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Paying for Performance: How is the Hospital Acquired Conditions Reduction Program Affecting Safety-Net Hospitals and their Infection Rates?

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Abstract

Paying for Performance: How is the Hospital Acquired Conditions Reduction Program Affecting Safety-Net Hospitals and their Infection Rates?

By Victoria L. Bonisese

The Centers for Medicare and Medicaid Services' (CMS) Hospital Acquired Conditions Reduction Program (HACRP) is a pay-for-performance program that ranks and penalizes hospitals based upon their hospital acquired condition rates. Research on pay-for-performance programs has indicated that safety-net hospitals are disproportionately fined compared to their non-safety-net counterparts. This has led to concern that pay-for-performance policies widen the gap between safety-net and non-safety-net hospitals. Though research has been done on other pay-for-performance programs, it is unclear how HACRP penalties are distributed amongst hospital type and how the policy is affecting the clinical outcome of interest, infection rates. The purpose of this study is twofold. It examines how penalization by the HACRP is distributed across safety-net and non-safety-net hospitals and how catheter-associated urinary tract infection (CAUTI) and catheter-associated bloodstream infection (CLABSI) rates change after policy implementation. HACRP performance data (2015-2017) and hospital infection rates (2013-2016) were gathered from Hospital Compare. Hospital characteristics were gathered from the CMS Inpatient Prospective System. Logistic regression was used to examine odds of penalization by the HACRP, and ordinary least squares regression was used to assess CAUTI and CLABSI rates before and after policy implementation. Safety-net hospitals are 1.32 times more likely to be fined by the HACRP than non-safety-net hospitals. Relative to 2013, the gap in CAUTI rates between safety-net and non-safety-net hospitals closed by 20.2 infections per 1,000 device days. The decline in CLABSI rates was not significant, however this was likely due to a high degree of variation in rates in 2013-2014. Both safety-net and non-safety-net hospitals experienced a 48% reduction in CAUTI rates from 2013-2016, while safety-net hospitals improved their CLABSI rates by 36% and non-safety-net hospitals improved by 19.7%. This analysis indicates that safety-net hospitals are disproportionately fined under the HACRP. Results also indicate that, despite this penalization difference, safety-net hospitals are improving their infection rates. Although safety-net hospitals are improving, it is important to note that hospitals with lower baseline performance may never improve enough to escape penalization. With this in mind, pay-for-performance policy may benefit from incentives or reduced penalization for lower performing hospitals that reach a specified improvement benchmark.

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Table of Contents

I. Introduction

The Affordable Care Act (ACA) may be best known for its individual insurance mandate, but the law is also responsible for the institution of new methods of payment reform and quality improvement. Changing the way Medicare reimburses hospitals for their services was deemed necessary in order to curb increased healthcare spending and promote higher quality care. To do this, the ACA introduced many reforms, three of which are pay-for-performance programs that alter Medicare reimbursement rates based on quality measures. Two of these programs, Value Based Purchasing (VBP) and the Hospital Readmissions Reduction Program (HRRP), were introduced in fiscal year (FY) 2013, and the third program, the Hospital Acquired Conditions Reduction Program (HACRP) was implemented in FY 2015.[1]

VBP is a payment system designed to incentivize quality improvement by rewarding hospitals for the quality of care they provide to Medicare patients; quality is measured by the adherence to clinical best practice, patient experience and mortality rates of patients with selected diagnoses.[2] This program redistributes the funds saved from cutting reimbursement to lower scoring hospitals by increasing reimbursement to higher scoring hospitals.[2] Similarly, the HRRP aims to increase quality of inpatient care by reducing payments to hospitals with excess readmissions.[3] The HACRP reduces Medicare reimbursement to hospitals with the worst performance on various hospital acquired conditions (HAC) measures. While improved quality and decreased costs are positive changes, there is evidence to support they may be disproportionally affecting safety-net hospitals.[4] [5]

While most of the literature on previous HAC-related programs address overall effectiveness, there has been little to no investigation into how these programs affect safety-net hospitals. A breakdown of the various programs and their effects mentioned throughout this literature review can be found in Table 1 (see Appendix.) There is evidence that safety-net hospitals, defined as those with a high Medicaid caseload, have both greater rates of HACs[6] and lower rates of improvement in quality measures over time.[7] [8] This trend may be inherent to the nature of a safety-net hospital rather than a result of sub-par care. Safety-net hospitals serve a relatively poor population that is largely uninsured or insured via Medicaid and, as a result, is less able to access regular care. If the new HACRP policy disproportionally affects safety-net hospitals, and this is compounded by other pay-for-performance programs (see Appendix, Table 2) and upcoming DSH payment cuts, safety-net hospitals may suffer a substantial funding reduction that could create or further widen quality disparities.

This study will contribute to filling two main research gaps. First, it will provide insight into whether safety-net hospitals are disproportionately penalized, as has been found with assessments of other pay-for performance programs and some early analyses of the HACRP. Second, it will examine if the incidence of CAUTI and CLABSI decreases after the HACRP is implemented. Examination of the HACRP is important because safety-net hospitals are vital to the healthcare of many communities and are already facing systematic funding cuts regardless of their performance. If this newest pay-for performance program does disproportionally affect safety-net hospitals, then the social cost of fining safety-net hospitals needs to be weighed against the benefit of potential quality improvement.

II. Background

a. Safety-Net Hospitals

There is no consensus on what constitutes a safety-net hospital, but recent studies have defined safety-net status using Medicare disproportionate-share hospital (DSH) patient percentage[9] or Medicaid caseload.[10] [11] DSH patient percentage is defined by (Medicare

Supplemental Security Income Days/Total Medicare Days) + (Medicaid, Non-Medicare Days/Total Patient Days.)[12] This formula encompasses a hospital's Medicare patients who are eligible for Supplemental Security Income (SSI) and a hospital's Medicaid caseload. SSI is given to those who qualify based on the determination that Social Security Income and other sources of income are not enough to meet basic needs.[13] Researchers have examined safety-net hospitals for decades, and results indicate these hospitals have many of the same characteristics. Safety-net hospitals are more likely to have fewer registered-nurses (RNs),[14, 15] along with fewer hospitalists, privileged physicians and full-time personnel.[16] In addition, a 2014 analysis on failure to rescue (FTR), or the failure to recognize and mitigate mortality from a surgical complication, found that safety-net hospitals had higher odds of FTR than non-safety-net hospitals, and were less likely to have a fully implemented electronic medical record (EMR.)[14] Similarly, a study by Hoehn et al. examined surgical outcomes and found that safety-net hospitals had higher odds of mortality for 3 out of 9 procedures studied, higher odds of readmissions for 2 procedures, and the highest cost of care for 7 of 9 procedures.[17] It was also found that safety-net hospitals had the highest proportion of emergency cases, longer length of stay and higher rates of surgical complications.[17]

In addition to lower staffing levels and higher odds of poor outcomes, a 2016 study conducted by Hoehn et al., referenced above, found the population in safety-net hospitals was more likely to be of low socioeconomic status and have high severity of illness.[17] This finding reinforces a 2014 report by the Healthcare Cost and Utilization Project (HCUP) which notes that 41.2% of patients at safety-net hospitals are in the lowest income quartile.[18] This report also found that 27.4% of safety-net hospitals are located in a large central metropolitan area and, compared to non-safety net hospitals, patient admissions were more likely to be for mentalhealth related disorders such as schizophrenia.[18] Safety-net patient demographics reported in a recent analysis on the Hospital Readmissions Reduction Program noted that the typical safety-net hospital patient was less likely to be white and more likely to be dual-eligible for Medicaid.[19]

Due to their tendency to be under resourced and serve a more complex case-mix, it is reasonable to hypothesize that safety-net hospitals will perform worse than non-safety-net hospitals on hospital-acquired condition metrics. This research addresses how often safety-net hospitals are fined by the HACRP in comparison to non-safety-net hospitals. This research also aims determine the policy's effectiveness by assessing if selected hospital-acquired conditions are reduced when the HACRP is introduced. In short, the purpose of the research is twofold; to examine and compare the frequency of penalization by the HACRP between safety-net and non-safety-net hospitals and assess the policy's effectiveness at reducing hospital-acquired conditions by examining the incidence of Catheter-Associated Urinary Tract Infections (CAUTIs) and Catheter-Associated Bloodstream Infections (CLABSIs.)

This analysis is pertinent today because of the constant change and debate surrounding health policy, and the movement toward value-based care. Moving toward healthcare that is value rather than volume-based is an important progression, but it is equally important to ensure that policies intended to promote high value are, in fact, doing so. If incidences of CAUTIs and CLABSIs are not declining with the institution of the HACRP, then it may be of interest to reexamine the policy's design. In addition, if safety-net hospitals are disproportionally fined by the HACRP but infection rates *do* decline, policy makers must consider which priority is more important: lowering hospital infection rates or preventing the widening of care disparities caused by lack of fiscal resources.

It is apparent that safety-net hospitals have a complicated case mix and serve a larger percentage of Medicaid and uninsured patients than their non-safety-net counterparts. As a result of this, they often operate at a low or negative margin. The potential that new policies are consistently penalizing safety-net hospitals is problematic when considering their low operating margin, but even more concerning considering the recent Medicare DSH cuts and pending cuts in Medicaid DSH scheduled for FY 2020.[20] These payment reductions, which will continue through 2025, will reduce funds to safety-net hospitals by 4 billion in 2020 and increase to a reduction of 8 billion per year from 2021 through 2025.[20] This is a notable decrease in funds and is likely to significantly affect safety-net hospitals. In 2010, it was estimated that, without DSH payments, safety-net hospitals would have an average operating margin of -6.1%.[21] This estimate exemplifies the potential harm that DSH payment reduction could cause safety-net hospitals even without the compounding effects of pay-for-performance programs.

a. CAUTIs, CLABSIs, and Their Implications

CAUTIs and CLABSIs are device-associated infections, that is, they are caused, in part, by a device foreign to the human body. Both CAUTIs and CLABSIs occur as the result of catheterization. CAUTIs occur when there is an infection in any part of the urinary system and a catheter is present; the greatest risk factor for a CAUTI is prolonged use of a urinary catheter.[22] CLABSIs occur when the central line placed in a large vein to deliver medicine, fluids, or draw blood becomes infected. This infection results from bacteria entering the bloodstream through the central line site.[23] There are established best practices employed to reduce the incidence of CAUTIs and CLABSIs; for prevention of CAUTIs, the CDC recommends adherence to proper hand hygiene, minimization of catheter use and duration, and proper training of personnel who insert catheters.[24] For prevention of CLABSIs, the CDC recommends hand hygiene, the use of skin antiseptic around insertion site, the use of sterile barrier precautions and the removal of the central line as soon as it is no longer needed.[25]

In 2009, it was estimated that HAIs cost hospitals anywhere from $28 to $45 billion and affect nearly 2 million patients.[26] CAUTIs and CLABSIs comprise a large part of this burden. It is estimated that CAUTIs cost about $1,006 per infection, affect 561,677 patients per year and result in 8,205 deaths per year, and CLABSIs cost $36,441per infection, affect 248,678 patients per year and result in 30,655 deaths.[26] With such high cost, incidence, and mortality these HAIs are natural targets of quality improvement.

b. Pay-for-Performance Programs

While the Hospital Acquired Conditions Reduction Program (HACRP) is the most recent ACA-related pay-for-performance initiative, it is not the first reimbursement related program that addresses HACs. In 2008, a Hospital Acquired Conditions program was instituted to stop Medicare reimbursement to hospitals for specified conditions not present on admission.[27] This policy, referred to as the Hospital Acquired Conditions (Present on Admissions Indicator) was created to reduce cost and improve quality. The policy targeted multiple hospital related conditions but those that are of interest to this analysis are hospital- acquired infections CAUTI and CLABSI, which are also targets of the 2015 HAC program. For correctness and consistency, when referring to CAUTI and CLABSI, I will use the term hospital-acquired infection (HAI) because these infections are caused by a pathogen whereas a hospital-acquired condition does not *have* to be caused by a pathogen (e.g. pressure ulcers.)

The literature on the effectiveness of the 2008 policy at reducing CAUTI and CLABSI rates examines various timeframes and datasets, but no general consensus has been reached. While some studies find the policy had no effect on the targeted infections,[28] [29] [30] others find the policy significantly reduced both CAUTI and CLABSI rates.[31] [32] This lack of consensus brings into question the effectiveness of the policy and supports further analysis to understand if these policies are achieving their goals of improving quality.

In addition to the 2008 HAC policy it is important to note an additional, ongoing, program aimed at reducing hospital-acquired conditions. CMS's Partnership for Patients (PfP) program was established in 2011 by the Affordable Care Act with the goal of reducing all-cause patient harm.[33] The program is a public-private partnership that employs the use of Hospital Improvement Innovation Networks (HIINs) to provide resources and collaboration with over 4,000 US hospitals on ways to reduce patient harm.[33] A Health and Human Services (HHS) report notes that the timeframe for which this PfP program was active, there was a 21% drop in HACs (2010-2015), but HHS was not able to conclude this drop was a direct result of the program.[34] The lack of a concrete correlation between the program and decreased HAC rates supports the rationale for further investigation of the HACRP, a CMS program designed to reduce HACs.

c. HACRP Design and Eligible Hospitals

The HACRP policy excludes children's hospitals, long-term acute care hospitals, inpatient rehab facilities, inpatient psychiatric facilities, and cancer hospitals.[35] All eligible hospitals are given a HAC score that ranges from 1-10 with a higher score being less desirable, and hospitals that score above the 75th percentile are penalized.[36] This scoring is developed from a combination of quality data from the Agency for Healthcare Research and Quality (AHRQ) and the CDC's National Healthcare Safety Network (NHSN). The AHRQ portion of the data is referred to as the Patient Safety Indicator Composite (PSI 90) and is calculated using Medicare claims discharge data.[37] The PSI 90 composite is composed of eight PSIs for FYs 2015-2016 and was updated to include 10 PSIs in 2016,[38] however this updated PSI was not utilized in HAC scoring until FY 2017.[39] The PSIs utilized by the HACRP for FYs 2015-2016 are shown in Table 3 (See Appendix) and are obtained from Medicare-affiliated Quality.net.[40] The changes to the PSI 90 utilized in HAC scoring for FY 2017 are shown in Table 4 (See Appendix).[41] The changes removed PSI 07 due to its duplication in NHSN data as CLABSI and added PSIs 10 and 11; PSIs 08 and 15 have different descriptions than in prior years but measure the same condition.[42]

The NHSN portion of the data is used to determine CAUTI and CLABSI rates for FY 2015, CAUTI, CLABSI and Surgical Site Infection (SSI) rates for FY 2016, and MRSA and *Clostridium difficile* rates for FY 2017. The weighting of AHRQ PSI 90 and NHSN data changes each year such that in FY 2015 the weighting was 35% PSI 90 (Domain 1) and 65% NHSN data for CAUTI and CLABSI (Domain 2.) This changed to 25% and 75% for FY 2016 and changed again to 15% and 85% for FY 2017.[43] The increasing emphasis on Domain 2 weights the majority of the hospital's score on a select few HACs rather than acting as a comprehensive evaluation of quality. Domain weighting and NHSN documented infections by fiscal year are shown in Table 5 in the Appendix.

d. Current Literature

A 2015 study by Kahn et al. examined the characteristics of hospitals that were penalized by any of the ACA-related pay-for-performance programs (VBP, HRRP and HACRP).[44] This study focused on all US hospitals eligible for VBP, HRRP, and HACRP-related payment reductions and utilized data from Hospital Compare and the FY 2015 final rule tables from CMS. Hospital safety-net status was determined using the top fifty percent of Medicare DSH payments.[44] Focusing on the HAC Reduction Program, Kahn et al. found that nearly half of hospitals penalized for FY 2015 were major teaching hospitals, and more than one third of those hospitals were considered to be safety-net hospitals.[44]

Similar to these results, a study by Rajaram et al. utilized data from Hospital Compare for hospitals' HAC scores and obtained hospital characteristics from the American Hospital Association (AHA) Annual Survey and the CMS Payment Impact File for 2015.[45] This study found that teaching hospitals and safety-net hospitals were fined most often: of the 820 safety-net hospitals subject to the program, 28.3% were penalized versus only 19.9% of the 2,462 non-safety-net hospitals.[45]

In a study similar to that of Kahn et al., Figueroa et al. examine all three ACA-related pay-for-performance policies to find if there are definitive characteristics of hospitals most likely to be fined.[46] Researchers utilized publicly available data for all program analyses and calculated the odds of a hospital being penalized by hospital characteristics (i.e., teaching status, size, safety-net status, location, ownership status, and whether the hospital had an ICU.) Hospitals were classified into three groups ranging from least penalized to most penalized and it was found that, with respect to the HACRP, safety-net hospitals were twice as likely to be in the most penalized group (32.8%) compared to the least penalized group (16.9%.)[46] In addition, as with previous studies[44 45], it was found that the adjusted odds of being most penalized were 2.17 (95% CI 1.23 to 3.83.) for major teaching hospitals and 1.96 for safety-net hospitals (95% CI 1.46 to 2.63.)[46]

These analyses suggest that the HACRP is impacting safety-net hospitals more than non-safety-net hospitals, but they do not examine multiple years of the HACRP or rates of HACs targeted by the program. This analysis will expound upon current literature through the use of three years of HACRP data as well as analysis of CAUTI and CLABSI rates in order to gauge the program's effectiveness. Literature has established that safety-net hospitals have a different patient population, case mix, staffing levels and, sometimes, resources, so it is warranted that safety-net hospitals are studied separately from their non-safety-net counterparts when examining policy implications. While policy is often well intended, it is possible for negative externalities to result and, thus, it is imperative that effects of policies be thoroughly analyzed.

III. Conceptual Model

To examine my research question, I developed a conceptual framework that borrows from Donabedian's Structure, Process, Outcome Quality of Care Model.[47] As stated in the name, Donabedian's model breaks quality of care into three components: Structure, Process and Outcome, and utilizes the categories to assess quality of care. My research question aims to assess quality of care as a result of a policy and, therefore, fits fairly well into this framework.

My framework incorporates two focal relationships; the relationship between the Hospital Acquired Conditions Reduction Program (HACRP) and CAUTI and CLABSI infections, and the relationship between the HACRP and penalization of safety-net hospitals. The first focal relationship is of interest because it assesses the quality of care (measured by CAUTI and CLABSI rates) as a result of the HACRP, and the second focal relationship is of interest because it examines how this policy, aimed at improving quality, impacts a potentially vulnerable group.

a. Safety-net Status as a Moderator

As mentioned previously, literature suggests that safety-net hospitals have higher rates of hospital acquired conditions[48] and lower rates of improvement in quality measures over time.[49] This finding may be due to issues with staffing or high case mix index as discussed in the confounders section below, but provides evidence as to why safety-net status may weaken the effect of a quality improvement program like the HACRP. An example of a hospital's safety-net status moderation of the relationship between a policy and improvement because of lack of financial resources and human capital. If a hospital is unable to implement adequate staff due to lack of funding, they may be less likely to leverage quality improvement tools available to them. If a hospital is unable to improve their quality of care, they may experience higher infection rates and, thus be penalized more frequently by the HACRP. For these reasons, it is hypothesized that safety-net status moderates (weakens) both the relationship between the HACRP and CAUTI and CLABSI rates, as well as the relationship between the rates and penalization.

b. Hypotheses

H1: The Hospital Admissions Reduction Program (HACRP) is associated with a decreased rate of CAUTIs and CLABSIs after controlling for hospital teaching status, safety-net status, case mix index, bed size, and hospital EHR compliance status.

As stated previously, the HACRP was implemented with the intention of improving quality of care through reducing the occurrence of hospital-acquired conditions. Following this logic, it is hypothesized that the policy will reduce the hospital-acquired infections of interest: CAUTI and CLABSI.

H2: The relationship between the HACRP and penalty rates is moderated by safety-net status.

H2a: Safety-net hospitals will have higher rates of CAUTI and CLABSI

H2b: Safety-net hospitals will be penalized more often by the HACRP

As noted in earlier, there is evidence to support that safety-net hospitals have higher incidences of hospital acquired infections and are disproportionally penalized by pay-for-performance programs.

IV. Methods

a. Analytic Strategy

There are two analytic samples in this analysis, one that tracks the rates of CAUTI and CLABSI over time and one that allows for understanding the odds of penalization by the HACRP. To examine the relationship between the HACRP and numbers of CAUTI and CLABSI cases, four years of data will be used (2013-2016.) These data consists of hospitals and their annual number of CAUTIs and CLABSIs. To examine the relationship between hospital safety-net status and penalization by the HACRP, three years of data (2015-2017) comprised of acute care hospitals participating in Medicare will be used. These data consists of hospitals and their performance scores, with the worst performing quartile of hospitals receiving a penalization.

The first analysis aims to test H1 and H2a, and uses a linear regression with interaction terms between safety-net status and year to determine the relationship between the HACRP, hospital safety-net status, and rate of CAUTIs and CLABSIs observed. The model is:

$$R = B_0 + B_1S_j + B_2Y + B_3S_jY + B_4C + E,$$

where S_j represents hospital safety-net status, Y represents the vector of years 2013-2016, S_jY is the interaction between the vector of years and hospital safety-net status, and C is a vector of control variables.

The second analysis aims to test H2b and uses logistic regression to examine the relationship between hospital safety-net status and the probability of penalization by the HACRP. The model is:

$$Pr(Penalization =1) = B_0 + B_1S_j + B_2T + B_3C + E,$$

where S_j represents hospital safety-net status, T represents hospital teaching status and C represents a vector of control variables. All analyses were performed in Stata Version 15.

b. Measured Confounders

The following variables are measureable and hypothesized to have a confounding effect on the focal relationships. A hospital's teaching status is defined by the presence of a residency program and is classified as non-teaching or teaching. As previously stated, literature has established there is a relationship between teaching status and penalization by pay-for-performance programs.[49 50 51] and thus examination of hospital teaching status is of interest in this analysis. Teaching status will be included as a confounder for both focal relationships, despite risk adjustment for affiliation with a medical school in the HACRP penalization algorithm. Similarly, hospital bed number will also be included despite some risk adjusting regarding hospital size. These inclusions are in line with previous literature.[49 50 51]

A study by Thompson et al. examined risk factors for *Clostridium difficile* (CDI) incidence and found that a hospital's case mix index was a significant predictor.[52] While CAUTI and CLABSI are fundamentally different hospital acquired infections than CDI, case mix is still hypothesized to be an important predictor of a hospital's infection rates. CLABSIs generally occur in the ICU where patients are sickest, and CAUTIs occur because a patient required a catheter, a requirement that is often found with sicker patients. It is hypothesized that case mix has a positive association with CAUTI and CLABSI rates. As raw rates of CAUTI and CLABSI are not risk adjusted, controlling for case mix in the focal relationship between the HACRP and CAUTI/CLABSI rates is necessary. However, case mix is not analyzed in the relationship between the HACRP and hospital penalization because the data used to develop the penalty scores are risk-adjusted.

c. Unmeasured Confounders

Unmeasured confounders include effects of the 2008 Medicare HAC-related policy, checklists and toolkits, mandated NHSN reporting, the use of NHSN data to improve healthcare-associated infection rates and length of stay. Toolkits developed by the CDC include items such as adhering to proper hand hygiene protocols, and aseptic insertion techniques. Mandated NHSN reporting is the basis for hospitals' data posted on public reporting websites such as Hospital Compare. Hospitals' use of NHSN data and/or the CDC's Targeted Assessment for Prevention Strategy (TAP) is a construct to measure hospitals' efforts to improve their infection rates. It is hypothesized that these unmeasured constructs have a negative association with both outcome variables (penalization by the HACRP and CAUTI and CLABSI rates), apart from length of stay, which is hypothesized to have a positive relationship with the outcome variables.

An additional unmeasured construct is electronic health record (EHR) use. EHR use is included as a confounder as literature has found use of an EHR system to be associated with decreased rates of CLABSIs.[53] In two analyses, EHRs were found to increase the use of CLABSI checklist-related items.[54] [55] One analysis found that hospitals could leverage their EHR system to improve surveillance of CAUTIs.[56] EHR compliance may be reflective of a hospital's financial resources, and literature has found that safety-net hospitals are significantly less likely to have a fully implemented EHR system.[57] Due to these factors, EHR compliance is hypothesized to have a negative association with rates of CAUTI and CLABSI and HACRP penalization.

The last unmeasured construct is hospital staffing. Literature has identified hospitals' nurse staffing levels to be associated with patient outcomes. [15, 16] A study that examined nurse staffing in California hospitals after a mandate that dictated acceptable nurse to patient ratios was implemented found that most hospitals with the lowest nurse staffing level were safety-net.[58] In addition, the study found that the safety-net hospitals that had the lowest staffing levels were significantly less likely to hire enough staff to meet the mandate after its first year.[58] An analysis of surgical outcomes at various hospitals found that hospitals with a lower number of Medicaid patient days were significantly more likely to have more hospitalists, privileged physicians, and full-time personnel.[59] While this construct is unmeasured, it is hypothesized that hospitals that employ an adequate number of staff will be more likely to provide quality care in a timely manner, resulting in lower rates of healthcare-associated infections. Thus, hospital staffing is hypothesized to be negatively associated with both CAUTI and CLABSI rates and penalization by the HACRP.

d. Strengths and Limitations

This analysis has three main strengths. The first strength of this study is that the data are not subjective, and all community hospitals that participate in Medicare (with the exception of Maryland hospitals) must make their quality data available. These data must be reported only upon meeting explicitly defined criteria that is uniform across all hospitals; this type of stringent criteria decreases response bias and limits missing results. Second, this study utilizes the most recently available data and, thus, provides an up-to-date analysis of the current state of infection rates and of the risk of pay-for-performance penalization based upon certain hospital characteristics. The third strength is that this analysis examines 3 years of HACRP performance scores while simultaneously examining the rates of two HAIs targeted by the policy. This, to my knowledge, has not been done before and is the first study to examine if the policy is affecting HAI rates as intended.

While there are many strengths, there are also limitations to this analysis. One limitation is the inability to measure hospital staffing. There is evidence to suggest that hospital staffing such as numbers of RNs vs LPNs or number of physicians on staff is related to quality of patient care. Omitting this variable does not allow for exploration of how staffing effects the relationship between CAUTI and CLABSI rates and/or penalization by the HACRP. Since many safety-net hospitals struggle with maintaining ideal staffing levels, understanding this relationship is of interest. An additional limitation is the relatively low number of CAUTIs and CLABSIs observed due to aggressive elimination efforts over the past decade. The low numbers of CAUTIs and CLABSIs may make it difficult to assess pre-and post-policy variation as well as detect a significant reduction in infection rates.

e. Dataset Description

Data on raw HAI rates, HACRP penalization, and hospital characteristics will be compiled from a number of different sources, as shown in below.

Table1. Dataset Descriptions

Name	Used For	Collected By	Published By
HAI Rates	CAUTI and CLABSI rates	CDC via NHSN	CMS via Hospital Compare
HACRP Scores	HACRP Penalization	NHSN, AHRQ and compiled by CMS	CMS via Hospital Compare
Medicare DSH Supplemental File	Determining Safety-net Status	Medicare	Medicare.gov
IPPS hospitals	Teaching Status, Bed Size, Location, CMI	Medicare	Medicare.gov

Hospital Compare began as part of the Quality Initiative announced in 2001 intended to improve quality of care through “public accountability and disclosure.”[60] The Hospital Compare website has a wide variety of publicly available data for this use as well as for research and analysis. Over 4,000 hospitals that are Medicare Certified (i.e., deemed to have met a set of standards set by CMS) are included in the datasets on the website.[61] The Hospital Compare database pertaining to the HACRP currently consists of longitudinal data from the years 2015-

2017 collected on over 3,000 hospitals that participate in Medicare. Hospitals excluded from the HACRP are those in Maryland, specialty hospitals, critical access hospitals and rural hospitals. The data for the HACRP posted on Hospital Compare are collected via reporting to the National Healthcare Safety Network (NHSN) and the Agency for Health Quality Research (AHRQ). In addition to the data from hospital compare, a downloadable Medicare DSH Supplemental File[62] [12]will be used to link hospitals with their disproportionate share payments (DSH) and to subsequently separate safety-net from non-safety-net hospitals. Finally, a second Medicare file, the Inpatient Perspective Payment System Impact file for fiscal years 2015-2017 will be utilized to obtain hospitals' teaching status and bed size.[63] All datasets are linkable via the Medicare Hospital Provider Number (CCN).

f. Measures

Safety-net hospitals have no formal definition, but recent studies have defined safety-net status using Medicare disproportionate-share hospital DSH payment percentage[64] or Medicaid caseload.[65] [66] Safety-net hospitals are defined by DSH payment percentage as this is more reflective of a hospital's financial need than Medicaid caseload alone. This is because DSH payments take into account hospitals' Medicare and Medicare SSI days in addition to Medicaid days.[62] The first outcome variables of interest, CAUTI and CLABSI rates, are found on CMS's Hospital Compare website. For this analysis, the raw, unadjusted, infection numbers and device days are taken from CMS's Hospital Compare database and calculated into an infection rate per hospital (number of infections/device days). Penalization by the HACRP, the second outcome variable of interest, is expressed as a dichotomous variable with a 0 given to hospitals that are not penalized and 1 given to hospitals that receive a penalty.

Four important covariates, hospital teaching status, hospital case mix index, penalization by VBP and penalization by the HRRP are gathered from CMS's Inpatient Perspective Payment System's (IPPS). Teaching status is defined as a 0/1 dummy variable where 1 indicates a resident-to-bed ratio greater than 0. Case-mix index is a continuous variable and, for ease of interpretation, will be multiplied by 100 so that results can be discussed in terms of percentages. Penalization by pay-for-performance programs VBP and HRRP is indicated by 1 in a 0/1 dichotomous indicator. Penalization by more than one pay-for-performance program has been shown to impact safety-net hospitals and is of interest for this analysis as well.[46]

Despite risk adjustment for affiliation with a medical school, studies on pay-for-performance programs often examine how teaching hospitals are impacted. As literature has established this relationship,[67] [68] [69] examination of hospital teaching status is of interest in this analysis. A hospital's resident to bed ratio will be used to establish hospital teaching status. It is hypothesized that hospital teaching status will have a positive association with both CAUTI and CLABSI rates and penalization by the HACRP.

As with hospital teaching status, hospital bed size will also be gathered from the IPPS and coded as a categorical variable. Categories for bed size will consist of small (< 100 beds), mid-size (100-399) and large (≥400 beds) hospitals, as done in previous literature.[45] Due to risk adjusting with the HACRP there is no hypothesized relationship between bed size and penalization by the HACRP.

Case mix index is a construct developed to capture the complexity of cases in a hospital. It is developed by CMS via "summing the Diagnostic-Related Group (DRG) weights for all Medicare discharges and dividing by the number of discharges."[70] Case mix values in the data range from .5865 to 4.3626. As raw rates of CAUTI and CLABSI are not risk adjusted, controlling for case mix is necessary.

As recent HCUP statistics indicate that 27% of safety-net hospitals are located in large central metropolitan areas, compared to 17.9% of non-safety-net hospitals,[18] it is also necessary to examine whether a hospital is located in an urban or rural region. Hospitals are categorized into urban or rural region based upon classification by CMS.

g. Inclusion & Exclusion Criteria

Hospitals included in both analyses (penalization by HACRP and CAUTI and CLABSI rates) needed to be issued a score by the HACRP in all three years in order to be included in the analysis. This decision was made to create a consistent, balanced, panel as well as to mitigate any issues surrounding hospitals that dropped out of the sample due to mergers. To be eligible for the HACRP a hospital must be an acute care facility, participate in Medicare, have enough HAC cases to be eligible for reporting, and have no waiver of exemption for participation.[61,71] Excluding those hospitals not scored by the HACRP in 2015-2017 resulted in a total of 2,721 acute care hospitals per year in the infection rate dataset (a total of 10,884 hospitals) and 3,127 hospitals per year in the HACRP dataset (a total of 9,381 hospitals.) One-hundred and ninety-eight hospitals were excluded from the dataset used to analyze penalization and 774 hospitals were excluded from the dataset used to analyze rates. There are more hospitals excluded in the infection rate dataset likely due to the change in reporting requirements over time, as well as the fact that the infection rate dataset included a time period with an earlier beginning date (2013). In addition, nearly all excluded hospitals were small hospitals that likely did not meet reporting requirements for every year. The focal variable, hospital safety-net status, is similarly distributed in both the included and excluded samples, so there is little concern for a selection issue. Additional information about the excluded hospitals can be found in the Appendix, Figures 5-9.

V. Results

The dataset used to analyze CAUTI and CLABSI rates from 2013-2016 was reduced from all US acute care hospitals that participate in Medicare, and have their infection rate data posted on Hospital Compare, to hospitals that participate in the Hospital Acquired Conditions Reduction Program. This dataset was further reduced to only include hospitals that participated in the HACRP for years 2015-2017. The overall mean CAUTI rate for years 2013-2016 was 1.18 infections per 1,000 device days and the overall mean CLABSI rate was .78 infections per 1,000 device days. Mean infection rates by year and safety-net status are shown in Figures 1 and 2.

Regression results for CAUTI and CLABSI rates at safety-net hospitals are shown in the appendix in Tables 8 and 9. As these results report interactions, which are not easily interpreted alone, Table 2 highlights the coefficients of interest: the absolute differences in CAUTI and CLABSI rates per 1,000 device days for safety-net hospitals over time. All coefficients are relative to year 2013. The results in the table depict the narrowing of the performance gap between safety-net and non-safety-net hospitals. For CAUTI, this gap significantly narrows by 18.5 infections per 1,000 device days in 2015 and 20.2 infections in 2016. This means that, relative to 2013, the gap between safety-net and non-safety-net hospitals' infection rates in 2016 was about 20 infections narrower. A similar change is seen for CLABSI, however this change is seen pre-policy (2014) and is not significant.

While the closing of the infection gap via absolute rate difference is important, it is also important to investigate relative percent change in infection rates. Table 3 shows the relative percent change in infection rates at both hospital types. The percent change is taken at the mean and results show that, despite the decreased number of CAUTIs between the two hospitals, both safety and non-safety-net hospitals experienced about a 48% change in CAUTI rates. This indicates the performance gap is the same in 2016 as it was in 2013. A different scenario is seen with CLABSI, where safety-net hospitals experience a 16% greater rate of improvement than non-safety-net hospitals, which decreases the performance gap between the two hospital types.

While decrease in infection rates is one measure of quality, another measure is decrease in variation. With this in mind, it is important to examine the variance around infection rates in each year. Standard deviation around CAUTI rates (Table 4) remained steady at about 1 time the mean from 2013-2016, while CLABSI (Table 5) experienced much higher variation. In 2013, the standard deviation for CLABSI rates was about 5 times the mean and in 2014 standard deviation was about twice the mean. This variance decreased until it was about 1.3 times the mean in 2016. This high degree of variation likely explains the decrease in CAUTI rates' failure to reach significance, but it also shows something else about quality improvement. The consistent reduction in variation from 2013-2016 shows that fewer hospitals were experiencing CLABSI rates that deviated greatly from the national average; this standardization in quality may be another impact of the HACRP.

The second analysis examined the odds of penalization by the HACRP based upon safety-net status while controlling for multiple covariates. Regression results are shown in Table 6. Safety-net hospitals are 1.32 times more likely to be fined by the HACRP than their non-safety-net counter parts, and teaching hospitals were 2.08 times more likely to be penalized than non-teaching hospitals. In addition, results found that hospitals penalized by Value-Based Purchasing were 1.61 times more likely to also be penalized by the HACRP, but no significant effect was found for the Hospital Readmissions Reduction Program.

VI. Discussion

While the efficacy of pay-for-performance programs is debated, results of this analysis show a significant decrease in CAUTIs at safety-net hospitals corresponding with the implementation of the HACRP. The number of CLABSIs also decreased by year, although this was not significant. The difference in significance between the two infections is likely due to the high variation seen in CLABSI rates in 2013-2014. The decrease in variation among CLABSI rates from 2013-2016 is an indicator of quality improvement that should not be overlooked as decreasing variation across hospitals is quality improvement.

Both safety-net and non-safety-net hospitals experienced about a 48% change in CAUTI rates from 2013-2016. While this means a reduction in infection rates, it also means that the performance gap between the two hospital types that existed in 2013 still exists in 2016. This is concerning as it indicates that, for low performing hospitals, even a significant improvement may not be enough to avoid penalty. In contrast to CAUTI, safety-net and non-safety-net hospitals experienced a different rate of change from 2013-2016. On an absolute basis, safety-net hospitals improved 16% more than non-safety-net hospitals, resulting in a narrowing of the performance gap between the two hospital types.

While safety-net hospitals are able to decrease infection rates after subjected to pay-for-performance, this does not mean that the current HACRP design is optimal. For example, if a hospital improves its CLABSI rate by 10%, but they were originally among the lowest performing hospitals, that hospital will still be fined despite improvement because of its low starting point and the likelihood that all other hospitals are also improving. This type of design does not incentivize lower performing hospitals to improve, as their efforts will often still leave them in the penalized quartile.

Additional concerns with the pay-for-performance design is the disproportionate penalization of safety-net and teaching hospitals, as well as penalization in more than one pay-for-performance program for the same metrics. These concerns are validated by the results of the second analysis where odds of penalization are explored. It was found that safety-net hospitals are 1.32 times more likely to be penalized by the HACRP than non-safety-net hospitals and teaching hospitals were 2.08 times more likely to be penalized. In addition, it was found that hospitals penalized by Value Based Purchasing were about 1.61 times more likely to be penalized by the HACRP than hospitals that were not penalized by VBP. This is likely due, in part, to the fact that VBP also takes into account hospital-acquired conditions and the AHRQ PSI-90, the two components the HACRP is based on. Future policy reform should consider separating metrics in each pay for performance program to avoid double jeopardy.

Despite the challenges mentioned above, safety-net hospitals have been able to significantly lower CAUTI rates after the implementation of the HACRP. However, even with this significant improvement, these hospitals are still more likely to be penalized by the HACRP than their non-safety-net counterparts. The HACRP coincides with lower CAUTI and CLABSI rates, so is working as intended, however it is not closing the performance gap between safety-net and non-safety-net hospitals across both CAUTIs and CLABSIs. If the goal is for all hospitals to have an HAI rate of 0, then the current policy of forced ranking is appropriate. However, if we are concerned about lack of resources across hospital types, then the policy may be improved through the addition of incentives for lower performing hospitals that still reach specified improvement benchmarks. Future research should explore differences in resources across safety-net and non-safety-net hospitals as well as monitor the effects of upcoming DSH cuts.

Table 2.

Year	CAUTI	CLABSI
2013	Ref	Ref
2014	0.30	-24.80
2015	-18.50***	-25.07
2016	-20.20***	-35.40

** $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$*

Table 3. Relative Percent Change in Infection Rates

Infection	Hospital Type	Year		Percent Change	Performance Difference
		2013	**2016**		
CAUTI	SNH	1.8	0.94	47.8%	
	Non-SNH	1.44	0.75	47.9%	0.1%
CLABSI	SNH	1.39	0.89	36.0%	
	Non-SNH	0.76	0.61	19.7%	16.2%

Table 4. Mean and Standard Deviation of CAUTI Rates

Year	Mean	SD
2013	1.529	1.614
2014	1.544	1.570
2015	0.841	0.793
2016	0.799	0.754

Table 5. Mean and Standard Deviation of CLABSI Rates

Year	**Mean**	**SD**
2013	0.919	4.991
2014	0.753	1.403
2015	0.772	0.929
2016	0.685	0.909

Table 6: Odds of Penalization by the HACRP

	OR	SE
Hospital Safety-Net Status		
Non-Safety-Net	Ref	
Safety-Net	1.318***	0.13189
Teaching Status		
Non-Teaching Hospital	Ref	
Teaching Hospital	2.083***	0.23358
Hospital Size		
Small (<100 Beds)	Ref	
Mid-Size (100-399 Beds)	1.304**	0.16016
Large (>399 Beds)	2.955***	0.53685
Location		
Rural	Ref	
Urban	1.555***	0.20101
Fined by Other Pay-for-Performance Programs		
HRRP	0.851	0.08867
VBP	1.607***	0.12304

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 1. Mean CLABSI Rate per 1,000 Device Days

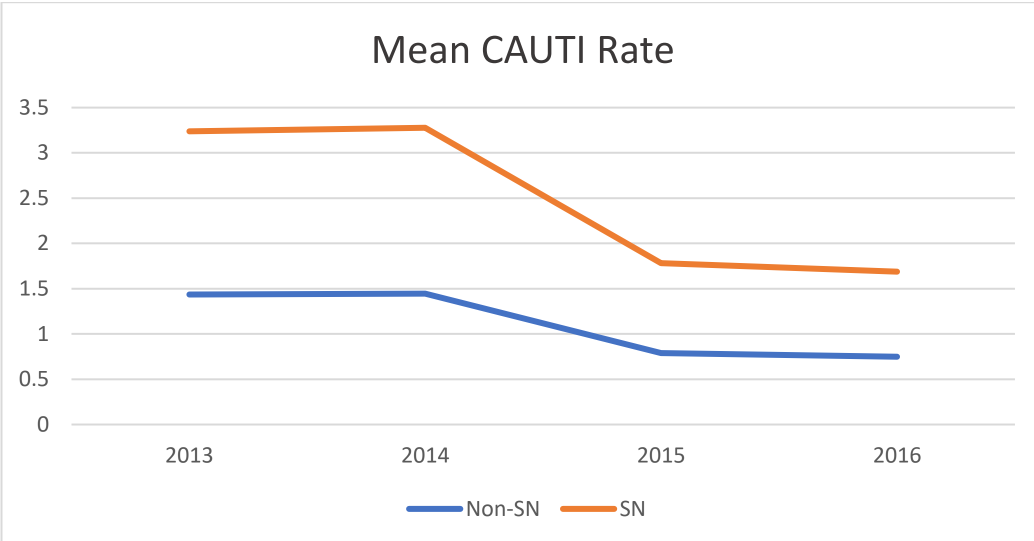
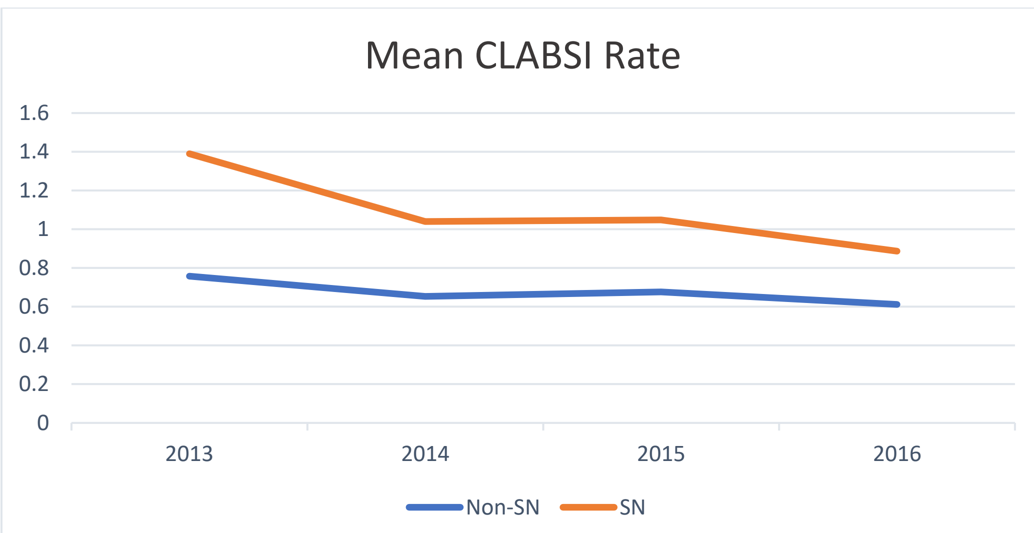


Figure 2. Mean CAUTI Rate per 1,000 Device Days



VII. Appendix

Table 1: Previous and Current HAC-Related Programs

	Present on Admissions Indicator	Partnership for Patients
Years	2008-Present	2011-Present
Incentive/Penalization?	No reimbursement for HACs	Neither
CLABSI	X	X
CAUTI	X	X
Others	X	X
Results	Mixed	Reduction in HACs potentially attributable to program

Table 2: Pay-for-Performance Programs

	VBP	HRRP	HACRP
Years	2012-Present	2012-Present	2015-Present
Incentive/Penalization?	Both	Penalization	Penalization
HAIs measured			
CLABSI	X		X
CAUTI	X		X
Others	X		X

Table 3: AHRQ PSI 90 Used in HACRP FY 2015-FY 2016

PSI 03 — Pressure Ulcer Rate
PSI 06 — Iatrogenic Pneumothorax Rate
PSI 07 — Central Venous Catheter-Related Bloodstream Infections Rate
PSI 08 — Postoperative Hip Fracture Rate
PSI 12 — Perioperative Pulmonary Embolism or Deep Vein Thrombosis Rate
PSI 13 — Postoperative Sepsis Rate
PSI 14 — Postoperative Wound Dehiscence Rate
PSI 15 — Accidental Puncture or Laceration Rate

Table 4: AHRQ PSI 90 Used in HACRP FY 2017

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

Table 5: HACRP Domain Weighting by Fiscal Year

	FY 2015	FY 2016	FY 2017
Domain Distribution			
Domain 1	35%	25%	15%
Domain 2	65%	75%	85%
Measures			
PSI 90	X	X	X
CAUTI	X	X	X
CLABSI	X	X	X
SSI		X	X
MRSA			X
C. Diff			X

Table 6: Descriptive Statistics for Infection Rate Dataset

	Safety-Net, N(%)	**Non-Safety-Net, N(%)**	**P-Value**
Hospital Type	2812 (25.84 %)	8072 (74.16%)	
Teaching Hospital	1329 (47.26%)	2582 (31.99%)	0.00^{***}
Small (<100 Beds)	547 (19.45%)	2399 (29.72%)	0.00^{***}
Mid-Size (100-399 Beds)	1651 (58.71%)	4820 (59.71%)	0.35
Large (>399 Beds)	614 (21.83%)	853 (10.57%)	0.00^{***}
Urban Location	2181 (77.56%)	6067 (75.16%)	0.01^{***}
Mean CMI	1.53	1.52	0.12^{*}

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 7: Descriptive Statistics for Penalization (HACRP) Dataset

	Safety-Net, N(%)	**Non-Safety-Net, N(%)**	**P-Value**
Hospital Type	2374 (25.31%)	7007 (74.69%)	
Teaching Hospital	1056 (44.48%)	2001 (28.56%)	0.00***
Small (<100 Beds)	613 (25.82%)	2749 (39.23%)	0.00***
Mid-Size (100-399 Beds)	1302 (54.84%)	3614 (51.58%)	0.01***
Large (>399 Beds)	459 (19.33%)	644 (9.19%)	0.00***
Urban Location	1784 (75.15%)	5268 (75.18%)	0.97
Fined by HACRP	693 (29.19%)	1468 (20.95%)	0.00***
Fined by VBP	1239 (52.19%)	2755 (39.32%)	0.00***
Fined by HRRP	2074 (87.36%)	5530 (78.92%)	0.00***
Mean CMI	1.51	1.56	0.00***

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8. CAUTI Rates at Safety-Net Hospitals 2013-2016

	CAUTI Rate
Teaching Hospital	0.371^{***} [9.77]
Number of Beds	0.001^{***} [8.87]
CMI	0.666^{***} [7.61]
Urban Location	0.096^{**} [2.57]
RRP Fine	0.081^{**} [2.56]
VBP Fine	0.081^{**} [0.73]
Non-Safety Net Hospital	Ref [.]
Safety-Net Hospital	0.081^{**} [3.10]
2013	Ref [.]
2014	-0.001 [-0.04]
2015	-0.689^{***} [-20.41]
2016	-0.747^{***} [-22.01]
Safety-Net Hospital*2013	Ref [.]
Safety-Net Hospital*2014	0.004 [0.06]
Safety-Net Hospital*2015	-0.185^{***} [-2.67]
Safety-Net Hospital*2016	-0.202^{***} [-2.87]
Observations	10866

t statistics in brackets
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 9. CLABSI Rates at Safety-Net Hospitals 2013-2016

	CLABSI Rate
Teaching Hospital	0.045 [1.48]
Number of Beds	0.0004** [2.40]
CMI	0.009 [0.04]
Urban Location	0.113 [1.44]
RRP Fine	0.122*** [3.81]
VBP Fine	0.068 [1.55]
Non-Safety-Net Hospital	Ref [.]
Safety-Net Hospital	0.567 [1.60]
2013	Ref [.]
2014	-0.106*** [-3.10]
2015	-0.107*** [-2.86]
2016	-0.168*** [-4.41]
Safety-Net Hospital*2013	Ref [.]
Safety-Net Hospital*2014	-0.248 [-0.66]
Safety-Net Hospital*2015	-0.251 [-0.68]
Safety-Net Hospital*2016	-0.354 [-1.02]
Observations	10865

t statistics in brackets
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Figure 1. Conceptual Framework: Non Safety-Net Hospital

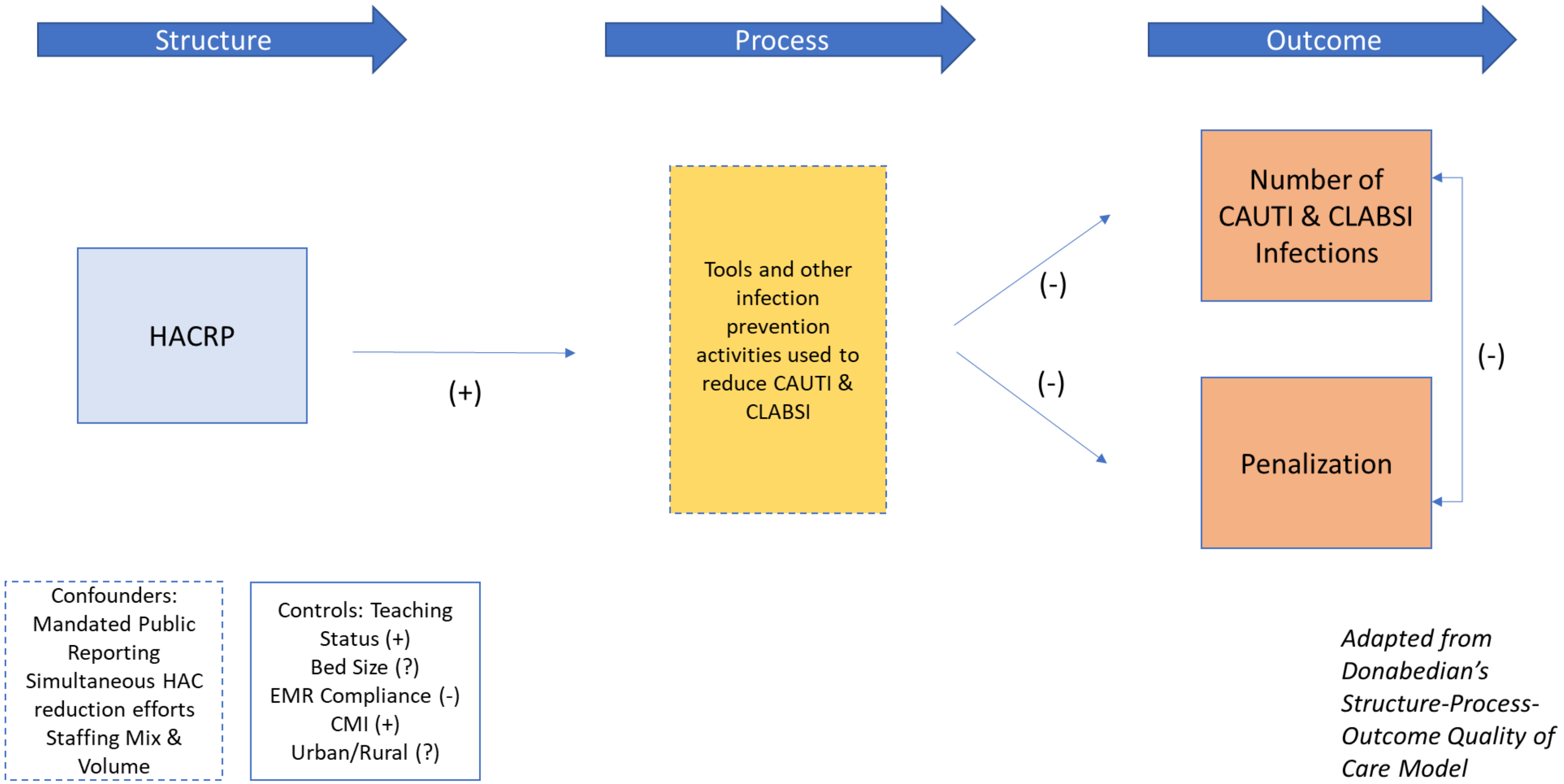


Figure 2. Conceptual Framework: Safety-Net Hospital

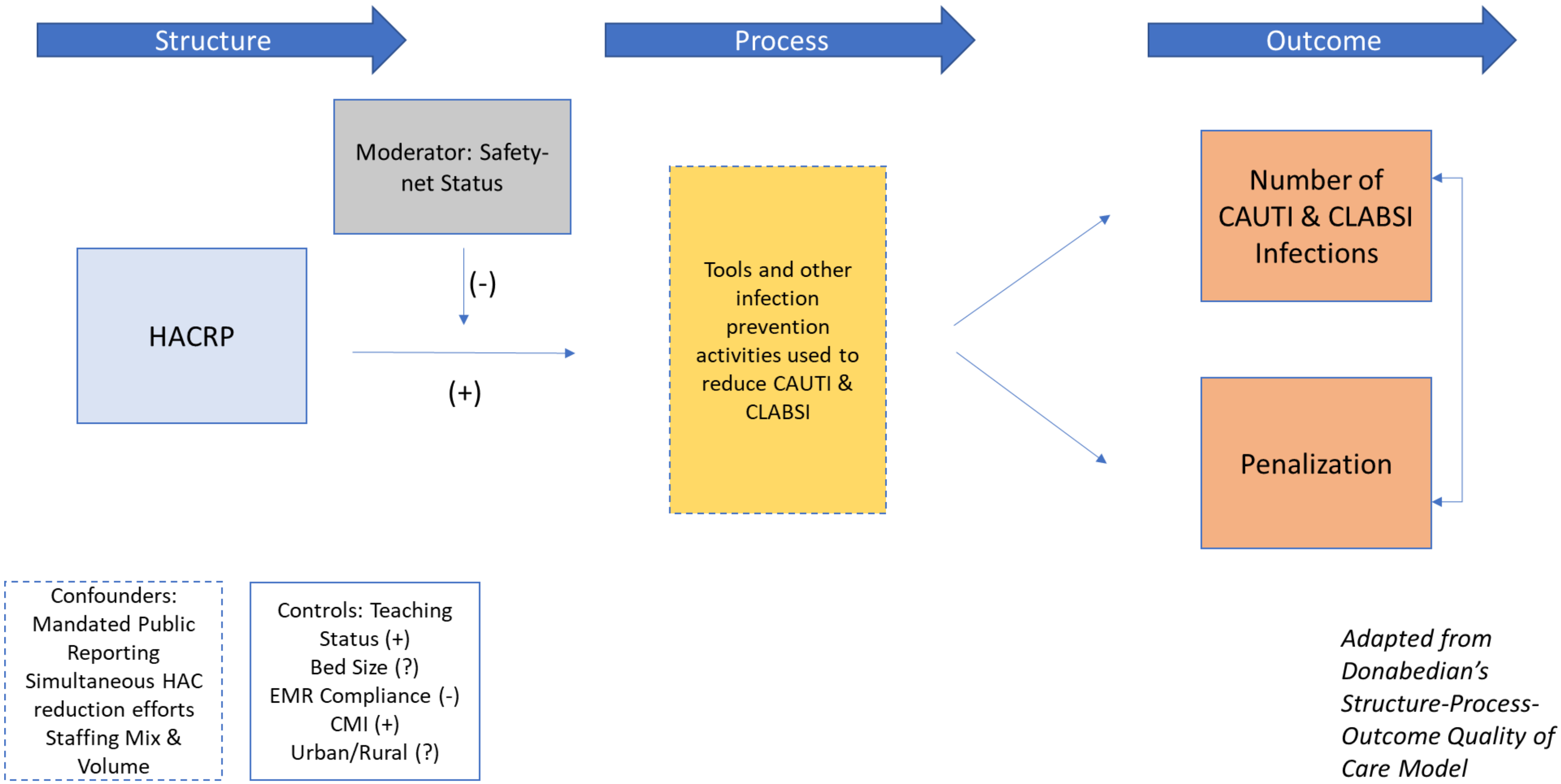


Figure 3. Hypotheses

Hypothesis 1:

Hypotheses 2a & 2b:

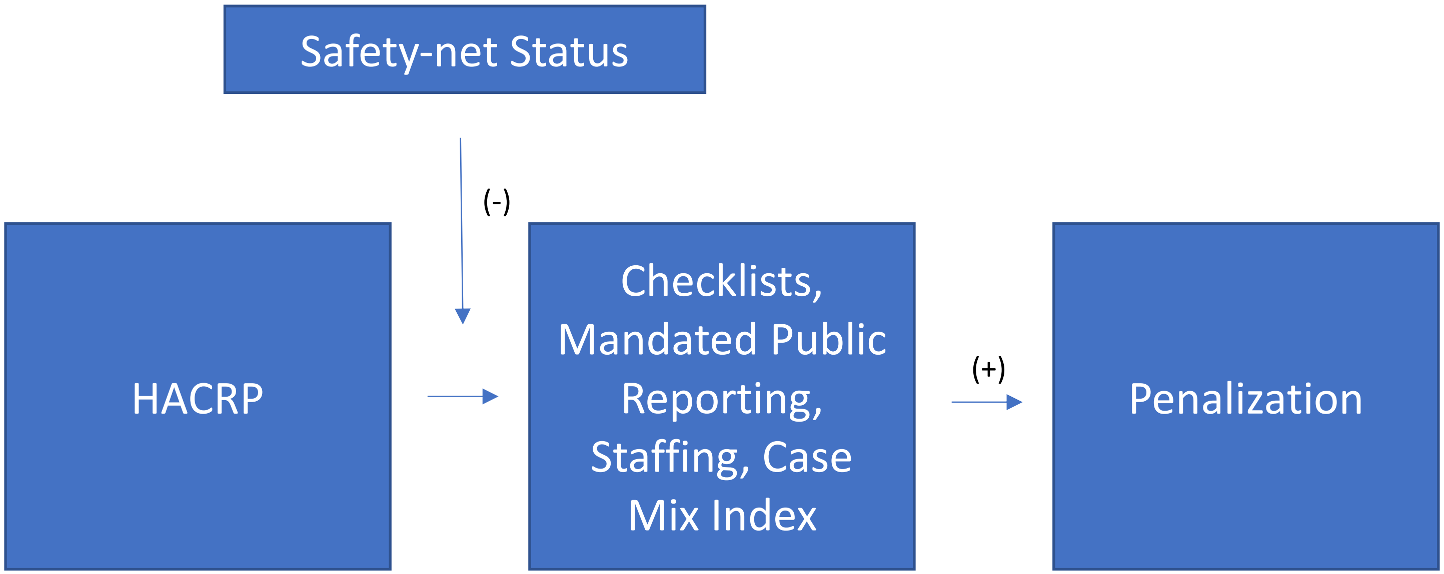


Figure 4. Construct Measures

Construct	**Measures Available**	**Hypothesized Relationship with Dependent Variable**
Safety-Net	DSH Payment (Top quartile of DSH payment amount)	(+) with Penalization & CAUTI/CLABSI Rates
CAUTI/CLABSI Rates	Hospital Compare Rates (Continuous)	(+) with Penalization
Teaching Status	Resident to Bed Ratio	(+) with Penalization & CAUTI/CLABSI Rates
Case Mix	Case Mix (Quartiles) (Range .3 – 3.3)	(+) CAUTI/CLABSI Rates
Bed Size	Number of Beds (Thirds: Small, Medium, Large)	(+) with CAUTI/CLABSI Rates
Checklists/Toolkits	Unmeasured	(-) with Penalization & CAUTI/CLABSI Rates
Mandated NHSN/Public Reporting	Unmeasured	(-) with Penalization & CAUTI/CLABSI Rates
Previous HAC Policy (2008)	Unmeasured	(-) with Penalization & CAUTI/CLABSI Rates
Use of NHSN Data/CDC TAP Strategy	Unmeasured	(-) with Penalization & CAUTI/CLABSI Rates
Length of Stay	Unmeasured	(+) with Penalization & CAUTI/CLABSI Rates
Hospital Staffing	Unmeasured	(-) with Penalization & CAUTI/CLABSI Rates
HACRP Penalization	Score in Worst Quartile (Range 1-10)	N/A

Figure 5. HACRP Penalization Data Set: Safety-Net Hospitals as Percent of Sample in Analytic and Excluded Samples

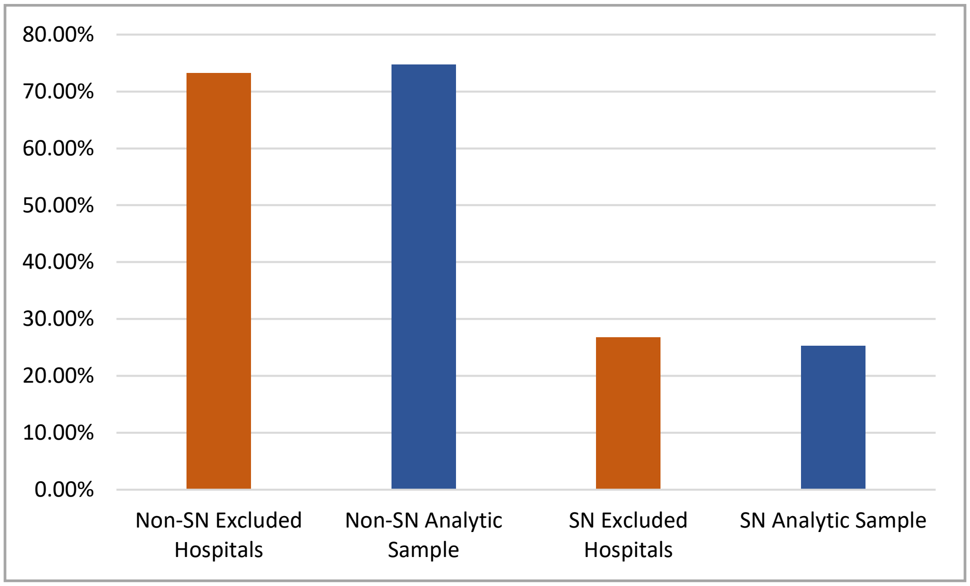


Figure 6. HACRP Penalization Data Set: Penalization by HACRP in Analytic and Excluded Samples

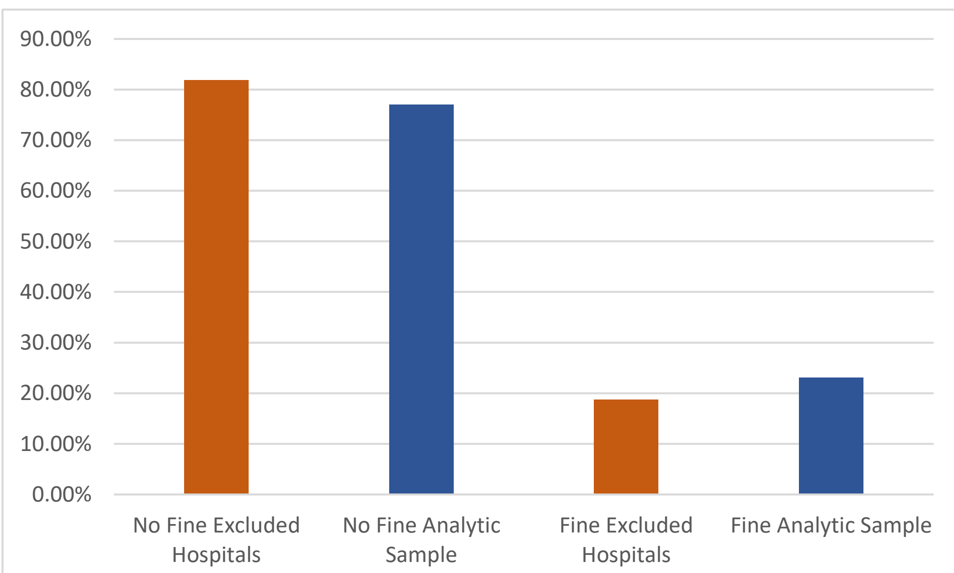


Figure 7. HACRP Dataset: Bed Size of Excluded Hospitals

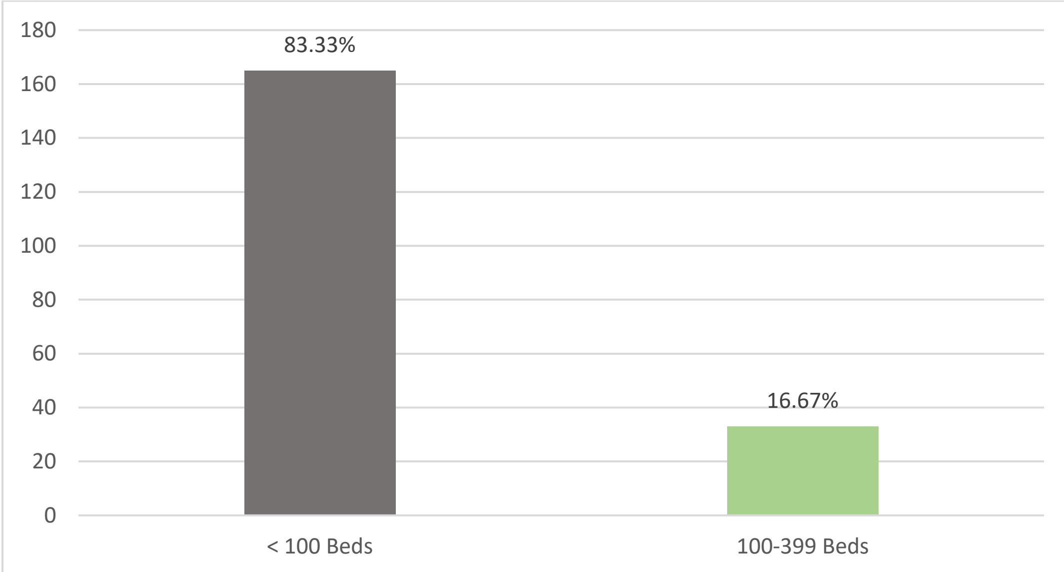


Figure 8. Infection Rate Dataset: Bed Size of Excluded Hospitals

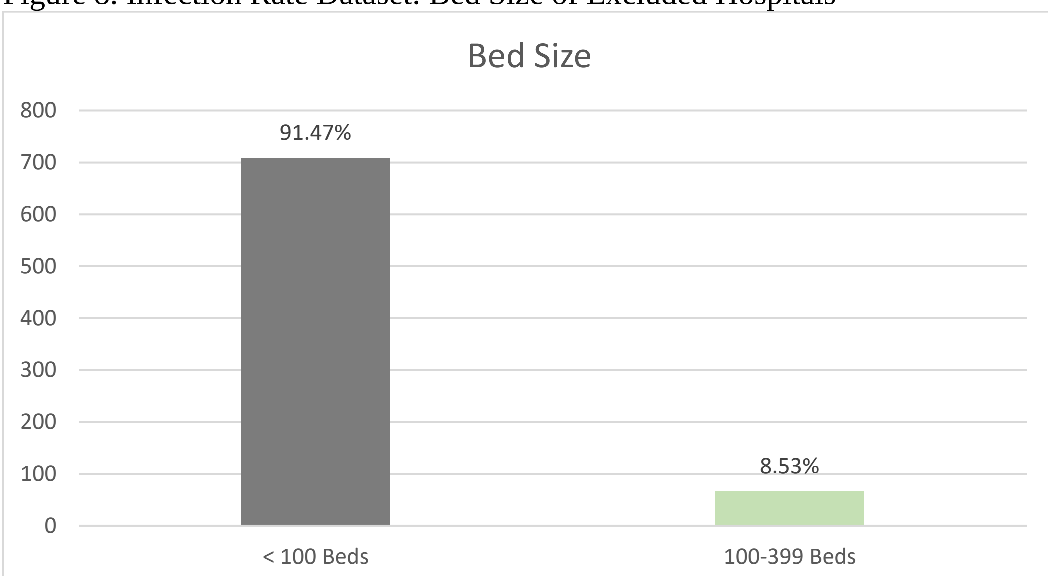
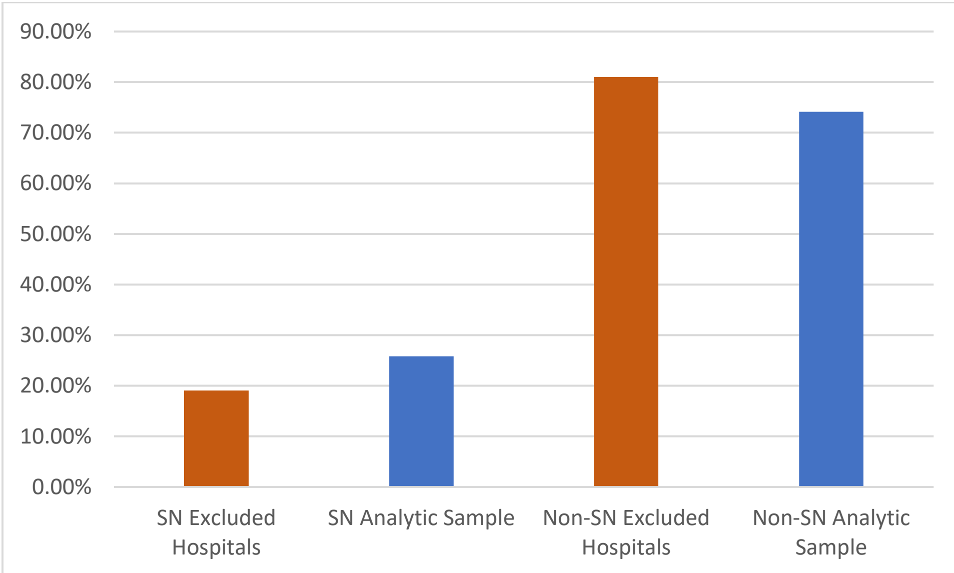


Figure 9. Infection Rate Dataset: Safety-Net Status in Excluded and Analytic Samples



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