing health and health care.

A criticism of the Hospital VBP and HAC programs is that payment adjustments are based on old data, making it difficult to gauge the national pace of improvement. Performance monitoring and forecasting is hindered by the lag time between performance

measurement and when an incentive or penalty is imposed. In the second-curve of health care reform, the population is becoming the unit of concern. Hospitals should denote their "population of concern" and pursue strategic initiatives that improve quality and value of care for that specified population (Berwick, Nolan, & Whittington, 2008, p. 762). Hospitals can use information about their communities, which includes sharing data with other entities and conducting population-level risk assessments, to ensure that activities are timely and relevant. Research into associations between hospital outcomes and social risk factors can help inform hospital processes, as well as broader social programs and policies. This corresponds with ongoing research into health disparities and inequalities. Hospitals can work with partners and stakeholders to identify and address community priorities for health promotion, including allocation of resources and responding to the needs of vulnerable or high-risk groups.

For the VBP achievement measures, hospitals throughout the U.S. are compared to each other, with none of them knowing precisely how much improvement is required to earn incentives or avoid penalties for the upcoming fiscal year. This lack of real-time data to monitor performance relative to peers is a source of anxiety for hospital administrators and quality directors. Another critique of the VBP program is the risk of unfair penalties to physicians and hospitals who care for patients with complex health problems (Miller, 2014). A report from the Office of Inspector General (OIG, 2017) articulated concerns about the validity of Inpatient Quality Reporting (IQR) data. Improved procedures for validation, incorporating the use of most advanced data

analytics, could help identify hospitals with inaccurate data for healthcare-associated infections (HAIs) and clinical process of care (OIG, 2017).

"Patients may respond differently to a given intervention as a result of multiple illness or interactions with treatment regimens for such co-morbidities" (Cannon, 2007, p. 11). Performance measures tend to be based on aggregate data and adherence to generalized treatment guidelines. Consequently, hospitals may be penalized for providing individualized care to patients with complex medical problems. "Having multiple health conditions exposed patients to multiple treatment regimens and a correspondingly heightened risk of adverse drug events" (Cannon, 2007. p. 12). "If we are going to publicly report outcomes and reward providers who achieve the best outcomes, we must approach outcome measures as rigorously as we did process measures and use extreme caution to ensure that the measures are valid" (Baker & Chassin, 2017, p. 422).

"Fee-for-service payment emphasizes the provision of health services by individual providers rather than coordinated across providers" (Davis and Schoenbaum, 2010). Over the past several years, the Centers for Medicare and Medicaid Services (CMS) has progressively shifted payment incentives to target outcomes and value of care. Economic futurist Ian Morrison calls this a first-curve to second-curve shift (1996). In the second curve, hospitals are compelled to enhance patient engagement, engage in multi-disciplinary and inter-organizational collaboration, and utilize data to identify opportunities for improvement. Value-based programs emphasize the need for hospitals to communicate and cooperate with other organizations to promote meaningful

population health improvements. As Pfeffer and Salancik observed: "It is our impression that organizations are becoming more interconnected and that the cause of this increasing system connectedness is most often government action" (2003, p. 70).

Environmental pressure and resource interdependence are factors that impact how hospitals are building value-based systems of care delivery (American Hospital Association, 2014). Pay-for-performance encourages competition among hospitals, by ranking hospitals and penalizing low-performers and rewarding high-performers. However, hospitals are realizing that they can achieve greater – and more sustainable – improvements by forming multihospital infection prevention collaboratives (Doebbeline et al., 2013). An example of this was a collaborative to reduce bloodstream infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA). Doebbeline et al. found that collaboration among various hospitals facilitated quality improvement efforts by helping to identify and overcome organizational barriers to change.

Interorganizational collaboration can help hospitals share ideas and information, clarify goals, and enhance sustainability of interventions. "Industry experts have projected that multiple, intersecting environmental forces will drive the transformation of health care delivery and financing over the next decade" (American Hospital Association, 2011, p. 3). The shift to pay-for-performance creates some uncertainty and anxiety for hospitals, forcing them to redefine their role in the community and engage in population health management to receive full reimbursement for clinical services. Collaborative relationships can help hospitals gain information about their environment. Hospitals seek insights into how to improve the health status of their communities. This information can

help to reduce uncertainty about the organization's future (Pfeffer and Salancik, 2003, p. 77).

National Healthcare Safety Network (NHSN)

Until very recently, it was difficult to make meaningful comparisons of healthcare-associated infection data among states. This was due to different state demographics, different baseline infection rates, different infectious disease threats (due to climate, geography, endemic diseases, etc.), and lack of standardized infection reporting systems. Beginning in 2011, the National Healthcare Safety Network (NHSN) was designated as the official HAI reporting structure for facilities participating in the Medicare or Medicaid programs. This allows more consistent data collection, including structured surveillance definitions for what constitutes a healthcare-associated infection.

The National Healthcare Safety Network (NHSN) is an internet-based surveillance system. NHSN facilitates data reporting, providing a standardized set of definitions for various healthcare-associated infections (HAIs). Through NHSN, healthcare entities can share data and directly compare their infection measures with other facilities. Financial disincentives or penalties are imposed if facilities fail to report the required data. Mandatory public reporting of HAI data is "the most extensive component within existing state HAI statues and have largely been driven by consumer demand for transparency and accountability on HAI in healthcare facilities" (ASTHO, 2011, p. 14).

Standardized Infection Ratio (SIR)

The current study examined state levels of methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia. Hospitals are required to report all laboratory-identified events to the National Healthcare Safety Network (NHSN). This surveillance and reporting is performed by specially-trained personnel (Sydnor & Perl, 2011). Data that hospitals report to the national NHSN is used for the Inpatient Quality Reporting (IQR) program, the Inpatient Prospective Payment System (IPPS), Hospital Value-Based Purchasing (VBP) program, and the Hospital-Acquired Condition (HAC) Reduction Program. The CDC calculates a standardized infection ratio (SIR) based on patient-level and facility-level risk factors. The CDC used data from 2015 to establish an updated national baseline for levels of MRSA bacteremia. Some risk adjustments are included in the calculation, including adjustments based on the rate of infections that originate prior to being admitted to the hospital. The risk adjustments also include average length of stay (LOS), medical school affiliation, facility type, and number of ICU beds (CDC, 2017). These factors are incorporated into a negative binomial regression model to calculate the number of predicted events for MRSA bacteremia (CDC, 2017). The number of predicted events is compared to the number of actual events to calculate the SIR.

The comprehensive health care reforms enacted by the Affordable Care Act of 2010 (ACA) are intended to enhance the quality of health care services and promote healthier lifestyles, while also controlling costs and improving access to care (Obama, 2016). To accomplish this, the ACA established the Hospital Value-Based Purchasing (VBP) Program (CMS, 2012). The VBP program is funded by a percentage withheld

from participating hospitals' Diagnosis-Related Group (DRG) payments (CMS, 2012). New value-based models in the second curve of health care require "measurement, analysis, and reduction of clinical variation to improve quality" (American Hospital Association, 2011, p. 14). Berwick et al. defined the "Triple Aim" goals of "improving the individual experience of care; improving the health of populations; and reducing the per capita costs of care for populations" (2008, p. 760). These goals provide a guiding framework for improvements to the U.S. health care system. To pursue the Triple Aim, hospitals and providers must define the populations that they serve, and establish ways to monitor the health status and needs of those populations over time (Berwick et al., 2008).

Value-driven efforts in Medicare

Since 1965, Medicare has offered health insurance to people ages 65 and older, regardless of income, medical history, or health status. The program was expanded in 1972 to cover people under age 65 with long-term disabilities (KFF, 2016). In fiscal year (FY) 2015, the federal government spent $539 Billion on Medicare and $350 Billion on Medicaid, comprising 3% and 2% of the GDP, respectively. This was over 1.5 times more than spending on defense (CBO, 2016). The health care system in the United States is steadily incorporating more quality measures to evaluate hospital outcomes. These measures incentivize quality, safety, and efficiency, emphasizing the importance of preventive services and early interventions to diagnose and manage disease. Care coordination and social support are among the facets of value-driven efforts to improve management of chronic illness. To succeed in a second-curve future, hospitals must promote alignment among providers and settings across the continuum of care. Another

"must-do strategy" is to seek population health improvement through pursuit of the "Triple Aim" (American Hospital Association, 2011, p. 4).

Hospital leaders have expressed uncertainty about the shift from the first to second curves (American Hospital Association, 2011). There are concerns about whether clinical performance measures adequately account for patient risk factors. Underlying health status, household income, health literacy, and patient compliance can be factors that influence clinical outcomes, but are variables beyond providers' direct control (Cannon, 2007). Some question whether variations in hospital infections are due to actual differences in healthcare quality, differences in how infections are reported, or differences caused by the prevalence of social risk factors. "Outcome measures and risk adjustment are likely to be perennial battlegrounds on which providers are pitted against those seeking to measure quality" (Cannon, 2007, p. 22).

In 2016, a report from the Office of Assistant Secretary for Planning and Evaluation (ASPE) suggested that patient-level clinical data from the CDC healthcare-associated infection (HAI) measures may benefit from additional risk-adjustment to account for differences in patients' clinical risk. The report noted that higher levels of medical risk are associated with a higher risk for many patient safety events, particularly infections. "Providers that disproportionately served beneficiaries with social risk factors tended to have worse performance on quality measures" (ASPE, 2016, p. 8, 364). The ASPE report acknowledged that improving outcomings in socially at-risk populations "may require more effort on the part of providers, or more resources and more support, than achieving the same outcomes in a lower-risk population" (2016, p. 361). "Providers

with sicker-than-average patients could be penalized for below-average outcomes, even if the care provided is of the highest quality" (Cannon, 2007, p. 22). CMS has been called upon to more fully account for social risk factors in adjustments to payment models and incentive programs (ASPE, 2016). Medicare payment models "need to be risk-adjusted for the patient population served" (Davis and Schoenbaum, 2010). Prior studies recognize that patient outcomes may be adversely impacted by factors beyond hospitals' direct control (Gohil et al., 2015). There is growing awareness that social factors should be considered to establish "fair and accurate quality measurement in the context of Medicare's increasing use of value-based purchasing programs" (ASPE, 2016, p. 18, 374).

Population health statistics are often mentioned at the state level, but infection statistics tend to be cited at the individual facility level. All 50 states submitted plans to prevent healthcare-associated infections (HAIs), in accordance with the 2009 Omnibus Law for receiving Preventive Health and Health Services (PHHS) Block Grant funds (National Targets and Metrics, n.d.). State plans are expected to align with the national goals for reducing HAIs. The national targets include a 50% reduction in facility-onset MRSA bacteremia, as measured by the standardized infection ratio (SIR) from the calendar year 2015 baseline period (National Targets and Metrics, n.d.).

Over the past few years, regulatory bodies have actively sought to emphasize safety, efficiency, and patient-centered health care. Other public values that are addressed by health care reform include accountability, transparency, and coordination. Consequently, the Affordable Care Act of 2010 (ACA) established a value-based

purchasing program (VBP) which utilizes performance measures to determine reimbursement for healthcare services. Since January 2011, healthcare facilities have been involved in "pay-for-reporting" activities. Beginning in the 2013 fiscal year, performance measures serve as a basis for reimbursement for health services. Performance-based measures have major implications for the delivery of healthcare services in the United States. Specifically, acute care hospitals are concerned about the consequences of the inpatient prospective payment system (IPPS) on reimbursement and revenue. Hospitals are also worried about misperceptions of data that is made publicly available. Statistical data might lead to erroneous conclusions about the quality of health services and misleading comparisons among health care providers.

The Medicare Access and CHIP Reauthorization Act (MACRA) was signed into law on April 16, 2015. Title I of MACRA repealed the Sustainable Growth Rate (SGR) formula, which was a method used by the Centers for Medicare and Medicaid Services (CMS) to control spending by Medicare. The Balanced Budget Amendment of 1997 required physician fee schedule updates for Medicare patients to be tied to the gross domestic product (GDP) through the sustainable growth rate (SGR). MACRA streamlined several quality and value programs into a comprehensive system that rewards providers for value instead of volume. The quality payment program (QPP) offers incentives for Medicare providers based on quality, resource use, clinical practice improvement activities, use of electronic health record (EHR) technology, or participation in an advanced alternative payment model (APM) (CMS, 2017). The overall concept is that value-driven models will result in better care, healthier people, and

smarter spending as providers are rewarded for providing higher-quality care and controlling costs.

Nonprofit hospitals

To maintain tax-exempt status, nonprofit hospitals must periodically conduct a community health needs assessments (CHNA) and demonstrate how the hospitals benefit their communities. The CHNA requirement was added to the Internal Revenue Code by the Affordable Care Act (ACA). Hospitals must conduct the CHNA and develop strategies to meet the needs identified in the assessment at least once every three years (Internal Revenue Service, 2016; James, 2016). Researchers have examined how hospitals collaborate with various organizations to address the medical and social needs of the areas they serve (Proenca, Rosko, & Zinn, 2000). Approximately 78 percent of community hospitals in the U.S. were operated as nonprofit organizations in 2014. Consequently, a large portion of inpatient hospital services are provided by nonprofit entities.

The IRS requirements holds hospitals accountable for providing community benefits, in exchange for tax exemptions. This can help to ensure that hospitals are addressing social determinants of health. Hospitals should address community health needs in a manner that is socially and culturally appropriate (HRET, 2016). As nonprofit hospitals fulfill the IRS obligation, they can simultaneously identify and address the needs of vulnerable populations, which could lead to better patient outcomes and improved sustainability of health-related interventions. "Engaging patients, families and communities in the CHNA process can also support hospitals and health systems in better

understanding how to share with their communities the results of existing and ongoing research and evidence-based interventions" (HRET, 2016, p. 15).

A study by Proenca, Rosko, and Zinn (2000) asserted that "for-profit hospitals are less community-oriented than their nonprofit peers" (p. 1026). Their presumption was that for-profit hospitals tend to be more concerned with profit margins and accountability to their investors, whereas nonprofit hospitals are fundamentally driven by their mission and meeting the needs of the community.

Isomorphic changes

The current study considered DiMaggio and Powell's institutional model of isomorphic change (1983) in its assessment of social factors associated with mandatory reporting of healthcare-associated infections (HAIs). Within the healthcare industry, there is increasing scrutiny of infection control practices, and the consequences of healthcare-acquired conditions. This study explored the ways in which various social, economic, and organizational forces are exerted in a process of convergence, as facilities in each state attempt to align their infection prevention practices (DiMaggio and Powell, 1983). To the extent that change is driven by internal and external pressures on organization, institutional theory (AKA: New Institutionalism) outlines three types of pressure that induce isomorphism: coercive, mimetic, and normative. Institutional theory is particularly applicable to this study of infection prevention efforts due to the multi-dimensional forces prompting hospitals to adopt new policies and processes to manage infection risks.

Institutional theory has been widely used to evaluate the impact of various regulations in the healthcare industry, and the organizational changes necessary to achieve compliance. This line of inquiry is consistent with prior studies, particularly the adoption of electronic medical records (EMRs) in healthcare organizations as they strive for compliance with federal mandates stemming from the American Recovery and Reinvestment Act (ARRA). Consequently, there is considerable justification for the use of institutional theory to conceptualize the organizational dynamics surrounding compliance with the HAI mandates. The course of hospital adoption of EMRs could forecast the general approach that hospitals will take to implement strategies of HAI reduction. Both issues involve organizational change, investment of resources, compliance with federal mandates, and input from trade associations. Ultimately, all three types of institutional isomorphism – coercive, normative, and mimetic – are applicable to the investigation of hospital progress toward regulatory compliance and quality improvement.

Although isomorphism can be a motivating force for organizational change, it can also lead to diminished innovation and stagnation (DiMaggio & Powell, 1983). Some of the benefits of conformity also confer risks. One risk is that isomorphic pressures will lead to the adoption of inefficient, ineffective, inappropriate, (or harmful) organizational practices. "Political and regulatory pressures are compelling hospitals and care systems to provide efficient and optimal patient care and address market volatility" (American Hospital Association, Committee on Research, 2014, p. 6). Mimesis is a response to uncertainly (Selznick, 1996). Mimetic forces explain the way "organizations tend to

model themselves after similar organizations in their field that they perceive to be more legitimate or successful" (DiMaggio & Powell, 1983, p. 152).

Professional organizations and trade associations are sources of normative influence. Membership and participation in professional groups help to promote cooperation and reduce uncertainty about change (Pfeffer & Salancik, 1978). The role of external groups is a factor in this analysis of pressures on hospitals to adopt new mechanisms of infection prevention and community collaboration.

The original formulation of institutional theory focused on rational-actor models of organizational behavior, explaining decisions based on utility-maximizing principles. In contrast to "old" institutionalism, the new institutionalism places greater emphasis on cognitive and cultural explanations of behavior (Powell & DiMaggio, 1991, as cited in Selznick, 1996). This newer conception of institutional theory proposes that organizational behavior cannot be reduced to a simple cost/benefit calculation. Decisions may not follow a purely rational, straightforward quest for benefit optimization. New institutionalism is more congruent with the concepts of social constructionism (Vygotsky, 1978) and social cognitive theory (Bandura, 1986).

Since passage of the Affordable Care Act in 2010, the regulatory spotlight has grown brighter on infection prevention in hospitals, motivating facilities to seek new mechanisms for handling infection risks. The impetus for change stems from multiple pressures: coercive, normative, and mimetic. The result seems to be a process of convergence through which health care organizations adopt similar policies and procedures to reduce infection rates. DiMaggio and Powell (1983) express the tendency

for isomorphism to stifle innovation. DiMaggio and Powell give a largely unfavorable view of this phenomenon. However, in the healthcare industry, routinization and standardization are important ways to achieve stability and compliance. Thus, the tendency for healthcare organizations to converge on similar practices can be a constructive force, facilitating the adoption of processes in accordance with laws and regulations. Assessments of the organizational change processes can foster improved compliance with federal policy.

A Swedish study explored the concept of goal congruence as it relates to collaborative behavior (Lundin, 2006). This study suggests that hospitals will be more likely to cooperate if they trust each other and have similar goals and priorities. Value-based purchasing programs can promote inter-organizational collaboration as hospitals mutually benefit from community health initiatives. Clinical outcomes are influenced by the availability of preventive care services in communities and the timeliness of medical interventions. Hospitals can work together on population health management by recognizing how pay-for-performance programs enhance organizational interdependence. Hospitals in the same community – or overlapping communities – have a shared interest in promoting the health of all residents.

"More than three-fourths of adults over age 65 suffer from at least one chronic medical condition that requires ongoing care and management" (IOM, 2008, p. xi). The new generation of seniors receiving Medicare benefits brings unprecedented challenges for the U.S. health care system. "The current health care system in the United States is fragmented and costly" (American Hospital Association, Committee on Research, 2014,

p. 6). The American Hospital Association (2011) identified shifting demographics of patients and the workforce as another challenge faced by hospitals and care systems. In their issue brief, Harrington and Heidkamp (2013) enumerate some challenges posed by the aging U.S. healthcare workforce. Demand for medical services is increasing as the aging U.S. population increases, and as more Americans gain access to health care. Simultaneously, a significant proportion of the healthcare workforce reaching retirement age or being forced to leave health care due to disabilities or chronic medical conditions. A report by the Institute of Medicine (IOM, 2008, p. 14) projects an impending health care crisis "if current reimbursement policies and workforce trends continue." In 2011, the baby boom generation began turning 65. The IOM warns that the "dramatic shift in the age distribution of America's population will place accelerating demands upon the U.S. health care system" (IOM, 2008, p. ix). Healthcare workforce challenges are another example of organizational interdependence.

A report in 2011 by the AHA Committee on Performance Improvement noted that "the relationship between physicians and hospitals has evolved from necessary association to competition to interdependency" (American Hospital Association, p. 13). Hospitals need a better understanding of how to develop local partnerships and collaborations to address social risk factors and target improvement efforts. Hospitals must delineate what is within their direct control, and which population health initiatives involve collaborative relationships with patients and community stakeholders. Partnerships between physicians and hospitals are necessary to improve care coordination and reduce unnecessary admissions (American Hospital Association, 2011). "To succeed

and move to the second curve, hospitals must collaborate with physicians and all other clinical providers not only on financial goals but also on quality and strategic objectives" (American Hospital Association, 2011, p. 13).

Hospital ownership and leadership

A study by Beauvais and Wells (2006) examined the association between financial resources of hospitals and quality of care data. More specifically, the authors characterized what type or resources have the greatest impact on delivery of health care services. The theory is based largely on extrapolations from research conducted in the railroad and airline industries. The authors characterized healthcare quality as a function of the sequential development of appropriate structures, process, and outcomes. Financial indicators consisted of profit margins, fiscal margins, and investment ratios. Beauvais and Wells discovered that existing healthcare organization financial research primarily involved outcomes-based data, with considerably fewer studies utilizing structural or process measures. The authors found an association between higher expenses and fewer adverse events. As an example of this phenomenon, hospitals that had higher expenses per patient day tend to have lower mortality rates. Conversely, hospitals with lower operating costs exhibited higher rates of negligent injury. Interestingly, higher administrative costs were associated with lower quality of care. Larger profit margins were linked to improved patient process measures for inpatient facilities. The organizations' asset management status was correlated with lower mortality rates. Hospitals with lower asset availability (i.e. higher liability ratios) tended to have higher rates of poor process measures, including death, nosocomial infections,

falls in the hospital, and medical errors. All three financial measures were significantly associated with improved quality in acute-care settings. Positive fiscal margins tended to relate to higher quality of care. Healthcare organizations in the top tier of quality measures suggested that increased investments in service delivery (i.e. higher expenditures) were rewarded by improved processes and outcomes. Contrastingly, larger investments in administrative functions were not associated with improvements in quality. The researchers suggest the implications for this study in the most effective use of financial resources through investments in the clinical processes, versus administrative activities.

Some healthcare organizations have chief executive officers (CEOs) with a background in finance or management. Other organizations have CEOs with formal medical education. A study by Shultz and Pal (2004) compared the decision-making ability of medically-educated CEOs versus managerially-educated CEOs. Ultimately, it was found that educational degree was not a strong predictor of a CEO's ability to make sound organizational decisions. Healthcare organizations face "dual performance goals" of service quality and fiscal responsibility. The authors cite work done by Friedson in distinguishing between the mentality of physicians and nonmedical managers. Friedson notes that physicians have a "clinical mentality" that places emphasis on allegiance to the patient, and also to flatter organizational structures. Meanwhile, other managers feel that their allegiance is to the organization, with emphasis on maintaining hierarchical relationships with subordinates. Traditionally, the role of hospital CEO has been filled by managerially-educated executives. There is a greater tendency to value the medical

perspective that physician executives bring to leadership in healthcare organizations. Despite having a lack of formal training in business and finance, this study found that medically-educated CEOs were as effective as non-medically trained CEOs at making strategic decisions. The researchers used a computer simulation to test the strategic decision-making ability of 38 senior managers from two large healthcare organizations. Overall, there was no significant difference between medically-educated and managerially-educated senior managers with regards to consideration of financial information or total information. However, "medically educated participants used more quality-of-care information in their decision making that did managerially educated participants." Most significantly, performance-related measures were similar between the two groups. This research downplays the influence of professional background in forecasting the ability of senior managers to make decisions that will improve quality of care or financial performance in the organization. Two slogans are used throughout this article. An emphasis on quality of care in healthcare organizations aligns with the philosophy of "no health, no wealth." By contrast, healthcare executives with a managerial focus tend to believe "no money, no mission." In addition to lack of significant differences between executives from different professional backgrounds, the study also found that executives did not have performance differences based on age, gender, years of work experience, or years of management experience. These variables wound not found to be correlated with performance outcomes. Choosing an effective leader in healthcare organizations may not be as simple as looking to educational or professional experience. The researchers indicate that the ability of CEOs to make good

decisions cannot be easily objectified or predicted by assessments of educational or professional experience.

HAIs are a significant issue for public budgeting. Estimates for direct medical costs of healthcare-associated infection are $35.7-45.0 billion annually in the United States (Scott, 2009). The CDC estimates that approximately 1 out of every 20 hospitalized patients will contract an HAI. The risk of developing a healthcare-associated infection (HAI) increases when a patient is obese, has other medical conditions, does not have access to adequate health care, and due to advancing age. Additionally, the cost of treating HAIs has increased due to the prevalence of multi-drug-resistant organisms (MDROs). The matter of healthcare-associated infections has wide-ranging repercussions – from direct impacts on the health status of individuals, to the overall quality of health care in the United States, and to government decisions at the state and federal level.

The field of infection prevention has been through several phases. The first definite phase was when the concepts of hygiene and asepsis were first recognized. Notable contributors to this era of infection prevention include Pasteur, Koch, Lister, Semmelweis, John Snow, and Florence Nightingale. The Industrial Revolution marked a time when greater emphasis was placed on scientific and technological advancements to diagnose and manage disease. For a period of about 150 years – from the mid-19th century to the late 20th century – the focus shifted to the development of evidence-based guidelines in health care. Then, over the past few years, another change in basic assumptions seems to have occurred. Infection prevention has entered an era dominated

by legislative agendas, regulations, and federal mandates. A body of specialized knowledge has been established, with subsequent public pressure to encourage and enforce the use of evidenced-based care strategies. The emergence of new ways to disseminate information has also contributed to the public demand for greater accountability and responsiveness in health care.

In 1950, the proportion of the U.S. population over age 65 was 8.1%. This increased to 12.8% in 2009, and is projected to reach 20.2% by 2050 (Shrestha and Heisler, 2011). As people age, their bodies naturally become more susceptible to disease or injury. Furthermore, slower healing times can lead to significantly greater cost to treat a healthcare-associated infection in someone over age 65. "Changes in the population size, racial and ethnic composition, and age structure affect the healthcare resources needed, spending levels, and health conditions observed" (Shrestha and Heisler, 2011, p. 26).

The U.S. Department of Labor's Occupational Outlook Handbook (2012-2013 Edition) confirms the immense size of the U.S. healthcare industry. Providing health care to citizens consumes a vast amount of U.S. financial resources. The expanding scope of the health care industry increases its relative significance for state and federal budgets. In 2008, the Institutes of Medicine concluded that the U.S. healthcare workforce is grossly inadequate to manage the health needs of a growing aging population (Shrestha and Heisler, 2011).

The U.S. Bureau of Labor Statistics estimates that the healthcare and social assistance industry will create about 28 percent of all new jobs in the U.S. economy

between 2010 and 2020. Employment opportunities in the health care sector are driven by a population of individuals that are living longer, and who are generally less healthy. Also, health care has expanded the options for disease treatments and surgical interventions. The U.S. economy is experiencing a shift away from goods-producing in favor of service-providing industries (U.S. Department of Labor, 2012).

The total cost related to healthcare-associated infections (HAIs) is multi-faceted. Obviously, there are the direct medical costs, due to medical care, physician payments, medications, surgery, nursing care, etc. There are also societal (intangible) costs in terms of reduced worker productivity, lost wages, decreased taxable income, diminished participation in usual activities, and impacts to quality of life. In the United States, a significant proportion of medical expenditures results from indirect (non-medical) costs. Health care reform is mainly targeted at the economic burden of direct medical costs, since it is easier to delineate the connection between HAIs and medical expenditures.

It is essential to measure how much is spent on health care. But it's also important to know whose care the government is paying for. After all, knowing how the money is spent is a clue to how government expenses can be minimized, and how to predict future health costs. The Kaiser Family Foundation (www.statehealthfacts.org) utilized data from the Department of Health and Human Services (HHS) and AHRQ to analyze how broadly the nation's health expenditures are distributed among its citizens. The Medical Expenditure Panel Survey (MEPS) reveals that a small proportion of the U.S. population receives about half of the money spent on health care in the United

States. Half of health care expenses for the nation's budget are used to care for only 5% of the population. A significant portion of the population (roughly 1/2) utilizes very little of our health care budget, accounting for only 2.9% of total spending. The remaining costs (about 47%) are ascribed to citizens in the middle-range expense category.

Medicare is a federal health insurance program. Americans are eligible for Medicare coverage when they reach 65 years of age, or if they are under age 65 with a permanent disability. The U.S. population is growing, and the average age of U.S. residents is increasing, resulting in a significant increase in the number of Medicare beneficiaries. As the number of beneficiaries rises, the government will face notably higher expenditures. When more citizens are eligible for Medicare benefits, there is a corresponding tendency for health expenses to increase. Medicare beneficiaries may be enrolled in programs that provide for payment of hospital expenses, supplemental medical insurance, and/or managed care. There has been an increasing number (and proportion) of Medicare enrollees are who are nonelderly, which means that they are eligible based on disability status, and not due to age (KFF, 2017).

A criticism of the U.S. health care financing structure is the complex bureaucratic structure. The Affordable Care Act (ACA) purports to include methods to improve the communication and coordination among healthcare providers, consumers, and insurance providers. The Centers for Medicare and Medicaid Services (CMS) conducts validation surveys to ensure that hospitals are reporting their data promptly and accurately. These strategies are intended to eventually streamline the process of care delivery and improve outcomes. In the initial phases of implementation, however, many healthcare facilities

have realized that the existing infrastructures and workflow systems are inadequate to meet the expanded reporting requirements established by CMS. To promote the sustainability of HAI prevention programs, states are encouraged to form advisory councils and offer financial incentives to healthcare providers (ASTHO, 2011).

Some states are experiencing more challenges associated with the implementation of CMS mandatory reporting requirements and pay-for-performance initiatives. States with a higher proportion of their residents enrolled in Medicare are confronted with an increased burden of meeting the regulatory demands. The value-based payment modifier and HAC penalties have greater bearing on hospitals that rely on CMS reimbursements as a significant share of their overall revenue. A report by The Trust for America's Health acknowledged "major differences in disease rates and other health factors in states around the country" (Hamburg, Segal, & Martin, 2016, p. 8). Some of the states with the highest proportion of Medicare beneficiaries are also states with higher rates of certain chronic health conditions, which will exacerbate the challenges associated with resource allocation, budgeting, and regulatory compliance.

In a report on the financial implications of the Affordable Care Act (ACA), Richard Foster, CMS Chief Actuary, acknowledged possible increases in total national health expenditures by more than $200 billion from 2010 to 2019 (Lindenauer et al., 2007). Foster expressed concern that funding pressures might eventually cause lawmakers to recall some of the Medicare cuts, which would result in even higher costs to the federal government. If implemented as amended, the ACA is estimated to reduce Medicare expenditures by $575 billion by year 2019. However, increased expenses

offset these savings due to expanded eligibility criteria and funding for the Children's Health Insurance Program (CHIP). The ACA includes several funding sources for the prevention of healthcare-associated infections (HAI) through the Prevention and Public Health Fund. These financial resources would be directed through the public health departments of each state.

Hospitals would be subjected to significant funding cuts, thereby putting them in financial jeopardy (Foster, 2010). Medical professionals, who typically enter the profession out of a desire to help people, may become frustrated and disillusioned by the administrative costs of seeking payment for services rendered. The CMS Chief Actuary expressed his own concern that "providers for whom Medicare constitutes a substantive portion of their business could find it difficult to remain profitable and, absent legislative intervention, might end their participation in the program" (Foster, 2010). The result of this would be fewer providers in the health care market, potentially limiting access to health care for Medicare enrollees.

A study by Lindenauer et al. (2007) found indications of quality improvements among hospitals that were involved in public reporting and pay-for-performance initiatives. Significantly, hospitals that only did the public reporting component had somewhat less improvements in quality those hospitals that received performance incentives in addition to public reporting. However, the researchers were unable to assess whether the benefits of implementing these initiatives were sufficient to justify the added costs associated with the interventions.

The federal government is the primary driver of the shift to pay-for-performance reimbursement strategies. The Centers for Medicare and Medicaid Services (CMS) plays a pivotal role in the design and implementation of health care reform efforts. According to an overview of the Department of Health and Human Services available on their website (www.hhs.org), CMS is the nation's largest health insurer, helping to finance health care for approximately 1/4 of all Americans. The U.S. Department of Health and Human Services administers more grant dollars than all other federal agencies combined.

There are inherent moral and ethical considerations pertaining to health care. Among these is the fundamental debate about whether health care should be considered a human right. If citizens have a right to health care, what is the government's role in upholding that right? What is the government's responsibility in ensuring equitable healthcare for all Americans? Richard A. Epstein discussed the notion of health care as a right in his book *Moral Peril: Our inalienable right to health care?* (1997). Epstein's views are compatible with the ideology expressed by Friedrich von Hayek, who believed that whenever government exerts greater control over a public service there are moral and ethical implications of the government infringing on individual liberty and curtailing the economic benefits of the free market system. Epstein and Hayek would concur that, by allowing health care to be driven by the free market, the effect of competition among health care providers (and insurance companies) would serve to preserve higher quality service and responsiveness to public health needs.

Antibiotic-resistant bacteria

Antibiotic-resistant bacteria are an emerging threat to health care. Virulent strains of methicillin-resistant *Staphylococcus aureus* (MRSA) are now being linked to community-acquired infections and outbreaks. A report published in by the Association of State and Territorial Health Officials (ASTHO, 2011) indicates that "there has been a rise in the profile of consumer advocates and public outrage over the extent of HAI in the U.S. as well as a growing societal expectation in many parts of the country for HAI to be publicly reported." The current study examined standardized infection ratios for MRSA bacteremia, a type of infection that results in high cost of care and morbidity each year in the U.S. In fiscal year 2017, the federal government added hospital rates of methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia to the payment calculations for the Value-Based Purchasing (VBP) Program and Hospital-Acquired Condition Reduction Program (HACRP).

CHAPTER III

METHODOLOLGY

This explanatory study investigates relationships between various factors using secondary data from publicly-available sources. The existing literature stresses the financial and societal implications of pay-for-performance in U.S. healthcare. Media and regulatory attention is traditionally focused on hospital rankings and the performance of individual facilities. However, the second curve of health care reform acknowledges that health outcomes are a function of medical, social, economic, and organizational factors. In large part, performance depends on the ability of hospitals to identify and respond to the needs of their communities. Clinical outcomes depend on the quality of care delivered in the hospital, but they also depend on whether patients have fundamental resources and capacity to maintain or regain health.

To make sustainable improvements in quality of care, hospitals need to collaborate with state partners and stakeholders to mitigate the effects of regional variations in social, cultural, and economic determinants of health. The research hypotheses for this study consider the linkages between state-level measures of healthcare-associated infections (HAIs) and various contextual factors. The study was conducted with data from all 50 states. State-level data about poverty, education, chronic disease, and hospital ownership help to illuminate potential causes for variability in standardized infection ratios (SIRs).

Research Hypotheses

Hypothesis 1 – Higher percentage of adults with high school diploma or higher will be associated with lower state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 2 – Higher percentage of adults with a bachelor's degree or higher will be associated with lower state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 3 – Higher percentage of population living in rural areas will be associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 4 – States with a higher percentage of nonprofit hospitals will be associated with lower SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 5 – Higher percentage of adults with diabetes will be associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 6 – Higher percentage of obese adults will be associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 7 – Higher percentage of adults living in poverty will be associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Measurement of the Variables

All variables for this study were assessed using publicly-available secondary data sources, with measures aggregated at the state level.

Dependent Variable

The study examines state standardized infection ratio (SIR) for a type of healthcare-associated infection (HAI) in the context of various medical, social, economic, and organizational factors. The SIR is a risk-adjusted summary statistic that is used to make comparisons among individual facilities or states. HAI calculations served as the dependent variable and was derived from Hospital Compare datasets (CMS, 2016). Hospitals are required to report HAIs based on surveillance definitions and algorithms established by the Centers for Disease Control and Prevention's National Healthcare Safety Network (NHSN).

There are currently 6 infection measures that are part of the hospital inpatient quality reporting (IQR) program. Two of the measures involve infections associated with medical devices, 2 are measures of infections associated with surgical procedures, and 2 are measures of infections due to specific types of bacteria. Among these 6 measures, the standardized ratio for bloodstream infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA) was deemed must suitable for the current study. There are several rationales for this variable selection. Many smaller hospitals do not use enough central lines – a type of intravenous device – and consequently have insufficient data to calculate the standardized infection ratio (SIR) for the central line-associated bloodstream infection (CLABSI) measure. Likewise, some hospitals will not have a SIR calculated for the surgical site infection measures, either because surgical procedures are

not performed at the facility, or the hospital performs too few procedures to calculate a SIR value. There are variations in how hospitals collect *Clostridium difficile* infection (CDI) data, and hospital rates may be skewed due to differences in how patients are tested for *Clostridium difficile*. Due to variability in hospital reporting of this type of infection, this measure is considered unsuitable for the current study.

The study used the dependent variable of standardized infection ratios (SIRs) for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia, as calculated by the CDC, based on data reported to the National Healthcare Safety Network (NHSN). The MRSA bacteremia data for this study represents laboratory-identified (LabID) events. Facilities paid under the Inpatient Prospective Payment System (IPPS) are required to submit this data as part of the Hospital Inpatient Quality Reporting (IQR) Program.

State-level, quantitative data about each dependent and independent variable came from publicly-available data sources. The dependent variable for all hypotheses was the standardized infection ratio (SIR) for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia, which depicts aggregate data from hospitals reporting to CMS within each state for the period from January 1, 2015 through December 31, 2015.

Independent Variables

The study examined state measures of a type of healthcare-associated infection (HAI) in the context of various medical, social, economic, and organizational factors. The seven independent variables were measured using state-level data.

High school graduates

H1 – Higher percentage of adults with High School diploma or higher will be associated with lower state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 1 considers the relationship between educational attainment and risk of MRSA bacteremia infection. The independent variable was measured as the percentage of adults with a High School diploma or higher in each state. The data for educational attainment is derived from responses to the American Community Survey (ACS). The U.S. Census Bureau conducts the ACS, gathering annual data about educational attainment. The educational attainment 1-year estimates include 12-months of data collected between January 1, 2015 and December 31, 2015. This aligns with the time period used to measure the dependent variable.

Bachelor's degrees

H2 – Higher percentage of adults with a Bachelor's degree or higher will be associated with lower state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 2 considers the relationship between higher educational attainment and risk of MRSA bacteremia infection. The independent variable was measured as the percentage of adults with a Bachelor's degree or higher in each state. This will include persons who have received a bachelor's degree from a college or university, or a master's, professional, or doctorate degree. The independent variable was measured as the percentage of adults with a bachelor's degree or higher in each state. The data for educational attainment is derived from responses to the American Community Survey (ACS). The U.S. Census Bureau conducts the ACS, gathering annual data about educational attainment. The educational attainment 1-year estimates include 12-months

of data collected between January 1, 2015 and December 31, 2015. This aligns with the time period used to measure the dependent variable.

Rurality

H3 – Higher percentage of population living in rural areas will be associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 3 considers the relationship between rurality and risk of MRSA bacteremia infection. The independent variable was measured using 2010 U.S. Census Bureau data about the percentage of each state's population living in rural areas.

Nonprofit hospitals

H4 – States with a higher percentage of nonprofit hospitals will be associated with lower SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 4 considers the relationship between hospital ownership and risk of MRSA bacteremia infection. The independent variable was measured using data from the Kaiser Family Foundation (KFF). The original source of the data is the Annual Survey of Hospitals conducted in 2015 by the American Hospital Association (AHA).

Diabetes

H5 – Higher percentage of adults with diabetes will be associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 5 considers the relationship between diabetes and risk of MRSA bacteremia infection. The independent variable was measured using data from CDC's Behavioral Risk Factor Surveillance System (BRFSS). State-level estimates of

diagnosed diabetes is based on self-reported data, and includes both Type 1 and Type 2 diabetes.

Obesity

H6 – Higher percentage of obese adults will be associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia

Hypothesis 6 considers the relationship between obesity and risk of MRSA bacteremia infection. The independent variable was measured using data collected for "The State of Obesity" report by the Trust for America's Health and the Robert Wood Johnson Foundation. This report is published annually. The report published in 2016 includes data for 2015. The statistics are derived from the CDC's Behavior Risk Factor Surveillance System (BRFSS).

Poverty

H7 – Higher percentage of adults living in poverty will be associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia

Hypothesis 7 considers the relationship between poverty and risk of MRSA bacteremia. The independent variable was measured as the percent of people below poverty level, as derived from the U.S. Census Bureau's American Community Survey (ACS).

Statistical Analysis

Statistical analyses were performed using SPSS (Version 24.0). The level of significance was set at $P < .05$ for all tests. Prior to analysis, all variables were assessed using the Shapiro-Wilk test of normality and descriptive statistics were generated.

Scatterplots

Once the data were collected and assessed for normality, the variables for each hypothesis were graphed on a scatterplot diagram. The pattern of the data points was inspected to evaluate the nature of the relationship between the independent and dependent variables. This served as a preliminary assessment of trends and correlations between the variables.

Correlation coefficients

The next phase of analysis involved determining the correlation coefficient for each set of independent and dependent variables. Pearson's *r* was used to measure the strength and direction of a linear relationship between each set of variables.

Linear regression

Simple linear regression was performed for each hypothesis. This analysis was used to determine the relationship between state SIR and the independent variables (Chatterjee, 2006). The linear regression model shows the change in the dependent variable as a function of the independent variable. The formula for the regression equations used in the analyses is:

$$\mathbf{Y = a + bX}$$

Y = dependent variable

X = independent variable

a = Y intercept (constant)

b = regression coefficient (slope)

CHAPTER IV

RESULTS

Statistical Analysis

Descriptive Statistics

The following table shows the descriptive statistics for each variable. The sample size was 50 for all variables and included respective data for all 50 states in the U.S. The range in values was greatest for state percentages of adults with bachelor's degrees, population living in rural areas, and percent of nonprofit hospitals in the state.

Table 1 Descriptive statistics for all dependent and independent variables

	N	Range	Minimum	Maximum	Mean	Std. Deviation
MRSA Bacteremia (SIR)	50	1.129	.241	1.370	.90074	.293923
High School Graduates (%)	50	11.3	82.2	93.5	88.724	2.9458
Bachelor's Degrees (%)	50	21.9	19.6	41.5	29.806	5.0531
Rurality (%)	50	56.29	5.05	61.34	26.4182	14.56456
Nonprofit Hospitals (%)	50	78.9	21.1	100.0	62.254	21.6422
Diabetes (%)	50	7.2	6.4	13.6	9.160	1.6839
Obesity (%)	50	16.0	20.2	36.2	29.426	3.7703
Poverty (%)	50	13.8	8.2	22.0	14.172	3.1002

Prior to constructing the simple regression models, the data for each variable was evaluated to determine whether it is normally distributed. The Shapiro-Wilk test for normality was used, and this indicated that none of the data was significantly different from a normal distribution pattern.

Table 2 Shapiro-Wilk Test of Normality

	Test Significance
MRSA Bacteremia	.113
High School Graduates	.062
Bachelor's Degrees	.745
Rurality	.065
Nonprofit Hospitals	.138
Diabetes	.123
Obesity	.415
Poverty	.446

All variables exhibit normally-distributed data with $P > .05$

Scatter Plots

Once the data was collected for each variable, scatter plots were generated in SPSS for the independent and dependent variables in each hypothesis. The scatter plots were used to visually assess the state data points. This graphical depiction of the data includes state labels, facilitating an at-a-glance appraisal of relationships between the variables, as well as the strength and direction of potential correlations. The figures on the following pages show the scatter plots for each hypothesis and a summary of what information can be reasoned from these initial assessments. The figures also include the regression line, which will be explained in more detail in the next section of this chapter.

Hypothesis 1

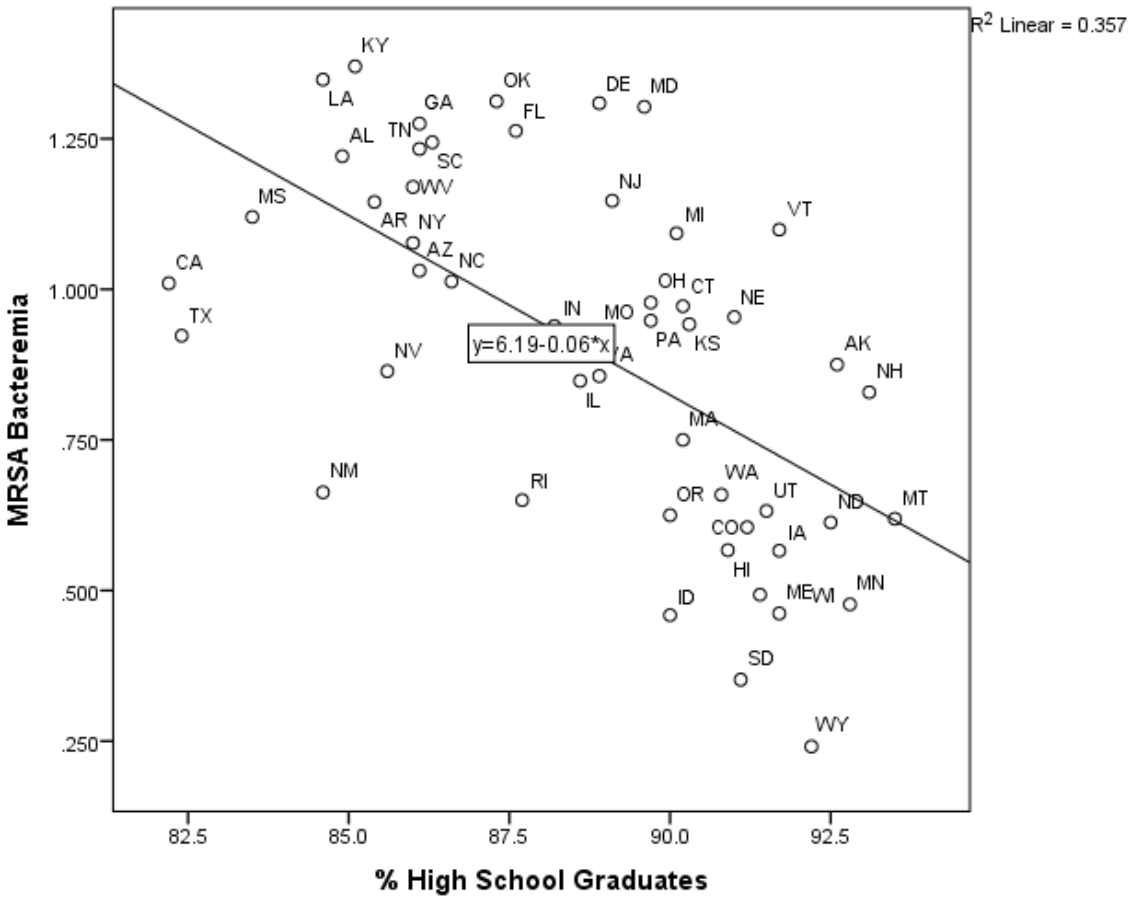

Figure 1 Scatter plot of MRSA bacteremia SIR and % high school graduates

Examination of the scatter plot shows that state MRSA bacteremia infection ratios exhibit a linear relationship with educational attainment, as measured by the percent of high school graduates in each state. The plot has a negative slope. The coefficient of determination (R^2) value is 0.357, indicating that 35.7% of the total variability in state MRSA bacteremia infection ratios is accounted for by rates of high school graduation.

Hypothesis 2

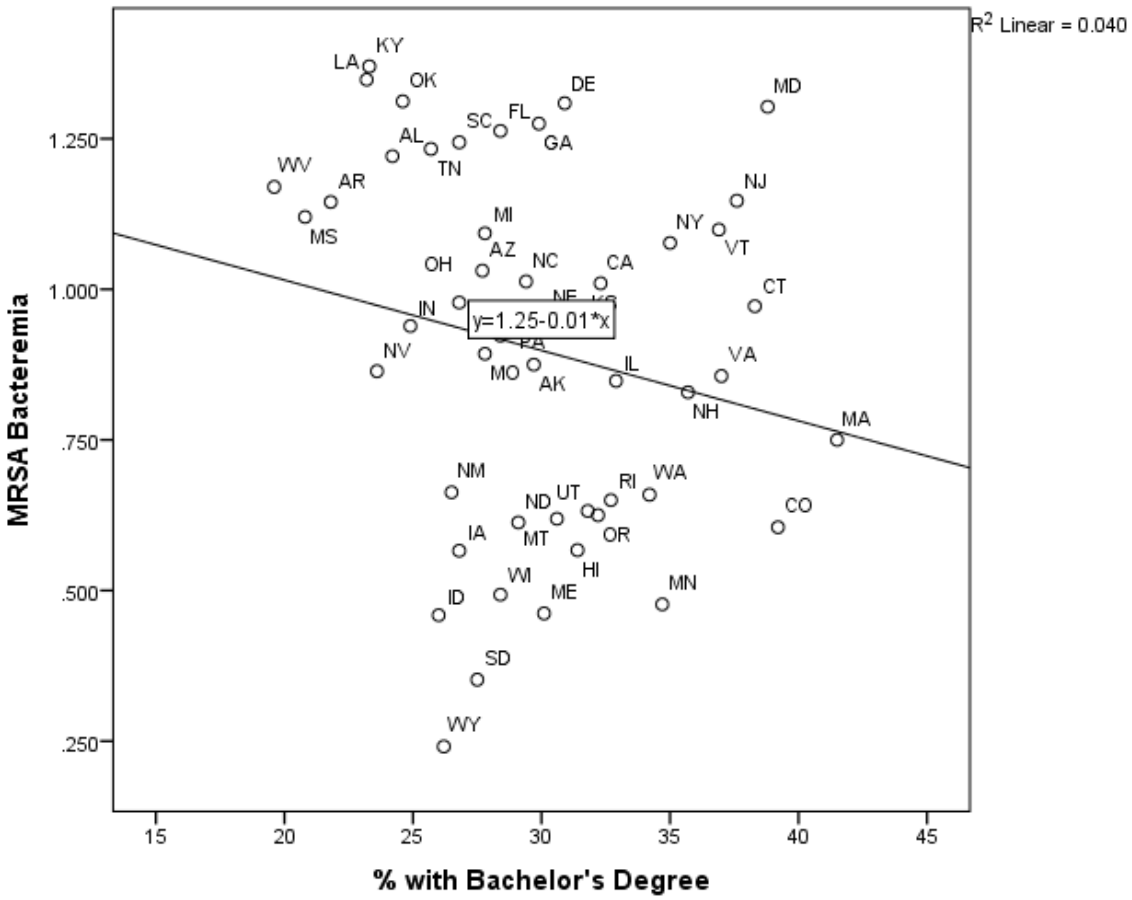

Figure 2 Scatter plot of MRSA bacteremia SIR and % of adults with bachelor's degree

Examination of the scatter plot does not indicate a strong linear relationship between state MRSA bacteremia infection ratios and educational attainment, as measured by the percent of adults with bachelor's degree in each state. The plot has a slightly negative slope. The coefficient of determination (R^2) value is 0.040, indicating that 4% of the total variability in state MRSA infection ratio is accounted for by percent of adults with bachelor's degrees.

Hypothesis 3

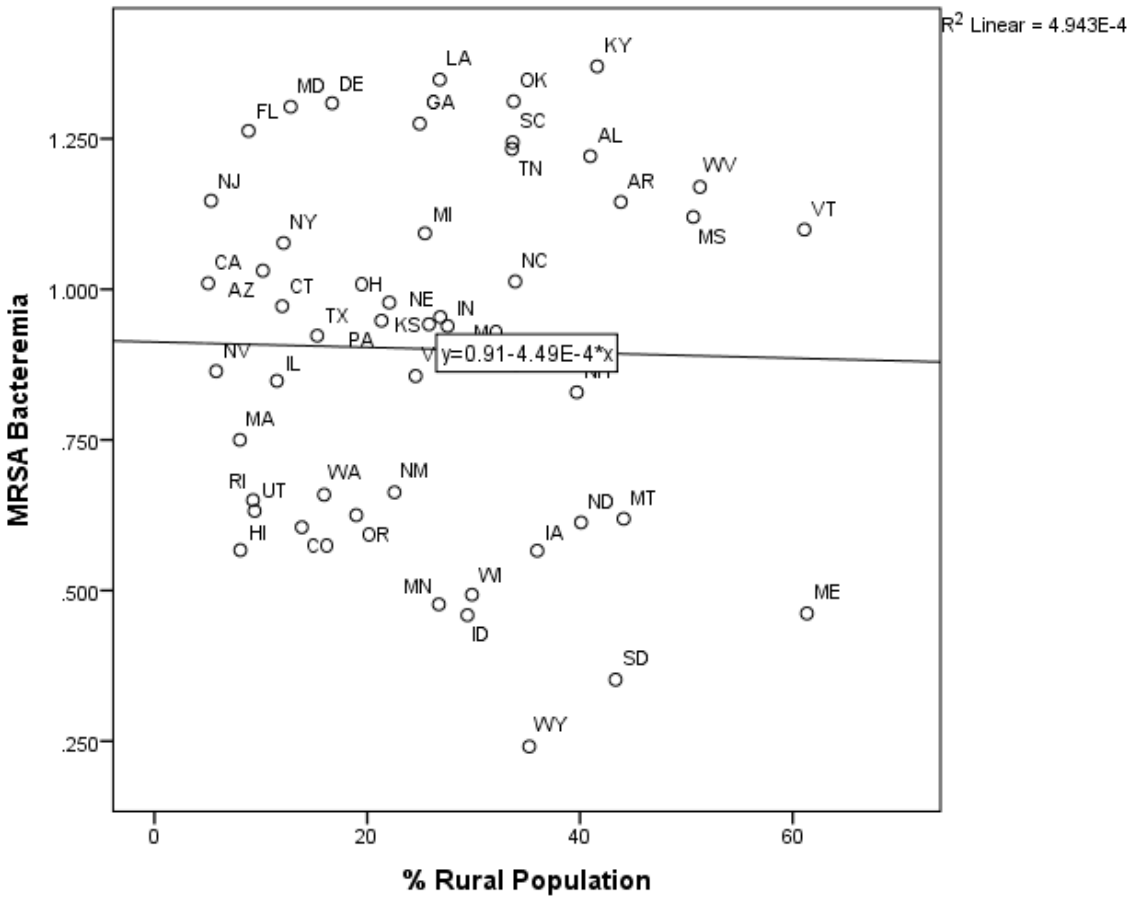

Figure 3 Scatter plot of MRSA bacteremia SIR and % rural population

Examination of the scatter plot shows that state MRSA bacteremia infection ratios do not exhibit a clear linear relationship with educational attainment, as measured by the percent of the population living in rural areas. The slope is nearly flat. The coefficient of determination (R^2) value is 0.000, indicating that none of the total variability in state MRSA bacteremia infection ratios is accounted for by the percent of state residents in rural areas.

Hypothesis 4

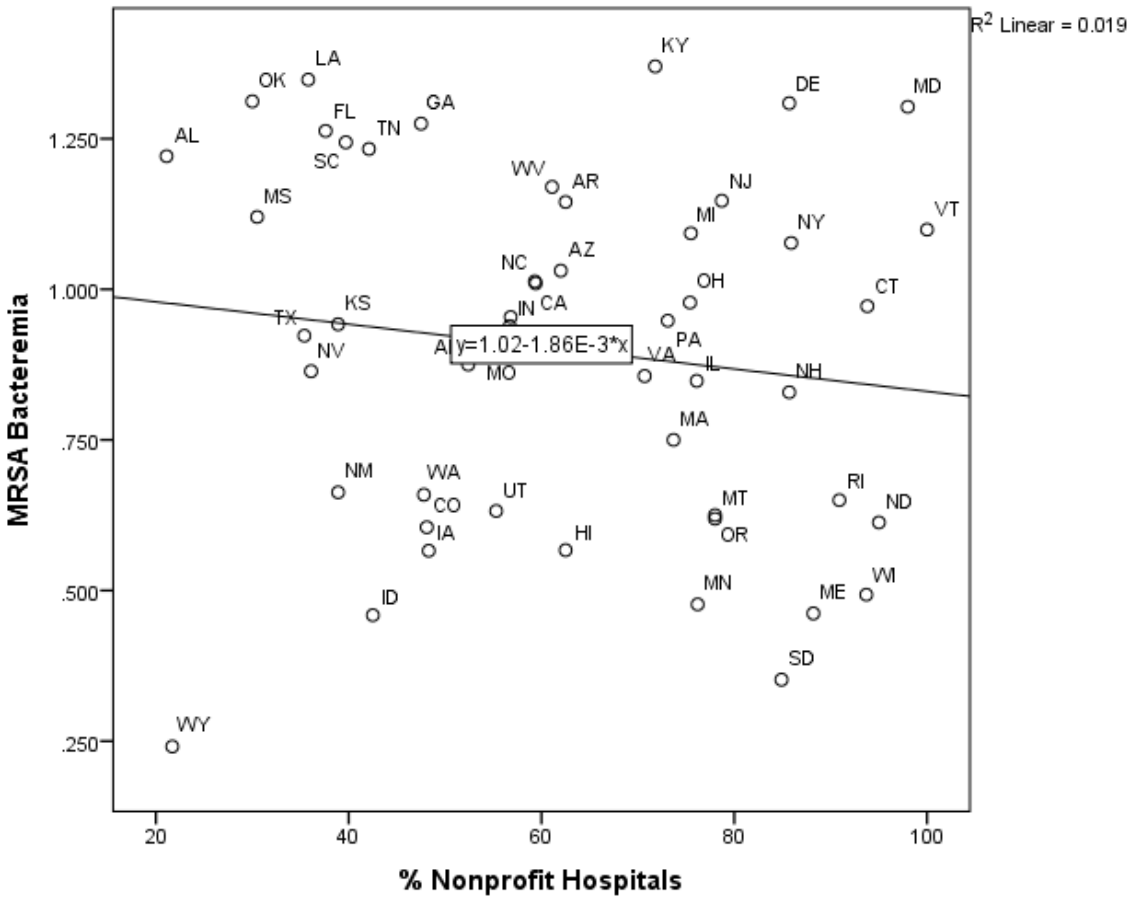

Figure 4 Scatter plot of MRSA bacteremia SIR and % nonprofit hospitals

Examination of the scatter plot does not indicate a linear relationship between state MRSA bacteremia infection ratios and the percent of nonprofit hospitals in the state. The slope is slightly negative. The coefficient of determination (R^2) value is 0.019, indicating that 1.9% of the total variability in state MRSA rates is accounted for by percent of nonprofit hospitals.

Hypothesis 5

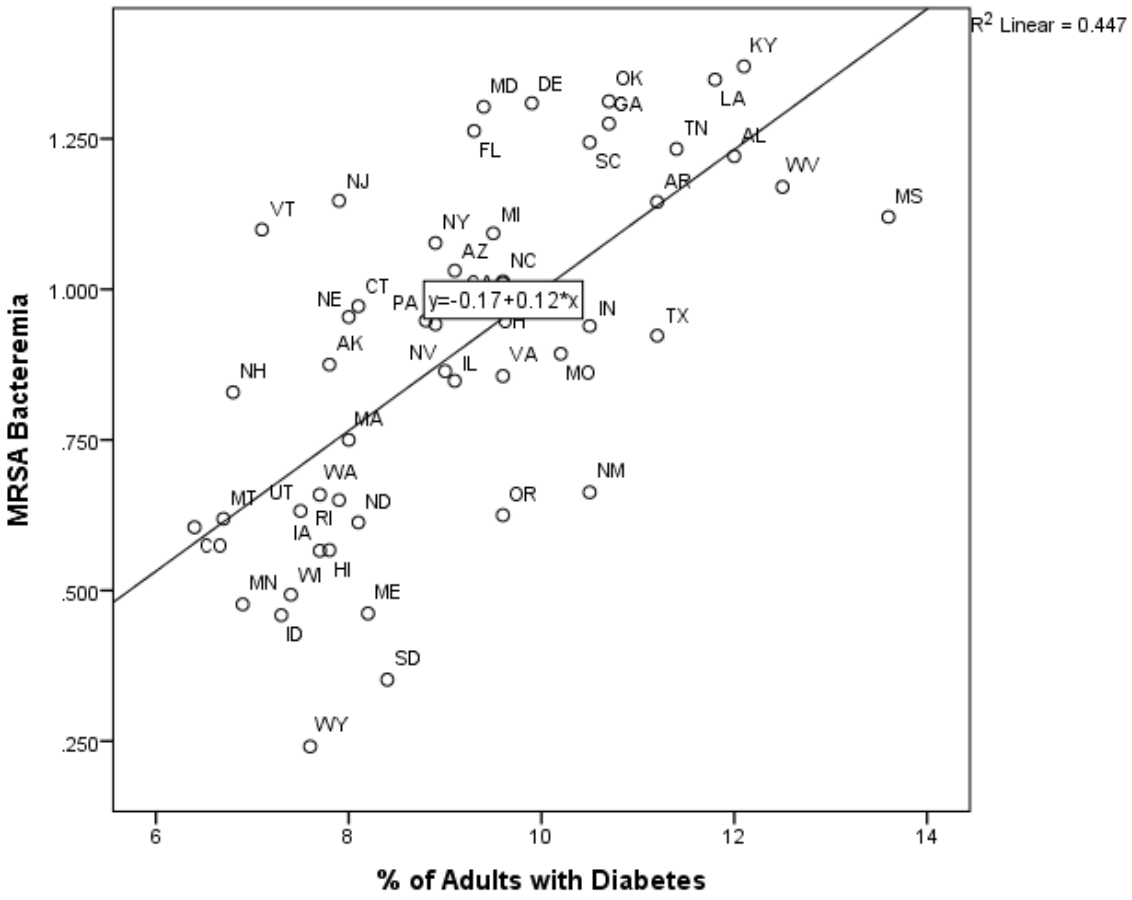

Figure 5 Scatter plot of MRSA bacteremia SIR and % of adults with diabetes

Examination of the scatter plot shows that state MRSA bacteremia infection ratios exhibit a strong linear relationship with diabetes, as measured by the percent of adults diagnosed with diabetes. The slope is distinctly positive. The coefficient of determination (R^2) value is 0.447, indicating that 44.7% of the total variability in state MRSA bacteremia infection ratios is accounted for by the percent of adults diagnosed with diabetes.

Hypothesis 6

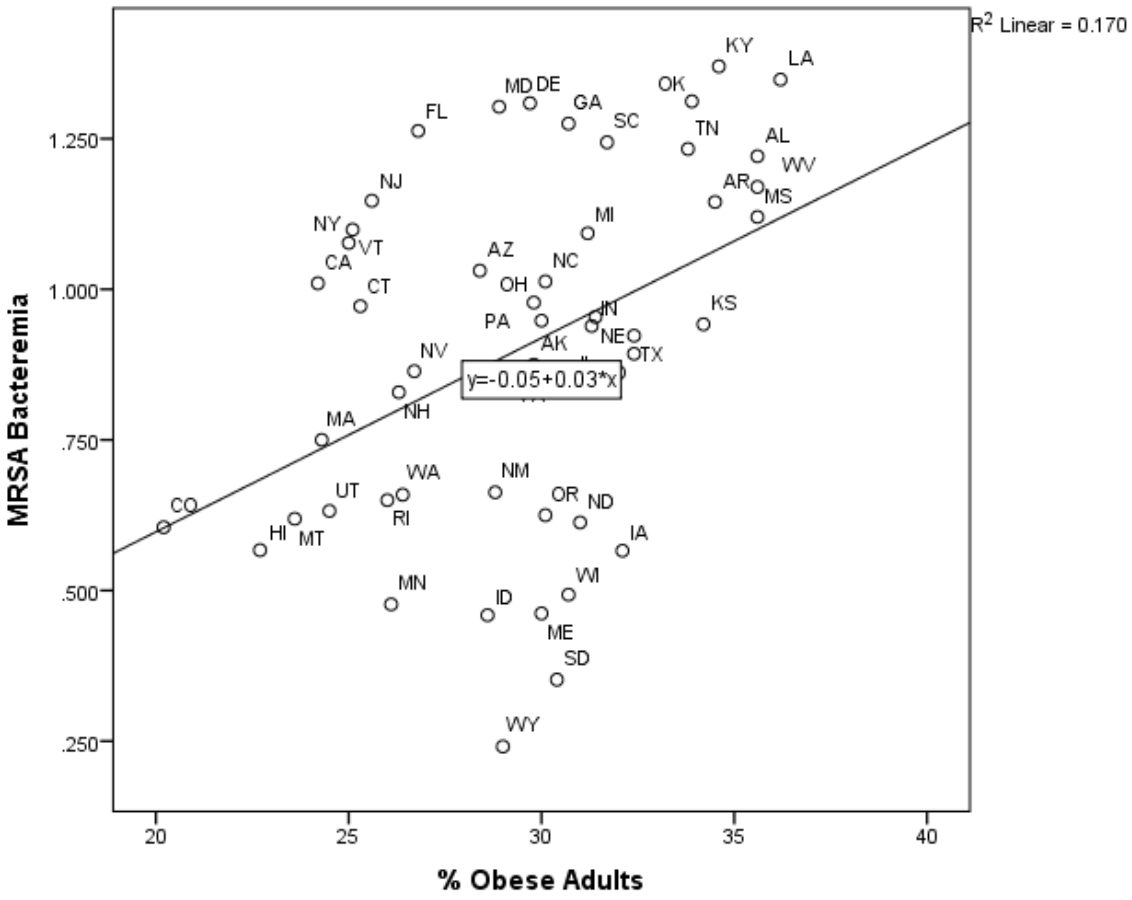

Figure 6 Scatter plot of MRSA bacteremia SIR and % obese adults

Examination of the scatter plot shows that state MRSA bacteremia infection ratios exhibit a generally linear relationship with obesity, as measured by the percent of obese adults. There is a positive slope. The coefficient of determination (R^2) value is 0.170, indicating that 17% of the total variability in state MRSA bacteremia infection ratios is accounted for by the percent of obese adults.

Hypothesis 7

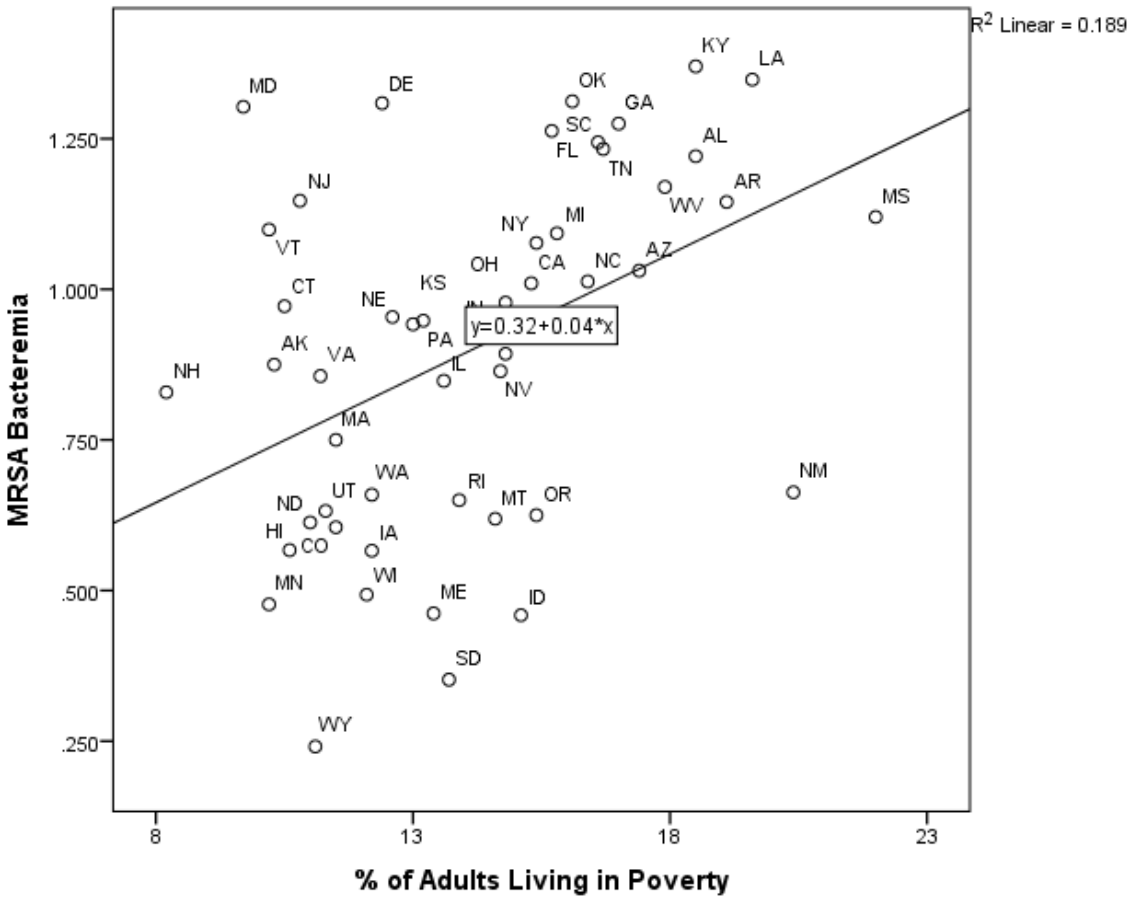

Figure 7 Scatter plot of MRSA bacteremia SIR and % of adults living in poverty

Examination of the scatter plot shows that state MRSA bacteremia infection ratios exhibit a somewhat linear relationship with poverty, as measured by the percent of adults living in poverty. There is a positive slope, indicating that as the percent of adults living in poverty increases, the MRSA bacteremia infection ratios generally exhibit a corresponding increase. The coefficient of determination (R^2) value is 0.189, indicating that 18.9% of the total variability in state MRSA rates is accounted for by the percent of adults living in poverty.

Correlation and Simple Linear Regression

Table 3 Pearson correlation and simple regression model statistics

Predictor Variables N=50	Pearson Correlation	Sig. (1-tailed)	R^2 Linear	F	Std. Error of the Estimate
High School Graduates	-.597**	.000	.357	26.642	.238144
Bachelor's Degrees	-.201	.081	.040	2.019	.290913
Rurality	-.022	.439	.000	.024	.296896
Nonprofit Hospitals	-.137	.172	.019	.916	.294175
Diabetes	.668**	.000	.447	38.758	.220891
Obesity	.413**	.001	.170	9.864	.270475
Poverty	.435**	.001	.189	11.219	.267363

**. Correlation is significant at the 0.01 level (1-tailed).

Several independent variables demonstrated statistically significant correlations with state SIR. The percentage of adults who had graduated high school was strongly associated with SIR, with higher percentages of high school graduates associated with lower SIR for the state. There was no statistically significant relationship between SIR and state percentage of adults with bachelor's degrees. The percentage of nonprofit hospitals did not exhibit a significant relationship to SIRs at the state level. State percentages of adults with obesity or diabetes exhibited a corresponding increase in SIR. The associations between SIR and high school graduates, obesity, diabetes, and poverty were significant at the $p < .01$ level. The coefficient of determination is strongest for high school graduates and diabetes, with r squared values of .357 and .447 respectively.

At the $\alpha = 0.01$ level of significance, state SIR for MRSA bacteremia is correlated with state percentages of high school graduates, state percentages of adults with diabetes, state percentages of obese adults, and state percentage of adults living in poverty.

The F values depict the overall significance of the regression models and how well the independent variables predict the dependent variable. The F values are highest for the regression models that predict state SIR as a function of the percentage of high school graduates in the state ($F = 26.642$) and the model that predicts state SIR as a function of the percentage of adults with diabetes in the state ($F = 38.758$). From among the 4 independent variables with p-values < 0.01, high school graduates and diabetes had the strongest correlation and highest F values.

Acceptance of Research Hypotheses

The results of correlation analysis and simple linear regression led to acceptance of 4 research hypotheses, and rejection of 3 hypotheses.

Hypothesis 1 – This hypothesis was accepted after statistical analysis revealed that a higher percentage of adults with high school diploma or higher was associated with lower state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia. This correlation was significant at the $P < 0.01$ level.

Hypothesis 2 – This hypothesis was not accepted because a higher percentage of adults with a bachelor's degree or higher was not strongly associated with lower state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 3 – This hypothesis was not accepted because a higher percentage of population living in rural areas was not associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 4 – This hypothesis was not accepted because a higher percentage of nonprofit hospital in states was not associated with lower SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia.

Hypothesis 5 – This hypothesis was accepted after statistical analysis confirmed that a higher percentage of adults with diabetes was associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia. This correlation was significant at the $P < 0.01$ level.

Hypothesis 6 – This hypothesis was accepted after statistical analysis confirmed that a higher percentage of obese adults was associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia. This correlation was significant at the $P < 0.01$ level.

Hypothesis 7 – This hypothesis was accepted after statistical analysis confirmed that a higher percentage of adults living in poverty was associated with higher state SIR for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia. This correlation was significant at the $P < 0.01$ level.

Linear Regression Models

The equations for linear regression models for each hypothesis are expressed below.

Table 4 Linear Regression Model Coefficients

Independent variable	Constant *(a)*	Slope *(b)*
High School Graduates**	6.190	-.060
Bachelor's Degrees	1.249	-.012
Rurality	.913	.000
Nonprofit Hospitals	1.016	-.002
Diabetes**	-.168	.117
Obesity**	-.046	.032
Poverty**	.316	.041

Dependent variable = MRSA bacteremia SIR
**. Correlation is significant at the 0.01 level (1-tailed).

The simple linear regression model equations are:

Predicted state MRSA bacteremia SIR = 6.190 - (.060)(state high school graduate %)

Predicted state MRSA bacteremia SIR = 1.249 - (.012)(state bachelor's degree %)

Predicted state MRSA bacteremia SIR = .913 + (.000)(state rural population %)

Predicted state MRSA bacteremia SIR = 1.016 - (.002)(state nonprofit hospital %)

Predicted state MRSA bacteremia SIR = -.168 + (.117)(state diabetic adult %)

Predicted state MRSA bacteremia SIR = -.046 + (.032)(state obese adult %)

Predicted state MRSA bacteremia SIR = .316 + (.041)(state adult poverty %)

CHAPTER V

DISCUSSION

The Study Variables

The results of this study provide insights into factors associated with standardized infection ratios, a metric used for several quality indicators for Medicare's value-based payment programs. The standardized infection ratio (SIR) is intended to be applicable to all hospitals, yielding a comparable measure of performance regarding infection prevention. This summary statistic is being used to track progress in preventing healthcare-associated infections (HAIs), and in determining financial rewards or penalties through the Hospital Value-Based Purchasing (HVBP) Program and Hospital Acquired Conditions Reduction Program (HACRP).

Some patterns and trends become more evident when data are aggregated. This examination of state-level data revealed some striking associations between standardized infection ratios (SIRs) for MRSA bacteremia and social risk factors and population health characteristics. An interesting finding was the lack of significant correlation between state SIR and the percent of nonprofit hospitals in the state. If MRSA bacteremia is associated with poverty, obesity, diabetes, and education, the expectation was that states with a greater proportion of nonprofit hospitals would have better (i.e. lower) SIRs. This was not the case, however, when examining state-level data. A potential reason for this lack of correlation involves what sort of community benefit is provided by nonprofit

hospitals. When hospitals provide services to uninsured or otherwise medically indigent populations, these uncompensated services comprise a portion of their community benefit requirement to maintain their nonprofit status.

Among the interesting findings of this study was that the percent of adults with a high school diploma was a much more significant predictor of state SIR than the percent of adults with a college degree. The original presumption was that higher levels of educational attainment would be associated with improved outcomes, in this case improved state SIRs for MRSA bacteremia. This effect is due to the established connection between education and health literacy (Mantwill, Monestel-Umaña, & Schulz, 2015). The effects of education – by way of health literacy – on SIR is consistent with the results of a Dutch study that concluded that "health literacy plays a larger role among those with lower education than among those with higher education" (van der Heide et al., 2013). Basic education at the high school level is a more salient predictor of health literacy and numeracy, which may explain its reason for exhibiting a stronger correlation with state SIR for MRSA bacteremia. Health literacy and numeracy facilitate compliance with medical instructions, medication adherence, positive health-related behaviors, and prevention of adverse events. Differences in educational attainment – and the vicarious relationship to levels of health literacy, numeracy, and technology skills – are a critical link in understanding causes of social disparities and health disparities (CDC, 2016). Improvements in medical, economic, and social position that can come from educational attainment can reduce the risk of infections and their complications. This is particularly

relevant given increasing chronic disease prevalence, which confounds efforts to manage infections effectively.

One research hypothesis speculated that states with a greater percent of their population in rural areas would have higher SIR. The data did not support this hypothesis. A possible reason for this is the tendency for state SIRs to be dominated by data from large hospitals, and those larger hospitals tend to be in urban areas. Thereby, the effect of rurality may not have been as pronounced in this study. If the average SIR was calculated for all hospitals in the state – as opposed to the traditional method of using the state sum of all observed events divided by the state sum of all predicted events – this would give equal representation to each hospital in the state SIR. This is explained in more detail in the next section discussing the limitations of the current study. Another reason that rurality may not have been a significant predictor of state SIRs for MRSA bacteremia is that there are great differences within and among rural areas in the U.S. Rural Wyoming is different from rural Kentucky, which is moreover different from rural Vermont. States with the similar levels of rurality may have other distinct differences in terms of public health funding, prevalence of chronic diseases, unemployment, environmental hazards, etc. Highly rural states may vary in terms of how they have overcome the health barriers typically associated with rurality, such as access to care. An example of this is the use of telemedicine, which allows patients to receive medical consultations and monitoring without traveling to the hospital (Goodwin & Tobler, 2013; West et al., 2014; Corrigan, Eden & Smith, 2003; HRET, 2014; Lee et al., 2015). Some health disparities that were exacerbated due to rurality can now be minimized with access

to telemedicine services. With respect to state SIR for MRSA bacteremia, it appears there are confounding variables that may inhibit the use of regression models based on rurality alone.

Two hypotheses that are related, but not the same, involved the relationship between state SIR for MRSA bacteremia and the percent of adults with obesity and diabetes. Both factors were significant predictors of state SIR, but the percent of adults with diabetes had a stronger correlation to the dependent variable. Obesity has been identified as a risk factor for infectious diseases and impaired immune system function (Campitelli, Rosella & Kwong, 2014; Guh et al., 2009; Pi-Sunyer, 2009; Poulain et al., 2006; Executive Summary, 1998). The percent of adults with diabetes may be a better predictor of state SIR than the percent of obese adults. The tendency for diabetic patients to have other medical conditions, such as cardiovascular disease or impaired functioning of the kidneys or immune system, could be putting these patients at risk of developing MRSA bacteremia. The growth of some bacteria is stimulated when levels of blood glucose are elevated, making it more likely that a patient will develop bacteremia. The association between diabetes and state SIRs for MRSA bacteremia may also be attributable to the extra burden on health systems to manage more medically and socially vulnerable patients. This may partially explain why states with more diabetic adults tend to have proportionally higher SIRs. Even when diabetic individuals are not the ones actually developing the MRSA infections, the mere act of managing diabetic patients contributes to the overall strain on health care resources that adversely impact outcomes for the patient population overall.

It is possible that the effects of some risk factors may not be immediately apparent when considered individually, and may be more pronounced when evaluated in combination with other factors. Other forms of regression analysis may also help to recognize relationships between state SIRs and social or medical risk factors.

Implications

There are wide-ranging implications of this study for individuals, healthcare facilities, policymakers, and those working in civil service.

The Public

Keller et al. emphasized that "given the potential impact on reputation and reimbursement, reliable reporting of HAIs is critical for hospitals, payers, and the public" (2013, p. 2). It is important for the public, as consumers of healthcare, to realize how social risk factors impact some measures of hospital performance. The purpose of public reporting of hospital measures is to allow individuals to make informed decisions about where to seek care. This also compels hospitals to improve their scores so that they will appear more attractive to consumers.

Hospitals

The U.S. Department of Health and Human Services (HHS) established targets for the reduction of healthcare-associated infections (HAIs). The targets are based on the new baseline data released by the Centers for Disease Control and Prevention (CDC) in late 2016. The target for invasive MRSA is a 50% reduction from the 2015 SIR. It is hoped that this research will contribute to an understanding of factors outside of the

hospital setting and their associations with infection rates and performance measures. The results can help manage organizational pressures that motivate compliance. The findings may aid in identifying resources necessary for successful adoption of infection prevention strategies in healthcare. Each state's ability to reach the established HHS targets will depend on the ability of hospitals to address fundamental risk factors among the populations they serve. Although this study focuses on standardized infection ratios in hospitals, it is expected that many of the concepts and concerns expressed here can help navigate regulatory compliance efforts beyond the realm of infection prevention. This study highlights the importance of communication and collaboration as essential ingredients for effective and sustainable quality improvement activities in health care.

Policy and Public Administration

The information gained from this study can serve to highlight the role of social risk factors in mediating health status and medical outcomes. Educational attainment, at least at the high school level, is among the factors that demonstrated a meaningful connection to state SIR for MRSA bacteremia. Experts have stated that improving health literacy should be a public health priority (Baur, 2010). The findings of the current study suggest the role that high school completion has on mitigating hospital infections. Basic education can provide foundational knowledge and skills to aid in communication, computation, comprehension, and patient engagement in medical care. This reinforces the need for states to invest resources in achieving or maintaining high rates of high school completion.

The present study invites a more holistic assessment of the risk adjustments used for calculating the standardized infection ratio (SIR). The data that is reported to NHSN by hospitals should be used in a manner that creates an accurate portrayal of the status of infection prevention efforts in the U.S. The strength of correlations between various social factors and state SIR for MRSA bacteria suggest that the adjustment factors in the 2015 baseline model insufficiently account for these variables. Refer to Appendix A for a table outlining the risk adjustment factors included in the 2015 model for SIR calculation. The model includes adjustments for certain facility characteristics, but does not account for broader social, economic, or medical risk factors that disproportionately affect certain regions of the U.S. Hospital size and number of predicted events should be considered when conducting program evaluations and appraising state progress in reducing healthcare-associated infections (HAIs). The SIRs should be stratified based on facility size and the number of predicted events, so that the overall state SIR can be assessed in the context of the types of facilities depicted in the measure.

Experts have alerted federal policymakers that there may be a justifiable need to consider the socioeconomic status (SES) of patient populations when comparing hospitals and issuing financial rewards or penalties under value-based purchasing programs. Advocates for the SES adjustment contend that it would help to avoid excessive penalties for hospitals that care for socially disadvantaged patients. Without these adjustments for SES, quality performance measures may essentially reward hospitals for having lower risk patients (Jha & Zaslavsky, 2014). Some experts have proposed using two separate measures – one for public reporting that does not include risk adjustments based on SES,

and another for calculating financial incentives that would adjust payment determinations based on the SES of the population (National Academies, 2016). The main criticism of an approach to risk stratification based on SES is that it would diminish the motivation for hospitals to improve quality for socially disadvantaged patients (Jha & Zaslavsky, 2014).

State SIRs for MRSA bacteremia may be analogous to the "canary in the coal mine" for antibiotic-resistant infections. Public health experts and medical professionals may be able to use these SIRs as a lead indicator for a rise in drug resistance and/or community disease transmission. Medical facilities can use the threat of MRSA bacteremia as a framework for enhancing overall surveillance processes, improving communication with internal and external stakeholders, and addressing community health risks. These activities and improvements would be transferrable to other emerging infectious disease threats and emergency preparedness efforts.

Governments may use grants and cooperative agreements with private and nonprofit organizations to address social risk factors, such as poverty. Patients who are poor may delay seeking medical care, and therefore be sicker by the time they arrive at a hospital. The results of this study are consistent with prior studies that establish poverty as a statistically significant determinant of health outcomes (Lied & Haffer, 2004; Gohil et al., 2015; Key Facts, n.d.).

The Affordable Care Act (ACA) created the Prevention and Public Health Fund (PPHF), which provides roughly 12 percent of the funding for various CDC activities involved in nationwide infection prevention efforts, including the Epidemiology and

Laboratory Capacity Program; infection surveillance, reporting, response, and prevention; and immunization support (APHA, n.d.). The findings of the current study reinforce the need for continued funding for the PPHF in order to make health improvements more widespread and sustainable.

Community vulnerabilities should be considered when drafting public policies regarding health promotion strategies or compensatory schemes for hospital performance. Demographic analysis can detect economic, social, and medical factors associated with poor health outcomes. As value-based payment programs are evolving to put greater emphasis on outcome measures, hospitals are compelled to "address both the medical and nonmedical factors that determine health status" (HRET, 2014, p. 4). Hospitals and health systems can expand their use of information technology and predictive analytics to identify high-risk populations. Ultimately, there may be greater use of genetic markers that would make medical providers aware that a patient may have greater propensity for unfavorable outcomes, thereby allowing them to be more proactive in preventing or mitigating the problem.

Prior research has found geographic variations in health care outcomes, with variability decreasing as outcomes were aggregated over larger geographic areas (Rosenberg et al., 2016). The researchers for that study cited the appeal by the Institute of Medicine (IOM) for more research on health care outcomes and quality. To answer this call – and recognizing that state-level analysis might obscure some of the variability in outcomes – additional studies are needed to explore factors associated with outcomes at the local level. Outcomes data transparency, including risk-adjusted measures to

account for social risks, helps patients make informed decisions, hospitals target their quality improvement efforts, and policymakers make comparisons among facilities (Rosenberg et al., 2016, p. 13).

Limitations

There are some limitations to this study, and to the study of healthcare-associated infections in general. The following pages delineate some of the potential shortcomings of the current study, and how those may be mitigated in subsequent research endeavors.

Reporting of Healthcare-Associated Infections

The primary threat to the integrity of this study is the reliability and comparability of data used to measure the dependent variable. Standardized infection ratios (SIRs) for methicillin-resistant *Staphylococcus aureus* (MRSA) bacteremia are derived from surveillance data that hospitals report to the CDC's National Healthcare Safety Network (NHSN). There may be inconsistencies in how surveillance definitions are applied in different healthcare facilities. Hospitals vary in terms of the knowledge, expertise, and surveillance capacity of their staff. Some facilities have specialized software, data mining programs, or computer-based algorithms to facilitate data collection. Novice (or overburdened) infection prevention staff are more likely to deviate from the CDC's established protocol, definitions, and criteria for reporting (CDC, 2015). There have been accounts of medical facilities 'gaming' their data to influence their infection rates. This could occur through intentional non-reporting of infection data, or through manipulation of how diagnostic testing is used to rule-in or rule-out certain types of infection (CDC, 2015). Data collected for January-December 2015 was used for payment calculations for

FY2017 Value-Based Purchasing (VBP) and FY2017 and FY2018 of the Hospital-Acquired Condition (HAC) Reduction Program. Appendix B shows FY2017 domain weighting for the Hospital VBP Program. Appendix C shows key information pertaining to FY2017 and FY2018 of the HAC Reduction Program.

State Lines

Some hospitals are located near state lines, causing their facility rates to be impacted by medical, social, economic, and organizational factors across multiple states. Residents in one state may seek hospital care in another state. There can be great disparities within states that could be obscured by aggregate statistics. There is also the potential for poor data quality among the measures used for the independent variables. There is a chance that measuring these variables at the state level could fail to detect key distinctions that would otherwise be apparent when examining data measured at the individual facility or county level. There is a chance that the independent variables may not accurately, or adequately, depict the nature of the relationship between standardized infection ratios (SIRs) and various medical, social, economic, and organizational factors.

Risk Adjustments

The standardized infection ratio (SIR) is intended to be a summary statistic that can be compared across geographic areas and medical settings. Data for 2015 was used to create a new baseline for MRSA bacteremia LabID SIRs. Utilizing negative binomial regression, the CDC developed a model to calculate the number of predicted events (CDC, 2017). The accuracy and adequacy of these risk adjustments depends on how well hospitals performed location mapping in the National Healthcare Safety Network

(NHSN). Hospitals must ensure that they input the appropriate location codes and include all applicable inpatient and outpatient locations in their reporting plan. This mapping process is intended to reflect the type of patients, their acuity level, and the clinical services provided in that unit. Data from outpatient departments is used to determine the community-onset prevalence of MRSA bacteremia. Additionally, hospitals must submit accurate and complete annual facility surveys in NHSN to input the average length of stay and medical school affiliation, as these have been found to be statistically significant predictors of MRSA bacteremia (CDC, 2017).

Despite the efforts to incorporate risk adjustments into the SIR calculation, this study suggests that there may be insufficient adjustments for social risk factors and population health status. Consequently, some hospitals may be unfairly subjected to penalties under Medicare's value-based payment programs. Some of the compelling reasons for increased infection risk and poor outcomes may be forces beyond the hospital's direct or immediate control.

Hospitals situated in states with higher rates of poverty and lower educational attainment may need more resources to effectively address these social determinants of health. The emphasis on drug-resistant infections – such as MRSA bacteremia – as an outcome measure for clinical quality is understandable considering the growing prominence of population health in health care reform efforts. It is also reasonable considering the growing threat of antibiotic-resistant bacteria. The purpose of these quality measures is to evaluate progress in effectively identifying and mitigating the root causes of infections. The results of this study illuminate some potential root causes that

exist within communities and populations. Based on these findings, improving state SIRs for MRSA bacteremia will necessitate multidisciplinary approaches to address health disparities, improve health literacy, and help manage chronic diseases like diabetes. These approaches will require investments in community health activities and preventive services. It may take a considerable amount of time before measurable improvements in the state SIR are seen, especially with regard to smaller hospitals, as will be explained in the next section of this chapter.

Size Matters

Larger hospitals have more influence on state SIRs, because they contribute more to the numerator and denominator of the standardized infection ratio calculation. This effect is demonstrated in the following simulated data table (Table 5). For this hypothetical example, the state has 100 hospitals: 50 large hospitals with 30 predicted infections each, and 50 small hospitals with 4 predicted infections each. This gives an overall predicted number of infection events as 1700 for the entire state.

Table 5 Simulation of effect of hospital size on state SIR

N = 100 Hospitals (50 large hospitals, 50 small hospitals)	# Observed Events	# Predicted Events	Combined SIR (Observed /Predicted)	Average SIR	Difference (Combined – Average)
All hospitals SIR = 1	1700	1700	1.0	1.0	0
Large hospitals SIR = 1 Small hospitals SIR = 2	1900	1700	1.118	1.5	-.382

Table 5 (Continued)

Large hospitals SIR = 2 Small hospitals SIR = 1	3200	1700	1.882	1.5	.382
Large hospitals SIR = 1 Small hospitals SIR = 0.5	1600	1700	.941	.75	.191
Large hospitals SIR = 0.5 Small hospitals SIR = 1	950	1700	.559	.75	-.191
Large hospitals SIR = 2 Small hospitals SIR = 0.5	3100	1700	1.824	1.25	.574
Large hospitals SIR = 0.5 Small hospitals SIR = 2	1150	1700	.676	1.25	-.574

This table shows the impact of hospital size on calculated state SIR. Larger hospitals have greater influence over the numerator and denominator.

As illustrated in Table 5, the state SIR depends heavily on the size of the hospitals factored into the state total of observed infection events. A single infection occurring in a small hospital could have dramatic impacts on that facility's SIR but will have a relatively negligible impact on the overall state SIR. When interpreting state SIRs it is important to consider the amplified influence of larger hospitals on the state calculation. The state SIR may not adequately represent the status of infection prevention efforts in smaller hospitals, because the larger facilities overshadow and dilute their influence.

Future Research

This study investigated whether social vulnerability corresponds to one of the outcome measures used for Medicare's value-based payment programs. The correlations and simple regression models for this study could be used with other healthcare-associated infection (HAI) measures as the dependent variable: catheter-associated

urinary tract infection (CAUTI), central line-associated bloodstream infection (CLABSI), surgical site infection, or *Clostridium difficile* laboratory-identified (LabID) events. This would determine whether the same independent variables that were significant in this study translate to other quality measures. The variables that were not significant in the current study (i.e. rurality, percent of population with bachelor's degree, and percent of nonprofit hospitals in the state) might have greater significance when correlated with other outcome measures as the dependent variable.

Another follow-up to this study would be to conduct analysis using data for subsequent years to detect changes over time. Researchers could monitor state performance with serial comparison of SIRs annually, in the context of socioeconomic, geographic, and organizational factors. Another possibility is to develop a multiple linear regression model to assess the SIR in the context of several independent variables simultaneously. The effect of some variables may be more pronounced when combined with other variables.

One of the tenets expressed in Mary Schmidt's article (1993) is that certain individuals possess an intimate understanding of the complex settings in which they work. Like the workers patching holes in the dam in Schmidt's article, experienced infection preventionists (IPs) develop a meticulous "feel for the hole." These IPs "build up a repertoire of strategies" and specialized knowledge that can be applied to particular situations (Schmidt, 1993). Unfortunately, there is a shortage of qualified IPs, which poses a risk to patient safety, care quality, and hospital performance on value-based metrics. It would be noteworthy to assess SIRs in the context of whether hospitals'

infection surveillance and reporting is performed by someone certified in through the Certification Board in Infection Control and Epidemiology, Inc (CBIC). A prior study by Keller et al. (2013) found significant variations in how surveillance definitions were interpreted, indicating "a need to better clarify these definitions, especially when comparing HAI rates across institutions" (p. 2). Like the hands-on workers who had developed an awareness and perception of how to handle specific situations, healthcare-associated infections "must be further understood in the context of particular local conditions." (Schmidt, 1993, p. 526). Specially-trained and experienced IPs are more likely to be attune to the social, economic, and geographic factors that impact infection risk.

The same independent and dependent variables used in this study might yield very different results if the unit of analysis was at the county or zip code level. This type of investigation would yield a more nuanced perspective of the contextual factors that influence health outcomes. Examining the data at the county level could help alleviate some of the limitations caused by SIR being influenced by larger hospitals. County-level analysis would help discern the effects of social risk factors on small and/or rural hospitals, whose data was overshadowed by larger hospitals in the state-level assessment. To further help distinguish the effects of hospital size on SIR, the results could be stratified based on facility characteristics, such as the number of licensed beds, number of ICU beds, and average length of stay.

From an epidemiological standpoint, it would be helpful to know what strains of MRSA are causing infections. There may be regional or facility-level differences in

circulating strains, with implications for prevent and treatment of infections. Microbiologic sampling could identify patterns of antibiotic resistance. It would also be interesting to study the association between MRSA bacteremia and various types of medical devices, procedures, and medications. Surveillance cultures could identify reservoirs of MRSA in the hospital and throughout the community, aiding in targeted efforts to prevent transmission. Public health officials could collaborate with hospital laboratories to share insights into local trends in incidence and prevalence of MRSA bacteremia, including high-risk populations.

Validation of infection data being reported to the National Healthcare Safety Network (NHSN) is an important consideration that merits further study. On the organizational theory front, it would be worthwhile to study hospital responses to Medicare's value-based payment programs through the lens of new intuitionalism. State and federal mandates are compelling coercive forces acting in conjunction with normative influences from professional associations and medical societies. Mimetic influence can be measured in the form of participation in community coalitions and inter-facility sharing of best practices, policies, and procedures. Value-based payment programs are also suitable for the study of interdependence as delineated in Pfeffer and Salancik's book *The External Control of Organizations: A Resource Dependence Perspective* (2003).

Case studies would be useful in appraising medical risk factors among patients that experience an MRSA bloodstream infection. Because MRSA bacteremia infections used for quality reporting are laboratory-identified (LabID) events, they do not consider

the patient's medical status or any clinical information about the patient beyond the admission date and the date that the specimen was collected.

A study published in January 2017 (Hu & Nerenz) found support for the notion that hospital quality scores "may be affected by community factors such as poor public transportation or limited social support services" (p. 137). Hu and Nerenz examined hospital quality star ratings, as published by CMS on the Hospital Compare website, relative to "stress" rankings of 150 US cities. They found that hospital star ratings tend to be higher in cities with lower stress. For their study, overall stress was based on 27 metrics of work-related stress; money-related stress; family-related stress; and health and safety related stress; and coping ability. Similar methodology could be applied to a study of individual quality measures to determine whether some performance metrics are more influenced by stress level in communities.

Conclusions

The inferences drawn from this study are that efforts aimed at addressing social determinants of health can reduce rates of infections in hospitals. To succeed under value-based payment schemes, hospitals must recognize risk factors in the community that influence health outcomes. Medical facilities should be engaging in activities that promote population health, health equity, and considering social determinants of health, such as poverty and educational attainment. "Almost all outcome measures require risk adjustment to account for differences in the severity of a patient's illness, comorbid conditions, physiologic and socioeconomic status, and other characteristics that may affect outcomes but are not under providers' control" (Baker & Chassin, 2017, p. 420).

As a direct result of value-based payment measures, hospitals are recognizing that patient outcomes impact community health, and vice-versa. This study found that higher prevalence of diabetes, obesity, and poverty in a state may adversely impact the number of MRSA bacteremia events, when compared to the number of events predicted by the CDC's current risk adjustment methodology. Additionally, states with a higher percent of adults that did not complete high school fared worse on their standardized infection ratio (SIR), suggesting the consequence of educational attainment with regard to health outcomes.

The National Healthcare Safety Network (NHSN) offers a rich source of data about healthcare processes and outcomes. The standardized infection ratio (SIR) adjusts for certain facility-level factors, such as facility size, number of ICU beds, and average length-of-stay. These risk adjustments serve to standardize the data across facility types. However, when data is aggregated at the state level, SIRs are highly correlated with non-hospital risk factors, suggesting that hospitals' performance may be a function of broader characteristics of the populations they serve. Originally developed as a platform for public health surveillance and epidemiologic research, NHSN established a national baseline to which hospital can compare. This allowed hospital to set goals for improvement and track their performance relative to a national baseline. However, when the data from NHSN was integrated into the Medicare value-based payment programs, the surveillance data was used to make direct interfacility comparisons, ranking hospitals by performance, and stigmatizing and penalizing hospitals with higher SIRs. The striking limitation of NHSN data is the lack of adjustments for social risks, health-related

behaviors, or overall health of the population when calculating the predicated number of events for the standardized ratio.

As Schmidt (1993) alluded to, experts tend to select solutions to fit their methods. In that vein, NHSN data started being used for value-based payment programs because it was available, not necessarily because it was optimally-suited for the task of making assessments about quality of care delivered. When the Centers for Medicare and Medicaid Services (CMS) decided to use NHSN data for their reporting programs to make comparisons of hospital performance throughout the U.S., there were no additional risk adjustments made to the SIR to account for local health and social disparities that affect the outcome measures. NHSN data is a phenomenal resource for epidemiologic surveillance, which it was designed to do. However, variations in SIR are likely attributable to many factors outside the hospital and within the community or region. Value determinations made based on the SIR could exacerbate problems with health care access and health equity. If social risks are not considered in the SIR, hospitals may be penalized for factors beyond their immediate control. In the era of the second curve of health care reform, hospitals are working to address community health needs and improve population health, but those efforts could take years to show significant positive effects on infection-related outcomes.

A goal of federal reporting and payment programs has been to increase transparency and accountability through public reporting of HAI data. By posting hospital scores, consumers have more data to guide their decisions about where to seek care, and hospitals would be driven by competitive forces to improve their market

position. Critics have asserted that some of the outcome measures could create misleading perceptions of hospital performance because they don't show complete information about intervening factors that may have influenced the outcomes (Baker & Chassin, 2017).

The Department of Health and Human Services (HHS) has acknowledged the relevance of social risk factors and is considering ways to better account for these dynamics in quality measures so that hospitals in high-risk areas are not unduly penalized (National Academies, 2016). Experts have remarked that "judging whether an outcome measure is adequate often is more subjective and nuanced than evaluating process measures" (Baker & Chassin, 2017, p. 422). The information that can be extrapolated from NHSN may be insufficient to allow federal regulators to make sound judgements about adequacy or appropriateness of care delivered in hospitals, without knowing more about the patient population and the social context in which services are provided.

Federal programs are increasingly using outcome measures to determine payments and penalties. Quality measures can be enhanced by incorporating risk adjustments for factors that are significantly associated with outcomes, such as diabetes, obesity, poverty, and educational attainment (Baker & Chassin, 2017). The inclusion of these risk adjustments into the calculation of the standardized infection ratio (SIR) for MRSA bacteremia would yield a metric that is more accurate, relevant, and supportive of the overall aims of better health and safer care. Given the unprecedented legislative and regulatory focus on healthcare-associated infections (HAIs) as an outcome measure for hospital quality, it is imperative that these measures are assessed in the context of the

local populations, taking into account the "alternative kinds of bottom-up knowledge" that can improve the accuracy and appropriateness of regulatory actions (Schmidt, 1993, p. 530). This type of knowledge could come from clinical staff, patients, hospital administrators, pharmacists, quality directors, and infection preventionists (IPs). Another point that Schmidt makes is that "removing objects from contexts and dividing them into independent parts" (p. 527) runs the risk of disrupting valuable discernments of the circumstances and details of the thing as a whole. This is certainly the case with healthcare-associated infections for which "partial knowledge" may not add to up "reliable knowledge of the whole" (p. 527). The NHSN data represents partial knowledge of the overall issue of factors contributing to health outcomes. Furthermore, the way that HAI measures are depicted on public reporting websites only offers a limited view of the broader issue of hospital quality. There is important and relevant information that is not represented by publicly-reported quality measures. The public thereby only gets partial knowledge from which to make determinations about the organization as a whole.

The variables explored in this study yield insights into types of information – and types of knowledge – that pertain to state performance on the MRSA bacteremia measure. In 1993, Mary Schmidt described four alternative kinds of knowledge that are sometimes ignored or overlooked. This study highlights several possible sources of information that have not received sufficient consideration in federal value-based payment programs. With greater input from frontline medical professionals and local public health authorities, the quality measures included in these programs can be

enhanced to better reflect hospital performance, while accounting for vulnerabilities and risks inherent among the patient population.

Policy decisions that can be made in response to the issues brought forth in the current research include actions to address social risk factors, such as community programs to alleviate the adverse effects of poverty. The relationship between health status and education attainment suggests that efforts to reduce high school dropout rates could ultimately improve hospital efforts at HAI reduction. Public education can also benefit health outcomes through the health curriculum in schools, improving students' health literacy. Transportation can be a major obstacle to receiving medical care. Local policymakers can work to improve accessibility to public transportation, high-speed internet service, safe drinking water, parks and recreation, affordable housing, mental health services, employment opportunities, and nutritious foods. Smoking bans and vaccination programs help to keep communities healthy. To help overcome systemic barriers to health care access, policymakers can create incentives for medical providers to practice in rural or underserved areas (Goodwin & Tobler, 2013).

Although many hospitals report hospital infection data to NHSN to comply with CMS regulations, some states have gone a step further, issuing mandates requiring facilities to publicly report certain conditions. Another state policy issue that impacts hospitals is Medicaid expansion. In states with stricter Medicaid eligibility requirements, there may be a larger population that lacks insurance coverage. Consequently, those individuals may delay seeking medical care until a problem has gotten very serious, making it less likely for them to have a good outcome. The opioid crisis creates

additional challenges for improving patient outcomes. Individuals with substance use disorders have increased risk for infection, and intravenous drug use is associated with higher rates of HIV and hepatitis, which contribute to poor health status. Substance use disorders are also associated with risky sexual behaviors and higher rates of sexually-transmitted infection (STI), which includes HIV and hepatitis, as well as various bacterial infections such as gonorrhea, chlamydia, and syphilis. Communities with higher rates of bloodborne diseases or sexually-transmitted infections may experience more substantial challenges with achieving positive health outcomes for other conditions. For this reason, public health efforts to combat substance abuse and STIs simultaneously address some of the risk factors for healthcare-associated infections.

Healthcare-associated infections (HAIs) continue to be an important issue burdening patients and health systems worldwide. The purpose of this study was to determine if a specific type of infection (MRSA bacteremia) is associated with certain characteristics of the population, as measured at the state level. Many variables influence healthcare outcomes. Although data may be summarized into performance scores or star ratings, in reality these results come from the interaction of multiple complex factors. Through interdisciplinary teams and community partnerships, hospitals can help improve the health of their communities (Lee et al., 2015). Healthcare coalitions and trade organizations should share best-practices, lessons learned, and contribute to the collective knowledge about the medical and social environment. Although many aspects of the value-based purchasing program perpetuate a culture of competition, greater and more

sustainable improvements can be made through collaboration. "No one sees it all, but each may contribute to a fuller picture" (Schmidt, 1993, p. 527).

As Schmidt (1993) indicated, reality is rich and complex. Each action or condition does not have a single reaction or outcome. Some communities endure the cumulative burden of multiple forms of risk: social, environmental, economic, and medical. Federal value-based payment models will benefit from efforts to better understand the intricacies of their measures – the "holes"– and ultimately to get an enhanced sense of what is needed to reduce MRSA bacteremia events. This also gives a sense of how to improve patient experiences, achieve better population health, and use resources wisely. This is not simply a matter of seeing the big picture versus seeing the detailed picture; it's a matter of assembling multiple pictures taken by different photographers from various vantage points to get a feel for the "whole" that is healthcare quality.

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APPENDIX A

RISK ADJUSTMENT FACTORS INCLUDED IN THE STANDARDIZED INFECTION RATIO (SIR) CALCULATION FOR MRSA BACTEREMIA

Table 6 Risk factors included in SIR calculation for MRSA bacteremia

Parameter	Parameter Estimate	Standard Error	P-value
Intercept	*-11.3759*	*0.1167*	*<0.0001*
Inpatient community-onset prevalence rate: > 0.037 per 100 admissions	0.3650	0.0286	<0.0001
Inpatient community-onset prevalence rate: ≤ 0.037 per 100 admissions	REFERENT	-	-
Average length of stay: ≥ 5.1 days	0.2787	0.0343	<0.0001
Average length of stay: 4.3-5.0 days	0.0955	0.0341	0.0050
Average length of stay: 0-4.2 days	REFERENT	-	-
Medical school affiliation: Major	0.2585	0.0334	<0.0001
Medical school affiliation: Graduate/undergraduate	0.1166	0.0345	0.0007
Medical school affiliation: Non-teaching	REFERENT	-	-
Facility type: Cancer Hospital	1.1894	0.2085	<0.0001
Facility type: General Acute Care Hospital	0.4355	0.0897	<0.0001
Facility type: Other Specialty Hospital	REFERENT	-	-
Number of ICU beds: ≥ 45	0.5650	0.0898	<0.0001
Number of ICU beds: 21-44	0.4599	0.0899	<0.0001
Number of ICU beds: 11-20	0.3394	0.0922	0.0002
Number of ICU beds: 7-10	0.4720	0.0993	<0.0001
Number of ICU beds: 0-6	REFERENT	-	-
Outpatient community-onset prevalence rate ED/24-hour Observation unit: > 0.032 per 100 encounters	0.3476	0.0336	<0.0001
Outpatient community-onset prevalence rate ED/24-hour Observation unit: > 0 and ≤ 0.032 per 100 encounters	0.1048	0.0330	0.0015

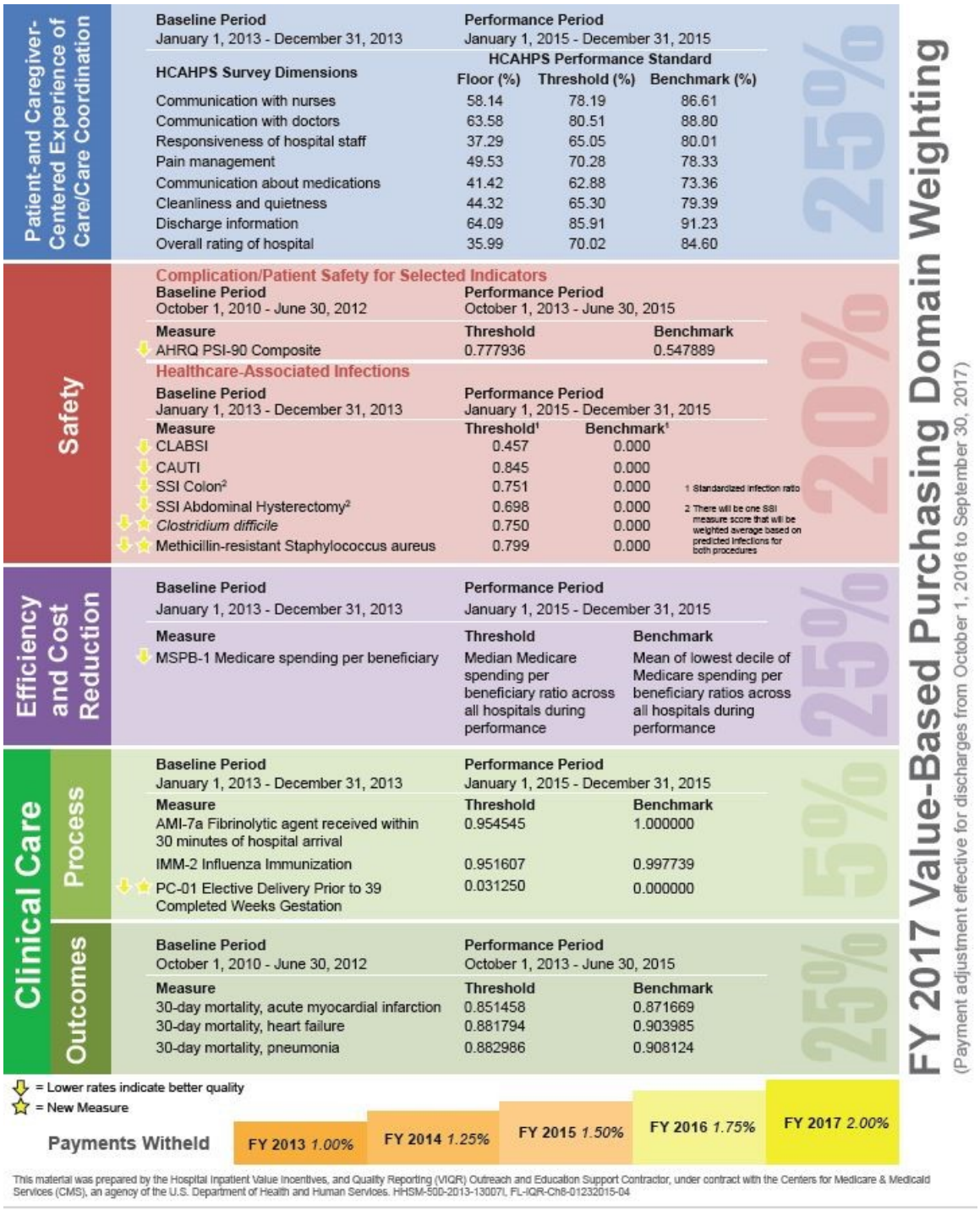
Table 6 (Continued)

Parameter	Parameter Estimate	Standard Error	P-value
Outpatient community-onset prevalence rate ED/24-hour Observation unit: 0 per 100 encounters, or no applicable locations	REFERENT	-	-

From the document "The NHSN Standardized Infection Ratio (SIR): A Guide to the SIR" (CDC, 2017).

APPENDIX B

FISCAL YEAR 2017 VALUE-BASED PURCHASING DOMAIN WEIGHTING



This figure shows key dates and measures for fiscal year (FY) 2017 of the Hospital Value-Based Purchasing (VBP) Program. The standardized infection ratio (SIR) for MRSA bacteremia for calendar year (CY) 2015 is in the performance period for this fiscal year.
https://www.qualityreportingcenter.com/wp-content/uploads/2015/02/IQR-FY2017_VBP-Domain-Weighting-Infographic.pdf

APPENDIX C

KEY INFORMATION FOR THE HOSPITAL-ACQUIRED CONDITION (HAC)

REDUCTION PROGRAM, FISCAL YEARS 2017 AND 2018

KEY INFORMATION FOR THE HOSPITAL-ACQUIRED CONDITION (HAC) REDUCTION PROGRAM

Key Dates

Fiscal Year (FY)	Measures Included	Performance Period[1]	Domain Weighting	Review and Corrections Period[2]	Medicare Discharge Payment Adjustment Dates[3]	Public Reporting on *Hospital Compare*
FY 2017	**Domain 1:** Recalibrated Patient Safety Indicator (PSI) 90 Composite **Domain 2:** CDC NHSN Measures (CAUTI, CLABSI, SSI, MRSA, CDI)	**Domain 1:** 7/1/2013 – 6/30/2015 **Domain 2:** 1/1/2014 – 12/31/2015	**Domain 1:** 15% **Domain 2:** 85%	7/19/2016 – 8/17/2016 **Second Review and Correction Period:** 9/1/2016 – 09/30/2016[5]	Payment adjustment applies to all Medicare discharges from: 10/1/2016 – 9/30/2017	December 2016
FY 2018	**Domain 1:** Recalibrated PSI 90 Composite[6] **Domain 2:** CDC NHSN Measures (CAUTI, CLABSI, SSI, MRSA, CDI)	**Domain 1:** 7/1/2014 – 9/30/2015 **Domain 2:** 1/1/2015 – 12/31/2016	**Domain 1:** 15% **Domain 2:** 85%	7/19/2017 – 8/17/2017	Payment adjustment applied to all Medicare discharges from: 10/1/2017 – 9/30/2018	December 2017

Domain 1 – Agency for Healthcare Research and Quality Recalibrated PSI 90 Composite Component Measures[6]

Recalibrated PSI 90 Composite Claims-Based Measure	PSI 03	PSI 06	PSI 07	PSI 08	PSI 09	PSI 10	PSI 11	PSI 12	PSI 13	PSI 14	PSI 15
FY 2017 – Performance period ends 6/30/2015 Claims data "Snapshot[4]" 9/25/2015	X	X	X	X	-	-	-	X	X	X	X
FY 2018 – Performance period ends 9/30/2015 Claims data "Snapshot[4]" 9/30/2016	X	X	-	X	X	X	X	X	X	X	X

Domain 2 – Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN) Healthcare-Associated Infection (HAI) Measures

Chart-Abstracted Surveillance Data (CLABSI, CAUTI, SSI) and Laboratory-Identified Surveillance Data (MRSA, CDI)	CLABSI	CAUTI	SSI	MRSA	CDI
FY 2017 – 1/1/2014 – 12/31/2015	X	X	X	X	X
FY 2018 – 1/1/2015 – 12/31/2016	X	X	X	X	X

The tables above show key dates and measures for fiscal years 2017 and 2018 of the hospital-acquired condition (HAC) Reduction Program. The standardized infection ratio (SIR) for MRSA bacteremia for calendar year (CY) 2015 is in the performance period for these fiscal years.