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Disparities in Reportable Quality Metrics by Insurance Status in the Primary Spine Neoplasm Population

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Abstract

STUDY DESIGN—Retrospective cohort study.

BACKGROUND CONTEXT—CMS defines “adverse quality events” as the incidence of certain complications such as post-surgical hematoma and/or iatrogenic pneumothorax during an inpatient stay. Patient safety indicators (PSI) are a means to measure the incidence of these adverse events. When these occur, reimbursement to the hospital decreases. The incidence of adverse quality events among patients hospitalized for primary spinal neoplasms is unknown. Similarly, it is unclear what the impact of insurance status is on adverse care quality among this patient population.

PURPOSE—We aimed to determine the incidence of patient safety indicators (PSI) among patients admitted with primary spinal neoplasms, and to determine the association between insurance status and the incidence of PSI in this population.

STUDY DESIGN—Retrospective cohort design

PATIENT SAMPLE—All patients, 18 years and older, in the Nationwide Inpatient Sample (NIS) that were hospitalized for primary spine neoplasms from 1998–2011.

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OUTCOME MEASURES—Incidence of PSI from 1998–2011.

METHODS—The Nationwide Inpatient Sample (NIS) was queried for all hospitalizations with a diagnosis of primary spinal neoplasm during the inpatient episode from 1998–2011. Incidence of PSI was determined using publicly available lists of ICD-9-CM diagnosis codes. Logistic regression models were used to determine the effect of primary payer status on PSI incidence. All comparisons were made between privately insured patients and Medicaid/self-pay patients.

RESULTS—We identified 6,095 hospitalizations in which a primary spinal neoplasm was recorded during the inpatient episode. We excluded patients younger than 18 years as well as those with “other” or “missing” primary insurance status, leaving 5,880 patients for analysis. After adjusting for patient demographics and hospital characteristics, Medicaid/self-pay patients had significantly greater odds of experiencing one or more PSI (OR 1.81 95% CI 1.11– 2.95) relative to privately insured patients.

CONCLUSIONS—Among patients hospitalized for primary spinal neoplasms, primary payer status predicts the incidence of PSI, an indicator of adverse healthcare quality used to determine hospital reimbursement by CMS. As reimbursement continues to be intertwined with reportable quality metrics, identifying vulnerable populations is critical to improving patient care.

Keywords

Spinal neoplasm; insurance status; patient safety indicator; NIS; patient outcome; affordable care act

Introduction

In the United States, socioeconomic status has been shown to predict the quality of care patients receive.[1–9] Although acquiring health insurance may play a role in reducing disparities across socioeconomic groups,[10–12] expanding health insurance access does not guarantee that patients receive high quality care.[9, 13, 14] The Hospital Value Based Purchasing Program, implemented by the Centers for Medicare and Medicaid Services (CMS) as part of the Affordable Care Act (ACA), links healthcare quality with healthcare reimbursements to improve the quality of care received by all patients, regardless of socioeconomic or insurance status.[15, 16] CMS measures healthcare quality and patient safety according to a suite of patient safety indicators (PSI) developed by the Agency for Healthcare Research and Quality (AHRQ).[17, 18] PSIs measure the incidence of adverse inpatient events including post-surgical hematoma and iatrogenic pneumothorax at the provider and hospital levels. Hospitals participating in the Hospital Value-Based Purchasing Program are financially rewarded for providing high quality care and penalized for a decline in quality of care as determined by yearly PSI incidence.[15, 16] As the U.S. healthcare system continues to transition toward value-based reimbursement models, it is increasingly important to identify predictors of variation in healthcare quality among patients presenting with complex and costly diagnoses.

Over the last decade, the number of patients hospitalized for primary spinal cord neoplasms and the associated costs of these hospitalizations have increased significantly.[19] From a patient perspective, primary spinal cord neoplasms can significantly and adversely impact

quality of life in the form of pain and neurologic deficits. Based on data from the National Program of Cancer Registries, there were an estimated 18,000 incident cases of spinal cord metastases in the United States in 1998 and an estimated 11,700 cases of primary spinal cord tumors from 2004–2007.[20, 21] In addition to the growing incidence of spinal cord tumors, the financial burden of spinal cord tumors also increased during the last decade.[19] In the modern era of healthcare reform, determining the incidence of adverse patient safety events among spinal cord neoplasm patients can benefit stakeholders from across the healthcare system. Although prior studies describe patient safety and care quality among patients hospitalized with spinal cord neoplasms, no prior study has quantified the incidence of PSI in this patient population.[21–23] Furthermore, identifying and quantifying disparities in healthcare quality for spinal cord neoplasm patients will enable the creation of targeted programs to reduce disparities that will benefit not only patients but also physicians and hospital systems.

The present study utilizes a nationally representative, all-payer database to quantify the incidence of adverse health care quality outcomes, as defined by PSI, in the primary spinal cord neoplasm population. We then quantify the relationship between patient insurance status and PSI in patients hospitalized for primary spinal cord neoplasms. Based on the results of prior studies from similar patient populations,[9, 24, 25] we hypothesize that the incidence of PSI in patients hospitalized for primary spinal cord neoplasms will be significantly higher in the Medicaid and self-pay patient population compared to the privately insured population.

Materials and Methods

Overview and Study Design

The present study utilized a retrospective cohort design. A nationally representative, all-payer database was used to quantify the association between patient insurance status and adverse inpatient quality outcomes among patients hospitalized with a diagnosis of primary spinal cord neoplasm.

Data Source

The present study used data from the Nationwide Inpatient Sample (NIS) from 1998–2011. The NIS was established by the AHRQ and represents the largest all-payer healthcare database in the United States.[26] The NIS is a 20% stratified sample of all hospital discharges in the United States, with data collected annually beginning in 1988. A single entry in the database represents a single inpatient episode. Additionally, the NIS includes patient-level sampling weights that enable the generation of national estimates. Data in the NIS include patient-level data on demographics, comorbidities, diagnoses, procedures performed, outcomes (such as length of hospital stay, hospital charges, and mortality), and in-hospital complications in addition to hospital characteristics (e.g., hospital size, geographic location, hospital teaching status).[26] An administrative database, the NIS uses International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) codes to define diagnoses, procedures, and in-hospital complications. Furthermore, Elixhauser comorbidity data are included in the NIS beginning with the 1998 sample.[27,

28] The Elixhauser comorbidity index includes thirty comorbidities associated with in-hospital mortality and allows for standardized risk adjustment in administrative databases. The NIS includes twenty-nine of the original thirty Elixhauser comorbidities.[27]

Study Population

NIS data were extracted based on the presence of an inpatient episode listing an ICD-9-CM diagnosis code for benign or malignant primary spinal cord neoplasm (225.3 and 192.2, respectively) at any point during the inpatient episode.[19] All patients recorded in the NIS that were diagnosed with a primary spinal cord neoplasm between 1998 and 2011 were included in the present study. The present study only included data from 1998 onward to mitigate bias because the sampling strategy used to create the NIS changed in 1998.[29] Patients younger than 18 years and patients with a primary payer status of “missing” or “other” were excluded. Furthermore, Medicare patients were omitted from our primary analysis for two reasons. First, significant age differences exist between the Medicare population and other insured populations. Second, privately insured patients and Medicaid/self-pay patients differ significantly with respect to barriers in healthcare access and extent of insurance coverage than between either population and Medicare beneficiaries. Accordingly, limiting our comparison to Medicaid/self-pay patients and privately insured patients allows for the identification of the relationship between insured status and PSI incidence among primary spinal cord neoplasm patients. Hooten et al. used an identical analytical approach.[9]

Outcome of Interest

Our outcome variable of interest was incidence of one or more PSI during an inpatient episode. PSI incidence was determined if a patient discharge record included a specific list of ICD-9-CM diagnosis codes published by AHRQ.[30, 31] Insurance status was our independent variable of interest (privately insured relative to Medicaid/self-pay). We included demographic data (patient age, gender, race [black, Hispanic, Asian, Native American, and other, all relative to white]), hospital characteristics (academic hospital setting, admission source [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 29 Elixhauser comorbidities as covariates. “Each covariate was included in our models because we felt that that the association between insurance status and PSI incidence would 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.” Age was recorded and analyzed as a continuous variable.

Analytic Approach

Multivariable logistic regression was used to adjust for differences between insured populations. Incidence of one or more PSI served as our outcome variable, while insurance status, Elixhauser comorbidities, age, gender, hospital teaching status, hospital bed size, hospital region, and admission status served as covariates.[9] We assumed an independent working correlation because this approach led to the largest standard errors and the most conservative estimates and we considered each hospital as a repeated factor to adjust for

clustering of observations on hospitals. Our threshold for statistical significance was $p < 0.05$. [9]

The SAS statistical software package (version 9.4, SAS Institute Inc) was used to calculate means, standard deviations, and frequencies for patient demographics, hospital characteristics, and PSI incidence. Throughout this study, continuous variables were compared using the student t-test and categorical data were compared using the chi-squared test.

Results

From 1998–2011 the NIS included 6,095 hospitalizations in which a primary spinal cord neoplasm was recorded during the inpatient episode for a patient aged 18 years and older. Patient demographics and hospital characteristics are presented in Table 1. The mean age of included patients was 51.5 ± 17.0 years. Privately insured patients were significantly older than Medicaid/Self-pay patients ($p < 0.001$) and had a significantly lower mean comorbidity index score ($p < 0.001$). A significantly greater proportion of privately insured patients were admitted electively relative to Medicaid/self-pay patients at 60.3% compared to 37.9% ($p < 0.001$).

Among patients who met the inclusion criteria, 202 total PSI were recorded throughout the study period. These results are presented in Table 2. Among patients admitted for primary spinal cord neoplasms, the estimated national incidence rate of 1 or more PSI during an inpatient episode is 3,100 per 100,000 patient-years. The most common PSI was PE/DVT with an incidence rate of 1,250 per 100,000 patient-years and the second most common PSI was post-operative respiratory failure with an incidence rate of 782 per 100,000 patient-years.

Without adjusting for potential confounders, patients in the Medicaid/self-pay cohort had significantly greater odds of experiencing one or more PSI when compared to the privately insured cohort (OR 1.58 95% CI 1.01–2.49). After adjusting for patient demographics and comorbidities, patients in the Medicaid/self-pay cohort continued to have significantly greater odds of experiencing one or more PSI during the inpatient episode compared to the privately insured cohort (OR 1.78 95% CI 1.09–2.92). Finally, when adjusting the multivariable model to include specific hospital characteristics in addition to patient demographics and comorbidities, Medicaid/self-pay patients continued to face significantly greater odds of experiencing one or more PSI during the inpatient episode relative to privately insured patients (OR 1.81 95% CI 1.11–2.95). These results are presented in Table 3.

Discussion

The present study observed an association between insurance status and the incidence of adverse quality events among patients admitted for primary spinal cord neoplasms. Beginning in 1994, the AHRQ began publishing a list of patient safety indicators (PSI) to improve the overall quality of healthcare delivered in the United States.[32] PSI monitor the incidence of preventable hospital complications such as postoperative hemorrhage or

respiratory failure.[17] In tracking these complications, PSI represent a quantifiable and standardized metric for patient safety during an inpatient episode. Prior studies have demonstrated a relationship between increased PSI incidence and worse patient outcomes. [14, 24, 33] In addition to the obligation faced by physicians to provide high quality care to their patients, provisions in the ACA have begun to link reimbursement with quantifiable quality metrics such as PSI.[16] Rajaram et al. utilized data from the CMS, Center for Disease Control, and Medicare to demonstrate that 721 hospitals were financially penalized by CMS for substandard quality of care in 2015.[34] Those 721 hospitals accounted for 22% of all participating hospitals in the first year of the CMS Hospital Acquired Condition Reduction Program.[34] As healthcare reimbursement continues to transition to a value-based system that uses standardized care quality metrics to determine reimbursement, it is vital not only to identify disparities in patient care quality but also to enact reforms designed to eliminate these disparities among patients hospitalized with complex and costly diagnoses including primary spinal cord neoplasms. Using a broader and less specific definition of spinal cord neoplasm than the present study, Sharma et al. found that the financial burden of spinal cord neoplasms increased significantly during the last decade.[19] The authors used the NIS database to identify 15,545 admissions for spinal cord tumors from 2003 to 2010 and found an increase in the total cost of hospitalization from \$45,452 in 2003 to \$76,698 in 2010 ($p<0.001$).[19]

The increasing incidence, costs of hospitalization, and the natural history of spinal cord neoplasms upon patient quality of life highlight the importance of identifying disparities in quality of care.[19, 20] The present study is the first to utilize a national database to determine the incidence of PSI in patients hospitalized with primary spinal cord neoplasms. We hypothesized that Medicaid/self-pay patients face worse odds of experiencing a PSI compared to privately insured patients.

Incidence of PSI

Although the incidence of adverse safety events has been quantified in multiple patient populations[3, 7, 9, 14, 24, 25, 35, 36], no prior study has quantified the incidence of adverse events in patients undergoing hospitalization for primary spinal cord neoplasms using PSI as a metric. In the present study, we observed a lower incidence of PSI in patients treated for primary spinal cord neoplasms (2.8%) compared to prior studies of other neurosurgical patient populations. Hooten et al. analyzed NIS data on 548,727 patients admitted for brain tumors over a 9 year period and estimated the national incidence of one or more PSI to be 16.3%.[9] In a similar study, Fargen et al. used NIS data on 54,589 patients admitted for unruptured aneurysms and estimated the national incidence of one or more PSI to be 14.6% (95% CI 13.9%–15.4%) if the patient underwent surgical clipping. However, if the patient underwent endovascular clipping, the authors found a lower incidence of one or more PSI at 10.5% (95% CI 9.9%–11.1%).[36] One explanation for the differences in PSI incidence among these patient populations is the severity of pathology in each patient population. While cerebral aneurysms and brain tumors require acute care followed by an extending hospital stay, primary spinal neoplasms may develop for months before exhibiting symptoms that require hospitalization.[37].

Association of Insurance Status with PSI Incidence

Across surgical specialties, prior studies have found a decreased likelihood of adverse outcomes among privately insured patients relative to uninsured patients and patients with Medicaid.[4, 38] Hacquebord et al. studied 1,591 patients who underwent spinal surgery at a single institution in 2003 and 2004. The authors reported that patients with Medicaid had 1.68 times greater odds (95% CI 1.23 – 2.29, $p=0.001$) of experiencing an adverse event during their two years of follow-up compared to patients with private insurance.[6] An adverse event was defined as a complication in one of six different organ systems (cardiac, pulmonary, GI, neurological, hematological and urological). Alosch et al. performed a retrospective review of 965,600 anterior cervical spine procedures included in the NIS between 1992–2005. The authors reported that the odds of in-hospital mortality among patients that underwent in-hospital anterior cervical spine procedures were significantly higher in the Medicaid and uninsured patient populations compared to privately insured patients.[2] Specific to cancer patients, Weyh et al. performed a retrospective cross-sectional study of 89 patients that underwent head and neck cancer surgery. The authors observed that uninsured patients, followed by Medicare and Medicaid patients, were significantly more likely to have an extended length of hospital stay and a higher incidence of postoperative complications compared to privately insured patients.[39] Finally, Kelz et al. performed a retrospective cohort study of 13,415 adults admitted for colorectal carcinoma and found that uninsured and Medicaid patients were 22% more likely (95% CI 1.06 – 1.40) to develop complications during their hospital admission and were 57% more likely (95% CI 1.01 – 2.42) to die postoperatively compared to privately insured patients.[40] While the relationship between insurance status and patient safety has been quantified for pathologies such as head and neck cancer and colorectal cancer, the present study is the first to quantify the association between primary payer status and PSI among patients admitted with primary spinal cord neoplasms. It is crucial to understand this relationship not only to improve patient outcomes but also because CMS utilizes these quantifiable quality metrics when determining hospital reimbursement.

Using an analytical method identical to that of the present study, Hooten et al. did not identify a statistically significant association between insurance status and PSI incidence in brain tumor patients.[9] In our study, however, insurance status alone was predictive of a PSI incidence. Similarly, after adjusting for potential cofounders, there was still a significant association. After adjusting for patient demographics, comorbidities, and hospital characteristics, we found significant disparities among differently insured patients diagnosed with primary spinal cord neoplasms. This finding suggests that patients with Medicaid or no insurance may experience suboptimal quality of care relative to privately insured patients. Variability in patient care for spinal pathologies across insurance groups has also been identified in the utilization of diagnostic imaging. A study by Derakhshan et al. demonstrated that uninsured patients with lumbar radiculopathy and/or myelopathy were statistically significantly less likely to undergo advanced imaging such as MRI and CT compared to privately insured patients.[41] The authors concluded that physician awareness of patient insurance status might alter treatment decisions.[41] The findings of Derakhshan et al. apply to patients with primary spinal cord neoplasms because a decrease in the

utilization of advanced imaging in uninsured patients may lead to both a delay in proper diagnosis and delay in early initiation of appropriate treatment.

The present study found a significant disparity in the level of care quality provided to patients with primary spinal cord neoplasms. Despite controlling for confounding differences in populations including patient demographics and hospital characteristics, we observed that Medicaid and self-pay patients had greater odds of experiencing one or more PSI compared to those with private insurance. One explanation of our principal finding is that barriers in access to healthcare result in Medicaid and uninsured patients presenting with more advanced spinal neoplasms. A study performed by Calfee et al. that analyzed data on 3,988 patients from a single institution concluded that patients with Medicaid or no insurance needed to overcome substantially greater obstacles in access to the same surgical care as their privately insured counterparts.[42] Furthermore, Weyh et al. demonstrated that uninsured patients with head and neck cancer were significantly more likely to present with Stage III or Stage IV cancer compared to privately insured patients.[39] While the Medicaid and self-pay patient populations were combined in our analysis, analyzing only self-pay patients would have likely resulted in a higher observed relationship between insurance status and odds of experiencing an adverse quality event. Uninsured patients face even greater barriers to accessing care than Medicaid patients and may therefore present with more advanced neoplasms relative to Medicaid patients.[39] While the present findings identify a disparity in care quality between differently insured patient populations, further research is needed to better understand the causes of this disparity and elucidate interventions to address discrepancies in care. One potential future study could utilize data from single or multi institutional level to characterize the differences amongst Medicaid/self-pay patients and privately insured patients to identify potential drivers of these observed disparities. Using this data would supplement the growing literature around disparities in PSI because it would have significantly greater granularity than data from large administrative databases.

Limitations

There are some limitations to consider when interpreting this study. First, the NIS utilizes ICD-9 codes when reporting diagnoses and surgical procedures. Proper reporting of ICD-9 codes is based on physician documentation. If a clinician fails to properly report a diagnosis or procedure or a coder fails to include a relevant ICD-9 code, then misclassification can occur.[43] Second, based on the ICD-9 codes we utilized, we were unable to distinguish between different types of primary spinal cord neoplasms, such as intramedullary vs. extramedullary. Third, due to an inherent limitation of using a large database such as the NIS, we were unable to determine whether any of the hospitalizations represented multiple admissions for the same patient. Finally, we could not adequately compare privately insured patients to self-pay patients because of the small sample size of self-pay patients. Even after combining the self-pay and Medicaid patient populations, the Medicaid/self-pay population was less than 10% of the overall sample size. Combining Medicaid and self-pay patients likely reduced the observed relationship between insurance status and PSI incidence. Despite these limitations, this study highlights the tools accessible to clinicians and healthcare administrators who choose to study the incidence of PSI in various patient populations.

Large databases such as the NIS are a vital tool in studying trends in patient safety during hospitalizations as they offer large sample sizes from an all-payer patient population.

Conclusions

This study is the first to demonstrate an association between insurance status and the quality of care administered to patients undergoing inpatient treatment for primary spinal cord neoplasms. PSIs are a quantitative measure implemented by CMS for measuring quality of care received by hospitalized patients to determine hospital reimbursement. As reimbursement continues to become intertwined with reportable patient outcomes, PSI will increasingly serve as a metric for clinicians and hospitals. Identifying methods to reduce the incidence of PSI in hospitalized patients will therefore not only benefit patients but also surgeons and hospital systems. Further research is warranted to better understand the cause of the observed disparities in PSI incidence and to develop initiatives that can improve care quality for all spinal neoplasm patients.

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References

1. Shen JJ, Washington EL. Disparities in outcomes among patients with stroke associated with insurance status. *Stroke*. 2007; 38(3):1010–6. [PubMed: 17234983]
2. Alosch H, Riley LH 3rd, Skolasky RL. Insurance status, geography, race, and ethnicity as predictors of anterior cervical spine surgery rates and in-hospital mortality: an examination of United States trends from 1992 to 2005. *Spine (Phila Pa 1976)*. 2009; 34(18):1956–62. [PubMed: 19652634]
3. Curry WT Jr, Carter BS, Barker FG 2nd. Racial, ethnic, and socioeconomic disparities in patient outcomes after craniotomy for tumor in adult patients in the United States, 1988–2004. *Neurosurgery*. 2010; 66(3):427–37. discussion 437–8. [PubMed: 20124933]
4. LaPar DJ, et al. Primary payer status affects mortality for major surgical operations. *Ann Surg*. 2010; 252(3):544–50. discussion 550–1. [PubMed: 20647910]
5. Lapar DJ, et al. Primary payer status affects outcomes for cardiac valve operations. *J Am Coll Surg*. 2011; 212(5):759–67. [PubMed: 21398153]
6. Hacquebord J, et al. Medicaid status is associated with higher complication rates after spine surgery. *Spine (Phila Pa 1976)*. 2013; 38(16):1393–400. [PubMed: 23591656]
7. Lad SP, et al. Disparities in the outcomes of lumbar spinal stenosis surgery based on insurance status. *Spine (Phila Pa 1976)*. 2013; 38(13):1119–27. [PubMed: 23354106]
8. Stone ML, et al. Primary payer status is significantly associated with postoperative mortality, morbidity, and hospital resource utilization in pediatric surgical patients within the United States. *J Pediatr Surg*. 2013; 48(1):81–7. [PubMed: 23331797]
9. Hooten KG, et al. Insurance status influences the rates of reportable quality metrics in brain tumor patients: a nationwide inpatient sample study. *Neurosurgery*. 2015; 76(3):239–47. discussion 247–8. [PubMed: 25603104]
10. Hadley J. Sicker and poorer--the consequences of being uninsured: a review of the research on the relationship between health insurance, medical care use, health, work, and income. *Med Care Res Rev*. 2003; 60(2 Suppl):3S–75S. discussion 76S–112S. [PubMed: 12800687]
11. Quimbo SA, et al. Evidence of a causal link between health outcomes, insurance coverage, and a policy to expand access: experimental data from children in the Philippines. *Health Econ*. 2011; 20(5):620–30. [PubMed: 20540042]

12. Cebul RD, et al. MetroHealth Care Plus: Effects Of A Prepared Safety Net On Quality Of Care In A Medicaid Expansion Population. *Health Aff (Millwood)*. 2015; 34(7):1121–30. [PubMed: 26153306]
13. Baicker K, et al. The Oregon experiment--effects of Medicaid on clinical outcomes. *N Engl J Med*. 2013; 368(18):1713–22. [PubMed: 23635051]
14. Fargen KM, et al. Health disparities and stroke: the influence of insurance status on the prevalence of patient safety indicators and hospital-acquired conditions. *J Neurosurg*. 2015; 122(4):870–5. [PubMed: 25658779]
15. Centers for Medicare and Medicaid Services. Hospital Value-Based Purchasing Program. 2015 Jan 2, 2016]; Available from: <http://www.cms.gov/Medicare/Quality-Initiatives-Patient-Assessment-Instruments/hospital-value-based-purchasing/index.html?redirect=/hospital-value-based-purchasing>
16. United States, U.S.C.H.O.o.t.L.C., United States. Congress. House. Committee on Ways and Means, United States. Congress. House. Committee on Energy and Commerce, United States. Congress. House. Committee on Education and Labor, Compilation of Patient Protection and Affordable Care Act. As Amended through November 1, 2010 Including Patient Protection and Affordable Care Act Health-related Portions of the Health Care and Education Reconciliation Act of 2010. Washington, DC: U.S. Government Printing Office; 2010.
17. McDonald, KMRP. University of California San Francisco-Stanford Evidence-Based Practice Center United States, Agency for Healthcare Research and Quality. Measures of Patient Safety Based on Hospital Administrative Data—The Patient Safety Indicators.
18. Agency for Healthcare Research and Quality. Quality Indicator User Guide: Patient Safety Indicators (PSI) Composite Measures Version 5.0.
19. Sharma M, et al. Discharge dispositions, complications, and costs of hospitalization in spinal cord tumor surgery: analysis of data from the United States Nationwide Inpatient Sample, 2003–2010. *J Neurosurg Spine*. 2014; 20(2):125–41. [PubMed: 24286530]
20. Duong LM, et al. Descriptive epidemiology of malignant and nonmalignant primary spinal cord, spinal meninges, and cauda equina tumors, United States, 2004–2007. *Cancer*. 2012; 118(17):4220–7. [PubMed: 22907705]
21. Lei M, et al. Posterior decompression and spine stabilization for metastatic spinal cord compression in the cervical spine. A matched pair analysis. *Eur J Surg Oncol*. 2015; 41(12):1691–8. [PubMed: 26603676]
22. Sciubba DM, et al. Long-term outcomes in primary spinal osteochondroma: a multicenter study of 27 patients. *J Neurosurg Spine*. 2015; 22(6):582–8. [PubMed: 25793467]
23. Tang Y, et al. Metastatic Spinal Cord Compression from Non-Small-Cell Lung Cancer Treated with Surgery and Adjuvant Therapies: A Retrospective Analysis of Outcomes and Prognostic Factors in 116 Patients. *J Bone Joint Surg Am*. 2015; 97(17):1418–25. [PubMed: 26333737]
24. Fargen KM, et al. The prevalence of patient safety indicators and hospital-acquired conditions in patients with ruptured cerebral aneurysms: establishing standard performance measures using the Nationwide Inpatient Sample database. *J Neurosurg*. 2013; 119(6):1633–40. [PubMed: 23991899]
25. Nuno M, et al. Association between in-hospital adverse events and mortality for patients with brain tumors. *J Neurosurg*. 2015:1–9.
26. HCUP National Inpatient Sample (NIS). Healthcare Cost and Utilization Project (HCUP). Agency for Healthcare Research and Quality; R., MD: 1998–2011. <http://www.hcup-us.ahrq.gov/nisoverview.jsp> [Accessed 12/15/14]
27. Elixhauser ASC, Harris DR, Coffey RM. Comorbidity Measures for Use with Administrative Data. *Med Care*. 1998; 36:8–27. [PubMed: 9431328]
28. Li BED, Faris P, Dean S, Quan H. Risk adjustment performance of Charlson and Elixhauser comorbidities in ICD-9 and ICD-10 administrative databases. *BMC health services research*. 2008; 8:12–12. 2007. [PubMed: 18194561]
29. Memtsoudis SG, HA, Ma Y, Chiu YL, Sama AA, Girardi FP. Increased In-hospital Complications After Primary Posterior versus Primary Anterior Cervical Fusion. *Clin Orthop*. 2011; 469:649–657. [PubMed: 20838946]

30. AHRQ. Quality Indicators – Guide to Patient Safety Indicators. Rockville, MD: Agency for Healthcare Research and Quality; 2003. Version 2.1, Revision 2, (October 22, 2004). AHRQ Pub. 03-R203. Updated 2014
31. CMS. Final HAC list: 2013, 2014, 2015. 2015. [cited 2015. 10/15/2015]; Available from: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/HospitalAcqCond/Downloads/FY_2013_Final_HACsCodeList.pdf
32. Farquhar, M. AHRQ Quality Indicators, in Patient Safety and Quality: An Evidence-Based Handbook for Nurses. Hughes, RG., editor. Rockville (MD): 2008.
33. Ang D, et al. Benchmarking statewide trauma mortality using Agency for Healthcare Research and Quality's patient safety indicators. J Surg Res. 2015; 198(1):34–40. [PubMed: 26115808]
34. Rajaram R, et al. Hospital Characteristics Associated With Penalties in the Centers for Medicare & Medicaid Services Hospital-Acquired Condition Reduction Program. JAMA. 2015; 314(4):375–83. [PubMed: 26219055]
35. Hoh BL, et al. In-hospital morbidity and mortality after endovascular treatment of unruptured intracranial aneurysms in the United States, 1996–2000: effect of hospital and physician volume. AJNR Am J Neuroradiol. 2003; 24(7):1409–20. [PubMed: 12917139]
36. Fargen KM, et al. Prevalence of patient safety indicators and hospital-acquired conditions in those treated for unruptured cerebral aneurysms: establishing standard performance measures using the Nationwide Inpatient Sample database. J Neurosurg. 2013; 119(4):966–73. [PubMed: 23746098]
37. Thakur NA, et al. Benign tumors of the spine. J Am Acad Orthop Surg. 2012; 20(11):715–24. [PubMed: 23118137]
38. Parikh AA, et al. The effect of health insurance status on the treatment and outcomes of patients with colorectal cancer. J Surg Oncol. 2014; 110(3):227–32. [PubMed: 24810008]
39. Weyh AM, Lunday L, McClure S. Insurance Status, an Important Predictor of Oral Cancer Surgery Outcomes. J Oral Maxillofac Surg. 2015; 73(10):2049–56. [PubMed: 25981863]
40. Kelz RR, et al. Morbidity and mortality of colorectal carcinoma surgery differs by insurance status. Cancer. 2004; 101(10):2187–94. [PubMed: 15382089]
41. Derakhshan A, et al. The Impact of Socioeconomic Status on the Utilization of Spinal Imaging. Neurosurgery. 2015; 77(5):746–54. [PubMed: 26214318]
42. Calfee RP, et al. The influence of insurance status on access to and utilization of a tertiary hand surgery referral center. J Bone Joint Surg Am. 2012; 94(23):2177–84. [PubMed: 23224388]
43. Evans JM, MacDonald TM. Misclassification and selection bias in case-control studies using an automated database. Pharmacoepidemiol Drug Saf. 1997; 6(5):313–8. [PubMed: 15073765]

Table 1**Patient Demographics and Hospital Characteristics**

	Overall n = 6,095	Medicare n = 1,651	Private Insurance n = 3,691	Medicaid/Self-Pay n = 753	P - value
Age (years) ± SD	51.5 ± 17.0	68.6 ± 13	45.9 ± 13.4	41.0 ± 14.1	<0.0001
Female	2,938 (48.4)	859 (52.1)	1,722 (47.0)	357 (47.5)	0.8
Race					
White	3,475 (57.0)	1,077 (65.1)	2,116 (57.4)	282 (37.2)	<0.0001
Black	424 (6.9)	*	217 (5.8)	109 (14.4)	<0.0001
Asian	210 (3.5)	*	129 (3.5)	*	<0.0001
Hispanic	393 (6.3)	*	203 (5.4)	121 (15.8)	<0.0001
Other	*	*	103 (2.7)	*	0.04
Elective Admission	3,2109 (53.0)	718 (43.4)	2,217 (60.3)	284 (37.9)	<0.0001
Academic Hospital	4,438 (73.8)	1,022 (63.1)	2,853 (78.3)	563 (75.6)	0.11
Hospital Size					
Small	487 (7.5)	148 (8.4)	292 (7.4)	*	<0.0001
Medium	1,120 (18.3)	332 (20.1)	630 (17.0)	158 (21.0)	<0.0001
Large	4,472 (74.0)	1,165 (71.2)	2,762 (75.1)	545 (73.3)	0.003
Hospital Location					
Northeast	1,211 (20.9)	354 (22.4)	702 (20.0)	155 (21.7)	0.3
Midwest	1,289 (21.8)	352 (22.0)	801 (22.4)	136 (18.5)	<0.0001
South	2,093 (33.1)	574 (33.5)	1,266 (33.0)	253 (32.5)	0.8
West	1,502 (24.2)	371 (22.1)	922 (24.5)	209 (27.2)	0.14
Number of Comorbidities	1.45 ± 1.44	2.2 ± 1.6	1.11 ± 1.3	1.37 ± 1.4	<0.0001
Comorbidity					
Alcohol Abuse	*	*	*	*	0.041
Arthritis	*	*	*	*	0.6
CHF	133 (2.1)	103 (6.3)	*	*	0.22
Coagulopathy	126 (2.1)	*	*	*	0.4
Depression	425 (7.0)	152 (9.2)	225 (6.1)	*	0.22
DM	561 (9.3)	252 (15.6)	245 (6.7)	*	0.74

	Overall n = 6,095	Medicare n = 1,651	Private Insurance n = 3,691	Medicaid/Self-Pay n = 753	P - value
Drug Abuse	*	*	*	*	*
Hypertension	1,842 (30.5)	821 (50.4)	875 (23.9)	146 (19.7)	0.26
Hypothyroidism	412 (6.8)	182 (11.0)	213 (5.8)	*	0.4
Liver Disease	*	*	*	*	*
Lymphoma	*	*	*	*	*
Obesity	332 (5.5)	100 (6.1)	194 (5.3)	*	0.62
Paralysis	1,141 (18.8)	387 (23.6)	558 (15.2)	196 (26.1)	<0.0001
Psychosis	*	*	*	*	*
PSI	202 (3.1)	68 (4.1)	87 (2.4)	28 (3.7)	0.06

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

* denotes an incidence rate that is below the reporting guidelines and cannot be reported.

Table 2

Incidence of PSI by Insurance Status
Absolute number of patient safety indicators (PSI) by insurance status and the insurance status specific PSI incidence rates.

	Overall n = 6,095	Medicare n = 1,651	Private Insurance n = 3,691	Medicaid/Self-Pay n = 753	P - value
PSI	202 (3.1)	68 (4.1)	87 (2.4)	28 (3.7)	0.06

Results are listed as N (weighted %). P-values refer to comparison of Medicaid/Self-Pay and Private Insurance.

Table 3

Effect of Insurance Status on Odds of PSI

	Insurance Status Only	95% CI	Insurance Status + Patient Characteristics	95% CI	Insurance Status + Patient and Hospital Characteristics	95% CI
PSI	1.58*	1.01 – 2.49	1.78*	1.09 – 2.92	1.81*	1.11 – 2.95

All results are odds ratios comparing Medicaid/self-pay to private insurance.

* denotes statistical significance at p<0.05.

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 as explanatory variables, and a multivariable analysis with insurance status and patient and hospital characteristics as explanatory variables. All calculations were performed using SAS version 9.4.

PSI = patient safety indicator