Published in final edited form as:

Spine (Phila Pa 1976). 2014 September 15; 39(20): 1707–1713. doi:10.1097/BRS.0000000000000496.

Medicaid Status is Associated with Higher Surgical Site Infection Rates after Spine Surgery

Mark W. Manoso, M.D.^{*,#}, Amy M. Cizik, M.P.H, M.S.^{*}, Richard J. Bransford, M.D.^{**}, Carlo Bellabarba, M.D.^{**}, Jens Chapman, M.D.^{**}, and Michael J. Lee, M.D.^{*}

^{*} University of Washington Department of Orthopedics and Sports Medicine Seattle, WA

^{**} Harborview Medical Center Department of Orthopedics and Sports Medicine Seattle, WA

[#] Uniformed Services University of the Health Sciences Department of Surgery Bethesda, MD

Abstract

STUDY DESIGN—The Spine End Results Registry (2003–2004) is a registry of prospectively collected data of all patients undergoing spinal surgery at the University of Washington Medical Center and Harborview Medical Center. Insurance data was prospectively collected and used in multivariate analysis to determine risk of perioperative complications.

OBJECTIVE—Given the negative financial impact of surgical site infections and the higher overall complication rates of patients with a Medicaid payer status, we hypothesized that a Medicaid payer status would have a significantly higher surgical site infection rate.

SUMMARY OF BACKGROUND DATA—The medical literature demonstrates lesser outcomes and increased complication rates in patients that have public insurance as compared to private insurance. No one has shown that patients with a Medicaid payer status as compared to Medicare and privately insured patients have a significantly increased surgical site infection rate for spine surgery.

METHODS—The prospectively collected Spine End Results Registry provided data for analysis. Surgical site infection was defined as treatment requiring operative debridement. Demographic, social, medical, and the surgical severity index risk factors were assessed against the exposure of payer status for the surgical procedure.

RESULTS—The population included Medicare (N=354), Medicaid (N=334), the Veterans' Administration (N=39), private insurers (N=603), and self-pay (N=42). Those patients whose insurer was Medicaid had a 2.06 odds (95% CI: 1.19, 3.58, p=0.01) of having a surgical site infection when compared to the privately insured.

CONCLUSION—The study highlights the increased cost of spine surgeries for Medicaid patients with the passage of the Patient Protection and Affordable Care Act of 2010 (PPACA). The PPACA provisions could cause a reduction in re-imbursement to the hospital for taking care of patients with Medicaid insurance due to their higher complication rates and higher costs. This very issue could inadvertently lead to access limitations.

Keywords

surgical site infection; spine surgery; payor status; surgical severity index; Medicaid

INTRODUCTION

Surgical site infections have always been a serious complication associated with spine surgery. An enhanced knowledge of the risks factors for infection is essential in preventing the complication and in improving the outcome of surgery. A better understanding of the causes of surgical site infections aids in appropriately counseling a patient on the risks for what is possibly a preventable complication. Numerous authors have looked at the complications associated with spinal surgery.[1-12] Recent literature spanning multiple disciplines of medicine would support payer status as a cause for inferior outcomes and increased complication rates in surgical procedures and medical treatments.[2, 13-29] An ever increasing body of evidence suggests that publicly insured and particularly Medicaid patients have an increased complication rate and poorer outcomes when compared to those with commercial insurance.[13, 17-19, 23-27, 29-43]

With the passage of the Patient Protection and Affordable Care Act of 2010 (PPACA), insurance will be extended to millions of Americans largely through expansion of Medicaid.[44] As of January 2014, Medicaid eligibility will be expanded to Americans who earn less than 133% of the poverty level. It is estimated that half of those who gain insurance under PPACA by 2019 will do so under this provision.[45] Proponents of the PPACA argue that "...with the extensive improvements in health insurance coverage provided by the Affordable Care Act, the United States is poised to narrow if not eventually eliminate the profound inequity that currently characterizes the health care system." [46]

An additional provision in PPACA that went into effect in October 2012 was the new Hospital Value-Based Purchasing Program. In this program, Medicare payments to hospitals were linked to various outcome measures. Beginning in 2013, hospitals may receive payment reductions if they fail to meet certain patient care criteria such as excessive 30-day readmissions.[44] Further payment reductions will take effect if hospitals have high rates of certain hospital acquired conditions. Quality metrics are being used to assess the quality of care provided by a hospital and are used to compare the outcomes between hospitals.[47, 48] Surgical site infections are one of many quality metrics used in analyzing a hospital's performance[47-50] and may directly affect reimbursement based on payer status.[49, 51] Surgical site infections have historically increased hospital stay and treatment costs between \$11,000 and \$36,000.[51-53] With spine surgical site infections the average increased cost of treatment has been reported as \$26,000.[51] Medicaid patients account for 48.6 million or 15.9% of the population[54]. If a Medicaid patients develops a surgical site infection, they will negatively impact on the financial stability of medical treatment facilities.[51]

Given the negative financial impact of surgical site infections and the higher overall complication rates of patients with a Medicaid payer status, we hypothesized that a Medicaid payer status would have a significantly higher surgical site infection rate. We analyzed the Spine End Results Registry to University of Washington Medical Center and

Harborview Medical Center. Detailed information regarding patient demographics, insurance status, medical comorbidity, surgical invasiveness, and adverse occurrences were followed for up to two years and obtained prospectively using earlier published methods. [55, 56]

METHODS

Data Source

The Spine End Results Registry to University of Washington Medical Center and Harborview Medical Center. Detailed information regarding patient demographics, insurance status, medical comorbidity, surgical invasiveness index based on blood loss and operative time, and adverse occurrences were followed for up to two years and obtained prospectively using earlier published methods. [55] This registry included patients undergoing any type of spinal surgery between January 1st 2003 and December 31st 2004 at two academic hospitals: a university based medical center, and a county hospital serving as the only Level I trauma center in a large multi-state area. All patients were prospectively followed for the occurrence of a surgical site infection for at least two years after their surgery. The University institutional review board approved the study and an informed consent was obtained from participants. Although insurance data were prospectively collected, this factor was not initially considered in determining risk and was not used in the multivariate analysis of our previous studies in determining risk of perioperative complications.[2, 3] Insurance data were provided by the University of Washington Medical Center (UWMC) quality improvement database, which prospectively records and reports payor information in accordance with the Centers for Medicare and Medicaid Services (CMS) reporting criteria.

Exclusion Criteria—There were 1745 patients enrolled in the study from January 1, 2003 to December 31, 2004. Exposure as defined by the type of treatment being nonsurgical or surgical management. Of those 213 were excluded for the following reasons: missing exposure status (N=16/83, 19%) or exposure status equal to zero (N=67/83, 81%) and < 18 years of age (N=38/213, 18%), and those diagnosed with a previous infection (N=91/213, 43%). Exposure status equal to zero included those who did not have surgical intervention, including cast and halo placement and thoracolumbosacral orthosis (TLSO) (Figure 1).

Surgical Site Infection and Risk Factor Definitions—The primary outcome of interest was surgical site infection that required return to the operating room for irrigation and debridement. We assessed the odds ratio of several risk factors using univariate (Table 1) and multivariate analysis (Table 2). The exposure of interest was payor of surgical procedure and associated hospital stay. Risk factors assessed for confounding or effect modification included: age, gender, smoking status, alcohol use, drug use, diabetes, body mass index (BMI), medical co-morbidity (myocardial infarction, history of non-MI cardiac disease (valve disease, prolapse, abnormal EKG), congestive heart failure, cerebrovascular disease, chronic obstructive pulmonary disease (COPD), asthma, hypertension, rheumatoid arthritis, renal conditions, pre-existing neoplasm, history of syncope or seizure, anemia, bleeding disorder), previous spinal surgery, primary diagnosis (degenerative, trauma,

neoplasm, infection, and other), level of surgery (cervical, thoracic, lumbosacral), surgical approach (anterior, posterior, combined), and surgical invasiveness. Surgical invasiveness (SI) was defined using methods described in previously published works of the same cohort. [55]

Analysis—Categorical data are presented as the number of cases and percentages. For categorical values, Pearson's Chi-square or Fisher's exact tests (where cell counts were low) were used to assess the univariate effect of various risk factors, including the exposure of interest, payor status, on the outcome. Odds Ratio (OR) and 95% confidence intervals (95% CI) were calculated for each of the categorical variables using univariate and multivariate logistic regression analysis to examine the association between payor status and, adjusting for confounding factors of comorbidity. In the model we included risk factors that were deemed of clinical importance by the study investigators to contribute to surgical site infection, were a known confounder, or were chosen a-priori based on previous published papers using this dataset.[2, 3] Because surgical approach and the number of vertebral levels operated on are a component of the invasiveness index they were not included in the multivariate model.

Statistical analysis was performed using SAS Enterprise Guide 4.3 software (SAS Inc., Cary, NC) and STATA 12.1 (StataCorp, College Station, TX) with hypothesis testing using a 2-tailed test of significance and an alpha level of $p < 0.05$

RESULTS

There were 1745 patients who underwent spine surgery from Jan 1st 2003 to Dec 31st 2004. Of these, 212 were excluded for reasons outlined in Figure 1, leaving 1532 patients who were analyzed in this study.

The United States Government was the majority payer (N=727/1532, 47.5%) in our study, with almost half of patients received either Medicare (N=354/1532, 23.1%), Medicaid (N=334/1532, 21.8%) or some other federally funded program, including the Veterans' Administration (N=39/1532, 2.6%). This was followed by private insurers (N=603/1532, 39.4%), and self-pay (N=42/1532, 2.7%).

As we had previously reported univariate analysis of risk factors for surgical site infections in greater detail,[3] we did not present the complete results of the univariate analysis in this manuscript as those risk factors are not the focus of our study question (Table 1). However, we did incorporate the results of the univariate analysis into our multivariate analysis and do present the significantly associated risk factors along with the payer data (Table 2).

The risk for surgical site infection was highest among those patients receiving the most invasive surgical treatment (surgical invasiveness > 25). The odds of any adverse event following the most invasiveness spinal surgeries (SI>25) was 6-fold higher than those who received the least invasive (SI ≤ 5) spine surgeries (OR=6.00, 95% CI: 2.26, 15.9, $p < 0.001$). When controlling for age as a risk factor in the multivariate, Medicare was not statistically, significantly associated with any adverse event. However after controlling for confounders and known risk factors in the multivariate analysis, those patients whose insurer was

Medicaid had a 2.06 odds (95% CI: 1.19, 3.58, $p=0.01$) of having a surgical site infection when compared to the privately insured (Tables 1 & 2). Self-pay status was not statistically, significantly associated with any adverse event.

DISCUSSION

The medical literature clearly demonstrates lesser outcomes and increased complication rates in patients that have public insurance as compared to private insurance.[13, 14, 16-19, 23-31, 34-37, 39, 40, 42, 54, 57-59] However, no one has shown that patients with a Medicaid payer status as compared to Medicare and privately insured patients have a significantly increased surgical site infection rate for spine surgery. We demonstrated that a Medicaid payer status conferred a 2 fold higher risk of a surgical site infection when controlled for surgical severity over other publically or privately insured patients.

The study is based on the patient population of the University of Washington Medical Center Spine End Results Registry (2003-2004) which was a prospective observational cohort of all patients undergoing spine surgery from January 1, 2003 to December 31, 2004. All of the patients were followed for a minimum of 2 years, prospectively, for the development of complications. Our sample size is limited to 1745 patients who were seen at a tertiary referral center and at a level 1 trauma center. Although a relatively small cohort, it is one of the largest prospectively collected data bases created to evaluate for complications. The population has a selection biased with a higher than average Medicaid population of 21.8% versus the average population of 15.9%.[54] The selection bias, however, affects all public hospitals. Additionally this study was an observational study without randomization. Surgical decisions and procedures were chosen by multiple surgeons with different perspectives. The invasiveness of the surgery chosen may have been biased by the perceived health of the patient, with patients with more comorbidities receiving less invasive surgery. Additionally, as previously reported, a large portion of the population was treated for traumatic injuries with a bias toward an increased complication rate.[3, 55]

Our study adds new insight into the body of literature that would support the increased complication rate of a Medicaid payer status. [13, 14, 16-19, 23-31, 34-37, 39, 40, 42, 54, 57-59] Alosch et al. demonstrated the increased mortality odds ratio of 3.22 when comparing the privately insured versus a Medicaid insured patient undergoing anterior cervical surgery. [14] Boomer showed that in the treatment of appendicitis, a public insurance status had a higher perforation rate and length of hospital stay than patient's with private insurance.[16] In Ann Arbor, a Medicaid status more than doubled the rupture rate of abdominal aortic aneurysms and significantly increased the operative mortality rate.[17]

A lack of access to care may be at the heart of the poorer prognosis associated with patients that are Medicaid insured. When evaluating the effect of Medicaid insurance on outcomes of patients presenting with spinal metastases in a nationwide database, Dasenbrock et al. demonstrated a higher in-hospital mortality and complication rate in the Medicaid recipient. [18] Although, the in-hospital mortality rate of Medicaid patients became equivalent with the privately insured, when adjusting for severity of illness at presentation. This would suggest an issue with a lack of access to care for the publically insured patient. A similar

issue with access to care is demonstrated by Desantis in women with breast cancer. Women with Medicaid had significantly larger tumors, with a greater risk of presenting with nodal disease and metastasis than did the privately insured.[60] However, Kelz et al. despite adjusting for severity of disease presentation found patients with Medicaid insurance had higher postoperative complications and in-hospital deaths during the treatment of colorectal cancer.[25]

Besides poorer outcomes, the cost of care for Medicaid patients has been shown to be significantly increased despite the lower reimbursement. Hasan et al. demonstrated that patients with Medicaid had significantly longer hospital stays for the treatment of pneumonia, myocardial infarction, and cerebrovascular accidents.[23] Medicare insured patients being treated for pneumonia and myocardial infarction had a significantly greater cost of treatment than the privately insured.[23] In analyzing the Office of Statewide Planning and Development Californian inpatient database, Vitale evaluated young patients undergoing spine procedures for scoliosis and demonstrated that Medicaid insured patients had statistically significant increased lengths of stays, postoperative complications, and re-operations.[25] Vitale and Hasan clearly demonstrate the conditions that invariably lead to an increased cost of treatment.

Why does Medicaid status lead to a poorer outcome in the clinical results as documented by the literature and in our study lead to a higher surgical site infection risk? The concept of underinsurance is the key basis to consider. Underinsurance occurs when the health insurance benefits are lacking or inadequate in some. Bashsur et al. defined the concept as “coverage that fails to provide adequate protection against health care expenditures.”[61] Three key markers of underinsurance have been identified as: “lack of needed benefits or services, limited access to providers, or out-of-pocket costs that are considered to be unreasonable.”[39, 62] Bodenheimer addressed the problem of underinsurance in stating that it reduced access to health care, for lower-income people, created an inequitable method of financing care, and could contribute to substandard clinical outcomes.[63] Underinsured children have been shown to have suboptimal access and quality of health care.[39] In a more recent study, the underinsured patient was less healthy and had a poorer health related quality of life than uninsured patients, and the results of the study could be generalized to the U.S. population.[64] Link et al. surmised that underinsurance was as a big of a challenge to public health and health policy as no insurance.[64] Similarly, Lidor et al. came to the conclusion that a lack of adequate health insurance was powerful predictor of disease severity and mortality.[34]

In addition to suboptimal access, another key element of underinsurance is coverage that inadequately protects the individual against medical expenses. Therefore, patients with Medicaid may be unable to meet the expense of higher medical payments and as a result choose to not follow recommended treatment. With this in mind, Dasenbrock found Medicaid patients in his study presenting with a higher acuity of disease than those private insured.[18] Socioeconomic disparities are the root cause for differences between the privately insured and the Medicaid insured patient, when considering lack of resources may prevent a patient from being able to follow a physician's recommendations. A second conclusion is the possibility that education and the ability to fully understand the medical

condition and its treatment may be an additional cause for the poor outcomes in the Medicaid insured patient.

The results of our study demonstrate the higher risk of surgical site infections in spine surgery in the Medicaid insured population and add to the growing body of evidence that Medicaid patients have higher complications. The senior author has previously reported on the risk factors for medical complications following spine surgery from this database.[2, 3] Medicaid status was not a covariate previously commented upon in this work. In this study, when analyzing publically insured patients, Medicare and Medicaid, both were found to be statistically significant for an increased risk in surgical site infections on univariate analysis, but only Medicaid insurer status was significant on multivariate analysis when controlling for age. Just as other risk factors are considered when recommending surgery to patients, the patient's insurance status should be considered for a marker of an increased risk for infection. This knowledge will aid in the appropriate preoperative counseling of patient's when considering elective surgery.

In a broader perspective, the study highlights the possibility of the increased cost of spine surgeries with the passage of the Patient Protection and Affordable Care Act of 2010 (PPACA). In 2014, the PPACA will largely expand the Medicaid population by extending it to the millions of the currently uninsured Americans who earn less than 133% of the poverty level.[44] Half of those who gain insurance under PPACA by 2019 will do so under this provision.[45] Additionally, a provision in PPACA that went into effect in October 2012 was the new Hospital Value-Based Purchasing Program. In this program, Medicare payments to hospitals were linked to various outcome measures. Beginning in 2013, hospitals may receive payment reductions if they fail to meet certain patient care criteria such as excessive 30-day readmissions.[44] The quality metrics of surgical site infections and re-admissions can be used to further reduce hospital payments if high rates of certain hospital acquired conditions occur. This study demonstrates the increased risk for surgical site infections in spine surgery that occurs in Medicaid patients. In hospitals that have a greater than average Medicaid population, the higher risks for surgical site infections would correlate with higher re-operation rates, higher readmission rates, longer lengths of stay, and an overall higher cost of treatment. The PPACA provisions, that took effect on January 1, 2013, could cause a reduction in re-imbursement to the hospital for taking care of patients with Medicaid insurance due to their higher complication rates. The increased cost with a reduction in re-imbursement would penalize institutions for caring for the Medicaid population. This very issue could subsequently lead to quotas on the number of patients cared for with Medicaid and a reduction in access to care. A limitation to access is the complete opposite effect intended by the PPACA, but may be an unintended consequence. Our study does not prove that this will occur, but does highlight what will cause the health care costs of Medicaid patients to be increased and that is a higher surgical site infection risk. Further investigation will needed to be performed to better understand why this is a risk factor and aid in developing strategies to improve the care of this population.

Acknowledgments

We would like to acknowledge Dr. Sohail Mirza (Dartmouth Medical Center) for his tremendous contribution to the registry utilized in this manuscript.

The manuscript submitted does not contain information about medical device(s)/drug(s). NIH/NIAMS 5K23AR48979 and 5P60-AR48093 grant funds and Spine End-Results Research Fund at the University of Washington Medical Center through a gift from Synthes Spine (Paoli, PA) funds were received to support this work. Relevant financial activities outside the submitted work: consultancy, grants/grants pending and payment for lectures.

REFERENCES

1. Cassinelli EH, et al. Risk factors for the development of perioperative complications in elderly patients undergoing lumbar decompression and arthrodesis for spinal stenosis: an analysis of 166 patients. *Spine (Phila Pa 1976)*. 2007; 32(2):230–5. [PubMed: 17224819]
2. Lee MJ, et al. Risk factors for medical complication after lumbar spine surgery: a multivariate analysis of 767 patients. *Spine (Phila Pa 1976)*. 2011; 36(21):1801–6. [PubMed: 22046614]
3. Lee MJ, et al. Risk factors for medical complication after spine surgery: a multivariate analysis of 1,591 patients. *Spine J*. 2012; 12(3):197–206. [PubMed: 22245448]
4. Schoenfeld AJ, et al. Risk factors for immediate postoperative complications and mortality following spine surgery: a study of 3475 patients from the National Surgical Quality Improvement Program. *J Bone Joint Surg Am*. 2011; 93(17):1577–82. [PubMed: 21915571]
5. Weiss HR, Goodall D. Rate of complications in scoliosis surgery - a systematic review of the Pub Med literature. *Scoliosis*. 2008; 3:9. [PubMed: 18681956]
6. Whitmore RG, et al. Patient comorbidities and complications after spinal surgery: a societal-based cost analysis. *Spine (Phila Pa 1976)*. 2012; 37(12):1065–71. [PubMed: 22045005]
7. Carreon LY, et al. Perioperative complications of posterior lumbar decompression and arthrodesis in older adults. *J Bone Joint Surg Am*. 2003; 85-A(11):2089–92. [PubMed: 14630835]
8. Patel N, et al. Obesity and spine surgery: relation to perioperative complications. *J Neurosurg Spine*. 2007; 6(4):291–7. [PubMed: 17436915]
9. Street JT, et al. Morbidity and mortality of major adult spinal surgery. A prospective cohort analysis of 942 consecutive patients. *Spine J*. 2012; 12(1):22–34. [PubMed: 22209243]
10. Fu KM, et al. Morbidity and mortality in the surgical treatment of 10,329 adults with degenerative lumbar stenosis. *J Neurosurg Spine*. 2010; 12(5):443–6. [PubMed: 20433290]
11. Deyo RA, et al. Morbidity and mortality in association with operations on the lumbar spine. The influence of age, diagnosis, and procedure. *J Bone Joint Surg Am*. 1992; 74(4):536–43. [PubMed: 1583048]
12. Nasser R, et al. Complications in spine surgery. *J Neurosurg Spine*. 2010; 13(2):144–57. [PubMed: 20672949]
13. Abdo A, et al. The effect of insurance status on outcomes after partial nephrectomy. *Int Urol Nephrol*. 2012; 44(2):343–51. [PubMed: 21894468]
14. 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]
15. Atlas SJ, et al. The impact of workers' compensation on outcomes of surgical and nonoperative therapy for patients with a lumbar disc herniation: SPORT. *Spine (Phila Pa 1976)*. 2010; 35(1):89–97. [PubMed: 20023603]
16. Boomer L, et al. Perforation in adults with acute appendicitis linked to insurance status, not ethnicity. *J Surg Res*. 2010; 163(2):221–4. [PubMed: 20599222]
17. Boxer LK, et al. Payer status is related to differences in access and outcomes of abdominal aortic aneurysm repair in the United States. *Surgery*. 2003; 134(2):142–5. [PubMed: 12947310]
18. Dasenbrock HH, et al. The impact of insurance status on outcomes after surgery for spinal metastases. *Cancer*. 2012; 118(19):4833–41. [PubMed: 22294322]

19. Fedewa SA, et al. Insurance status and racial differences in uterine cancer survival: a study of patients in the National Cancer Database. *Gynecol Oncol.* 2011; 122(1):63–8. [PubMed: 21463888]
20. Greene WR, et al. Insurance status is a potent predictor of outcomes in both blunt and penetrating trauma. *Am J Surg.* 2010; 199(4):554–7. [PubMed: 20359573]
21. Gum JL, Glassman SD, Carreon LY. Is type of compensation a predictor of outcome after lumbar fusion? *Spine (Phila Pa 1976).* 2013; 38(5):443–8. [PubMed: 23080428]
22. Halpern MT, Renaud JM, Vickrey BG. Impact of insurance status on access to care and out-of-pocket costs for U.S. individuals with epilepsy. *Epilepsy Behav.* 2011; 22(3):483–9. [PubMed: 21890417]
23. Hasan O, Orav EJ, Hicks LS. Insurance status and hospital care for myocardial infarction, stroke, and pneumonia. *J Hosp Med.* 2010; 5(8):452–9. [PubMed: 20540165]
24. Kapoor JR, et al. Payment source, quality of care, and outcomes in patients hospitalized with heart failure. *J Am Coll Cardiol.* 2011; 58(14):1465–71. [PubMed: 21939830]
25. Kelz RR, et al. Morbidity and mortality of colorectal carcinoma surgery differs by insurance status. *Cancer.* 2004; 101(10):2187–94. [PubMed: 15382089]
26. Kwok J, et al. The impact of health insurance status on the survival of patients with head and neck cancer. *Cancer.* 2010; 116(2):476–85. [PubMed: 19937673]
27. 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]
28. Patel S, Schroeder JW Jr. Disparities in children with otitis media: the effect of insurance status. *Otolaryngol Head Neck Surg.* 2011; 144(1):73–7. [PubMed: 21493391]
29. Robbins AS, et al. Insurance status, comorbidity level, and survival among colorectal cancer patients age 18 to 64 years in the National Cancer Data Base from 2003 to 2005. *J Clin Oncol.* 2009; 27(22):3627–33. [PubMed: 19470927]
30. Stulberg DB, Zhang JX, Lindau ST. Socioeconomic disparities in ectopic pregnancy: predictors of adverse outcomes from Illinois hospital-based care, 2000–2006. *Matern Child Health J.* 2011; 15(2):234–41. [PubMed: 20177756]
31. Nguyen GC, et al. Race and health insurance are predictors of hospitalized Crohn's disease patients undergoing bowel resection. *Inflamm Bowel Dis.* 2007; 13(11):1408–16. [PubMed: 17567876]
32. Bjurlin MA, et al. Race and insurance status are risk factors for orchiectomy due to testicular trauma. *J Urol.* 2012; 187(3):931–5. [PubMed: 22264470]
33. Rosen H, et al. Lack of insurance negatively affects trauma mortality in US children. *J Pediatr Surg.* 2009; 44(10):1952–7. [PubMed: 19853754]
34. Lidor AO, et al. Effect of race and insurance status on presentation, treatment, and mortality in patients undergoing surgery for diverticulitis. *Arch Surg.* 2008; 143(12):1160–5. discussion 1165. [PubMed: 19075166]
35. Lemaire A, et al. The impact of race and insurance type on the outcome of endovascular abdominal aortic aneurysm (AAA) repair. *J Vasc Surg.* 2008; 47(6):1172–80. [PubMed: 18407451]
36. Parikh PB, et al. Association of health insurance status with presentation and outcomes of coronary artery disease among nonelderly adults undergoing percutaneous coronary intervention. *Am Heart J.* 2011; 162(3):512–7. [PubMed: 21884869]
37. Shen JJ, Washington EL. Disparities in outcomes among patients with stroke associated with insurance status. *Stroke.* 2007; 38(3):1010–6. [PubMed: 17234983]
38. Freeman J, et al. Ethnicity and insurance status affect health disparities in patients with gallstone disease. *J Surg Res.* 2012; 175(1):1–5. [PubMed: 21872888]
39. Kogan MD, et al. Underinsurance among children in the United States. *N Engl J Med.* 2010; 363(9):841–51. [PubMed: 20818845]
40. Hakim RB, Benedict MB, Merrick NJ. Quality of care for women undergoing a hysterectomy: effects of insurance and race/ethnicity. *Am J Public Health.* 2004; 94(8):1399–405. [PubMed: 15284050]
41. Haider AH, et al. Race and insurance status as risk factors for trauma mortality. *Arch Surg.* 2008; 143(10):945–9. [PubMed: 18936372]

42. Vitale MA, et al. The contribution of hospital volume, payer status, and other factors on the surgical outcomes of scoliosis patients: a review of 3,606 cases in the State of California. *J Pediatr Orthop*. 2005; 25(3):393–9. [PubMed: 15832162]
43. Tepas JJ 3rd, et al. Insurance status, not race, is a determinant of outcomes from vehicular injury. *J Am Coll Surg*. 2011; 212(4):722–7. discussion 727–9. [PubMed: 21463821]
44. <<http://www.healthcare.gov/law/features/index.html>>, K.F.o.t.L.H.g.a
45. Ku L. Ready, set, plan, implement: executing the expansion of Medicaid. *Health Aff (Millwood)*. 2010; 29(6):1173–7. [PubMed: 20530350]
46. Collins SR, et al. The income divide in health care: how the Affordable Care Act will help restore fairness to the U.S. health system. *Issue Brief (Commonw Fund)*. 2012; 3:1–24. [PubMed: 22351972]
47. National Summary Statistics for RHQDAPU clinical process measures as reported on Hospital Compare March 2009. 2009
48. National Hospital Inpatient Quality Reporting Measures Specifications Manual v4.2. 2012
49. Fiscal Year 2009 Quality Measure Reporting for 2010 Payment Update. 2009
50. Romano PS, et al. Can administrative data be used to compare postoperative complication rates across hospitals? *Med Care*. 2002; 40(10):856–67. [PubMed: 12395020]
51. Eappen S, et al. Relationship between occurrence of surgical complications and hospital finances. *JAMA*. 2013; 309(15):1599–606. [PubMed: 23592104]
52. Urban JA. Cost analysis of surgical site infections. *Surg Infect (Larchmt)*. 2006; 7(Suppl 1):S19–22. [PubMed: 16834543]
53. Scott, RD. The direct medical costs of healthcare-associated infections in U.S. hospitals and the benefits of prevention. D. National Center for Preparedness, and Control of Infectious Diseases, Coordinating Center for Infectious Diseases, Centers for Disease Control and Prevention Editor; 2009.
54. Income, Poverty, and Health Insurance Coverage in the United States: 2010. 2010
55. Mirza SK, et al. Development of an index to characterize the “invasiveness” of spine surgery: validation by comparison to blood loss and operative time. *Spine (Phila Pa 1976)*. 2008; 33(24):2651–61. discussion 2662. [PubMed: 18981957]
56. Romano PS, Schembri ME, Rainwater JA. Can administrative data be used to ascertain clinically significant postoperative complications? *Am J Med Qual*. 2002; 17(4):145–54. [PubMed: 12153067]
57. Rosen H, et al. Downwardly mobile: the accidental cost of being uninsured. *Arch Surg*. 2009; 144(11):1006–11. [PubMed: 19917936]
58. Abbott MM, Kokorowski PJ, Meara JG. Timeliness of surgical care in children with special health care needs: delayed palate repair for publicly insured and minority children with cleft palate. *J Pediatr Surg*. 2011; 46(7):1319–24. [PubMed: 21763828]
59. Carter JE, Neff LP, Holmes J.H.t. Adherence to burn center referral criteria: are patients appropriately being referred? *J Burn Care Res*. 2010; 31(1):26–30. [PubMed: 20061833]
60. DeSantis C, Jemal A, Ward E. Disparities in breast cancer prognostic factors by race, insurance status, and education. *Cancer Causes Control*. 2010; 21(9):1445–50. [PubMed: 20506039]
61. Bashshur R, Smith DG, Stiles RA. Defining underinsurance: a conceptual framework for policy and empirical analysis. *Med Care Rev*. 1993; 50:199–218. [PubMed: 10127083]
62. Perrin JM. Treating underinsurance. *N Engl J Med*. 2010; 363:881–3. [PubMed: 20818850]
63. Bodenheimer T. Underinsurance in America. *N Engl J Med*. 1992; 327:274–8. [PubMed: 1614471]
64. Link CL, McKinlay JB. Only half the problem is being addressed: underinsurance is as big a problem as uninsurance. *Int J Health Serv*. 2010; 40:507–23. [PubMed: 20799673]

Figure 1.
Participant Flow Diagram SSI payor

Table 1

Univariate Association of Payor Status with Surgical Site Infection

		95% Confidence Interval		
Reference (Private)	Odds Ratio	Low	High	p-value
Medicaid	2.181	1.145	4.153	0.018
Medicare	1.946	1.015	3.731	0.045
Labor & Industry	0.833	0.278	2.498	0.745
Other Federal including VA	1.757	0.393	7.859	0.461
Self - Pay	0.793	0.103	6.087	0.823

Table 2

Multivariate Association of Payor Status with Surgical Site Infection (using Stepwise)

		95% Confidence Interval		
	Odds Ratio	Low	High	p-value
Surgical Invasiveness Index Score	1.061	1.034	1.089	<0.001
Congestive Heart Failure	3.827	1.733	8.449	0.001
Medicaid Payor	2.061	1.186	3.582	0.010
Diabetes	2.176	1.170	4.046	0.014