Published in final edited form as:
Spine J. 2017 January ; 17(1): 62–69. doi:10.1016/j.spinee.2016.08.005.

Insurance Status and Reportable Quality Metrics in the Cervical Spine Fusion Population

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Abstract

BACKGROUND CONTEXT—The incidence of adverse care quality events among patients undergoing cervical fusion surgery is unknown using the definition of care quality employed by the Centers for Medicare and Medicaid Services (CMS). The effect of insurance status on the incidence of these adverse quality events is also unknown.

PURPOSE—This study determined the incidence of hospital acquired conditions (HAC) and patient safety indicators (PSI) in cervical spine fusion patients and analyzed the association between primary payer status and these adverse events.

STUDY DESIGN—Retrospective cohort design

PATIENT SAMPLE—All patients in the Nationwide Inpatient Sample (NIS) aged eighteen and older that underwent cervical spine fusion from 1998–2011 were included.

OUTCOME MEASURES—Incidence of HAC and PSI from 1998–2011.

METHODS—We queried the NIS for all hospitalizations that included a cervical fusion during the inpatient episode from 1998–2011. All comparisons were made between privately insured

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patients and Medicaid/self-pay patients because Medicare enrollment is confounded with age. Incidence of non-traumatic HAC and PSI were determined using publicly available lists of ICD-9-CM diagnosis codes. We built logistic regression models to determine the effect of primary payer status on PSI and non-traumatic HAC.

RESULTS—We identified 419,424 hospitalizations with cervical fusion performed during an inpatient episode. The estimated national incidences of non-traumatic HAC and PSI were 0.35% and 1.6%, respectively. After adjusting for patient demographics and hospital characteristics, Medicaid/self-pay patients had significantly greater odds of experiencing one or more HAC (OR 1.51 95% CI 1.23–1.84) or PSI (OR 1.52 95% CI 1.37–1.70) relative to the privately-insured cohort.

CONCLUSION—Among patients undergoing inpatient cervical fusion, primary payer status predicts PSI and HAC (both indicators of adverse healthcare quality used to determine hospital reimbursement by CMS). As the U.S. healthcare system transitions to a value-based payment model, the cause of these disparities must be studied to improve the quality of care delivered to vulnerable patient populations.

Keywords

cervical fusion; NIS; insurance status; hospital acquired condition; patient safety indicator; affordable care act

Introduction

Socioeconomic inequality drives disparities in access to healthcare, treatment decisions, and patient outcomes in the United States.[1–11] Gaining access to health insurance may ameliorate these disparities.[12–14] However, studies that adjusted for patient-level covariates observed that Medicaid patients suffer inferior outcomes relative to Medicare patients following craniotomy for brain tumor,[9] endovascular aneurysm treatment,[15] and lumbar spinal stenosis surgery.[6] The Oregon Medicaid Expansion and the Metro Health Care Plus experiments demonstrated that expanding access to insurance does not guarantee improved outcomes across all patient populations because improved healthcare access does not ensure the delivery of high quality care.[12, 16] The Patient Protection and Affordable Care Act (ACA) attempts to rectify this disconnect by tying healthcare reimbursement to healthcare quality as part of the Hospital Value Based Purchasing Program administrated by the Centers for Medicare and Medicaid Services (CMS).[17, 18]

Under this program, CMS withholds 1% of Medicare reimbursements to incentivize hospitals toward improving healthcare quality. Towards this goal, healthcare quality is partially determined by the annual incidence of a list of hospital-acquired conditions (HAC) published by CMS, including surgical site infection following spinal fusion and deep vein thrombosis.[18] Beyond the incidence of HAC, healthcare quality is also measured using patient safety indicators (PSI) developed by the Agency for Healthcare Research and Quality (AHRQ).[19, 20] PSI are used by AHRQ to report the annual incidence of adverse healthcare quality events such as post-surgical hematoma and iatrogenic pneumothorax at the provider, hospital, and regional healthcare market levels.

A dearth of large investigations exists describing the incidence of HAC and PSI in patients undergoing inpatient cervical spinal fusion. Determining the association between healthcare quality and insurance status among cervical spinal fusion patients may help identify patient populations most at-risk for adverse outcomes. Initiatives designed to reduce these disparities can benefit patients, physicians, purchasers, and insurers. This study uses a nationally representative, all-payer database to determine the association of insurance status with adverse quality outcomes in patients undergoing cervical spine fusion. Based on the results of prior studies in other patient populations,[10, 21, 22] we hypothesize that the incidence of HAC and PSI will be significantly higher among Medicaid or self-pay patients undergoing cervical fusion relative to patients with private insurance.

Methods

Data Collection

This study used Nationwide Inpatient Sample (NIS) data from 1998–2011. Data were obtained for any inpatient episode listing the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) procedure code for index or revision cervical fusion (81.01, 81.02, 81.03, 81.31, 81.32, 81.33).[23–25]

The NIS was established by the AHRQ and is the largest all-payer healthcare database in the United States.[26] NIS data are compiled annually, beginning in 1988, and are comprised of a 20% stratified sample of all hospital discharges. Entries in the database correspond to a single inpatient episode. National estimates may be generated using NIS data, as sampling weights are provided for each hospital discharge. The NIS includes data on patient demographics, comorbidities, diagnoses, procedures performed, outcomes (e.g., length of hospital stay, hospital charges, mortality), complications, and hospital characteristics (e.g., hospital size, geographic location, hospital teaching status).[26] The NIS classifies admission diagnoses, procedures, and in-hospital complications using ICD-9 codes.

In 1998, AHRQ modified the NIS sampling strategy; as such, the present study included data only from 1998 onward.[25] Furthermore, in this year the NIS began recording Elixhauser comorbidity data.[27, 28] The Elixhauser comorbidity index is an amalgamation of thirty comorbidities associated with in-hospital mortality, including acute and chronic conditions. This index permits standardized risk adjustment in administrative databases; the NIS (an administrative database) includes 29 of the AHRQ comorbidities originally discussed by Elixhauser et al.[27]

In addition to the Elixhauser comorbidity index, the following data were obtained: demographic data (patient age, gender, race), primary insurance type (Medicare, Medicaid, private insurance, self-payment, no charge), and hospital characteristics (academic hospital setting, admission source [emergency, urgent, or elective], weekend admission, hospital bed size, and hospital region). The presence of specific PSI and HAC within each hospitalization record was determined using lists of ICD-9 diagnosis codes published by AHRQ and CMS, respectively.[29, 30] Pressure ulcer and vascular catheter infection (both listed by CMS as HAC) were only included in the NIS from 2008–2011 and 2007–2011, respectively. Finally, fall and traumatic HACs were excluded, as cervical fusion may be indicated in the treatment of certain traumatic injuries and we could not distinguish traumatic injuries and fractures that led to hospital admission from those that occurred during the inpatient episode.

All patients that underwent cervical fusion and that were aged eighteen years and older were initially included in this study. Upon stratification by insurance status, patients with a primary insurance status listed as "other" or "missing" were excluded. Incidence of PSI and HAC served as our outcome variables.

Statistical Analysis

Means, standard deviations, and frequencies for patient demographics, hospital characteristics, HAC incidence, and PSI incidence were calculated using the sampling weights provided by the NIS to account for the stratified sampling design of the NIS. All analyses were completed in the SAS statistical software package (version 9.4, SAS Institute Inc). In accordance with NIS reporting guidelines, only incidence estimates ≥0.1% were reported. Student t-test was used for continuous variables and the chi squared test for categorical data.

We followed the analytical approach of Hooten et al. and constructed a generalized estimating equation multivariable logistic regression model using insurance status (Medicaid and self-pay relative to private insurance), gender, age, race (Black, Hispanic, Asian, Native American, and other, all relative to White), 29 Elixhauser comorbidities, hospital teaching status, hospital bed size (medium or large relative to small), hospital region (South, West, or Midwest relative to Northeast), and admission status (emergent and urgent relative to elective) as covariates.[10] Each covariate was included in our models because we felt that that the association between insurance status and PSI and HAC incidence may be confounded by patient-and hospital-level characteristics. This list of covariates is an exhaustive list of patient-and hospital-level characteristics included in the NIS. We assumed an exchangeable working correlation by designating each hospital as a repeated factor to adjust for clustering of observations among hospitals and used the sampling weights provided by the NIS to account for the stratified sampling design of the NIS. Medicare patients were omitted from our primary analysis to compare privately insured patients to Medicaid/self-pay patients. Medicare patients were omitted for the following two reasons. First, the Medicare population is not directly comparable to other insured populations secondary to older age and thus higher incidences of HAC and PSI. Second, greater differences in the extent and quality of healthcare likely exist between the privately insured and Medicaid/self-pay populations. Accordingly, comparisons between these cohorts permit identification of the independent effect of insured status upon reportable quality measures. This approach is identical to the analytical framework used by Hooten et al.[10] A Bonferroni correction was used to account for multiple comparisons: our threshold for statistical significance was $p<0.001$.

Results

From 1998–2011, the NIS included 422,352 hospitalizations with cervical fusion performed during an inpatient episode of care. After excluding patients younger than 18 years of age, 419,543 patients remained for analysis. Patient demographics and hospital characteristics are presented in Table 1. The mean age was 51.9 ± 12.7 years. Medicaid/self-pay patients were significantly younger than privately insured patients and were significantly more likely to be both non-white and admitted to an academic medical center (all p <0.001). A significantly greater proportion of privately-insured patients were electively admitted relative to Medicaid/self-pay patients (79.4% compared to 62.9%, p <0.001).

Throughout the study period, 1,467 non-traumatic HAC and 6,609 PSI were recorded. Among patients undergoing inpatient cervical fusion, the estimated national incidence rate of one or more non-traumatic HAC or PSI was 350 per 100,000 patient-years and 1,600 per 100,000 patient-years, respectively. The most common non-traumatic HAC was surgical site infection with an incidence rate of 260 per 100,000 patient years. The most common PSI was postoperative respiratory failure with an incidence rate of 889 per 100,000 patient years.

Without adjusting for confounding, patients in the Medicaid/self-pay cohort demonstrated significantly greater odds of experiencing one or more HAC (OR 3.23 95% CI 2.7–3.8) or PSI (OR 2.15 95% CI 1.93–2.4) relative to those in the privately-insured cohort. When adjusting for differences in patient demographics and comorbidities, patients in the Medicaid/self-pay cohort continued to demonstrate significantly greater odds of experiencing one or more HAC (OR 1.55 95% CI 1.27–1.9) or PSI (OR 1.57 95% CI 1.41–1.76) compared to the privately insured cohort. When adjusting the multivariable model to include hospital characteristics as well as patient demographics and comorbidities, patients in the Medicaid/self-pay cohort demonstrated significantly greater odds of experiencing one or more HAC (OR 1.51 95% CI 1.23–1.84) or PSI (OR 1.52 95% CI 1.37–1.70) relative to the privately-insured cohort. These results are presented in Table 2.

Discussion

The AHRQ began publishing lists of quality indicators in 1994 with the objective of improving quality of healthcare across the United States. The most recent iteration of these metrics includes four components: preventative, pediatric, inpatient, and patient safety indicators.[31] PSI offer unique insight into patient safety during inpatient episodes of care by detailing the incidence of preventable complications such as postoperative hemorrhage, postoperative respiratory failure, and pressure ulcer.[19] The adverse effect of PSI on patient outcomes has been well documented.[21, 32, 33] In addition to the ethical obligation for physicians to provide high quality care for their patients, physician and hospital reimbursement is increasingly tied to care quality. Rajaram et al. used CMS, Center for Disease Control (CDC), and Medicare data to show that 721 hospitals (22% of all participating hospitals) were financially penalized for substandard quality of care in the first year (fiscal year 2015) of the CMS HAC Reduction Program.[34] As the U.S. healthcare system transitions toward value-based reimbursement, identifying predictors of adverse quality outcomes for common procedures becomes increasingly important. The present study uses a nationally representative database to determine the incidence of PSI and HAC in the cervical spinal fusion population, with the hypothesis that self-pay or Medicaid-insured patients suffer a significantly greater burden of adverse inpatient events.

Incidence of PSI and HAC

Although patient safety following spine surgery has been extensively reported, [35–38] the incidence of adverse quality events among cervical fusion patients using PSI or HAC definitions established by AHRQ and CMS remain unclear. In the current study, we observed lower incidences of PSI and HAC (1.6% and 0.35%, respectively) in the cervical fusion population than previously reported in other neurosurgical patient populations. Hooten et al. used NIS data to identify 548,727 admissions for brain tumors between 2002 and 2011. The authors estimated the national incidence of a brain tumor patient experiencing one or more PSI or HAC as 16.3% and 2.8%, respectively.[10] Similarly, Fargen et al. identified 54,589 admissions for unruptured cerebral aneurysm and reported that the national incidence of one or more PSI among this patient population was 14.6% (95% CI 13.9%–15.4%) if the patient underwent surgical clipping and 10.5% (95% CI 9.9%–11.1%) if the patient underwent endovascular coiling.[39] Differences in acuity of care for patients admitted with brain tumors or cerebral aneurysms compared to patients undergoing cervical fusion likely explain the differences in the incidence of adverse quality outcomes among these populations. The difference is further explained by the exclusion of traumatic HAC from our analysis. As a result, records of traumatic injuries in the NIS could not specifically be designated as hospital-acquired for our patient population. Both Hooten et al. and Fargen et al. included traumatic HAC in their national estimates and reported that these were the most common HAC in their patient populations. Furthermore, Hooten et al. reported that length of hospital stay (LOS) was positively correlated with increasing incidence of PSI and HAC. The authors reported an average LOS of 6.4 days, whereas the average LOS among our study population was only 2.8 days. This difference in LOS may further explain the observed differences in PSI and HAC.

Association of Insurance Status with PSI and HAC Incidence

Prior studies have identified an association between insurance status and outcomes across surgical specialties. Calfee et al. reported single-institution data for 3,988 patients. The authors demonstrated significantly greater barriers in access to surgical care for Medicaid and uninsured patients relative to privately-insured patients.[40] LaPar et al. used NIS data for 893,658 hospitalizations and demonstrated that primary payer status adversely affected risk-adjusted mortality following a number of major surgical procedures including hip replacement, gastrectomy, and colectomy.[3] In the spine surgery population, Hacquebord et al. reviewed 1,591 patients that underwent spine surgery at a large academic medical center and observed that Medicaid or uninsured primary payer status was independently predictive of postoperative complications.[2] Finally, Alosh et al. performed a retrospective review of 965,000 anterior cervical fusion procedures in the NIS and found that the odds of in-hospital mortality following anterior cervical fusion were significantly higher among patients with Medicaid or no insurance relative to private insurance.[5] Despite the abundant literature describing the effect of insurance status on specific outcomes following cervical fusion, the effect of primary payer status on the specific reportable quality metrics used by CMS to determine reimbursement remains unknown.

We observed significant disparities among differently-insured patients with regard to both PSI and HAC in the cervical fusion population. Following the methodology of Hooten et al., we adjusted for patient demographics, comorbidities, and hospital characteristics.[10] Hooten et al. identified no statistically significant association between insurance status and PSI or HAC among brain tumor patients after adjusting similarly.[10] In contrast, we observed that insurance status was significantly associated with PSI or HAC during an inpatient episode for cervical fusion after controlling for confounding characteristics. Therefore, it is possible that Medicaid and self-pay patients experience systematically different care from privately insured patients. In a similar study, Derakhshan et al. reviewed the imaging history of 24,105 patients with diagnosed lumbar radiculopathy and/or myelopathy from a single institution and found that more robust insurance coverage and higher income were highly significant predictors of imaging utilization.[41] The authors concluded that physician awareness of an uninsured patient's status may lead to altered practice patterns that avoid imaging and substitute cheaper alternatives to avoid direct patient costs. These disparities may help explain the differential rate of adverse quality events that we observed between privately insured and Medicaid/self-pay patients.

Beyond our principal objective, we also observed that patients admitted electively faced significantly reduced odds of experiencing a PSI or HAC relative to emergent and urgent admissions. Prior studies have demonstrated that Medicaid and self-pay patients are significantly less likely to be electively admitted relative to privately insured patients.[42] Our results are similar as Medicaid and self-pay patients had a significantly lower rate of elective admissions relative to privately insured patients (OR: 0.34, 95% CI 0.33–0.35, $p<0.001$).

This study demonstrates that significant disparities exist in quality of patient care across health insurance groups. Despite controlling for patient demographics and hospital characteristics that may influence the rate of adverse events, Medicaid and self-pay patients faced significantly greater odds of experiencing such an event while hospitalized. Further studies are needed to better understand the latent variables at the patient, provider, institutional, and system-wide levels that underlie these disparities and drive the observed differences in outcomes.

Limitations

There are four main limitations that should be considered when interpreting the results of this study. First, the NIS uses ICD-9 codes to report both procedures and diagnoses. Reviewers assign codes based on a clinician's documentation. If a clinician omits relevant information in such documentation, relevant ICD-9 codes may be missed. Therefore, although these code are useful, relying on these codes to identify our study population renders our study population subject misclassification.[43] Second, although necessary given the composition of the NIS, excluding traumatic HAC from our analyses biases the true national incidence of HAC among cervical fusion patients; the true estimate is likely larger than we report and smaller than has been reported previously. Third, the specific diagnoses that are used to determine the presence of HAC or a PSI may not optimally reflect adverse outcomes among cervical fusion patients. For example, post-operative respiratory failure (the most common PSI in the present cohort) may refer to post-operative intubation. Although undesirable, post-oeprative intubation is required in some cervical fusion patients.

However, PSI are used by CMS to determine hospital reimbursement and it is therefore important to determine the national incidence of all PSI, regardless of the appropriateness of each specific PSI in the present study population. Finally, we were unable to compare privately insured patients with self-pay patients directly because the sample of self-pay patients was small. Combining self-pay patients with Medicaid patients likely biased our estimates of the effect of insurance status on PSI and HAC incidence downward because Medicaid patients do have some, albeit small, insurance coverage. In addition, there may be an undefinable intrinsic difference between insurance and self-pay populations from a risk of adverse event perspective. For example, the latter may be less healthy and, thus, exposed to greater risk of adverse outcome. Despite these limitations, large administrative databases such as the NIS are uniquely positioned to enable clinicians and researchers to study epidemiological trends in PSI and HAC according to insurance status. Interventions designed to limit the incidence of these untoward events in at-risk populations may be designed and implemented following these types of analyses.

Conclusion

This study is the first to demonstrate a statistically significant association between insurance status and quality of care among patients undergoing inpatient cervical fusion. Although PSI and HAC are relatively new constructs for assessing care quality, the adverse outcomes that underlie them are not novel. Rather, linking PSI and HAC incidence to reimbursement represents the first large-scale attempt to link compensation and care quality. As a result, from both a clinical and financial perspective, minimizing PSI and HAC in spine surgery populations offers value for patients, physicians, and hospital systems. The results of this study can be used when creating initiatives to improve the quality of care delivered to the most vulnerable populations. Future research investigating specific protocols and management strategies that reduce the rates of PSI and HAC across all populations is warranted.

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Table 1

Patient Demographics and Hospital Characteristics

	Overall n = 419,424 (%)	Medicare n = 93,842 (%)	Private Insurance n = 241,663 (%)	Medicaid/Self-Pay n = 32,363 (%)	*P* - value
Age (years) ± SD	51.9 ± 12.7	65.6 ± 11.8	48.6 ± 9.9	45.0 ±10.8	<0.0001
Female	210,771 (50.2)	48,187 (51.3)	125,237 (51.8)	16,441 (50.7)	0.0007
Race					
White	262,593 (62.6)	61,539 (65.6)	152,786 (63.1)	16,637 (51.3)	<0.0001
Black	29,515 (7.0)	7,249 (7.7)	13,496 (5.6)	4,332 (13.4)	<0.0001
Asian	3,787 (0.9)	*	2,064 (0.8)	*	<0.0001
Hispanic	15,930 (3.8)	3,474 (3.7)	7,028 (2.9)	2,310 (7.1)	<0.0001
Other	8,167 (1.9)	1,604 (1.7)	4,452 (1.8)	*	<0.0001
Elective Admission	318,874 (76.2)	69,425 (74.0)	1914,607 (79.4)	20,365 (62.9)	<0.0001
Academic Hospital	226,045 (54.7)	49,631 (53.6)	131,441 (55.2)	20,291 (62.7)	<0.0001
Hospital Size					
Small	46,050 (1.04)	9,524 (9.6)	27,324 (10.7)	2,544 (7.3)	<0.0001
Medium	95,187 (22.5)	20,343 (21.6)	55,119 (22.6)	6,844 (21.0)	<0.0001
Large	276,051 (66.6)	63,423 (68.2)	158,285 (66.3)	22,668 (70.7)	<0.0001
Hospital Location					
Northeast	61,970 (15.4)	12,232 (13.6)	35,992 (15.5)	5,460 (17.5)	<0.0001
Midwest	89,710 (22.1)	19,416 (21.3)	55,943 (23.9)	6,989 (22.2)	<0.0001
South	188,273 (43.9)	45,155 (47.2)	105,934 (42.8)	14,108 (42.5)	0.15
West	79,471 (18.6)	17,039 (17.9)	43,794 (17.8)	5,806 (17.8)	0.75
Comorbidity					
AIDS	*	*	*	*	<0.0001
Alcohol Abuse	7,751 (1.9)	1,582 (1.7)	3,349 (1.4)	1,994 (6.2)	<0.0001
Anemia Deficiency	12,142 (2.9)	5,405 (5.8)	4,755 (2.0)	1,113 (3.5)	<0.0001
Arthritis	9,220 (2.2)	4,260 (4.6)	3,928 (1.6)	*	<0.0001
Blood Loss Anemia	747 (0.2)	*	*	*	<0.0001
CHF	5,621 (1.4)	3,739 (4.0)	1,272 (0.5)	*	<0.0001
Chronic Lung Dis.	52,479 (12.6)	18,307 (19.6)	24,089 (10.0)	5,206 (16.2)	<0.0001

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Coagulopathy	3,240 (0.8)	1,356 (1.4)	1,262 (0.5)	*	<0.0001
Depression	37,752 (9.1)	10,473 (11.2)	20,043 (8.4)	3,674 (11.4)	<0.0001
DM	46,581 (11.2)	17,981 (19.2)	21,078 (8.8)	3,246 (10.1)	<0.0001
DM with Chronic Cx.	4,433 (1.1)	2,384 (2.6)	1,507 (0.6)	*	<0.0001
Drug Abuse	4,182 (1.0)	771 (0.8)	1,479 (0.6)	1,368 (4.3)	<0.0001
Hypertension	145,480 (34.9)	52,451 (56.1)	70,361 (29.3)	9,191 (28.5)	<0.0001
Hypothyroidism	27,095 (6.5)	9,836 (10.5)	14,045 (5.9)	1,280 (4.0)	<0.0001
Liver Disease	3,441 (0.8)	1,043 (1.1)	1,395 (0.6)	*	<0.0001
Lymphoma	801 (0.2)	*	*	*	0.22
Electrolyte Disorder	14,732 (3.6)	6,728 (7.3)	5,363 (2.3)	1,668 (5.2)	<0.0001
Metastatic Cancer	1,837 (0.4)	*	*	*	<0.0001
Neurological disorder	10,870 (2.6)	4,958 (5.3)	4,114 (1.7)	1,139 (3.5)	<0.0001
Obesity	26,408 (6.3)	6,182 (6.6)	15,159 (6.3)	2,039 (6.3)	0.97
Paralysis	9,364 (2.3)	4,112 (4.4)	3,111 (1.3)	1,565 (4.9)	<0.0001
Periph. Vasc. Dis.	4,429 (1.1)	2,648 (2.8)	1,275 (0.5)	*	<0.0001
Psychosis	6,791 (1.6)	2,720 (2.9)	2,460 (1.0)	1,160 (3.6)	<0.0001
Pulm. Circ. Dis.	1,082 (0.3)	*	*	*	<0.0001
Renal Failure	4,668 (1.1)	3,202 (3.4)	1,019 (0.4)	*	<0.0001
Tumor without Metastasis	4,202 (1.0)	1,883 (2.0)	1,793 (0.8)	*	0.14
Valvular Disease	9,484 (2.3)	3,484 (3.7)	4,913 (2.0	*	<0.0001
Ulcer	1,246 (0.3)	*	*	*	0.82
Pathologic Weight Loss	2,969 (0.7)	1,382 (1.5)	*	*	<0.0001

Table 1: Patient Demographics and Hospital Characteristics. All results are listed as N (%) except that age is reported as average± standard deviation (SD). P-values refer to comparison of Medicaid/Self-Pay and Private Insurance. In accordance with NIS reporting guidelines, only incidence 0.1% is reported.

* denotes an incidence <0.1%. CHF is congestive heart failure.

Chronic lung dis. is chronic lung disease. DM is diabetes mellitus. DM with chronic cx. is diabetes with chronic complicaitons. Periph. Vasc. Dis. is peripheral vascular disease. Pulm. Circ. Dis. is pulmonary circulatory disease. All comorbidities are defined by the NIS according to ICD-9-CM diagnosis codes

Table 2

Effect of Insurance Status on Odds of HAC and PSI

	Insurance Status Only	95% CI	Insurance Status + Patient Characteristics	95% CI	Insurance Status + Patient and Hospital Characteristics	95% CI
HAC	3.23*	2.7–3.8	1.55*	1.27 – 1.90	1.51*	1.23 – 1.84
PSI	2.15*	1.93 – 2.4	1.57*	1.41 – 1.76	1.52*	1.37 – 1.70

Table 2: Effect of Insurance Status on Odds of HAC and PSI. All results are odds ratios comparing Medicaid/self-pay to private insurance.

* denotes statistical significance at $p<0.001$.

The results of three models are displayed: a univariable analysis with insurance status as the sole explanatory variable, a multivariable analysis with insurance status and patient characteristics (gender, age, race [Black, Hispanic, Asian, Native American, or other, all relative to White], admission source [elective relative to emergent or urgent], and 29 Elixhauser comorbidities) as explanatory variables, and finally a multivariable analysis with insurance status, patient characteristics (defined above) and hospital characteristics (hospital teaching status, hospital bed size [medium and large relative to small], and hospital region [South, West, and Midwest relative to Northeast]) as explanatory variables. All calculations were performed using SAS version 9.4.