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National Incidence of Patient Safety Indicators in the Total Hip Arthroplasty Population

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Abstract

BACKGROUND—The Centers for Medicare and Medicaid Services (CMS) use the incidence of patient safety indicators (PSI) to determine healthcare value and hospital reimbursement. The national incidence of PSI has not been quantified in the total hip arthroplasty (THA) population and it is unknown if patient insurance status is associated with PSI incidence following THA.

METHODS—All patients in the Nationwide Inpatient Sample (NIS) that underwent THA in 2013 were identified using ICD-9-CM codes. The incidence of PSI was determined using the ICD-9 diagnosis code algorithms published by CMS and the Agency for Healthcare Research and Quality (AHRQ). The association of insurance status and the incidence of PSI during the inpatient episode was determined by comparing privately insured and Medicare patients to Medicaid/self-pay patients using a logistic regression model that controlled for patient demographics, patient comorbidities, and hospital characteristics.

RESULTS—In 2013, the NIS included 68,644 hospitalizations with primary THA performed during the inpatient episode. During this time period, 429 surgically-relevant PSI were recorded in the NIS. The estimated national incidence rate of PSI following primary THA was 0.63%. In our secondary analysis, the privately insured cohort had significantly lower odds of experiencing one or more PSI relative to the Medicaid/self-pay cohort (OR 0.47 95% CI 0.29 – 0.76).

CONCLUSIONS—The national incidence of PSI among THA patients is relatively low. However, primary insurance status is associated with the incidence of one or more PSI following THA. As value-based payment becomes more widely adopted in the United States, quality

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benchmarks and penalty thresholds need to account for these differences in risk-adjustment models in order to promote and maintain access to care in the underinsured population.

Keywords

patient safety; total hip arthroplasty; NIS; value-based purchasing; AHRQ

Introduction

As the population in the United States continues to age, the incidence and prevalence of total hip arthroplasty (THA) is expected to increase substantially.[1, 2] The increase in THA incidence and prevalence comes as the U.S. healthcare system continues to transition towards tying reimbursement to healthcare quality and patient safety. The Hospital Value Based Purchasing Program and the Hospital Acquired Conditions (HAC) Reduction Program are two initiatives created by the Centers for Medicare and Medicaid Services (CMS) designed to connect healthcare reimbursement to healthcare quality and patient safety.[3]

These two programs allow CMS to withhold Medicare reimbursements to incentivize hospitals to improve healthcare quality. The HAC Reduction Program determines healthcare quality in part by determining the annual incidence of patient safety indicators (PSI) developed by the Agency for Healthcare Research and Quality (AHRQ).[4, 5] PSI are used to calculate rates of adverse healthcare quality events such as post-operative hematoma, deep vein thrombosis (DVT), and pressure ulcer at the provider, hospital, and regional healthcare market levels.[4] Hospitals that perform poorly according to PSI incidence risk losing 1% of all Medicare reimbursements.[3]

Although the annual incidence of THA is estimated to increase to 587,000 by 2021, the national incidence of PSI is unknown in this population.[6] Quantifying the incidence rate of PSI will serve as a benchmark against which future progress can be measured. Additionally, prior studies adjusted for patient-level covariates show that relative to privately insured patients, Medicaid patients face longer delays to surgery,[7] are more likely to require readmission within 30 days following THA,[8] and are at higher risk of requiring early revision hip arthroplasty relative to commercially insured patients.[9] It is currently unknown if patient insurance status should be included in risk adjustment models when projecting PSI incidence as part of value based purchasing and HAC reduction programs.

The present study uses a nationally representative, all-payer database to: 1) determine the national incidence of PSI among THA patients and 2) quantify the association between insurance status and PSI among patients undergoing THA. This study focuses on PSI incidence among THA patients and based on the results of prior studies,[10–13] we hypothesize that insurance status is significantly associated with the odds of experiencing a PSI following THA.

Methods

Overview and Study Design

The primary aim of this study was to quantify the incidence of adverse patient safety events based on PSI among THA patients using a nationally representative, all-payer database. The secondary aim was to determine if insurance status is associated with PSI incidence following THA. Both analyses used a retrospective cohort design and included THA patients from 2013. This study obtained institutional review board (IRB) approval prior to study initiation (IRB # EM-14-30).

Participants/Study Subjects

In the primary analysis, we queried Nationwide Inpatient Sample (NIS) data to determine the total number of primary THA in 2013. The year 2013 was chosen because it was the most recent year of available data. Patients undergoing THA were identified using the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code 81.51.[1, 14, 15] In this primary analysis, all patients aged 18 and older that underwent primary THA in 2013 were included to determine the national incidence of PSI in this population.

In the secondary analysis, we analyzed significant associations between patient level variables and the risk of experiencing at least one PSI following THA. We specifically focused on comparing patients with private insurance to patients with Medicaid/self-pay to determine the association between primary insurance status and PSI incidence. We also compared Medicare patients to Medicaid/self-pay patients. Patients with a primary payer status of “missing” or “other” were excluded from this secondary analysis.

Variables, Outcome Measures, Data Source, and Bias

The present study used data from the NIS collected from 2013. As the largest inpatient database in the United States, the NIS is collected annually and is a 20% stratified sample of all hospital discharges in the United States. Individual entries in the NIS represent a single inpatient episode and do not extend to the post-discharge period. Hospitals contribute administrative data to the NIS that includes the ICD-9-CM diagnosis and procedure codes attributable to each patient discharge at that hospital in a given year. We obtained data from the NIS on patient-level demographics, comorbidities, diagnoses, procedure performed, length of stay (LOS), hospital charges, in-hospital mortality, and hospital characteristics (e.g., hospital size, geographic location, hospital teaching status).[16] The NIS has a complex survey design and sampling weights are provided with the NIS to enable calculation of national estimates.

Additionally, the NIS includes Elixhauser comorbidity data. The Elixhauser comorbidity index is composed of thirty specific comorbidities shown to have a strong association with in-hospital mortality. Out of the thirty comorbidities originally described by Elixhauser et al., the NIS includes twenty-nine of the original thirty Elixhauser comorbidities.[3]

Outcome of Interest

In both the primary and secondary analyses, the primary outcome variable of interest was the occurrence of a PSI during an inpatient episode following THA. The AHRQ and CMS publish a list of ICD-9-CM codes that can be used to determine if a patient experienced a PSI during an inpatient episode. Therefore, in the present study, patients were categorized as experiencing a surgically-relevant PSI if their NIS record included a specific list of ICD-9-CM codes published by the AHRQ and CMS.[17, 18] The AHRQ and CMS regularly update the specific ICD-9-CM codes that constitute surgically relevant PSI. In the present study, ICD-9-CM codes were used rather than ICD-10-CM codes because the most recently available data were from 2013, before ICD-10-CM codes were used in the United States. Specifically, the list of surgically-relevant PSI measured by AHRQ and CMS include codes for pressure ulcer, iatrogenic pneumothorax, central venous catheter-related blood infection, postoperative hip fracture, perioperative hemorrhage or hematoma, postoperative metabolic derangement, postoperative respiratory failure, postoperative pulmonary embolism or deep vein thrombosis (DVT), postoperative sepsis, postoperative wound dehiscence, and accidental puncture or laceration. These surgically relevant PSI are combined to create a single PSI variable, termed PSI 90 by AHRQ. The incidence of PSI 90 can be interpreted as the incidence of one or more of the surgically relevant PSI during an inpatient episode. Although the validity of using these specific PSI to measure adverse events following THA may be unclear, CMS uses this PSI 90 composite measure in value based purchasing programs.

In our secondary analysis, insurance status was the independent variable of interest (specifically privately insured relative to Medicaid/self-pay) and the incidence of one or more PSI was the outcome of interest. In the United States, Medicare is a federal health insurance program for people aged 65 years and older and other, younger patients with disabilities.^[19] Similarly, Medicaid is a social health insurance program for families and individuals with limited resources. Therefore, Medicaid is frequently used as a marker for low socioeconomic status. In our secondary analysis, we focused on the comparison between privately insured patients and Medicaid/self-pay (i.e. uninsured) patients because significant differences likely exist in the extent and quality of healthcare available to the privately insured and Medicaid/self-pay populations. We felt that the privately insured and Medicaid/self-pay cohorts represented the two extremes of insurance coverage in the United States and would therefore yield a clearer answer as to the potential association between insurance status and odds of experiencing one or more PSI following THA.

In this analysis, we included a series of potential confounders including demographic data (patient age, sex, race [black, Hispanic, Asian, Native American, and other, all relative to white]), hospital characteristics (academic hospital setting, admission status [elective versus non-elective], hospital bed size [medium and large, both relative to small], hospital region [South, West, and Midwest, all relative to Northeast]), and the 29 Elixhauser comorbidities included in the NIS. These covariates were abstracted from the NIS because of their perceived clinical significance. In both the primary and secondary analyses, age was recorded and analyzed as a continuous variable.

Statistical Analysis

In the primary analysis, the national incidence of PSI among all THA patients aged 18 years and older was determined using the sample weights provided in the NIS. We determined the overall incidence of PSI among THA patients as well as the incidence of each individual PSI that comprise the PSI 90 measure. In the secondary analysis, we included all patient demographics, patient insurance status, and hospital characteristics as potential confounders of the relationship between insurance status and PSI incidence because of their perceived clinical significance. We estimated this model using multivariable logistic regression. We adjusted for clustering of observations on hospitals by considering hospitals as repeated factors and assumed an exchangeable working correlation. This approach allowed us to account for within hospital effects such as higher infection rates at one hospital versus another hospital. Due to the large sample size of the NIS, we set our threshold for statistical significance as $p < 0.01$. [13] According to the NIS data reporting rules, no outcomes were reported if their incidence was less than 0.1%.

We calculated means, standard deviations, and frequencies for patient demographics, hospital characteristics, and PSI incidence. The independent t-test was used to compare continuous variables whereas categorical data were compared using the chi-squared test. SAS statistical software package (version 9.4, SAS Institute Inc.) was used for all analyses.

Results

In 2013, the NIS included 68,644 hospitalizations with primary THA performed during the inpatient episode. Patient demographics are presented in Table 1. The mean age was 65.1 ± 11.8 years and females comprised 55.9% of patients, while 49.0% of patients were treated at an academic hospital. Privately insured patients were significantly older than Medicaid/self-pay patients ($p < 0.001$) and were significantly more likely to be White relative to Medicaid/self-pay patients ($p < 0.001$). Among patients who met inclusion criteria, 429 surgically relevant PSI were recorded during the study period. The estimated national incidence rate of PSI following primary THA was 0.63%. The most common PSI was postoperative respiratory failure, with an estimated national incidence of 0.28%. The second most common PSI was postoperative pulmonary embolism or DVT, with an estimated national incidence of 0.24%. Although we hypothesize DVT to be more likely than postoperative pulmonary embolism, the PSI metric does not distinguish between these two adverse events. The incidences of specific PSI are shown in Table 2.

In our secondary analysis, after adjusting for patient demographics, comorbidities, and hospital characteristics, patients undergoing primary THA in the privately insured cohort had significantly lower odds of experiencing one or more PSI (OR 0.47 95% CI 0.29 – 0.76) compared to the Medicaid/self-pay cohort. We did not observe a significant difference in odds of experiencing a PSI between the Medicare and Medicaid/self-pay cohorts (OR 0.74 95% CI 0.46 – 1.19). Patients with a history of heart failure, chronic lung disease, coagulopathy, electrolyte imbalance, metastatic cancer, neurological compromise, obesity, and pulmonary circulatory disease were all associated with increased odds of experiencing one or more PSI following THA (all $p < 0.01$). Moreover, female sex (OR 0.71 95% CI 0.57 – 0.89) and patients undergoing THA in a western hospital (OR 0.55 95% CI 0.38 – 0.78)

were associated with lower odds of experiencing one or more PSI following THA. These results are shown in Table 3.

Discussion

The present study highlights PSI incidence among THA patients and found that patient insurance status is associated with the odds of experiencing a PSI following THA. PSIs provide insight into patient safety during inpatient episodes by describing the incidence of prevalent and preventable complications such as postoperative thromboembolic events and respiratory failure.^[20] Although the individual adverse events that comprise the PSI metric are not novel outcomes to report on following THA, physician and hospital reimbursement is increasingly tied to quality of care as measured by the combined PSI 90 metric.^[3]

CMS measures PSI using administrative data based on the same ICD-9 code data that comprise the NIS. Using administrative, ICD-9 based data from CMS, the Centers for Disease Control (CDC), and Medicare, Rajaram et al. found that over 22% of all hospitals participating in the CMS HAC reduction program were financially penalized for substandard quality of care in the first year of the program, where quality of care was determined in part using the incidence of PSI 90.^[3, 21] In the current climate of healthcare finance and the transition towards a value-based reimbursement system, identifying predictors of adverse quality outcomes for common orthopaedic procedures such as THA becomes increasingly important. The present study used a nationally representative, all-payer database to determine the incidence of PSI among patients undergoing THA.

National Incidence of PSI following THA

Patient safety following THA has been extensively reported.^[22–26] However, no previous study has determined the incidence of adverse quality events among patients undergoing primary THA using the PSI 90 metric as defined by AHRQ. In the current study, we observed similar rates of specific PSI in the primary THA population to those previously reported. Kester et al. used National Surgical Quality Improvement (NSQIP) data on 23,924 hip replacement patients and found that the rate of venous thromboembolism both during and after an inpatient episode for THA was 0.9%.^[22] Our findings were lower than those of Kester et al. likely due to the fact that we included only thromboembolic events that occurred in the hospital. Although this restriction may appear as a limitation of the present study, PSI were specifically designed to measure inpatient care quality based on administrative data generated during the inpatient episode and do not take adverse events that occur after discharge into account. Our findings were also lower than those reported in other surgical populations.^[27, 28] We were surprised to see that respiratory failure was the most prevalent PSI in the study population. Furthermore, it was not possible to determine if respiratory failure was linked to pulmonary embolism in these patients. However, we did find that patients with pulmonary circulatory disease were at increased risk of experiencing a PSI. Therefore, additional research on this complication after THA is needed.

PSI Incidence and Insurance Status

Significant disparities exist in access to healthcare, treatment decisions, and patient outcomes across socioeconomic groups in the United States.^[13, 29–38] By acquiring health insurance, patients may be able to mitigate the adverse effects related to these disparities.^[39–41] However, studies adjusted for patient-level covariates show that relative to privately insured patients, Medicaid patients face longer delays to surgery,^[7] are more likely to require readmission within 30 days following THA,^[8] and are more likely to undergo early revision hip arthroplasty.^[9] The Oregon Medicaid Expansion showed that extending health insurance to uninsured patients does not guarantee improved outcomes across all patient populations because obtaining health insurance does not ensure the receipt of high quality care.^[42] Instead, the Metro Health Care Plus experiment showed that when combined with an inclusive healthcare infrastructure designed to help patients navigate the healthcare system, enrollment in health insurance is associated with significant health improvements and lower per-patient costs.^[39] Therefore, it is important to understand if patients with varying levels of health insurance coverage may warrant additional attention because they are at increased risk for adverse outcomes such as PSI. Furthermore, if insurance status is associated with the odds of experiencing a PSI, then insurance status may be a justifiable addition to risk adjustment models that project PSI incidence for the purposes of value based purchasing.

Prior studies identified significant associations between primary payer status and outcomes in several surgical specialties. Calfee et al. used single institutional data on 3,988 patients to demonstrate that Medicaid and uninsured patients faced significantly greater barriers in access to surgical care compared to privately insured patients.^[43] Similarly, LaPar et al. analyzed NIS data on 893,658 patients and found that primary payer status led to worse risk-adjusted odds of mortality following hip replacement, gastrectomy, and colectomy.^[31] Specific to the orthopedic surgery population, Dy et al. used data on 207,256 hip replacement patients from California and New York to show that Medicaid patients were significantly more likely to undergo revision THA relative to privately insured patients.^[9] Ryan et al. analyzed NIS data on 2,121,215 patients undergoing surgical repair of hip fracture and found that Medicaid patients were significantly more likely to delay fracture repair and that lengthier delays were associated with worse outcomes.^[7] Finally, Browne et al. used NIS data on 6,844,705 patients undergoing total joint arthroplasty and showed that Medicaid patients had significantly greater resource utilization and poorer outcomes relative to other insurance cohorts.^[44]

In the current study, we found significant associations between insurance status and likelihood of experiencing one or more PSI among patients undergoing primary THA. Prior studies found similar results to those presented in this study. Zhan et al. used NIS data on 71,081 hip replacement patients from 2003 and found that primary payer status was predictive of PSI incidence.^[23] However, Zhan et al. only included four PSI in their study and used data from over a decade ago. Since 2003, THA techniques and postoperative management protocols have changed and we found that the PSI excluded by Zhan et al., including postoperative respiratory failure, accounted for over 33% of all observed PSI during our study period.

The reasons for the observed association between patient insurance status and experiencing a PSI are likely multifactorial. The significant association between insurance status and the odds of PSI 90 was limited to the comparison of privately insured patients to Medicaid/self-pay patients. We did not find a significant association between insurance status and odds of PSI 90 when comparing Medicare patients to Medicaid/self-pay patients ($p=0.21$). One possible explanation of this finding is that Medicare represents an intermediate level of insurance coverage between Medicaid/self-pay and commercial or private plans. There may therefore be underlying, unmeasured differences in the type and extent of pre-or post-operative care received by Medicare patients compared to privately insured patients that do not exist between the former and the Medicaid/self-pay populations. In the spine surgery population, Derakhshan et al. reviewed the imaging history of 24,105 patients from a single institution and found that insurance status was a significant predictor of imaging utilization. The authors concluded that physician awareness of an uninsured patient's status may lead to different practice patterns that limit the use of imaging and instead substitute cheaper alternatives to avoid cost incursion by patients. If this trend extends to the hip arthroplasty patient population, then these differences may partially explain the differential rate of PSI observed in Medicaid/self-pay patients relative to privately insured patients.^[45] Further studies are necessary to gain insight into the underlying latent variables across all levels of the U.S. healthcare system that drive the association between insurance status and PSI incidence.

Our findings suggest that among the inpatient hip arthroplasty population, Medicaid/self-pay patients experience higher rates of PSI than the patients with private insurance. Despite controlling for hospital characteristics and patient demographics and comorbidities, Medicaid/self-pay patients had significantly greater odds of experiencing an adverse quality event relative to privately insured patients following primary THA. Importantly, we found that eight comorbidities (history of heart failure, chronic lung disease, coagulopathy, electrolyte imbalance, metastatic cancer, neurological compromise, obesity, and pulmonary circulatory disease) were significantly associated with increased odds of experiencing a PSI following THA. Therefore, quality benchmarks and penalty thresholds need to account for these differences in risk-adjustment models in order to promote and maintain access to care in the underinsured population. Finally, although concerning, we were not surprised to find that there were regional differences in the odds of experiencing a PSI among our study population. This geographic heterogeneity in outcomes following identical treatments is concerning from several perspectives, and previous studies have documented similar regional differences in other orthopaedic populations.^[46, 47] One possible explanation of this finding is that surgeons practicing in different regions use different techniques and approaches, an explanation that has been demonstrated among spinal surgeons. Mroz et al. surveyed 2,560 orthopaedic and neurosurgical spine surgeons in the United States to assess surgical treatment patterns for recurrent lumbar disc herniation and found significant differences in treatment plans across several demographic and geographic variables.^[46] If this explanation extends to THA as well, then both patients and surgeons may benefit from adopting a standardized technique and reducing inter-surgeon variability to reduce the incidence of PSI among THA patients as the U.S. moves toward a value-based healthcare economy.

Limitations

This study has two main limitations. First, procedures and diagnoses are recorded in the NIS using ICD-9-CM codes. These codes are assigned by reviewers based on a clinician's documentation. Information omitted by clinicians is therefore omitted from the NIS. Relying on these codes to identify our study population means that our study population is subject to a small degree of misclassification and it is possible that PSI may be under-coded.^[48] However, CMS uses these same administrative, ICD-9 based data to determine hospital penalties under HAC reduction programs. Therefore, it is important to establish national benchmarks using the same data sources and quality of care criteria used by CMS. Second, the NIS only includes data generated during the inpatient episode. Outcomes and complications that become apparent with extended follow-up remain outside the scope of this investigation. Both Kester et al. and Januel et al. found higher rates of thromboembolic events among hip arthroplasty patients when both pre-and post-discharge data were used.^[22, 49] However, PSI were specifically designed to measure care quality during the inpatient episode and therefore excluding post-discharge events from this study is unlikely to significantly bias our findings.

Despite these limitations, large administrative databases such as the NIS represent a powerful tool to study epidemiological trends in PSI. Further investigations into interventions designed to specifically limit the incidence of these adverse events in at-risk populations is needed.

Conclusion

This study quantifies PSI incidence among THA patients, demonstrating a statistically and clinically significant association between insurance status and PSI among patients undergoing primary THA. Our findings suggest that risk adjustment models of PSI incidence should account for the payer mix of patients that are cared for by individual hospital systems. Minimizing PSI in the orthopaedic population can positively impact patients, surgeons, and hospital systems both clinically and financially. Future research into peri-operative protocols and management strategies designed to reduce the rates of PSI among vulnerable populations is warranted.

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Table 1

Patient Demographics and Hospital Characteristics

	Overall n = 68,644	Medicare n = 36,252	Private Insurance n = 27,291	Medicaid/Self-Pay n = 3,012	P - value
Age (years) ± SD	65.1 ± 11.8	72.2 ± 8.9	57.5 ± 9.0	52.8 ± 10.7	<0.001
Female	38,342 (55.9)	22,263 (61.4)	14,445 (49.4)	1,567 (52.0)	0.008
Race					
White	54,915 (80.0)	29,804 (82.2)	23,219 (79.4)	1,789 (59.4)	<0.001
Black	4,805 (7.0)	2,112 (5.8)	1,995 (6.8)	643 (21.3)	<0.001
Asian	618 (0.9)	284 (0.8)	254 (0.9)	*	0.02
Hispanic	2,205 (3.2)	1,037 (2.9)	927 (3.2)	226 (7.5)	<0.001
Other	1,258 (1.8)	565 (1.6)	611 (2.1)	*	0.16
Hospital Type and Admission Source					
Elective Admission	63,177 (92.2)	32,755 (90.5)	27,629 (94.7)	2,674 (88.8)	<0.001
Academic Hospital	33,627 (49.0)	16,797 (46.3)	15,110 (51.7)	1,628 (54.0)	0.24
Hospital Size					
Small	14,267 (20.8)	7,248 (20.0)	6,518 (22.3)	488 (16.2)	<0.001
Medium	18,689 (27.2)	9,852 (27.2)	7,941 (27.2)	864 (28.7)	0.34
Large	35,688 (52.0)	19,152 (52.8)	14,788 (50.6)	1,660 (55.1)	0.024
Hospital Location					
Northeast	13,719 (20.0)	6,836 (18.9)	6,224 (21.3)	634 (21.0)	0.9
Midwest	17,632 (25.7)	9,381 (25.9)	7,486 (25.6)	749 (24.9)	0.69
South	23,003 (33.5)	12,450 (34.3)	9,408 (32.2)	1,065 (35.4)	0.09
West	14,290 (20.8)	7,585 (20.9)	6,129 (21.0)	564 (18.7)	0.13
Comorbidity					
Alcohol Abuse	1,199 (1.7)	484 (1.3)	568 (1.9)	*	<0.001
Anemia Deficiency	7,646 (11.1)	4,645 (12.8)	2,652 (9.1)	335 (11.1)	0.002
Arthritis	2,771 (4.0)	1,685 (4.6)	944 (3.2)	*	0.001
Blood Loss Anemia	812 (1.2)	493 (1.4)	294 (1.0)	*	0.27
CHF	1,819 (2.6)	1,458 (4.0)	304 (1.0)	*	0.002
Chronic Lung Disease	9,924 (14.5)	5,971 (16.5)	3,319 (11.3)	611 (20.3)	<0.001

	Overall n = 68,644	Medicare n = 36,252	Private Insurance n = 27,291	Medicaid/Self-Pay n = 3,012	P - value
Coagulopathy	1,640 (2.4)	1,089 (3.0)	481 (1.6)	*	0.03
Depression	8,531 (12.4)	4,538 (12.5)	3,489 (11.9)	491 (16.3)	<0.001
DM	9,462 (13.8)	5,896 (16.3)	3,126 (10.7)	424 (14.1)	<0.001
DM with Chronic Conditions	922 (1.3)	666 (1.8)	211 (0.7)	*	<0.001
Drug Abuse	579 (0.8)	249 (0.7)	201 (0.7)	*	<0.001
Hypertension	41,269 (60.1)	25,078 (69.2)	14,601 (49.9)	1,520 (50.5)	0.59
Hypothyroidism	9,955 (14.5)	6,496 (17.9)	3,218 (11.0)	235 (7.8)	<0.001
Liver Disease	787 (1.14)	347 (1.0)	349 (1.2)	*	<0.001
Lymphoma	254 (0.34)	*	*	*	0.76
Electrolyte Disorder	6,255 (9.1)	4,104 (11.3)	1,839 (6.3)	295 (9.8)	<0.001
Metastatic Cancer	204 (0.3)	*	*	*	0.005
Neurological disorder	2,766 (4.0)	1,877 (5.2)	746 (2.6)	141 (4.7)	<0.001
Obesity	11,740 (17.1)	5,310 (14.6)	5,849 (20.0)	546 (18.1)	0.02
Periph. Vasc. Dis.	1,629 (2.4)	1,301 (3.6)	289 (1.0)	*	0.27
Psychosis	1,493 (2.2)	858 (2.4)	467 (1.6)	167 (5.5)	<0.001
Renal Failure	3,258 (4.7)	2,539 (7.0)	630 (2.2)	*	0.02
PSI	429 (0.63)	296 (0.82)	102 (0.35)	30 (1.0)	<0.001

All results are listed as N (%) except that age is reported as mean $\pm$ standard deviation (SD). P-values refer to comparison of Medicaid/Self-Pay and Private Insurance.

* denotes a value that could not be reported due to NIS guidelines. CHF is congestive heart failure, DM is diabetes mellitus, Periph. Vasc. Dis. is peripheral vascular disease.

Table 2

PSI Incidence

PSI	N (Weighted %)
Perioperative Pulmonary Embolism	165 (0.24)
Pressure Ulcer	*
Postoperative Respiratory Failure	179 (0.28)
Postoperative Sepsis	39 (0.47)
Accidental Puncture or Laceration	*
Postoperative Wound Dehiscence	*
Postoperative Physiologic or Metabolic Derangement	*
Perioperative Hematoma or Hemorrhage	38 (0.06)
Iatrogenic Pneumothorax	*
Central Venous Catheter-Related Blood Stream Infection	*
Postoperative Hip Fracture	*

All PSI are defined and weighted percentages were calculated using the definitions published by AHRQ and CMS. All values are listed as the total number with the weighted percentage in parenthesis.

* denotes an incidence rate that is too small to be reported based on NIS data reporting guidelines. All calculations were performed using SAS version 9.4.

Table 3

Effect of Insurance Status on Odds of PSI

	Estimate (OR)	95% CI	p-value
Medicare (relative to Medicaid/self-pay)	0.74	(0.46–1.19)	0.21
Private Insurance (relative to Medicaid/self-pay)	0.47	(0.29–0.76)	0.00
Age	1.01	(1–1.02)	0.06
Elective Surgery	1.61	(1.12–2.33)	0.01
Female	0.71	(0.57–0.89)	<.0001
Hospital Bedsize (relative to small)			
Medium	1.00	(0.71–1.41)	0.99
Large	1.34	(0.99–1.81)	0.06
Academic Hospital	1.11	(0.89–1.38)	0.37
Race (relative to White)			
Black	1.17	(0.76–1.8)	0.49
Hispanic	1.75	(1.11–2.75)	0.02
Asian	0.89	(0.3–2.59)	0.83
Other	2.04	(1.09–3.79)	0.03
Hospital Location (relative to Northeast)			
Midwest	0.68	(0.5–0.94)	0.02
South	0.73	(0.53–0.99)	0.05
West	0.55	(0.38–0.78)	<.0001
Comorbidity			
Alcohol Abuse	1.50	(0.86–2.62)	0.15
Anemia Deficiency	1.23	(0.93–1.62)	0.15
Arthritis	0.97	(0.59–1.58)	0.90
Blood Loss Anemia	1.53	(0.84–2.78)	0.17
CHF	2.00	(1.35–2.98)	<.0001
Chronic Lung Disease	1.62	(1.27–2.06)	<.0001
Coagulopathy	1.76	(1.15–2.69)	<0.01
Depression	1.39	(1.06–1.83)	0.02
DM	1.12	(0.85–1.48)	0.41
DM with Chronic Conditions	1.18	(0.6–2.31)	0.64
Drug Abuse	1.46	(0.66–3.2)	0.35
Hypertension	0.95	(0.75–1.19)	0.64
Hypothyroidism	0.68	(0.49–0.95)	0.02
Liver Disease	1.42	(0.71–2.81)	0.32
Lymphoma	2.04	(0.59–7.1)	0.26
Electrolyte Disorder	4.08	(3.2–5.21)	<.0001
Metastatic Cancer	5.40	(2.77–10.52)	<.0001
Neurological disorder	1.69	(1.15–2.47)	<0.01
Obesity	1.46	(1.13–1.87)	<.0001
Periph. Vasc. Dis.	1.31	(0.81–2.12)	0.26

	Estimate (OR)	95% CI	p-value
Psychosis	1.23	(0.67–2.22)	0.50

All results are odds ratios. These results are from a multivariable logistic regression model with incidence of one or more PSI as the outcome variable. CHF is congestive heart failure, DM is diabetes mellitus, Periph. Vasc. Dis. is peripheral vascular disease. Medicare and Private insurance are estimates relative to Medicaid/self-pay. Hospital bedsize estimates are relative to small hospital size. Race is relative to white race. Hospital location is relative to northeastern hospitals. All calculations were performed using SAS version 9.4.