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Primary Payer Status is Associated with Mortality and Resource Utilization for Coronary Artery Bypass Grafting

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Abstract

Background—Medicaid and Uninsured populations are a significant focus of current healthcare reform. We hypothesized that outcomes following coronary artery bypass grafting (CABG) in the United States is dependent upon primary payer status.

Methods—From 2003–2007, 1,250,619 isolated CABG operations were evaluated using the Nationwide Inpatient Sample (NIS) database. Patients were stratified by primary payer status: Medicare, Medicaid, Uninsured, and Private Insurance. Hierarchical multiple regression models were applied to assess the effect of primary payer status on postoperative outcomes.

Results—Unadjusted mortality for Medicare (3.3%), Medicaid (2.4%) and Uninsured (1.9%) patients were higher compared to Private Insurance patients (1.1%, $p<0.001$). Unadjusted length of stay was longest for Medicaid patients (10.9±0.04 days) and shortest for Private Insurance patients (8.0±0.01 days, $p<0.001$). Medicaid patients accrued the highest unadjusted total costs ($113,380±386, $p<0.001$). Importantly, after controlling for patient risk factors, income, hospital features, and operative volume, Medicaid (OR=1.82, $p<0.001$) and Uninsured (OR=1.62, $p<0.001$) payer status independently conferred the highest adjusted odds of in-hospital mortality. In addition, Medicaid payer status was associated with the longest adjusted length of stay and highest adjusted total costs ($p<0.001$).

Conclusions—Medicaid and Uninsured payer status confers increased risk adjusted in-hospital mortality for patients undergoing coronary artery bypass grafting operations. Medicaid was further associated with the greatest adjusted length of stay and total costs despite risk factors. Possible explanations include delays in access to care or disparate differences in health maintenance.

Keywords

Payer Status; Insurance; CABG; Mortality; Outcomes

INTRODUCTION

The influence of primary payer status and insurance type has become a central focus of recent United States health care reform debate. Recent estimates indicate that the number of uninsured Americans is over 46 million, the number of people covered by government-

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assistance insurance programs (Medicaid and Medicare) increased to greater than 87 million, while the number of Americans covered by private insurance has slightly decreased from 202 to 201 million.[1] In light of these trends, Medicaid and Uninsured patients have been shown to have worse outcomes compared to privately insured patients following medical admissions,[2, 3] and recent health care reform aims to increased government-sponsored health care coverage for many American patients. However, disparities in surgical treatment and resource utilization may exist for patients with varying insurance types.

Coronary artery disease and myocardial infarctions remains the leading cause of death in the United States. Coronary artery bypass grafting (CABG) remains gold standard of care for left main coronary artery and multi-vessel stenoses. According to the Society of Thoracic Surgeons national database, approximately 160,000 isolated coronary artery bypass grafting operations are performed annually.[4] Improvements in preoperative evaluation and surgical techniques have resulted in the performance of CABG with low morbidity and mortality. The operative mortality rates nationally for isolated CABG now approach 1.8%.[4] Furthermore, emerging technology has resulted in an increasing volume of off-pump, minimally invasive and robotic CABG operations.

Previous studies have examined the impact of primary payer status in statewide or individual center surgical populations. A recent New York and Florida based study examining among vascular surgery patients demonstrated that insurance status predicts disease severity,[5] while other series have documented disparate differences in allocation of surgical treatment.[6, 7] Moreover, differences in trauma care outcomes and resource utilization for Medicaid and uninsured patients have been demonstrated.[8–10] However, few studies have examined the impact of primary payer status on outcomes undergoing isolated CABG at a nationwide level. We hypothesized that primary payer status significantly influences patient outcomes in the United States.

METHODS

Data Source

The University of Virginia Institutional Review Board (IRB) did not perform a formal review of this study as it did not meet the regulatory definition of human subjects research. Data for this study was extracted from the Nationwide Inpatient Sample (NIS) databases 2003–2007. NIS is the largest, all-payer, inpatient care database that is publically available in the United States and is maintained by the Agency for Healthcare Research and Quality (AHRQ).[11] NIS methodology has been previously described,[12] Data includes in-patient hospital discharge records collected for patients of all ages and sources of insurance. A discharge weight is included for each patient discharge record to represent the relative proportion of the total U.S. in-patient hospital population for each record.[13] Therefore, the multi-institutional cohort represented in this study is broadly representative of individuals undergoing CABG operations within the U.S.

Patients

Patients undergoing isolated CABG were identified by using International Classification of Diseases-Ninth Revision, Clinical Modifications (ICD-9-CM) procedure codes 3610, 3611, 3612, 3613, 3614, 3615, 3616.[14] Concomitant cardiac valve operations were excluded by identifying discharge records with ICD-9-CM codes for valve replacement (ICD-9-CM codes 352, 3520, 3521, 3522, 3523, 3524, 3525, 3526, 3527, 3528) and valve repair (ICD-9-CM codes 351, 3511, 3512, 3513, 3514). Patients were stratified by primary payer status into four comparison groups: Medicare, Medicaid, Uninsured, and Private Insurance. The Uninsured payer group included both “no-charge” and “self-pay” patients.

Patient co-morbid disease was assessed using available AHRQ comorbidity categories, developed by Elixhauser et. al.[15] The Elixhauser method has been demonstrated to provide effective adjustments for mortality risk among surgical populations.[16, 17]

Hospitals

Hospital level data reflect details included in the NIS database. Hospital operative volume was categorized into quartiles: Low (<25th percentile), Medium (26–49th percentile), High (50–74th percentile), and Very High (>75th percentile).

Outcomes Measured

All outcomes of interest were established *a priori* before data collection. Primary outcomes were risk-adjusted, in-hospital mortality and adjusted hospital length of stay and total costs In-hospital death, unadjusted mean length of stay and total costs were identified according to discharge records.

Statistical Analysis

Patient risk factors and outcomes were compared by hierarchically structured univariate analyses using Pearson's χ^2 for all categorical variables and analysis of variance (ANOVA) for continuous variables. Importantly, the distribution of all continuous variables (patient age, length of stay, and total costs) within the dataset was assessed prior to subsequent analysis, and both length of stay and total costs were not normally distributed. As a result, logarithmic transformations of these variables were utilized in regression models. All group comparisons were unpaired.

Hierarchical, multi-level, multiple logistic and linear regression analyses were performed to estimate the adjusted effects of primary payer status on risk-adjusted mortality, hospital length of stay, and total costs for all patients undergoing isolated CABG procedures. All risk factors entered as covariates (patient age, gender, race, elective operative status, mean income, hospital geographic region, teaching hospital status, hospital operative volume, operative year, primary payer status, and categories for comorbid disease) were selected *a priori* as considered potential confounders for the effect of payer status on patient outcomes. All covariates were retained in each final model. All logistic regression models included appropriate adjustments for variance components estimated from the weighted study population.[18] The statistical significance of the association between primary payer status and in-hospital death or complications was assessed using the Wald χ^2 test. The discrimination achieved by these models was assessed using the Area Under the Receiver Operating Characteristics Curve (AUC). 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.

Sensitivity analyses for each multivariable logistic regression model were performed to validate model performance and discrimination. 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.[19] 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.

Categorical variables are expressed as a percentage of the group of origin. Continuous variables are reported as means ± standard deviation. Odds ratios (OR) with a 95% confidence interval (CI) are used to report the results of logistic regression models. Reported

P-values are two-tailed and were considered statistically significant if <0.05. Data analyses were performed using PASW software, version 18.0 complex samples module (IBM Corp, Somers, NY).

RESULTS

Patient and Hospital Characteristics

During the six-year study period, a weighted estimate of 1,250,619 patients nationwide (257,764 discharge records) underwent isolated CABG operations. Frequencies of all patient characteristics stratified by primary payer groups are detailed in Table 1. Patients with Medicare (53.9%) or Private Insurance (37.6%) represented the largest payer groups. Naturally, mean age was highest in the Medicare group (72.1±7.6 years). Female gender was more frequent in Medicare (32.7%) and Medicaid (38.3%) payer groups. Regarding racial and ethnic differences, Medicare and Private Insurance groups included a higher proportion of White patients, while the Medicaid and Uninsured groups contained a higher percentage of Black and Hispanic patients. Medicaid (42.1%) and Uninsured (35.1%) patients were more likely to reside in the lowest-income areas, while Private Insurance group had the highest proportion of patients in the highest income quartile (27.4%). Operations performed during elective admissions occurred more commonly among Medicare (46.8%) and Private Insurance (48.7%) patients, while operations during non-elective (urgent/emergent) admissions were more frequent in Medicaid and Uninsured patients. The majority of patients underwent 2 and 3 vessel coronary artery bypass grafting.

Incremental differences in co-morbid disease existed across payer groups. The presence of chronic pulmonary disease (27.9%), diabetes (37.3%), and liver disease (1.7%) was most common among Medicaid patients, while alcohol and drug abuse, as well as the incidence of psychoses, was most frequent among the Medicaid and Uninsured groups. Medicare patients had the highest incidence of preoperative anemia (1.6%), coagulopathy (9.2%), hypertension (69.2%), hypothyroidism (7.9%), and renal failure (9.6%).

Hospital characteristics for all payer groups are displayed in Table 2. The large majority of CABG procedures occurred in the urban setting for all payer groups and within large bed size hospitals. Medicaid (64.5%) patients had the highest proportion of operations performed at teaching hospitals. Geographically, the Southern region performed the highest proportion of operations for all payer groups. CABG was more commonly performed at large, high-volume (>75th percentile operative volume) centers (p<0.001). The distribution of CABG operations in each payer group remained similar across the study period.

Unadjusted Outcomes

Table 3 details the overall incidence of unadjusted outcomes for all primary payer groups. Mortality for Medicare (3.3%), Medicaid (2.4%) and Uninsured (1.9%) patient groups were higher compared to Private Insurance groups (1.1%, p<0.001). Medicaid patients accrued the highest unadjusted hospital length of stay (10.9±10.5 days) and total costs ($113,380±94,021) followed by Uninsured patients.

Adjusted Outcomes for the Effect of Primary Payer Status

Table 4 displays confounder adjusted odds ratios and means for the effect of primary payer status on mortality and postoperative resource utilization. After risk factor adjustment for the confounding effects of patient, hospital and operative factors, payer status remained a highly significant predictor of mortality (p<0.001). Specifically, Medicaid, Uninsured, and Medicare primary payer status conferred an 82%, 62%, and 35% increase in the odds of in-hospital death, respectively, compared to Private Insurance. Hierarchical multiple linear

regression analyses for postoperative resource utilization also demonstrated that Medicaid patients accrued the longest mean hospital length of stay and highest total costs among all payer groups. To compare the relative strength of association between primary payer status and mortality with other patient and operation-related factors, factors with significant associations with mortality were examined (Table 5), Upon comparing the likelihood ratios (Wald chi-square statistics) for modeled factors, patient age, congestive heart failure, renal failure, hypertension and coagulopathy had the highest likelihood ratios related to mortality risk. Importantly, on sensitivity analysis, the reported risk-adjusted associations between payer status and outcomes were not significantly attenuated upon re-estimation as described above, suggesting that adjustment for a potentially unmeasured confounder would not influence the estimated effect of payer status.

DISCUSSION

The present study demonstrates that primary payer status is an important predictor of outcomes following CABG surgery after controlling for a wide range of factors commonly associated with socioeconomic status (SES). Further, these results suggest that type of patient insurance was statistically associated with in-hospital mortality and hospital resource utilization. In these analyses, Medicaid payer status was associated with an 82% and 62% increase in the odds of in-hospital death compared to Private Insurance, which was even higher than that for Medicare patients. While the present study does not disprove that SES is an important predictive factor for outcomes in cardiac surgery, it does provide strong evidence that payer status alone remains an important factor impacting these outcomes. Our results are consistent with the limited literature suggesting that Medicaid patients have worse outcomes following CABG surgery than patients with Medicare or private insurance,[20, 21] and with our previous work demonstrating that Medicaid patients have worse outcomes in many major surgical operations.[22, 23]

Prior studies among patients with coronary artery disease (CAD) have also suggested that Medicaid patients have significantly worse outcomes than patients with private insurance or Medicare. Canto et al studied a national cohort of 332,221 AMI patients, and found that Medicaid and uninsured patients had significantly higher in-hospital mortality than privately insured patients.[24] Similarly, Horne et al reported that among patients with CAD, those with Medicaid but not Medicare were more likely than privately insured, charity paid, or uninsured patients to experience death or MI after a mean 6.7 years of follow-up. [25] With respect to treatment, separate studies have demonstrated that Medicaid patients were less likely than Medicare and privately insured patients to receive evidence-based care, resulting in worse outcomes.[26, 27] Moreover, work in other countries has suggested that patients enrolled in public health care plans may not fare as well as patients who are privately insured. [28] However, these studies either did not distinguish between effects due to payer status and effects due to SES, nor they did not control for risk factors commonly associated with low SES. Since payer status and SES tend to be highly correlated, this represents an important confounding factor.

The importance of socioeconomic status is reinforced by the persistence of outcome gaps between socioeconomic classes in nations with universal, single-payer health care. Pilote et al analyzed the effect of SES on access to interventional procedures following AMI in Quebec, Canada, and found that access to catheterization correlated with SES. [29] In a follow-up study, this same group also report the persistence of a “wealth-health” gradient in Canada, and suggest that it is due to intermediate factors such as lifestyle and comorbidities.[30] Interestingly, James et al assessed income-related disparities in health outcomes in Canada over the 25 years following the implementation of universal coverage in 1971 and concluded that disparities had narrowed over that time period but had not been

eliminated.[31] Quatromoni and Jones surveyed 43 studies investigating access to invasive coronary artery procedures in the United States and the United Kingdom, and reported that the same inequalities existed between patients with different SES in the two countries.[32] That fact these studies were conducted in populations with universal access to the health care system provides important evidence that SES is an influential factor in determining health outcomes independent of insurance or payer status.

The present study attempts to control for confounding due to SES by specifically accounting for mean income as well as a large number of other patient factors that cluster within SES groups, such as patient co-morbidities and differences in hospital correlated events. The use of median household income by patient ZIP code was used to adjust for SES in our estimates of the effect of primary payer status. Although not a direct measure of SES, the Agency for Healthcare Research and Quality (AHRQ) and Healthcare Cost and Utilization Project utilizes the median household income of a patient's ZIP code of residence as a proxy measure of an individual patient's socioeconomic status. Ultimately, by controlling for SES, these data suggest that social and economic factors alone do not fully account for surgical outcomes. Moreover, socioeconomic effects may in part arise because patients who lack insurance or who have financial worries tend to delay seeking care, thus implying a role for payer status.[33]

The NIS database allow for an extremely robust sample size from which to base our analyses. The majority of patients undergoing CABG within the United States are, not surprisingly, covered under either Medicare or Private insurance plans. Although differences in payer group sample size exist, the large number of patients included within each payer group allows us to examine at a national level for subtle associations and differences between study groups and variables that other cardiac and surgical databases do not currently capture well. Moreover, the hierarchical risk-adjustment models utilized in our analyses demonstrate adequate performance and discrimination between each study group and outcomes and factors in the effect of group sample size in its point estimates. Based on these statistics, patient age (Wald=2,631) as well as presence of hypertension (Wald=4,046), congestive heart failure (Wald=2,127), renal failure (Wald=2,686), and coagulopathy (2,387) are the five factors most influencing the effect of primary payer status (Wald=392) on in-hospital mortality. Thus, these factors contributed most to the significant changes observed between unadjusted and risk-adjusted mortality.

The present study does not address *why* Medicaid patients should have worse outcomes than patients with different payer statuses. Medicaid reimburses practitioners at lower rates than other forms of insurance, and for CABG procedures these rates appear to be less than the economic costs to the practitioner of performing the procedure.[34] This might encourage health care providers to substitute resources towards better-compensating patients, both to limit costs associated with Medicaid patients and to maximize the share of practice resources directed towards profitable activities. Such effects have been identified in reports demonstrating that full compliance with best-practice guidelines and treatment by cardiologists is greater for privately insured and Medicare patients than for Medicaid patients who present with coronary artery disease.[26, 35] This is also supported by studies suggesting that Medicaid patients are less likely than counterparts with other types of insurance to receive interventional procedures such as angioplasty or CABG.[36–38] On the other hand, research by Alter et al has suggested that patient behavior is an important determinant of outcomes following hospitalization for cardiac care [39]. If Medicaid patients are less likely to adhere to medical advice than patients with other forms of insurance – either because of increased financial burden or other social factors – outcomes may be negatively affected. Other explanations for inherent differences between payer groups may exist.

Factors such as language barriers as well as poor nutrition and health maintenance have also been identified.[2, 40] However, payer status impacts several different areas of health care delivery. Differences exist in not only access, but also in the type of primary care that patients receive. Medicaid and Uninsured patients appear to receive a majority of their primary care within Emergency Departments.[41, 42] In fact, fewer diagnostic studies during emergency department visits and decreased in-patient hospitalizations following specialty consultations have been documented for these populations compared to private insurance patients.[43] NIS does not report hospital admissions following patient presentation to the Emergency Department. Furthermore, Medicaid and Uninsured populations often present with more advanced disease compared to privately insured patients, and patient insurance type has been shown to affect access to cancer screening, treatment, and outcomes.[44, 45] Payer status may also effect hospital discharge processes as discharge from the hospital may be delayed for Medicaid and Uninsured populations due to lack of support and resources to be cared for properly at home. Regarding the Uninsured population. In this analysis, the Uninsured study group includes both “no pay” and “self pay” populations, it is possible that the improved odds of in-hospital death and lower resource utilization observed for the Uninsured group may be influenced by “self pay” patients, which may have a lower prevalence of co-morbid disease with improved access to care.

This study has potential limitations. First, its retrospective study design and the possibility of selection bias. Second, the potential for unrecognized miscoding among diagnostic and procedure codes within a large administrative database. The performed data analyses allow us to comment upon statistical measures of association and do not establish a cause and effect relationship between payer status and risk adjusted outcomes. This study reports only short-term outcomes. Consequently, the results reported herein may underestimate the true incidence of perioperative mortality and morbidity that follow patient discharge. Certain assumptions in our analyses may also impact the reported results such as the potential for dual insurance eligibility and cross over between payer groups or that operations following elective admissions represent non-urgent or emergent operations. However, NIS records reflect the primary payer status at the time of discharge mitigating the effect of dual eligibility in this analysis. In addition, it is possible that a small percentage of Privately Insured patients may have “inadequate” coverage and may more closely resemble those without insurance with respect to poor health maintenance and advanced disease. A degree of multicolinearity may exist between certain modeled factors, including primary payer status, mean income, and comorbid disease states that tend to cluster in lower income populations. In an effort to avoid the introduction of multiple comparisons bias or the bias associated with multiple hypothesis testing, we selected and defined all statistical analyses to be performed for this study *a priori* and did not perform additional testing to determine the degree of multicollinearity between modeled factors after the results of statistical analyses were obtained. We believe this to be the purest approach to data hypothesis testing. The results reported for primary payer status are adjusted for the influence of mean income, race, and other comorbidities that may have some relationship with primary payer status. Thus, we believe that our results provide a conservative estimate of the effect of payer status on our primary outcomes. Finally, in our data analyses we are unable to include adjustments for other well-established cardiac surgical risk factors such as low preoperative albumin levels, preoperative cardiac functional status (NYHA Class), cardiogenic shock, ventricular function, or cardiopulmonary bypass exposure times. However, as our sensitivity analyses proved resilient to to the influence of a potentially unmeasured confounder, it is unlikely that inclusion of such factors in our analyses would significantly change our primary results.

CONCLUSION

Primary payer status is significantly associated with mortality following performance of coronary artery bypass grafting within the United States. Medicaid and Uninsured payer status confers the highest risk adjusted in-hospital mortality for patients undergoing CABG. Medicaid was further associated with the greatest adjusted length of stay and total costs despite disparate differences in risk factors. Possible explanations include complex socioeconomic and health system related factors. Other patient factors were found to have stronger associations with mortality risk compared to primary payer status, which may serve as an area for future investigation. These results suggest, however, that primary payer status should be strongly considered during preoperative patient risk stratification in an effort to improve postoperative outcomes. Further investigation within national cardiac surgery databases may provide additional insight into underlying differences in payer populations.

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Table 1

Patient characteristics for all patients undergoing CABG operations by primary payer group.

Variable	Medicare	Medicaid	Uninsured	Private Insurance	*p*
Number of cases (unweighted)	139,098	12,265	9.485	96,916	≤0.001-
National estimate of cases (weighted)	674,658	59,694	45,472	470,795	≤0.001
Age (years)*	72.1±7.6	56.4±9.6	55.1±8.6	58.0±8.2	≤0.001
Female	32.7%	38.3%	26.3%	20.1%	≤0.001
Elective Operation	46.8%	34.9%	26.8%	48.7%	≤0.001
Number of Bypass Grafts					≤0.001
I Vessel	13.4%	16.0%	13.8%	14.7%	
2 Vessel	35.3%	34.6%	34.3%	33.3%	
3 Vessel	32.5%	30.7%	37.2%	31.2%	
4 or More Vessels	15.6%	14.4%	16.4%	16.3%	
Race					≤0.001
White	83.5%	53.5%	67.3%	82.7%	
Black	5.8%	11.7%	9.5%	5.5%	
Hispanic	6.2%	20.4%	13.7%	5.5%	
Asian/Pacific Islander	1.8%	5.9%	2.4%	2.5%	
Native American	0.2%	0.8%	0.7%	0.3%	
Other	2.5%	7.7%	6.5%	3.5%	
Comorbid Disease					
AIDS	0.0%	0.2%	0.1%	0.0%	≤0.001
Alcohol Abuse	1.5%	4.8%	5.7%	2.4%	≤0.001
Deficiency Anemia	13.5%	13.2%	10.7%	11.4%	≤0.001
Arthritis/Collagen Vascular Disorder	1.6%	1.0%	0.6%	1.1%	≤0.001
Chronic Blood Loss Anemia	1.6%	1.0%	1.0%	1.0%	≤0.001
Congestive Heart Failure	1.3%	1.1%	0.5%	0.4%	≤0.001
Chronic Pulmonary Disease	23.5%	27.9%	22.1%	18.0%	≤0.001
Coagulopathy	9.2%	7.1%	5.6%	6.0%	≤0.001
Depression	3.5%	5.5%	3.5%	4.0%	≤0.001
Diabetes Mellitus (uncomplicated)	29.2%	37.3%	30.8%	29.5%	≤0.001

Variable	Medicare	Medicaid	Uninsured	Private Insurance	*p*
Diabetes Mellitus (complicated)	5.6%	8.7%	4.3%	4.9%	≤0.001
Drug Abuse	0.3%	3.2%	3.5%	0.6%	≤0.001
Hypertension	69.2%	68.7%	64.0%	67.8%	≤0.001
Hypothyroidism	7.9%	5.0%	3.4%	5.2%	≤0.001
Liver Disease	0.5%	1.7%	0.9%	0.8%	≤0.001
Lymphoma	0.4%	0.2%	0.1%	0.3%	≤0.001
Fluid and Electrolyte Disorder	17.7%	16.4%	14.3%	13.7%	≤0.001
Metastatic Cancer	0.2%	0.1%	0.1%	0.1%	≤0.001
Neurologic Disorder (not CVA)	2.8%	2.9%	1.3%	1.5%	≤0.001
Obesity	9.1%	13.3%	12.8%	15.0%	≤0.001
Paralysis	1.2%	1.6%	0.6%	0.5%	≤0.001
Peripheral Vascular Disease	14.6%	11.3%	8.0%	8.5%	≤0.001
Psychoses	1.2%	2.3%	1.1%	0.6%	≤0.001
Pulmonary Circulation Disorder	0.1%	0.0%	0.0%	0.0%	≤0.001
Renal Failure	9.6%	8.2%	3.5%	4.2%	≤0.001
Solid Tumor (without metastasis)	1.3%	0.6%	0.4%	0.6%	≤0.001
Peptic Ulcer Disease (non-bleeding)	<0.1%	<0.1%	<0.1%	<0.1%	0.63
Valvular Disease	0.5%	0.3%	0.2%	0.1%	≤0.001
Weight Loss	1.6%	1.5%	0.6%	0.6%	≤0.001
Median Income Quartile					≤0.001
I ($1–24,999)	27.0%	42.1%	35.1%	19.9%	
II ($25,000–34,999)	27.5%	27.5%	29.9%	25.3%	
III ($35,000–44,999)	24.6%	18.9%	20.9%	27.4%	
IV (> $45,000)	20.9%	11.4%	14.0%	27.4%	

Table 2

Hospital characteristics for all patients undergoing CABG operations by primary payer group.

Variable	Medicare	Medicaid	Uninsured	Private Insurance	*p*
Rural Location	3.9%	3.5%	4.9%	2.6%	≤0.001
Teaching Hospital	57.4%	64.5%	58.3%	60.0%	0.003
Hospital Bed Size					0.02
Small	6.6%	4.5%	7.5%	5.5%	
Medium	19.6%	18.2%	17.8%	20.6%	
Large	73.7%	77.3%	74.7%	73.9%	
Hospital Region					≤0.001
Northeast	17.2%	22.2%	13.6%	16.6%	
Midwest	24.3%	18.4%	18.1%	25.0%	
South	43.2%	39.8%	61.1%	41.2%	
West	15.4%	19.6%	7.3%	17.3%	
Hospital Volume					≤0.001
Low	4.0%	5.5%	4.5%	3.7%	
Medium	11.5%	14.3%	13.0%	11.3%	
High	22.4%	21.6%	22.5%	22.2%	
Very High	62.2%	58.6%	59.9%	62.9%	

Table 3

Unadjusted effect of primary payer status on outcomes among patients undergoing CABG operations.

Outcome	Medicare	Medicaid	Uninsured	Private Insurance	*p*
Mortality	3.3%	2.4%	1.9%	1.1%	≤0.001
Length of Stay (Days) *	10.4±8.5	10.9±10.5	9.5±7.8	8.0±5.8	≤0.001
Total Cost ($) *	$103,324±82,846	$113,380±94,021	$96,688±68,070	$88,665±65,974	≤0.001

*Mean ± Standard Deviation;

†Effect size

Table 4

Risk-adjusted effect of primary payer status on outcomes among patients undergoing CABG operations.

Outcome	Medicaid	Uninsured	Medicare	Private Insurance
In-Hospital Mortality *[a]	1.82 [1.55, 2.15]	1.62 [1.22, 2.15]	1.35 [1.23, 1.49]	Ref
Length of Stay (days) *[b]	12.57±0.05	10.40±0.16	10.87±0.11	7.96±0.01
Total Costs ($) *[b]	$125,590±900	$105,068±1,907	$104,503±2,307	88,665±97

*$p<0.001$.

[a] Area Under Receiver Operator Curve (AUC)=0.80, Nagelkerke PsuedoR^2=0.15; Odds Ratio [95% Confidence Interval].

[b] Mean ± Standard Error of Mean (SEM). Reference group: Private Insurance.

Table 5

Factors with statistically significant associations with mortality among patients undergoing CABG operations.

Factor	Likelihood Ratio	*p*	Odds Ratio	95% C.I.	
				Lower	Upper
Patient age (years)	2631.74	<0.001	1.04	1.04	1.05
Elective status	1043.33	<0.001	0.65	0.63	0.67
Female Gender	1062.35	<0.001	1.53	1.49	1.57
Comorbid Disease					
Deficiency Anemia	704.04	<0.001	0.56	0.54	0.58
Chronic Blood Loss Anemia	65.05	<0.001	0.66	0.60	0.73
Congestive Heart Failure	2127.50	<0.001	3.99	3.76	4.23
Chronic Pulmonary Disease	26.91	<0.001	1.08	1.05	1.11
Coagulopathy	2386.98	<0.001	2.17	2.11	2.24
Depression	237.78	<0.001	0.47	0.42	0.52
Diabetes Mellitus (uncomplicated)	494.44	<0.001	0.70	0.68	0.72
Diabetes Mellitus (complicated)	112.43	<0.001	0.74	0.70	0.78
Hypertension	4046.59	<0.001	0.44	0.43	0.45
Hypothyroidism	194.75	<0.001	0.67	0.63	0.71
Liver Disease	421.97	<0.001	2.75	2.50	3.03
Lymphoma	18.86	<0.001	1.44	1.22	1.70
Fluid and Electrolyte Disorder	1976.17	<0.001	1.84	1.79	1.89
Metastatic Cancer	16.91	<0.001	1.61	1.28	2.02
Neurologic Disorder (not CVA)	299.10	<0.001	1.71	1.61	1.82
Obesity	121.63	<0.001	0.74	0.70	0.78
Paralysis	268.51	<0.001	2.08	1.91	2.27
Peripheral Vascular Disease	52.96	<0.001	1.14	1.10	1.18
Psychoses	20.97	<0.001	0.72	0.62	0.83
Renal Failure	2686.19	<0.001	2.49	2.41	2.58
Solid Tumor (without metastasis)	23.71	<0.001	0.72	0.63	0.82

Factor	Likelihood Ratio	*p*	Odds Ratio	95% C.I.	
				Lower	Upper
Valvular Disease	73.88	<0.001	1.53	1.39	1.69
Weight Loss	342.87	<0.001	1.75	1.65	1.86
Median Income Quartile	99.52	<0.001			
I ($1–24,999)	97.28	<0.001	1.21	1.16	1.25
II ($25,000–34,999)	35.06	<0.001	1.12	1.08	1.16
III ($35,000–44,999)	46.06	<0.001	1.14	1.09	1.18
IV (> $45,000, Reference)	-	-	1.00	-	-
Teaching Hospital	81.98	<0.001	1.13	1.10	1.16
Hospital Region	241.11	<0.001			
Northeast	93.22	<0.001	0.82	0.79	0.86
Midwest	62.46	<0.001	0.88	0.85	0.91
West	36.26	<0.001	1.12	1.08	1.16
South (Reference)	-	-	1.00	-	-
Hospital Volume	164.04	<0.001			
Low	92.34	<0.001	1.33	1.26	1.41
Medium	57.66	<0.001	1.16	1.12	1.21
High	81.55	<0.001	1.15	1.12	1.19
Very High (Reference)	-	-	1.00	-	-
Primary Payer Status	391.95	-	-	-	-