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RESEARCH ARTICLE

# Variation in Hospital Costs, Payments, and Profitability for Cardiac Valve Replacement Surgery

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**Objective.** Examine the variation for Medicare and privately insured patients in hospital costs, payments, and contribution margins and their association with characteristics of the patients, hospitals, and hospital markets.

**Data Sources.** Administrative records for 1,858 patients undergoing cardiac valve replacement surgery were obtained from 37 hospitals in 7 states for 2008.

**Study Design.** Bivariate and multivariate statistical analyses of costs, payments, and profitability (contribution margin) for Medicare and privately insured patients, adjusting for patient, hospital, and market characteristics.

**Data Collection.** Integrated Health Care Association, Aspen Health Metrics, American Hospital Association Annual Survey of Hospitals.

**Principal Findings.** Cardiac valve replacement surgery is an expensive but profitable procedure, with average cost and contribution margin per case of U.S.\$38,667 and U.S.\$21,967, respectively. Average costs per case for Medicare patients are 16.1 percent higher in concentrated than in competitive local markets after adjusting for patient comorbidities, complications, and other relevant factors ( $p < .01$ ). Payments per case were 33.2 percent ( $p < .01$ ) lower from Medicare than from private insurers. The average contribution margin earned by hospitals from Medicare was U.S.\$30,986 lower than the margin earned from private insurers ( $p < .01$ ), after adjusting for patient, hospital, and market characteristics.

**Conclusions.** Hospitals charge significantly higher prices and earn significantly higher contribution margins from private insurers than from Medicare for patients undergoing cardiac valve replacement.

**Key Words.** Hospital costs and prices, Medicare cost shifting, health care reform, prospective payment, insurance

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Expansions of insurance coverage under the Patient Protection and Affordable Care Act (PPACA) are to be financed partly through restrictions in Medicare payments, relative to expected trends in costs (Davis et al. 2010; Foster 2010; PricewaterhouseCoopers Health Care Research Institute 2010). This financing policy has reinvigorated a long-standing debate over the

indirect effects of Medicare payment policies on the prices charged by hospitals to private insurers, and on the role of market structure on hospital pricing strategies. Key empirical questions concern the extent of variance across hospitals in costs, payments, and contribution margins for privately insured patients; the magnitude of the differentials for Medicare and privately insured patients; and the influence of local market structure on hospital economic performance. Answers to these questions require data that permit detailed adjustments for patient characteristics such as comorbidities and complications; hospital characteristics such as procedure volume and input costs; and market characteristics such as the affiliation of individual hospitals with larger chains that negotiate on a unified basis with private insurers.

This paper analyzes the variance in costs, payments, and hospital contribution margins for 1,858 Medicare and privately insured patients undergoing one major surgical procedure, cardiac valve replacement surgery. Focus on a single procedure eliminates much of the case mix heterogeneity that challenges studies that use the hospital as the unit of observation, and it permits further adjustments as to whether the patient received cardiac catheterization in addition to valve replacement and for other characteristics including age, comorbidities, complications, length of stay, and discharge destination.

## HOSPITAL PRICING STRATEGY

Medicare does not negotiate prices with hospitals but uses an administrative formula that matches payments to the costs facilities should be expected to expend on beneficiaries. Hospitals, hence, do not develop pricing strategies for contracting with Medicare. However, private insurers negotiate rather than impose payments, and hospitals develop strategies with respect to negotiating prices for specific procedures and conditions. There is a minimum price below which a hospital will not contract with private insurers and a maximum price above which private insurers will not contract with a hospital, but there may exist considerable space between these pricing extremes. The level at which parties come into agreement on price will depend on the extent of competition in the local market, on whether a particular hospital is a “must-have” facility for the insurer’s provider network, and on whether the hospital is willing to accept less than the maximum possible price in exchange for

designation as a preferred or “Center of Excellence” facility and thereby increase the number of its admissions.

The influence on hospital pricing strategy for private insurers on Medicare’s administered payment system has been the subject of considerable analysis and debate under the rubric of “cost shifting” (Dobson et al. 2006; Zwanziger and Bamezai 2006). Many hospitals and private insurers and some policy analysts have argued that underpayments by Medicare relative to the costs of treating its beneficiaries impel hospitals to increase prices to private insurers (Dranove and Satterthwaite 2000; Ginsburg 2003; Lee et al. 2003; Fox and Pickering 2008). The term “cost shifting” has been used in quite different ways, with some focusing on differential prices for similar services while others limit the term to contexts where hospitals earn negative contribution margins from Medicare or increase prices to private insurers in direct response to an unanticipated reduction in Medicare payments.

More recently, the debate over hospital contribution margins from Medicare and private insurers has expanded beyond the role of differential payments to the determinants of hospital costs themselves. The MedPAC staff has argued that generous payments negotiated by hospitals from private insurers, due to market consolidation or must-have bargaining status, has relaxed the stringency of internal hospital cost control efforts and permitted cost-increasing expansions in staffing, salaries, and clinical technologies (Stensland, Gaumer, and Miller 2010). These higher costs lead to low or negative contribution margins from Medicare beneficiaries, because Medicare’s prospective payment system adjusts for patient characteristics and geographic variations in wage costs but not for cost growth resulting from hospital bargaining power.

The focus on hospital prices for privately insured patients as a determinant of contribution margins for Medicare patients occurs in the context of a continuing consolidation of local markets, as hospitals merge with neighboring facilities or are purchased by regional hospital chains. In this evolving context, the structure of local markets needs to be measured in terms of the number and relative shares of multihospital systems, not merely the number and shares of individual hospital facilities. Each chain negotiates with insurers as a single entity and thereby potentially gains higher prices than it would if each facility owned by the chain negotiated with insurers on its own. There is also likely to be within-market variation in hospital prices due to the quality reputation of particular institutions and to the decision by some facilities to pursue a low-price strategy in hopes of obtaining a larger market share, and thereby recoup in total margin what they give up through lower margin per patient.

## DATA AND METHODS

Data were obtained on all patients admitted in 2008 to any of 37 hospitals for cardiac valve replacement surgery (MS-DRG 216–221). These facilities were participants in the value-based purchasing initiative of the Integrated Health Care Association, a coalition of large hospitals, medical groups, and health plans in California, or worked on value purchasing with Aspen Health Metrics, a hospital consulting firm. Additional data on the hospitals where the procedures were performed were obtained from the American Hospital Association's 2008 Annual Survey of Hospitals, including number of staffed beds and the average annual earnings for hospital staff.

Costs per case were obtained from the hospital's accounting systems and were not based on the charges (list prices), which have little relationship to true underlying resource utilization (Reinhardt 2006). Hospital cost accounting systems represent the facilities' best efforts to assign staff time, operating room capacity, supplies, and other direct clinical expenditures to particular patients in order to be able to manage resources and set prices. Hospitals differ in their cost accounting systems and it is to be expected that some part of the variance across facilities in the costs attributed to particular patients will reflect variance in cost accounting methods (Tompkins, Altman, and Eilat 2006). To adjust for this factor, the calculation of standard errors for the multivariate regression analyses was modified to cluster for within-hospital correlation of costs, payments, and margins across patients (Greene 2008). There is no reason to believe that the variance across hospitals in accounting methods is systematically correlated with the severity of any individual patient's condition or the structure of the local hospital market.

Payments obtained by the hospitals were measured in terms of the amount collected from the third party payer (Medicare or private insurer) for each patient, after taking into consideration all contractual discounts, plus revenues collected from the patient through coinsurance and copayments. Collected revenues per patient are more valid indicators of true prices than are the hospital's billed charges, which typically never are collected in full (Lagnado 2004). In the multivariate statistical analyses, costs and payments were measured on a logarithmic scale to focus on the percentage (rather than dollar) differences in costs and payments. As a check, regressions also were conducted using the nontransformed dollar level of costs and payments per case. The profitability to the hospital of each patient was measured in terms of the dollar difference between the insurer's payment and the hospital's costs for treating that patient. This "contribution margin" measures the profitability of

each particular patient exclusive of indirect hospital costs such as administrative overhead, depreciation of capital investments, and the charity care provided to uninsured patients.

The data file included information on each patient's MS-DRG, age, length of stay in the facility, and discharge destination. Cardiac valve replacement patients fall into any of six MS-DRGs (216–221) depending on whether they receive cardiac catheterization in addition to valve replacement and whether they present with a major complication or comorbidity, minor complication or comorbidity, or none. We also measured the number of comorbidities for each patient. Age was measured in years. Length of stay was measured in terms of the number of days between admission and discharge. Discharge destination was measured in terms of whether the patient was discharged to home or to another setting, with the latter including skilled nursing facility, rehabilitation facility, or other hospital.

The market for each hospital was identified as the Hospital Referral Region, developed by the Dartmouth Atlas based on patient flow data for Medicare patients (Wennberg, Cooper, and Birkmeyer 1999). The Dartmouth Atlas assigns every hospital in the United States to one of 306 markets. The 37 hospitals used in this study are distributed across 23 of those markets, spanning 7 states. To control for the effect of market size, we also measured the population of the metropolitan regions served by each hospital.

The extent of consolidation of the local hospital market was measured in terms of the Herfindahl–Hirschman Index (HHI), the standard measure used in economic analyses of market competition (U.S. Department of Justice and Federal Trade Commission 1997). The HHI is constructed by dividing the number of staffed beds for each facility by the total number of beds within the market to obtain each hospital's share. The share of each hospital organization is squared and the shares of all hospitals are summed to create an index that potentially ranges from zero (large number of competitors, each with a negligible share) to 10,000 (one facility, with 100 percent market share). In this study, all hospitals owned by the same hospital chain in the same market were treated as part of the same organization in calculating market shares and the HHI. For ease of interpretation, the index was scaled so it ranges from a potential low of zero to a potential high of 100. In order to check for nonlinearities in the relationship between market structure and costs, we also divided the continuous HHI variable into a set of four dichotomous dummy variables representing the quartiles of the HHI distribution, and substituted this set of dichotomous variables for the continuous variable in the regression analyses. Also for ease of interpretation, number of staffed beds and number of

cardiac valve replacement procedures per year were measured in hundreds, while metropolitan area population and annual hospital staff earnings were measured in thousands.

To examine whether hospital costs, payments, and contribution margins differed between Medicare and privately insured patients, means were calculated for each enrollee group separately as well for the entire study sample. Multivariate regression analyses of hospital costs, payments, and contribution margins were conducted as a function of payer (Medicare, private insurance), hospital procedure volume (number of valve replacements performed in each hospital during 2008), other hospital characteristics (number of staffed beds, average staff salary), market structure (HHI, population size), and patient characteristics (MS-DRG category, number of comorbidities, age, length of stay, discharge destination).

## RESULTS

The 37 hospitals providing data for this study treated 1,858 patients for cardiac valve replacement surgery in 2008. They ranged considerably in size, from a minimum of 72 beds and 4 cardiac valve replacement surgeries to a maximum of 707 beds and 286 valve replacements, with a mean of 330 beds and 67 procedures. As indicated in Table 1, cardiac valve replacement surgery is a very expensive procedure, with costs per case averaging U.S.\$43,733 across hospitals, with a range from U.S.\$21,027 up to U.S.\$95,480. The average payment per case across hospitals was U.S.\$62,040 and the average contribution margin was U.S.\$18,308. The profitability of cardiac valve replacement varied considerably, however, from a negative margin (loss) of U.S.\$14,395 in one facility up to a positive margin (gain) of U.S.\$47,616 in another.

Average cost per patient is U.S.\$45,608 for Medicare beneficiaries and U.S.\$35,840 for privately insured patients, reflecting the age and disease severity of the publicly insured individuals. Payments per case are much higher for privately insured (U.S.\$82,966) than for Medicare (U.S.\$55,102) patients, however. Contribution margins therefore are much higher from privately insured (U.S.\$47,126) than for Medicare (U.S.\$9,495) patients. Of note is the large variance in contribution margins across hospitals for both Medicare and privately insured patients. The average hospital margin for Medicare patients ranges from a loss of U.S.\$20,010 to a gain of U.S.\$47,103 and ranges from a loss of U.S.\$1,754 to a gain of U.S.\$132,480 for privately insured patients. The standard deviation (SD) of the contribution margin is even higher when

Table 1: Characteristics of 37 Hospitals Providing Cardiac Valve Replacement Surgery in 2008

Variables	Standard			
	Mean	Deviation	Minimum	Maximum
Cost per case (all patients)	43,733	14,794	21,027	95,480
Medicare patients	45,608	15,784	21,947	95,480
Private insurance patients	35,840	9,126	19,263	52,658
Payment per case (all patients)	62,040	16,908	33,281	112,816
Medicare patients	55,102	16,103	28,632	112,816
Private insurance patients	82,966	36,837	27,052	172,087
Contribution margin (all patients)	18,308	15,000	-14,395	47,616
Medicare patients	9,495	13,364	-20,010	47,103
Private insurance patients	47,126	35,355	-1,754	132,480
Medicare (%)	72.0	14.3	47.9	100
Market concentration (HHI)	18.3	17.0	3.9	87.4
Market population (1,000)	4,625	5,351	112	12,873
Staffed beds (#)	330	165	72	707
Procedures per year	67	68	4	286
Hospital staff salary (U.S.\$1,000)	U.S.\$54.8	U.S.\$12.1	U.S.\$32.1	U.S.\$87.3
Patient age (year)	70.0	4.6	60.3	82.3
Length of stay (days)	11.9	7.4	8.1	53.0
Patient discharge to home (%)	35.7	27.8	0	100
Average number of comorbidities	1.7	0.9	0.3	4.8
MS-DRG 216 (%)	20.3	14.5	0	66.7
Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/MCC				
MS-DRG 217 (%)	13.3	9.6	0	33.3
Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/CC				
MS-DRG 218 (%)	5	9.2	0	50
Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/out CC/MCC				
MS-DRG 219 (%)	21.5	11.0	0	50
Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/MCC				
MS-DRG 220 (%)	27	16.4	0	64.3
Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/CC				
MS-DRG 221 (%)	12.6	10.3	0	50
Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/out CC/MCC				

*Note.* Card Cath, cardiac catheterization; CC, comorbidity/complication; MCC, major comorbidity/complication.

comparing across patients rather than across hospitals (where within-hospital variance is reduced to the mean), with the SD of the contribution margin for Medicare beneficiaries being U.S.\$20,309 and U.S.\$51,832 for privately insured patients (Table 2).

Table 2 presents patient-level data and hence exhibits greater variation in costs, payments, and margins than do the hospital-level data in Table 1.



Table 2: Characteristics of Patients Receiving Cardiac Valve Replacement Surgery in 2008

<i>Variables</i>	<i>All Patients (N = 1,858)</i>	<i>Medicare (N = 1,260)</i>	<i>Private Insurance (N = 598)</i>
Cost per case	U.S.\$38,667 (21,129)	U.S.\$41,248 (22,149)	U.S.\$33,230 (17,620)
Payment per case	U.S.\$60,636 (41,176)	U.S.\$52,431 (24,163)	U.S.\$77,924 (60,009)
Contribution margin	U.S.\$21,967 (37,263)	U.S.\$11,183 (20,309)	U.S.\$44,695 (51,832)
Market concentration (HHI)	17.4 (13.4)	18.1 (13.8)	15.8 (12.1)
Market population (1,000)	4,610 (5,278)	4,378 (5,219)	5,099 (5,373)
Staffed beds (#)	439 (185)	433 (187)	452 (180)
Procedures per year (100)	1.3 (0.88)	1.3 (0.88)	1.4 (0.86)
Hospital staff salary (U.S.\$1,000)	U.S.\$54.6 (11.7)	U.S.\$55.3 (12.0)	U.S.\$52.9 (10.7)
Patient age (year)	68.7 (13.2)	74.4 (8.8)	56.6 (12.7)
Length of stay (days)	10.0 (7.1)	10.8 (7.5)	8.2 (5.9)
Patient discharge to home (%)	39.2 (48.8)	32.5 (46.9)	53.2 (49.9)
Average number of comorbidities	1.73 (1.77)	1.88 (1.81)	1.43 (1.65)
MS-DRG 216 (%)	15.7 (36.4)	17.0 (37.6)	13.0 (33.7)
Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/MCC			
MS-DRG 217 (%)	14.5 (35.2)	15.6 (36.3)	12.4 (33.0)
Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/CC			
MS-DRG 218 (%)	4.3 (20.2)	3.9 (19.3)	5.0 (21.8)
Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/out CC/MCC			
MS-DRG 219 (%)	20.1 (40.1)	21.7 (41.3)	16.6 (37.2)
Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/MCC			
MS-DRG 220 (%)	33.1 (47.1)	32.5 (46.8)	34.4 (47.6)

*continued*

Table 2. *Continued*

<i>Variables</i>	<i>All Patients (N = 1,858)</i>	<i>Medicare (N = 1,260)</i>	<i>Private Insurance (N = 598)</i>
Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/CC			
MS-DRG 221 (%)	12.3	9.4	18.6
Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/out CC/MCC	(32.9)	(29.1)	(38.9)

*Note.* Standard deviations in parentheses below means.

Card Cath, cardiac catheterization; CC, comorbidity/complication; MCC, major comorbidity/complication.

The patient-level and hospital-level means are similar, differing only to the extent the number of valve replacement surgery patients differs among participating hospitals. The data in Table 2 highlight hospital pricing leverage for private insurers, compared with their lack of leverage with Medicare, because the average cost per case is higher for Medicare patients (U.S.\$41,248) than for the privately insured (U.S.\$33,230), but the average reimbursement is lower (U.S.\$52,431 versus U.S.\$77,924). These hospitals earned a positive contribution margin from Medicare (U.S.\$11,183), but it is substantially lower than the margin earned from private insurers (U.S.\$44,695). These differences are significant at the  $p < .01$  level.

As indicated in the subsequent rows in Table 2, Medicare beneficiaries undergoing valve replacement surgery are more likely to present with major complications and to have cardiac catheterization in addition to their valve procedure (17 percent versus 13 percent in MS-DRG 216). They have an average length of stay of 10.8 days compared with 8.2 days for the privately insured and are less likely to be discharged to home as compared with another health care facility (33 percent versus 53 percent). There are only minor differences in the hospitals most commonly used by Medicare and privately insured patients, as measured in terms of staffed beds, procedure volume, and market structure (HHI).

Table 3 presents the results of multivariate regression analyses of the costs and payments for cardiac valve replacement surgery, after adjusting for the patient and hospital characteristics described in Tables 1 and 2. Column 1 presents cost regression results measured on the logarithmic scale. After adjusting for age, cardiac catheterization, complications, comorbidities, and other relevant factors, Medicare patients incur costs per case 2.4 percent

Table 3: Multivariate Statistical Analysis of Costs and Payments for Patients Undergoing Cardiac Valve Replacement Surgery in 2008

<i>Variables</i>	<i>Log Cost</i>	<i>Log Payment</i>	<i>Log Payment (Medicare)</i>	<i>Log Payment (Private Insurance)</i>
Medicare beneficiary	0.0242 (0.0204)	-0.332*** (0.0990)		
Market concentration (HHI)	0.00600** (0.00273)	0.00283 (0.00309)	0.00272 (0.00311)	0.00342 (0.00516)
Market population (1,000)	1.44e-05** (5.94e-06)	1.41e-05* (6.98e-06)	2.15e-05*** (6.12e-06)	-3.29e-06 (1.51e-05)
Staffed beds (100)	-0.0471 (0.0321)	-0.00567 (0.0321)	0.0129 (0.0335)	-0.0605 (0.0724)
Procedures per year (100)	0.0354 (0.0514)	0.0334 (0.0631)	0.0356 (0.0684)	0.0187 (0.128)
Hospital staff salary (U.S.\$1000)	0.0129*** (0.00358)	0.00779** (0.00298)	0.00785** (0.00310)	0.00884 (0.00738)
Patient age	-1.59E-05 (0.000751)	-0.00341** (0.00152)	-0.00168 (0.00132)	-0.00685* (0.00342)
Length of stay	0.0388*** (0.00311)	0.0264*** (0.00222)	0.0242*** (0.00227)	0.0343*** (0.00895)
Patient discharge to home	-0.0919** (0.0427)	-0.0416 (0.0534)	0.00303 (0.0511)	-0.127 (0.1000)
Number of comorbidities	0.00540 (0.00981)	-0.00423 (0.0124)	0.00790 (0.00866)	-0.0320 (0.0305)
MS-DRG 217 Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/CC	-0.0207 (0.0266)	-0.0597 (0.0550)	-0.0233 (0.0572)	-0.142 (0.102)
MS-DRG 218 Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/out CC/MCC	-0.106** (0.0432)	-0.0743 (0.0479)	0.0270 (0.0512)	-0.290*** (0.0972)
MS-DRG 219 Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/MCC	0.0184 (0.0296)	-0.101* (0.0599)	-0.118* (0.0616)	-0.0824 (0.151)
MS-DRG 220 Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/CC	-0.0961** (0.0389)	-0.185*** (0.0490)	-0.157*** (0.0507)	-0.253** (0.111)
MS-DRG 221 Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/out CC/MCC	-0.209*** (0.0402)	-0.361*** (0.0830)	-0.297** (0.134)	-0.464*** (0.141)
Constant	9.412*** (0.207)	10.64*** (0.297)	10.03*** (0.263)	11.21*** (0.719)
$R^2$	0.634	0.208	0.196	0.217

Note. Robust standard errors in parentheses.

\*\*\* $p < 0.01$ ,

\*\* $p < 0.05$ ,

\* $p < 0.1$ .

Card Cath, cardiac catheterization; CC, comorbidity/complication; MCC, major comorbidity/complication.

higher than do privately insured patients, but the difference is not statistically significant, suggesting that hospitals do not treat Medicare and privately insured patients differently except as indicated by their disease severity. Costs per case are higher for patients treated in hospitals in concentrated markets, as measured by the HHI. A 2 SD difference in HHI would be associated with a 16.1 percent difference in average costs per case. The positive association between market concentration and cost per case also was found in regressions run for Medicare and privately insured patients separately. When replacing the continuous HHI variable with a set of dichotomous dummy variables representing quartiles on the HHI distribution, the positive association between concentration and cost was found to be due primarily to a particularly strong positive association in the most concentrated quartile of local markets.

As expected, cost per patient are higher for those with cardiac catheterization as well as valve replacement, those with major complications, and those with longer length of stay. Higher hospital input costs, measured in terms of average staff salary, are reflected in higher average costs per case. There is no association between hospital scale, measured either as staffed beds or annual number of patients undergoing valve replacement surgery, and the average cost per case.

The second column of Table 3 presents multivariate regression analyses of payments per case. The average level of payment is 33.2 percent lower for Medicare patients than for privately insured patients. When payments are analyzed for Medicare and privately insured patients separately, presented in the third and fourth columns of the Table, there are no major differences in the pattern of association between payments and patient, hospital, and market characteristics. The prices charged to privately insured patients are higher in more concentrated markets, as measured by the HHI, but not significantly so. The association between payment and length of stay is stronger for privately insured than for Medicare patients, reflecting the fact that many private insurers continue to pay hospitals on a per-day rather than per-admission basis. The positive association between length of stay and payment for Medicare reflects the role of stop-loss payments for especially sick patients who stay extra days in the facility.

The cost and payment regression specifications account for quite different percentages of the total variation across patients ( $R^2$ ). The cost regressions fit the data well for a cross-sectional analysis, accounting for 63.4 percent of variance for the full sample and similar fractions for the Medicare and privately insured samples. Goodness of fit was similar between the log cost and dollar cost versions of the regressions. For payments per case, however, goodness of fit is weaker, with the log payments regression specification in

Table 3 accounting for 22 percent of variance for privately insured patients and 20 percent for Medicare beneficiaries. ( $R^2$  statistics are higher when payments are measured in dollars rather than log dollars, but the pattern and statistical significance of the individual regression parameters are quite similar.) The relatively low percent of variance in payments that is explained by DRG category, length of stay, input costs (staff salary levels), and other measured variables highlights the important role for outlier payments (which cannot be predicted by DRG, length of stay, and other observed characteristics) for hospital revenues and hence for contribution margins.

Table 4 presents multivariate regression parameters for the contribution margin earned from each patient by the hospital in which he or she is treated. The combination of slightly higher costs and substantially lower payments, presented in Table 3, implies that Medicare patients are much less attractive financially to hospitals than are privately insured patients. The contribution margin per case is lower for Medicare compared with privately insured patients by U.S.\$30,986 (95 percent CI 18,716–43,256). Contribution margins are lower in more concentrated local markets, significantly so for Medicare patients (column 3). A 2 SD in HHI is associated with a lower contribution margin for Medicare patients of U.S.\$4,910 (95 percent CI 4,719–5,101). Medicare contribution margins also are significantly lower for patients with long lengths of stay, consistent with the per-admission prospective payment formula. In contrast, contribution margins for privately insured patients increase significantly with longer length of stay, consistent with the per diem payment methods often used by private plans. The extra days added on to the admission usually are composed of relatively low cost recovery and rehabilitation services, whereas the first days after admission often include high-cost tests and procedures (including the valve replacement procedure itself).

Patients with major complications and those undergoing cardiac catheterization incur higher costs when undergoing valve replacement surgery than do healthier patients, as would be expected (Table 3). Compared with the reference category of the most severely ill patients (those undergoing cardiac catheterization as well as presenting with major complications), patients with complications but no catheterization procedure incur 9.6 percent lower costs while those with neither complications nor catheterization incur 20.9 percent lower costs ( $p < .01$ ). The difference in payments exceeds the difference in costs for the sickest patients, as these characteristics allow hospitals to assign patients to higher-paying MS-DRG payment categories. For example, compared with the sickest patients undergoing catheterization and presenting with major complications, those with neither catheterization nor complications bring in

Table 4: Hospital Contribution Margin for Patients Undergoing Cardiac Valve Replacement Surgery in 2008

<i>Variables</i>	<i>All Patients (N= 1,858)</i>	<i>Medicare (N= 1,260)</i>	<i>Private Insurance (N= 598)</i>
Medicare beneficiary	- 30,986*** (6,260)		
Market concentration (HHI)	- 173.5 (147.9)	- 183.2* (97.57)	- 131.8 (428.9)
Market population (1,000)	0.00571 (0.415)	0.451* (0.257)	- 1.170 (1.113)
Staffed beds (100)	544.5 (2,159)	2,089* (1,146)	- 4,418 (5,309)
Procedures per year (100)	- 773.6 (4,455)	- 1,022 (2,266)	- 827.5 (9,781)
Hospital staff salary (U.S.\$1,000)	43.45 (204.7)	- 68.47 (142.9)	477.8 (522.4)
Patient age	- 210.9* (121.1)	- 80.40 (61.03)	- 507.8** (246.0)
Length of stay	141.7 (228.3)	- 359.4** (149.8)	2,097* (1,036)
Patient discharge to home	- 1,000 (3,726)	2,219 (2,660)	- 4,156 (6,892)
Number of comorbidities	- 249.2 (963.6)	- 72.25 (538.7)	- 377.4 (2,776)
MS-DRG 217 Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/CC	- 4,185 (2,876)	- 2,394 (2,736)	- 6,653 (8,564)
MS-DRG 218 Cardiac valve and other major cardiothoracic procedure w/Card Cath, w/out CC/MCC	- 1,408 (3,827)	1,596 (2,615)	- 6,957 (10,498)
MS-DRG 219 Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/MCC	- 2,821 (4,765)	- 5,109* (2,732)	697.1 (13,984)
MS-DRG 220 Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/CC	- 7,608** (3,295)	- 6,461** (2,528)	- 9,574 (10,172)
MS-DRG 221 Cardiac valve and other major cardiothoracic procedure w/out Card Cath, w/out CC/MCC	- 12,759*** (4,496)	- 4,745 (3,253)	- 18,848 (13,233)
Constant	61,464*** (16,028)	21,839** (8,291)	70,702 (43,204)
$R^2$	0.197	0.099	0.149

Note. Robust standard errors in parentheses.

\*\*\* $p < 0.01$ ,

\*\* $p < 0.05$ ,

\* $p < 0.1$ .

Card Cath, cardiac catheterization; CC, comorbidity/complication; MCC, major comorbidity/complication.

29.7 percent lower reimbursement from Medicare and 46.4 percent lower reimbursement from private insurers (Table 3). The substantially greater variance in payments than in costs implies that the sicker patients are the most profitable to the hospitals. For example, compared with patient (MS-DRG 216, the reference category), those with neither catheterization nor complications (MS-DRG 221) offer a contribution margin U.S.\$21,839 higher for Medicare beneficiaries and U.S.\$70,204 higher for privately insured patients.

## DISCUSSION

This study found substantial differences in the costs, payments, and contribution margins for patients undergoing cardiac valve replacement surgery, depending on type of insurance coverage. After adjusting for patient age, cardiac catheterization, complications, comorbidities, and other factors, Medicare patients are slightly sicker than their privately insured counterparts, but their care is reimbursed at a much lower level, with Medicare payments falling 33.2 percent below those for privately insured patients. These differences in costs and reimbursements result in a contribution margin for privately insured patients U.S.\$30,986 above those for Medicare patients, after adjusting for patient and hospital characteristics. However, the Medicare margin is positive for most of the patients for this procedure, inconsistent with one common interpretation of the concept of “cost shifting.” Specifically, the average contribution margin for Medicare is negative for six hospitals (out of 37) and the patient-specific margin is negative for 291 patients (out of 1,260). The average margin for privately insured patients is negative for one hospital and the patient-specific margin is negative for 57 patients (out of 598). While Medicare payments and margins fall substantially below those obtained by hospitals from private insurers, it therefore is not the case that Medicare payment rates fall below the direct costs of care for its beneficiaries. Rather, hospitals are able to cover a larger relative fraction of their overhead and indirect costs from private insurer payments than from Medicare.

We find hospital costs per case for valve replacement to be significantly higher in concentrated than in competitive markets, consistent with the MedPAC theory that market concentration permits higher pricing to private insurers, in turn leading to higher revenues and a relaxation by the hospital of its cost control efforts. However, payments per case received from private insurers, while higher in concentrated than in competitive markets, are not significantly so. It may be that hospitals are able to obtain higher prices and

revenues in concentrated markets for many services but choose not to exert their full leverage for very specialized procedures such as cardiac valve replacement. The geographic scope of the market for highly specialized services such as valve replacement may be broader than that for most other services, in which case the calculation of the scope of the market by the Dartmouth Atlas using claims data for all Medicare admissions may not accurately reflect the structure of the market for this one procedure. We also find no association between the size of the hospital, measured either by number of staffed beds or by annual number of valve replacement procedures, and the prices charged to private insurers. For this procedure, scale does not seem to be a proxy for “must-have” status on the part of the hospital.

The implications of this study must be evaluated in the light of its limitations. These data are drawn from one major procedure and 37 hospitals. Cardiac valve replacement surgery is not representative of the universe of hospital procedures and these hospitals are not fully representative of the universe of hospitals. Compared with the 995 U.S. hospitals that offer cardiac surgery, the study hospitals are slightly smaller (325 versus 370 beds) and they are more likely to be located in the western and southeastern regions. It also is important to recognize the difference between contribution margin as measured here and overall profitability of a service to a hospital. The contribution margin does not take into account indirect and overhead expenditures such as administration, capital investments, and charity care for the uninsured. Hospitals must earn positive contribution margins on insured patients in order to finance these indirect and overhead services.

Differences between Medicare and private insurers in hospital payments and contribution margins can be interpreted in either of two ways. Some hospitals and private health insurers view payment differences as a “cost shift” from Medicare to private insurers, arguing that low payments relative to costs from Medicare force hospitals to raise prices to private insurers. These then raise the premiums they charge to employers and individual enrollees, discouraging insurance purchasing and further aggravating the problem of patients without coverage (Koster 2010). In this view, the sustainability of the employment-based insurance system requires that Medicare raise its payments to hospitals and fully cover the costs of care for its beneficiaries.

A different interpretation of low Medicare payments and margins has been offered by the staff of the Medicare Payment Advisory Commission (Stensland, Gaumer, and Miller 2010). In this view, mergers among hospitals and the consolidation of local hospital markets has permitted hospitals to increase prices to private insurers (Town and Vogt 2006; Melnick and Keeler 2007).



Higher payments and revenues from private insurers reduce the pressure on hospitals to control costs, permitting them to engage in cost-increasing expansions of facilities, staffing, and clinical technologies. These higher costs then are reflected in low or negative Medicare margins, because Medicare reimburses hospitals according to the MS-DRG formula rather than based on the hospitals' bargaining power (Centers for Medicare and Medicaid Services, Acute Inpatient PPS: Steps in determining a PPS Payment 2010). In this view, the solution to the differential margins between Medicare and private insurers is for the private insurers to pay less, rather than for Medicare to pay more.

The consolidation of local hospital markets is continuing and may accelerate to the extent the 2010 PPACA encourages hospitals and physicians in each community to develop integrated "accountable care organizations" (H.R. 3590-111th Congress: The Patient Protection and Affordable Care Act 2010). It is increasingly difficult for private insurers to say no to hospital demands for payment increases for valve replacement surgery and other procedures. To the extent Medicare slows the annual updates on its hospital payments relative to hospital costs, as proposed in the PPACA, the differences for hospitals between Medicare and private insurance payments and margins may grow. Hospitals may compete ever more vigorously for profitable privately insured patients through the acquisition of new clinical technologies, facilities, and amenities of interest to physicians and patients.

Medicare and private insurers act independently in their efforts to moderate costs for their enrollees, but each one's efforts impact the success of the other's through the hospital financing ecosystem. Payment restrictions by Medicare, which holds a substantially stronger bargaining position than do the private insurers, may induce an offsetting increase in prices charged to and payments received from private insurers, and thereby exert little or no effect on underlying hospital costs. However, to the extent hospitals cannot offset Medicare payment restrictions through increased payments from private insurers, they will be forced to address underlying costs.

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