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Insurance status predicts acuity of thoracic aortic operations

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Abstract

Objective—Nonelective case status is the strongest predictor of mortality for thoracic aortic operations. We hypothesized that underinsured patients were more likely to require nonelective thoracic aortic surgery because of reduced access to preventative cardiovascular care and elective surgical services.

Methods—Between June 2005 and August 2011, 826 patients were admitted to a single aortic referral center and underwent 1 or more thoracic aortic operations. Patients with private insurance or Medicare (insured group, n = 736; 89%) were compared with those with Medicaid or no insurance (underinsured group, n = 90; 11%).

Results—The proportion of patients requiring nonelective surgery was higher for underinsured than insured patients (56% vs 26%, $P < .0001$). Multivariable analysis revealed underinsurance to be the strongest independent predictor of nonelective case status (odds ratio [OR], 2.67; $P < .0001$). Preoperative use of lipid-lowering medications (OR, 0.63; $P < .009$) or a history of aortic surgery (OR, 0.48; $P < .001$) was associated with a decreased risk of nonelective operation. However, after adjustment for differences in preoperative characteristics and case status, underinsurance did not confer an increased risk of procedural morbidity or mortality (adjusted OR, 0.94; $P = .83$) or late death (adjusted hazard ratio, 0.83, $P = .58$) when compared with insured patients.

Conclusions—Underinsured patients were at the greatest risk of requiring nonelective thoracic aortic operation, possibly because of decreased use of lipid-lowering therapies and aortic surveillance. These data imply that greater access to preventative cardiovascular care may reduce the need for nonelective thoracic aortic surgery and lead to improved survival from thoracic aortic disease.

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Surgical repair of the thoracic aorta is increasing in frequency and represents one of the most formidable challenges in cardiovascular medicine.^{1, 2 and 3} Prophylactic replacement of diseased aortic segments in the elective surgical setting is typically associated with operative mortality rates less than 5% in contemporary reports.^{1 and 3} However, 40% of operations are performed on an urgent or emergency basis as the result of acute aortic catastrophes, such as aneurysm rupture or aortic dissection, for which operative mortality rates can reach 50%.^{3, 4 and 5} Correspondingly, a recent report from the Society of Thoracic Surgeons found that patients undergoing nonelective operation were at the greatest risk of major morbidity and mortality after proximal thoracic aortic replacement.³ These data suggest the single most important method of improving the surgical outcomes of patients with thoracic aortic disease may be reducing the incidence of acute aortic events requiring expedited repair. Efforts to identify and target patients at high-risk of requiring nonelective thoracic aortic surgery are therefore warranted.

Prior studies have demonstrated that lack of health insurance was the strongest predictor of need for emergency operation for ruptured abdominal aortic aneurysm.^{6 and 7} Individuals without health insurance may be at higher risk of aortic instability because of decreased use of cardiovascular preventative care services, such as antihypertensive and lipid-lowering therapies, smoking-cessation programs, and aortic surveillance, or they may lack access to elective surgical care. We therefore hypothesized that patients with inadequate health insurance were more likely to require nonelective thoracic aortic operation and experience worse outcomes.

Methods

Patient Population and Data Collection

This study was approved by the institutional review board of Duke University, and the need for individual patient consent was waived. A query of the Duke Thoracic Aortic Surgery Database^{8, 9, 10 and 11} was performed to identify all patients who underwent 1 or more thoracic aortic operations (open, endovascular, or hybrid operations involving the proximal aorta, arch, descending, or thoracoabdominal aorta) between June 2005 and August 2011. Patients undergoing surgery for acute traumatic aortic transection were excluded (n = 18) because these procedures are uniformly performed nonelectively. Institutional billing databases were then queried to determine each patient's insurance status (private insurance, Medicare, Medicaid, or no insurance) at the time of hospital admission. Operations were performed as previously described.^{8, 9, 10 and 11}

Variable Definitions

Medicare is a national health insurance program administered by the US federal government that provides health insurance for people aged 65 years or more, people aged less than 65 years with certain disabilities, and people of all ages with end-stage renal disease requiring dialysis or a kidney transplant. Medicaid is jointly funded by state and federal governments and is a health insurance program that provides health insurance for lower-income people, families and children, the elderly, and people with disabilities.¹² Medicaid reimburses

practitioners at lower rates than other forms of insurance, and patients with Medicaid are generally considered underinsured.^{13, 14 and 15}

Comorbid conditions and postoperative complications were defined using Society of Thoracic Surgeons definitions (www.sts.org). Nonelective procedure status was defined as patients undergoing urgent or emergency operation. Operative mortality was defined as death from any cause in-hospital or within 30 days of the index procedure. Major morbidity or mortality was defined as the composite of prolonged ventilation, myocardial infarction, acute renal failure, permanent paraparesis/paraplegia, stroke, or death. Long-term survival was assessed from the medical record and a query of the Social Security death database.

Statistical Analysis

Patients were stratified into 2 insurance status groups (insured or underinsured) for statistical comparisons. Patients with private insurance or Medicare at the time of admission were classified as “insured,” and those with Medicaid or no insurance were classified as “underinsured.” Continuous and categorical variables were compared between insured and underinsured patients using the Mann–Whitney rank sum test or chi-square test, respectively. Predictors of nonelective procedure status were identified using multivariable logistic regression analysis. All preoperative patient characteristics (Table 1) with univariate association ($P < .05$) to nonelective procedure status were included and retained in the final model. The risk-adjusted association between insurance status and outcomes was performed using logistic regression or Cox proportional-hazards regression models to adjust for differences in patient demographics and procedure status between insurance groups. In both models, odds ratios and hazard ratios were adjusted for all variables with P value less than .05 on univariate analysis (age, race, hyperlipidemia, coronary artery disease, chronic obstructive pulmonary disease, peripheral vascular disease, and case status). Calculations were performed using STATA 11.1 (StataCorp LP, College Station, Tex).

Patient Characteristics

Between June 2005 and August 2011, 826 patients were admitted to a single aortic referral center and underwent 1 or more thoracic aortic operations. Of these, 736 (89%) had private insurance ($n = 325$; 39%) or Medicare ($n = 411$; 50%) and were classified as insured. The remaining 90 patients (11%) had Medicaid ($n = 38$; 5%) or no insurance ($n = 52$; 6%) and were classified as underinsured. A comparison of baseline patient characteristics between insured and underinsured patients is shown in Table 1. Underinsured patients were noted to be younger by an average of 14 years, and more were of minority race. Underinsured patients also were observed to harbor fewer comorbid diagnoses than insured patients and had lower documented rates of hyperlipidemia, coronary artery disease, chronic obstructive pulmonary disease, and peripheral vascular disease at the time of hospital admission.

Clinical Presentations, Operations, and Procedural Outcomes

The comparisons of operative parameters and procedural outcomes between insured and underinsured patients are shown in Table 2 and Table 3, respectively. The number of aortic emergencies were higher in the underinsured group, and 56% of underinsured patients underwent urgent or emergency operation compared with 26% of insured patients. However,

the indications for surgery and the case mix appeared similar between groups, and there were no major differences in the redo status, extent of aortic replacement, concomitant procedures, use of endovascular therapies, use of circulatory arrest, or operative times between insured and underinsured patients. In addition, unadjusted measures of procedural morbidity and mortality were comparable between groups, and no major differences in length of stay or rates of dialysis, paraplegia, stroke, or death were observed.

A multivariable analysis was performed to determine the preoperative patient factors that were independently associated with the need for nonelective operation (Table 4). Preoperative variables with univariate association with nonelective case status were younger age ($P = .007$), nonwhite race ($P < .0001$), absence of hyperlipidemia ($P < .0001$), renal insufficiency ($P = .001$), absence of peripheral vascular disease ($P = .01$), underinsured insurance status ($P < .0001$), and no history of aortic surgery ($P < .0001$). On multivariable analysis, underinsured insurance status, minority race, and renal insufficiency were associated with the need for nonelective operation. In contrast, patients with a preoperative diagnosis of hyperlipidemia (defined as lipid-lowering medication use at the time of admission) or a history of aortic surgery were less likely to require nonelective operation.

Association Between Insurance Status and Outcomes

The unadjusted and adjusted associations between insurance status and operative mortality, major morbidity and mortality, and late death were assessed to determine the independent effect of insurance status on patient outcomes. After adjustment for preoperative patient characteristics, comorbidities, and case status, insurance status was not associated with an increased risk of operative mortality or major morbidity (Table 5). Unadjusted survival analysis revealed improved long-term survival for underinsured patients (5-year survival 86.7% vs 76.3%; $P = .02$), possibly as a result of the significant age difference between the groups. However, after adjustment for age and other confounders, insurance status was not associated with late death (Table 5).

The present study assessed the association between insurance status and the presentation and outcomes of thoracic aortic operations, on the basis of the hypothesis that patients with inadequate health insurance are at a higher-risk of developing acute aortic events requiring expedited surgery because of decreased use of preventative health care resources or other barriers to elective surgical care. The primary study finding was that underinsured patients were at a significantly increased risk of requiring nonelective thoracic aortic operation when compared with insured patients. However, after presentation for treatment, insurance status did not confer additional independent operative risk.

The mechanism by which insurance status may affect the acuity of thoracic aortic disease at presentation is not addressed by the present analysis. However, multiple lines of evidence suggest inadequate health insurance leads to more severe cardiovascular disease because of decreased use of preventative care resources. Prior studies have shown that the underinsured are less likely to undergo screening for hypertension or hypercholesterolemia,¹⁶ have higher rates of undiagnosed hypertension and hypercholesterolemia,¹⁷ are less likely to be taking any antihypertensive or lipid-lowering medications,¹⁸ have inadequate blood pressure and cholesterol control among those who are taking medications,¹⁹ and have higher rates

of tobacco use than individuals with health insurance.¹⁶ and ²¹ Given that hypertension, hyperlipidemia, and smoking are the most significant modifiable risk factors for the development and progression of thoracic aortic disease,^{22, 23, 24, 25} and ²⁶ these factors likely contribute to the high incidence of acute aortic events in the underinsured. In the present study, patients with hyperlipidemia were defined as those who were taking lipid-lowering medications at the time of admission. The finding that patients undergoing treatment for hyperlipidemia were less likely to require nonelective surgery lends further support to the hypothesis that preventative cardiovascular care and risk factor modification reduce the frequency of aortic emergencies and suggests that the low rate of comorbid diagnoses among the underinsured was likely due in part to underdiagnosis.

Other explanations for the increased need for nonelective thoracic aortic surgery by underinsured patients may include delayed access to elective surgical services because of financial barriers, difficulties navigating the health care system, or withholding of costly prophylactic operations from asymptomatic individuals who do not have a means to pay. In support of the latter, studies have shown that uninsured patients receive fewer hospital resources and are less likely to undergo major cardiovascular therapeutic procedures, including cardiac catheterization and coronary artery bypass grafting, even after hospital admission for heart attack.¹⁸ However, individual review of patient charts revealed that no underinsured patients who underwent nonelective operation in our study had previously been referred for surgery at our institution, suggesting that this mechanism was not a significant contributor in our series. Alternatively, uninsured patients are known to receive fewer screening and diagnostic tests than insured patients,¹⁸ which may lead to decreased identification of occult aortic pathologies. Correspondingly, the finding of a reduced need for nonelective operation in patients with a history of aortic surgery may be due to increased use of aortic surveillance imaging in this population. Together, these data suggest that policy changes aimed at reducing the number of underinsured/uninsured patients in the United States may decrease the number of acute thoracic aortic events requiring surgery and limit mortality from this disease process.

Prior studies by LaPar and colleagues¹⁴ and ¹⁵ reported that Medicaid and uninsured payer status confer increased risk-adjusted in-hospital mortality for heart valve and coronary artery bypass graft operations. The explanation for this disparity is unknown but may again relate to decreased postoperative resource use for patients with lesser forms of health insurance or referral to less-experienced surgeons.¹³ However, after adjustment for baseline differences between patients and case status, the present study found no association between insurance status and patient outcomes. The difference between our study and the findings of LaPar and colleagues¹⁴ and ¹⁵ may be due to the single-institution design and unique differences in locoregional or hospital practices that relate to insurance status. For instance, all patients requiring thoracic aortic surgery at our hospital undergo operation by the same team of highly experienced surgeons regardless of insurance status,²⁷ which may contribute to the normalization of operative parameters and outcomes between insured and underinsured patients in our study.

Study Limitations

The present study contains several important limitations: (1) The study only includes patients who underwent operation and therefore excludes patients who died of thoracic aortic disease before hospital presentation, were deferred operation because of prohibitive operative risk, or who received medical management for uncomplicated type B dissection. This may have led to an underestimate of the effect of insurance status on presentations and outcomes, given that underinsured patients are predicted to experience more acute aortic events. (2) The present study is a retrospective, observational analysis and may be limited by unmeasured confounders that are not accounted for in risk-adjustment models. (3) The relationship among health insurance, health use, and health is complex and highly influenced by other social variables, such as education level, employment, and socioeconomic status. For instance, the association between race and nonelective operation may be due to the confounding effect of socioeconomic status, a variable that was not controlled for in the present analysis.²⁸ Thus, further study would be needed to reconcile the true effect of insurance status on the presentations and outcomes of thoracic aortic operations independently of these other considerations. (4) The present study represents a single-institution analysis, and the small sample size limits the number of insurance status groups that could be compared. In addition, regional differences in patient demographics, hospital practices, and insurance patterns may limit the generalizability of our results to other settings.

Conclusions

The present study found that underinsured patients were at the greatest risk of requiring nonelective thoracic aortic operations, possibly because of decreased use of lipid-lowering therapies and aortic surveillance. However, after presentation for treatment, insurance status did not confer additional independent operative risk. These data imply that greater access to preventative cardiovascular care may reduce the need for nonelective thoracic aortic surgery and lead to improved survival from thoracic aortic disease. Additional multi-institutional studies are needed to validate these results.

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Abbreviation and Acronym

OR odds ratio

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Table 1

Baseline characteristics

Variable	Insured (n = 736)	Underinsured (n = 90)	P value
Age (y)	61.6 (14.3)	47.2 (11.7)	.0001
Male	474 (64%)	60 (67%)	.67
White race	554 (75%)	35 (39%)	.0001
Body mass index (kg/m ²)	27.8 (5.7)	29.1 (6.7)	.08
Hypertension	615 (84%)	73 (81%)	.56
Hyperlipidemia	409 (56%)	29 (32%)	.0001
Active or recent tobacco use	397 (54%)	57 (63%)	.09
Diabetes	80 (11%)	7 (8%)	.37
Coronary artery disease	208 (28%)	13 (14%)	.005
History of stroke	79 (11%)	6 (7%)	.23
Chronic obstructive pulmonary disease	154 (21%)	10 (11%)	.03
Baseline creatinine >1.5 mg/dL	136 (18%)	18 (20%)	.73
Peripheral vascular disease	131 (18%)	1 (1%)	.0001
Connective tissue disease	46 (6%)	8 (9%)	.34
Previous aortic surgery	256 (35%)	27 (30%)	.37

Data are represented as mean (standard deviation) or number (percent).

Table 2

Operative parameters

Variable	Insured (n = 736)	Underinsured (n = 90)	P value
Nonelective case status	190 (26%)	50 (56%)	.0001
Nonelective indication			.87
Aortic dissection	94 (49%)	28 (56%)	
Symptomatic aneurysm/impending rupture	49 (26%)	11 (22%)	
Severe aortic insufficiency or stenosis	19 (10%)	6 (12%)	
Ruptured aneurysm	12 (6%)	1 (2%)	
Endocarditis	8 (4%)	2 (4%)	
Type I or III endoleak	3 (2%)	1 (2%)	
Unstable angina	2 (1%)	1 (2%)	
Other nonelective concomitant procedure	3 (2%)	0	
Maximum aortic diameter, cm			
Patients with acute dissection (n = 89, n = 25)	5.3 (1.1)	4.9 (0.8)	.13
All other patients (n = 602, n = 58)	5.9 (1.3)	6.0 (1.7)	.69
Segments of aorta repaired			
Root	168 (23%)	26 (29%)	.20
Ascending aorta	229 (31%)	26 (29%)	.66
Arch	378 (51%)	46 (51%)	.97
Descending aorta	212 (29%)	28 (31%)	.65
Thoracoabdominal aorta	85 (12%)	8 (9%)	.45
Redo sternotomy	106 (14%)	13 (14%)	.99
Concomitant procedure	206 (28%)	27 (30%)	.69
Use of thoracic endovascular aortic repair	251 (34%)	29 (32%)	.72
Use of circulatory arrest	349 (47%)	45 (50%)	.64
Crossclamp time (n = 409, n = 54)	138.4 (47.2)	130.9 (45.7)	.25
Cardiopulmonary bypass time (n = 443, n = 59)	214.4 (56.7)	218.9 (71.9)	.93

Data are represented as mean (standard deviation) or number (percent).

Table 3

Thirty-day/in-hospital adverse events

Variable	Insured (n = 736)	Underinsured (n = 90)	P value
Prolonged ventilation (>24 h)	76 (10%)	12 (13%)	.38
Tracheostomy	25 (3%)	1 (1%)	.24
Myocardial infarction	10 (1%)	0	.27
Acute renal failure (creatinine >2.0 mg/dL and >2× baseline)	80 (11%)	8 (9%)	.57
New-onset dialysis	26 (4%)	2 (2%)	.52
Permanent paraparesis/paraplegia	13 (2%)	1 (1%)	.65
Stroke (neurologic deficit lasting >72 h)	26 (4%)	3 (3%)	.92
Postoperative length of stay (d)	8.4 (9.0)	6.8 (7.7)	.05
30-d/in-hospital death	43 (6%)	4 (4%)	.59
Major morbidity or mortality	159 (22%)	18 (20%)	.73

Data are represented as mean (standard deviation) or number (percent).

Table 4

Independent predictors of nonelective operation

Variable	OR (95% CI)	P value
Underinsured	2.67 (1.61-4.41)	<.0001
Nonwhite race	2.25 (1.58-3.19)	<.0001
Baseline creatinine >1.5 mg/dL	1.75 (1.17-2.63)	.007
Age (y)	1.00 (0.99-1.02)	.55
Peripheral vascular disease	0.94 (0.56-1.58)	.83
Hyperlipidemia	0.63 (0.45-0.89)	.009
Prior aortic surgery	0.48 (0.33-0.70)	<.0001

CI, Confidence interval; *OR*, odds ratio.

Table 5

Association between insurance status and operative mortality, major morbidity and mortality, and late death for patients undergoing thoracic aortic operation

Underinsured vs insured (referent)	OR/HR (95% CI)	P value
Operative mortality		
Crude	0.75 (0.26-2.14)	.59
Adjusted	0.97 (0.30-3.12)	.96
Major morbidity and mortality		
Crude	0.91 (0.53-1.57)	.73
Adjusted	0.94 (0.51-1.73)	.83
Late death		
Crude	0.49 (0.27-0.91)	.02
Adjusted	0.83 (0.43-1.61)	.58

CI, Confidence interval; *HR*, hazard ratio; *OR*, odds ratio.