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# Primary Payer Status Affects Mortality for Major Surgical Operations

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## Abstract

**Objectives—**Medicaid and Uninsured populations are a significant focus of current healthcare reform. We hypothesized that outcomes following major surgical operations in the United States is dependent on primary payer status.

**Methods—**From 2003 to 2007, 893,658 major surgical operations were evaluated using the Nationwide Inpatient Sample (NIS) database: lung resection, esophagectomy, colectomy, pancreatectomy, gastrectomy, abdominal aortic aneurysm repair, hip replacement, and coronary artery bypass. Patients were stratified by primary payer status: Medicare (n = 491,829), Medicaid (n = 40,259), Private Insurance (n = 337,535), and Uninsured (n = 24,035). Multivariate regression models were applied to assess outcomes.

**Results—**Unadjusted mortality for Medicare (4.4%; odds ratio [OR], 3.51), Medicaid (3.7%; OR, 2.86), and Uninsured (3.2%; OR, 2.51) patient groups were higher compared to Private Insurance groups (1.3%, $P < 0.001$). Mortality was lowest for Private Insurance patients independent of operation. After controlling for age, gender, income, geographic region, operation, and 30 comorbid conditions, Medicaid payer status was associated with the longest length of stay and highest total costs ($P < 0.001$). Medicaid ($P < 0.001$) and Uninsured ($P < 0.001$) payer status independently conferred the highest adjusted risks of mortality.

**Conclusions—**Medicaid and Uninsured payer status confers increased risk-adjusted mortality. Medicaid was further associated with the greatest adjusted length of stay and total costs despite risk factors or operation. These differences serve as an important proxy for larger socioeconomic and health system-related issues that could be targeted to improve surgical outcomes for US Patients.

The influence of socioeconomic factors and insurance status among United States patients has been a primary focus of many public health initiatives and current health care reform investigations. According to the US Census Bureau, from 2007 to 2008, the number of uninsured Americans increased from 45.7 to 46.3 million, the number of people covered by private insurance decreased from 202 to 201 million, and the number of people covered by government insurance increased from 83.0 to 87.4 million.[1] The Medicaid and Uninsured patient populations have been shown to have worse medical outcomes compared with



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Privately Insured patients as a result of socioeconomic and patient-related factors.[2,3] Further, disparities in disease treatment and resource utilization may occur as a function of insurance and primary payer status. With a rising elderly population and increased initiatives for government-sponsored health care, such trends provide an important platform from which to examine contemporary surgical outcomes as a function of primary payer status.

Recent efforts to examine the impact of primary payer and insurance status within surgical populations have focused on specific patient populations and surgical subspecialties. A recent study examining insurance status among vascular surgery patients collected from 2 statewide (New York and Florida) data registries, demonstrated that type of insurance predicts disease severity at the time of treatment.[4] Other studies have focused on disparate differences in type of surgical treatment as a result of payer status.[5,6] Moreover, recent data suggest that important differences exist in trauma care outcomes and resource utilization with respect to Medicaid and uninsured payer status.[7–9] Few studies, however, have comprehensively examined the overall influence of primary payer status on outcomes among a broad population of patients undergoing major surgical operations.

The objective of this study was to examine the effect of primary payer status on outcomes and resource utilization within a diverse surgical population. We used a large, national administrative database to more completely examine this important question and hypothesized that outcomes following major surgical operations in the United States are independently influenced by primary payer status.

## METHODS

### Data Source

Data for this study were obtained from the Nationwide Inpatient Sample (NIS) databases for the years 2003 to 2007. NIS is the largest, publicly available all-payer, inpatient care database in the United States, and is maintained by the Agency for Healthcare Research and Quality as part of the Healthcare Cost and Utilization Project.[10] Each year, it contains data from 5 to 8 million hospital admissions from about 1000 hospitals, representing an approximate 20% stratified random sample of all hospital discharges in the United States. NIS includes hospitals designated as “community hospitals” (“all non-Federal, short-term, general, and other specialty hospitals, excluding hospital units of institutions”) in the American Hospital Association Annual Survey. Sampling strata used by the NIS is based on 5 hospital characteristics (geographic region, urban or rural location, ownership/control, teaching status, and hospital bed size) contained in American Hospital Association hospital files. Data include in-patient hospital discharge records collected for patients of all ages and sources of insurance. A discharge weight is included for each patient record, which represents the relative proportion of the total US in-patient hospital population represented by each record.[11] Consequently, the surgical population included in this dataset is broadly representative of individuals undergoing major surgical operations in the United States during the study period. Due to the absence of patient identifiers in collected data and the fact that the data are collected for purposes other than research, the University of Virginia Institutional Review Board did not perform a formal review of this study as it was determined that this study does not meet the regulatory definition of human subjects research.

### Patients

Using International Classification of Diseases, Ninth Revision, Clinical Modifications (ICD-9-CM) procedure codes,[12] we identified all patients in the NIS dataset undergoing at least 1 of 8 major surgical operations: lung resection (ICD-9-CM codes 323, 3230, 3239,

324, 3241, 3249, 325, 3250, 3259), esophagectomy (ICD-9-CM codes 424, 4240, 4241, 4242), colectomy (ICD-9-CM codes 457, 4571, 4572, 4573, 4574, 4575, 4576, 4579, 458, 4581, 4582, 4583), pancreatectomy (ICD-9-CM codes 526, 527, 525, 5251, 5252, 5253, 5259), gastrectomy (ICD-9-CM codes 435, 436, 437, 439, 4391, 4399), abdominal aortic aneurysm (AAA) repair (ICD-9-CM code 3844), total hip replacement (ICD-9-CM code 8151), and isolated coronary artery bypass grafting (CABG) (ICD-9-CM codes 3610, 3611, 3612, 3613, 3614, 3615, 3616). We chose these operations to include a group of commonly performed complex procedures, representing a broad range of surgical subspecialties, associated with significant risk of morbidity and mortality. Patients undergoing lung resection, esophagectomy, colectomy, gastrectomy, or pancreatectomy were not limited to those undergoing cancer-specific operations. For CABG operations, only isolated operations were included; concomitant valve or other cardiac operations were excluded. Patients were stratified by primary payer status into 4 comparison groups: Medicare, Medicaid, Uninsured, and Private Insurance. The Uninsured payer group included patients with reported no-charge and self-pay status.

Patient comorbid disease was assessed using 30 different Agency for Healthcare Research and Quality comorbidity measures and categories developed by Elixhauser et al.[13] The Elixhauser method has been demonstrated to provide effective adjustments for mortality risk among surgical populations and has been shown to be superior to the Charlson/Deyo method.[14,15]

## Outcomes Measured

The primary outcomes of interest in this study were adjusted in-hospital mortality, in-hospital complications, hospital length of stay, and total costs. In-hospital complications were categorized into 8 classifications (wound, infections, urinary, pulmonary, gastrointestinal, cardiovascular, systemic, and procedural) according to the ICD-9-CM based coding scheme developed by Guller et al (Table 1).[16] Death occurring during the in-patient stay was identified from the patients' discharge status. Unadjusted mean length of stay and total costs were determined from discharge records.

## Statistical Analysis

All group comparisons were unpaired. Incidence of preoperative and hospital variables as well as unadjusted outcomes were compared using analysis of variance for continuous variables, and either Pearson $\chi^2$ analysis or Fisher exact test for all categorical variables as appropriate.

Multivariable logistic regression was performed to calculate the adjusted odds of in-hospital death and in-hospital complications among patients undergoing major surgical operations. All preoperative variables entered as covariates (patient age, gender, elective operative status, mean income, hospital geographic region, teaching hospital status, type of operation, primary payer status, and categories for comorbid disease) were selected a priori based upon established clinical risk or were considered potential confounders for the effect of payer status among patients. All covariates contributing cases to each estimated outcome, including nonsignificant variables, were retained in the final models. The estimated odds of in-hospital death and in-hospital complications were adjusted for all covariates. All logistic regression models included appropriate adjustments for variance components estimated from the weighted study population.[17] The statistical significance of the association between primary payer status and in-hospital death or complications was assessed using the Wald $\chi^2$ test. Confidence intervals for all adjusted odds ratios (OR) were calculated using an alpha of 0.05. The discrimination achieved by these models was assessed using the area under the receiver operating characteristics curve (AUC). AUC values of 1.0 indicate perfect

discrimination between outcome groups, while values of 0.5 indicate results equal to chance. The Hosmer-Lemeshow test was used to assess the statistical significance of differences in each model's calibration across deciles of observed and predicted risk.

Multivariable linear regression models were created to estimate adjusted length of stay and total costs for each payer group. In each model, the same covariates entered into logistic regression models were used. Each linear regression model generated an unstandardized coefficient for each payer group, reflecting the slope of each linear regression trend. These coefficients were used to calculate adjusted means for hospital length of stay and total costs for each payer group.

Sensitivity analyses for each multivariable logistic regression model were performed. For each model, sensitivity was assessed to evaluate the possibility that the estimated effect of primary payer status on outcomes could be a spurious result, reflecting the influence of a closely related but unmeasured confounder. Accordingly, each model was re-estimated after removing the most statistically significant covariate as measured by the Wald statistic. The potential for spurious results is reduced if the originally observed effect is not substantially attenuated and remains statistically significant after re-estimation.[18] For each multivariable logistic regression model, operative category was the most highly significant covariate. After removing this covariate from each logistic regression model, the effect of primary payer status on the estimated odds of each outcome were not significantly attenuated (<10%), validating the sensitivity of each original model.

Frequencies of categorical variables are expressed as a percentage of the group of origin. Continuous variables are reported as means ± standard deviation. ORs with a 95% confidence interval are used to report the results of logistic regression models while adjusted means are reported for the results of linear regression models. Reported *P* values are 2-tailed. Statistical significance was identified by $P < 0.05$. Data manipulation and analysis were performed using SPSS software, version 17 (SPSS, Chicago, IL).

## RESULTS

### Patient and Hospital Characteristics

During the 6-year study period, a total of 893,658 patients underwent 1 of 8 major surgical operations, representing a weighted estimate of 4,351,163 patients nationwide. Frequencies of all patient characteristics stratified by primary payer group are listed in Table 2. Patients with Medicare (55.0%) or Private Insurance (37.8%) represented the largest payer groups. Mean age was highest in the Medicare (73.5 ± 8.6 years) group. Female gender was more common in the Medicare (49.6%) and Medicaid (48.8%) payer groups, and elective operations occurred more commonly among Medicare (62.8%) and Private Insurance (68.4%) patients. Isolated CABG was the most common operation among all payer groups followed by colectomy and hip replacement, respectively. Medicaid (41.3%) and Uninsured (33.6%) patients had the highest incidence of the lowest quartile for median household income.

Few important clinical differences in preoperative comorbid disease existed across payer groups. Chronic pulmonary disease and diabetes were more common within Medicare (22.2% and 22.1%, respectively) and Medicaid (19.5% and 19.9%, respectively) patients while alcohol abuse was more common among Medicaid (5.0%) and Uninsured (5.8%) patients. Medicare patients had the highest incidence of preoperative congestive heart failure (6.5%), hypertension (61.1%), hypothyroidism (10.0%), peripheral vascular disease (8.5%), renal failure (6.5%), and cardiac valve disease (4.3%).

The frequencies of hospital characteristics among all payer groups are listed in Table 3. The large majority of surgical operations occurred in an urban setting for all payer groups and within large hospital bed size hospitals. Medicaid (60.4%) patients had the highest proportion of operations performed at teaching hospitals. The Southern geographic region performed the highest proportion of major surgical operations for all payer groups.

### Unadjusted Outcomes

Unadjusted outcomes by primary payer group appear in Table 4. Private Insurance patients incurred the lowest incidence of all in-hospital complications except for systemic complications (Appendix B). Medicaid patients incurred the highest incidence of postoperative wound complications (1.7%), infections (3.4%), gastrointestinal complications (4.7%), and systemic complications (1.8%). Medicaid payer status conferred the highest unadjusted mean hospital length of stay (12.7 ± 18.5 days) and total costs ($93,567 ± 111,039) among all payer groups followed by Uninsured payer status. Unadjusted mortality for Medicare (4.4%; OR, 3.51), Medicaid (3.7%; OR, 2.86), and Uninsured (3.2%; OR, 2.51) patient groups were higher compared with Private Insurance groups (1.3%, $P < 0.001$). Moreover, Private Insurance patients also had the lowest unadjusted in-hospital mortality despite the operation (Table 5). Overall, in-hospital mortality was highest among patients undergoing AAA repair (11.3%) and lowest for those undergoing hip replacement (0.2%) independent of payer status. Importantly, in-hospital mortality following AAA repair was highest for Uninsured (14.8%) and Medicaid (14.5%) patients.

### Adjusted Outcomes for the Effect of Primary Payer Status

Results of multivariable logistic regression models used to estimate the effect of primary payer status on postoperative outcomes appear in Table 6. After adjustment for the concurrent effects of patient, hospital, and operative factors, Medicaid and Uninsured patients incurred a 97% and 74% increase in the odds of in-hospital death, respectively, compared to those with Private Insurance. The independent effect of primary payer status on in-hospital death was highly significant ($P < 0.0001$, AUC = 0.86).

Multivariable logistic regression models constructed for inhospital complications further implicated Medicaid payer status as an independent predictor of morbidity. Among payer groups, Medicaid payer status conferred the highest adjusted odds of wound complications (OR, 1.23), infectious complications (OR, 1.24), pulmonary complications (OR, 1.13), and systemic complications (OR = 1.12) compared with Private Insurance. Adequate discrimination of each multivariable logistic regression model for in-hospital complications was achieved (Table 5).

Multivariable linear regression models similarly demonstrated that Medicaid payer status was associated with the longest adjusted length of stay ($P < 0.0001$) compared with the Private Insurance group as well as the highest adjusted total costs ($P < 0.0001$, Table 6).

## DISCUSSION

To our knowledge, this study represents the largest and most comprehensive review of contemporary outcomes for major operations as a function of primary payer status. In this study, we have demonstrated disparate differences in short-term surgical outcomes among payer groups. The inclusion of a broad surgical population, comprising several different surgical subspecialties, allows us to more confidently comment upon trends that have been previously reported among smaller, more specific, surgical patient groups. Our results indicate that Medicaid and Uninsured payer status confers worse unadjusted and adjusted outcomes compared with that of Private Insurance. We have shown that Medicaid and

Uninsured status also independently increases the risk of adjusted in-hospital mortality, and that Medicaid status further increases the risk of adjusted in-hospital complications compared with those with Private Insurance. Moreover, our results demonstrate significant differences in resource utilization among payer groups as Medicaid patients accrued the longest adjusted hospital length of stay and highest adjusted total costs. These findings bolster those of other smaller series that have been performed in select surgical populations, and it extends the examination of payer status to include a large, nationwide, diverse surgical population.

The effect of insurance status on treatment allocation and surgical outcomes has been a recent focus of many investigators. In a study by Giacovelli et al (2008), insurance status was demonstrated to predict disease severity among a vascular surgery population of over 225,000 patients.[4] Alternatively, Kelz et al (2004) reported that Medicaid and uninsured patients encountered worse outcomes following colorectal cancer resections.[19] In their review of 13,415 patient records, Medicaid patients were found to incur a 22% increased risk of complications during hospital admission and a 57% increased risk of in-hospital death compared with those with private insurance. These findings are consistent with the results of our study. After adjusting for the potential confounding influence of several patient and hospital related factors, we found that Medicaid payer status conferred 97% increase in the odds of postoperative death compared with Private Insurance patients while Uninsured status independently increased the risk of in-hospital mortality by 74%. Interestingly, the adjusted odds of in-hospital death for both Medicaid and Uninsured patients were higher than that for Medicare patients after controlling for comorbid disease. We further demonstrated similar trends among the estimated odds of postoperative complications for Medicaid patients. Importantly, even after adjusting for socioeconomic status through mean income, primary payer status served as a significant independent predictor of risk-adjusted surgical outcomes.

The demonstrated effect of primary payer status on outcomes in this study is likely multifactorial in origin. First, among all payer groups, elective operations were more commonly performed in patients with Medicare or Private Insurance while Medicaid and Uninsured patients more commonly underwent nonelective (urgent and/or emergent) operations. The higher incidence of emergent operations among Medicaid and Uninsured populations and the presumed negative effect on outcomes is in agreement with previously published surgical literature.[4,20,21] However, in our analyses operative status was accounted for in the estimates of adjusted outcomes and the differences in payer groups were still significant. It is also likely that the confounding influence of inadequate preoperative resuscitation and planning that occurs in the emergent operative situation may have contributed to compromised outcomes for these populations. Second, it is plausible that the influence of healthcare provider and system bias may impact surgical outcomes for Medicaid and Uninsured payer groups. For many surgical patients, private insurance status often allows for referral to expert surgeons for their disease. Alternatively, Medicaid and Uninsured patients may have been referred to less skilled and less specialized surgeons. In this study, the most frequent operations performed were CABG, colectomy, and hip replacement. For these operations, the impact of surgeon volume on outcomes has been well established, and expert surgeons have been shown to significantly impact outcomes.[22] Third, differences in comorbid disease may serve as a proxy for larger social and lifestyle influences between payer groups. Both Medicaid and Uninsured payer groups had the highest incidence of drug and alcohol abuse. In addition, Medicaid patients had the highest incidence of acquired immunodeficiency syndrome, depression, liver disease, neurologic disorders, and psychoses. Furthermore, Medicaid patients had the highest incidence of metastatic cancer, which likely reflects the combined influence of deficits in access to care, poor health maintenance, and delayed diagnosis resulting in the presentation of advanced

disease stage within this population. Another possible explanation for the differences we observed among payer groups is the possibility of incomplete risk adjustment due to the presence of comorbidities that are either partially or unaccounted for in our analyses. Nevertheless, multivariable logistic regression identified Medicaid and Uninsured payer status as the highest significant independent predictors of in-hospital mortality after controlling for all patients, hospital- and operation-related variables.

Several explanations for inherent differences in payer populations have been suggested. Factors including decreased access to health care, language barriers, level of education, poor nutrition, and compromised health maintenance have all been suggested.[2,23] However, there is no question that payer status has significant implications on multiple processes of health care delivery. Differences exist in not only access but also in the type of primary care that Medicaid and Uninsured populations receive compared with Private Insurance patients. For example, studies have shown that Medicaid and Uninsured populations often receive the majority of primary care within Emergency Departments.[24,25] In a recent study by White et al (2007), Uninsured patients visiting the emergency department were shown to have significantly lower number of radiographic studies and were less likely to be admitted to the hospital following consultation as compared with private insurance patients.[26] In addition, the Medicaid and Uninsured populations often present with more advanced stages of disease, a reflection of cost prohibitive health maintenance, delayed diagnosis, and the higher incidence of comorbid disease. In fact, type of insurance has been shown to impact access to cancer screening, treatment, and outcomes.[27,28] Other social and lifestyle factors, including drug and alcohol abuse, psychiatric illness, obesity, and high-risk behavior, may further contribute to differences in payer group populations. The impact of the economic burden of poverty may also influence patients' ability to seek medical care and to be discharged from the hospital in a timely manner due to lack of support and resources to be cared for properly at home.

There are several noteworthy limitations to this study. First, inherent selection bias is associated with any retrospective study; however, the strict methodology and randomization of the NIS database reduces the likelihood of this bias. Second, NIS is a large, administrative database, and the potential for unrecognized miscoding among diagnostic and procedure codes as well as variations in the nature of coded complications must be considered. Further, we are only able to comment on short-term outcomes as data collected for NIS reflects a patient's inpatient admission. Consequently, the results reported herein may underestimate true perioperative mortality and morbidity rates that may have occurred following the patient's discharge. Assumptions regarding payer groups and status may also impact data analyses. Among payer groups the potential for cross over exists, and the possibility for miscoded payer status must be considered. For example, the proportion of Medicaid patients may be artificially inflated due to the fact that normally Uninsured patients may garner Medicaid coverage during a given hospital admission. In addition, it is possible that a small proportion of Privately Insured patients may actually have inadequate insurance coverage and may functionally represent an Uninsured patient with respect to the effects of poor health maintenance and presentation with advanced disease. However, as the NIS dataset is validated both internally and externally for each year, we believe it is reasonable to assume that payer status is accurately represented in our data analyses. With respect to comorbid disease, we are unable to comment on disease stages or severity. Finally, in our data analyses and statistical adjustments there exists a potential for an unmeasured confounder. Due to the constraints of NIS data points, we are unable to include adjustments for other well-established surgical risk factors such as low preoperative albumin levels or poor nutrition status. However, upon sensitivity analyses our statistical models proved resilient to the presence of a potentially unmeasured confounder.

## CONCLUSION

In this study, we conclude that Medicaid and Uninsured payer status confers increased risk adjusted in-hospital mortality compared with Private Insurance for major surgical operations in the United States. Medicaid is further associated with higher postoperative in-hospital complications as well as the greatest adjusted length of stay and total costs despite risk factors or the specific major operation. These differences serve as an important proxy for larger socioeconomic and health system-related issues that could be targeted to improve surgical outcomes for US patients.

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## TABLE 1

International Classification of Diseases, Ninth Revision, Clinical Modifications (ICD-9-CM) Diagnostic Codes for In-Hospital Complications

| |
|---|
| Mechanical wound complications |
| Delayed wound healing: 989.83 |
| Postoperative hematoma: 998.12 |
| Postoperative seroma (noninfected): 998.13 |
| Disruption of operative wound: 998.3 |
| Persistent postoperative fistula: 998.6 |
| Infections |
| Postoperative infection: 998.5 |
| Postoperative skin abscess: 998.59 |
| Postoperative septic wound complications: 998.59 |
| Postoperative skin infection: 998.59 |
| Postoperative intra-abdominal abscess: 998.59 |
| Postoperative subdiaphragmatic abscess: 998.59 |
| Postoperative infected seroma: 998.51 |
| Urinary complications |
| Postoperative urinary retention: 997.5 |
| Postoperative urinary tract infection: 997.5 |
| Pulmonary complications |
| Postoperative atelectasis: 997.3 |
| Postoperative pneumonia: 997.3 |
| Mendelson syndrome secondary to procedure: 997.3 |
| Postoperative acute respiratory insufficiency: 518.5 |
| Postoperative acute pneumothorax: 512.1 |
| Adult respiratory distress syndrome: 518.5 |
| Postoperative pulmonary edema: 518.4 |
| Gastrointestinal complications |
| Postoperative small bowel obstruction: 997.4 |
| Postoperative ileus: 997.4 |
| Postoperative ileus requiring nasogastric tube: 997.4 |
| Postoperative nausea: 997.4 |
| Postoperative vomiting: 997.4 |
| Postoperative pancreatitis: 997.4 |
| Complication of anastomosis of gastrointestinal tract: 997.4 |
| Cardiovascular complications |
| Postoperative deep venous thrombosis: 997.79 |
| Postoperative pulmonary embolism: 415.11 |
| Postoperative stroke: 997.02 |
| Phlebitis or thrombophlebitis from procedure: 997.2 |
| Cardiac arrest/insufficiency during or resulting from a procedure: 997.1 |
| Systemic complications |

- Postoperative shock (septic, hypovolemic): 998.0
- Postoperative fever: 998.89

Complications during procedure

- Accidental puncture or laceration, complicating surgery: 998.2
- Foreign body accidentally left during procedure: 998.4
- Bleeding complicating procedure: 998.11

## TABLE 2

Patient Characteristics for All Patients Undergoing Major Surgical Operations by Primary Payer Group

| Variable | Medicare | Medicaid | Uninsured | Private Insurance |
|---|---|---|---|---|
| No. cases (unweighted) | 491,829 | 40,259 | 24,035 | 337,535 |
| National estimate of cases (weighted) | 2,394,698 | 196,951 | 116,070 | 1,643,444 |
| Age (yr) | 73.5 ± 8.6 | 49.8 ± 16.4 | 51.8 ± 12.8 | 55.5 ± 11.4 |
| Female | 49.6% | 48.8% | 35.8% | 39.7% |
| Elective operation | 62.8% | 47.7% | 36.9% | 68.4% |
| Operation | | | | |
| Lung resection | 5.0% | 6.1% | 4.6% | 4.9% |
| Esophagectomy | 0.4% | 0.7% | 0.5% | 0.6% |
| Colectomy | 29.1% | 36.0% | 37.6% | 32.0% |
| Pancreatectomy | 1.1% | 2.1% | 2.2% | 1.6% |
| Gastrectomy | 1.6% | 3.3% | 2.9% | 1.7% |
| AAA | 2.8% | 1.1% | 1.3% | 1.3% |
| Hip replacement | 26.5% | 17.6% | 9.3% | 27.1% |
| CABG | 33.6% | 33.1% | 41.7% | 31.0% |
| AHRQ comorbidity | | | | |
| AIDS | 0.1% | 0.4% | 0.1% | 0.1% |
| Alcohol abuse | 1.4% | 5.0% | 5.8% | 2.0% |
| Deficiency anemia | 15.2% | 13.6% | 11.6% | 11.0% |
| Arthritis/collagen vascular disorder | 2.5% | 2.0% | 0.9% | 1.7% |
| Chronic blood loss anemia | 3.3% | 2.6% | 2.4% | 1.8% |
| Congestive heart failure | 6.5% | 3.1% | 1.5% | 1.5% |
| Chronic pulmonary disease | 22.2% | 22.1% | 16.7% | 14.6% |
| Coagulopathy | 6.0% | 5.3% | 4.3% | 3.4% |
| Depression | 4.9% | 7.1% | 3.8% | 5.5% |
| Diabetes mellitus (uncomplicated) | 19.5% | 19.9% | 17.7% | 15.5% |
| Diabetes mellitus (complicated) | 2.8% | 3.6% | 2.0% | 1.9% |
| Drug abuse | 0.3% | 3.4% | 3.2% | 0.5% |
| Hypertension | 61.1% | 43.8% | 42.8% | 47.1% |
| Hypothyroidism | 10.0% | 4.2% | 3.5% | 6.2% |
| Liver disease | 0.9% | 2.8% | 1.5% | 1.1% |
| Lymphoma | 0.6% | 0.3% | 0.2% | 0.3% |
| Fluid and electrolyte disorder | 19.2% | 18.3% | 16.5% | 12.1% |
| Metastatic cancer | 7.0% | 7.8% | 7.0% | 6.2% |
| Neurologic disorder (not CVA) | 3.6% | 3.8% | 1.5% | 1.6% |
| Obesity | 6.2% | 9.1% | 8.3% | 10.2% |
| Paralysis | 1.0% | 1.6% | 0.5% | 0.4% |
| Peripheral vascular disease | 8.5% | 5.5% | 4.5% | 4.1% |
| Psychoses | 1.5% | 3.4% | 1.3% | 0.8% |
| Pulmonary circulation disorder | 0.7% | 0.4% | 0.3% | 0.2% |

| Variable | Medicare | Medicaid | Uninsured | Private Insurance |
|---|---|---|---|---|
| Renal failure | 6.5% | 4.6% | 2.3% | 2.3% |
| Solid tumor (without metastasis) | 2.1% | 1.4% | 1.2% | 1.1% |
| Peptic ulcer disease (non-bleeding) | 0.1% | 0.1% | 0.1% | 0.1% |
| Valvular disease | 4.3% | 1.4% | 0.9% | 1.9% |
| Weight loss | 3.7% | 4.4% | 3.1% | 1.9% |
| Median household income national quartile for patient ZIP code | | | | |
| I ($1–24,999) | 24.2% | 41.3% | 33.6% | 17.3% |
| II ($25,000–34,999) | 27.0% | 27.6% | 23.8% | 29.6% |
| III ($35,000–44,999) | 25.5% | 19.6% | 27.8% | 21.5% |
| IV (>$45,000) | 23.3% | 11.4% | 31.1% | 15.3% |

AAA indicates abdominal aortic aneurysm; CABG, coronary artery bypass grafting; AHRQ, Agency for Healthcare Research and Quality; AIDS, acquired immunodeficiency syndrome; CVA, cerebrovascular accident.

## TABLE 3

Hospital Characteristics for all Patients Undergoing Major Surgical Operations by Primary Payer Group

| Variable | Medicare | Medicaid | Uninsured | Private Insurance |
|---|---|---|---|---|
| Rural location | 10.1% | 8.5% | 9.8% | 6.6% |
| Teaching hospital | 49.1% | 60.4% | 55.2% | 54.2% |
| Hospital bed size | | | | |
| Small | 10.0% | 8.6% | 10.5% | 10.2% |
| Medium | 22.8% | 21.9% | 20.8% | 22.5% |
| Large | 67.2% | 69.5% | 68.7% | 67.3% |
| Hospital region | | | | |
| Northeast | 19.8% | 22.2% | 15.5% | 20.0% |
| Midwest | 25.2% | 19.8% | 18.3% | 25.1% |
| South | 37.8% | 37.2% | 55.7% | 35.2% |
| West | 17.3% | 20.8% | 10.5% | 19.7% |

## TABLE 4

Unadjusted Outcomes for all Patients Undergoing Major Surgical Operations by Primary Payer Group

| Outcome | Medicare | Medicaid | Uninsured | Private Insurance | *P* |
|---|---|---|---|---|---|
| In-hospital mortality | 4.4% | 3.7% | 3.2% | 1.3% | <0.001 |
| Wound complication | 1.4% | 1.7% | 1.4% | 1.1% | <0.001 |
| Infectious complications | 2.0% | 3.4% | 2.8% | 2.0% | <0.001 |
| Urinary complications | 1.8% | 1.0% | 0.8% | 1.0% | <0.001 |
| Pulmonary complications | 9.7% | 9.3% | 8.3% | 6.7% | <0.001 |
| Gastrointestinal complications | 4.5% | 4.7% | 4.6% | 4.3% | <0.001 |
| Cardiovascular complications | 6.7% | 4.1% | 4.3% | 4.0% | <0.001 |
| Systemic complications | 1.5% | 1.8% | 1.4% | 1.5% | <0.001 |
| Procedure-related complications | 3.9% | 3.8% | 3.5% | 3.1% | <0.001 |
| Length of stay (d) | 9.5 ± 0.1 | 12.7 ± 0.4 | 10.1 ± 0.3 | 7.4 ± 0.1 | <0.001 |
| Total cost ($) | 76,374 ± 53.1 | 93,567 ± 251.4 | 78,279 ± 231.0 | 63,057 ± 53.0 | <0.001 |

## TABLE 5

In-Hospital Mortality for all Patients Undergoing Major Surgical Operations by Primary Payer Group

| Outcome | Medicare | Medicaid | Uninsured | Private Insurance | *P* |
|---|---|---|---|---|---|
| Lung resection | 4.3% | 4.3% | 6.2% | 2.0% | <0.001 |
| Esophagectomy | 8.7% | 7.5% | 6.5% | 3.0% | <0.001 |
| Colectomy | 7.5% | 5.4% | 3.9% | 1.8% | <0.001 |
| Pancreatectomy | 6.1% | 5.8% | 8.4% | 2.7% | <0.001 |
| Gastrectomy | 10.8% | 5.4% | 5.0% | 3.5% | <0.001 |
| AAA | 12.4% | 14.5% | 14.8% | 7.0% | <0.001 |
| Hip replacement | 0.4% | 0.2% | 0.1% | 0.1% | <0.001 |
| CABG | 4.0% | 2.8% | 2.3% | 1.4% | <0.001 |

CABG indicates coronary artery bypass grafting; AAA, abdominal aortic aneurysm.

## TABLE 6

Adjusted Outcomes for the Effect of Primary Payer Status Among Patients Undergoing Major Surgical Operations

| Outcome | Medicare | Medicaid | Uninsured | Private Insurance | AUC |
|---|---|---|---|---|---|
| In-hospital mortality | 1.54 (1.48–1.61)* | 1.97 (1.84–2.10)* | 1.74 (1.60–1.90)* | 1.0 | 0.86 |
| Wound complication | 1.16 (1.13–1.18)* | 1.23 (1.18–1.28)* | 1.06 (1.01–1.12)* | 1.0 | 0.68 |
| Infectious complications | 1.11 (1.09–1.14)* | 1.24 (1.20–1.27)* | 1.02 (0.98–1.06) | 1.0 | 0.79 |
| Urinary complications | 1.15 (1.12–1.18)* | 1.02 (0.97–1.08)* | 0.94 (0.88–0.99)* | 1.0 | 0.72 |
| Pulmonary complications | 1.06 (1.05–1.07)* | 1.13 (1.11–1.15)* | 0.96 (0.94–0.99)* | 1.0 | 0.77 |
| Gastrointestinal complications | 1.08 (1.06–1.09)* | 0.99 (0.97–1.02) | 0.88 (0.86–0.91)* | 1.0 | 0.81 |
| Cardiovascular complications | 1.12 (1.10–1.13)* | 1.04 (1.01–1.07)* | 1.00 (0.97–1.03) | 1.0 | 0.78 |
| Systemic complications | 0.99 (0.97–1.01) | 1.12 (1.08–1.16)* | 0.94 (0.90–0.99)* | 1.0 | 0.61 |
| Procedure related complications | 1.10 (1.08–1.12)* | 1.10 (1.07–1.13)* | 0.97 (0.94–1.01) | 1.0 | 0.69 |
| Length of stay (d)* | 8.77 % 0.01 | 10.49 % 0.04 | 7.01 % 0.03 | 7.38 % 0.01 | — |
| Total costs ($)* | $69,408 % 53.1 | $79,140 % 251.4 | $65,667 % 231.0 | $63,057 % 53.0 | — |

*$P < 0.05$. In-hospital mortality and postoperative complications reported as adjusted odds ratios (95% confidence interval). Length of stay and total costs reported as adjusted means ± standard deviation. Reference group: primary payer status (private insurance). Outcomes adjusted for patient age, gender, elective operative status, mean income, hospital geographic region, teaching hospital status, type of operation, primary payer status, and categories for comorbid disease.

AUC indicates area under receiver operator curve.