Hospital Price Markup and Outcomes of Major Elective Operations

Sara Sakowitz, MD, MPH, MBA; Syed Shahyan Bakhtiyar, MD, MBE; Yas Sanaiha, MD; Amulya Vadlakonda, MD; Troy Coaston, BS; Peyman Benharash, MD

➕ **Invited Commentary**

➕ **Supplemental content**

IMPORTANCE Hospital prices are currently not subject to regulation, yet have profound financial implications for patients, taxpayers, and governments. While significant for the contemporary era of value-based care, US national variation in hospital price markup has not been delineated.

OBJECTIVE To characterize national variation in the hospital price markup for major elective operations and to assess the association of markup with perioperative outcomes and overall quality of care.

DESIGN, SETTING, AND PARTICIPANTS This national cross-sectional study evaluated institutional markup ratios (MRs) across 1960 US hospitals performing 4 major elective operations (abdominal aortic aneurysm repair, colectomy, coronary artery bypass grafting, and hip replacement) among patients aged 18 years and older within the 2022 Nationwide Readmissions Database. MR was defined as the ratio of charges to costs. Centers with MRs in the top decile were considered high-markup hospitals (HMH), with others categorized as non-HMH. Data were analyzed from September 2024 to March 2025.

MAIN OUTCOME AND MEASURE The primary outcome was institutional MR, with secondary consideration of perioperative outcomes.

RESULTS Of 1960 unique institutions, 194 were HMH. The median (IQR) hospital price markup factor was 3.0 (1.9-4.4). Considering only HMH, the median (IQR) MR was 8.5 (7.1-10.8); the top 50 most expensive hospitals marked up the true costs of care by a median factor of 13. On average, HMH were more commonly investor-owned, for-profit hospitals located in metropolitan areas. Of 362 367 patients, 42 620 (11.8%) were treated at HMH. Overall mean (SD) patient age was 65.1 (12.7) years, and 174 067 patients (48.0%) were female. Following risk adjustment, care at HMH was associated with significantly greater odds of major morbidity (adjusted odds ratio [AOR], 1.45; 95% CI, 1.14-1.84), including higher adjusted risk of cardiac, respiratory, infectious, and kidney sequelae. Moreover, treatment at HMH was associated with increased likelihood of nonelective readmission within 30 days (AOR, 1.33; 95% CI, 1.24-1.42).

CONCLUSIONS AND RELEVANCE This cross-sectional study found that considerable variation in price markup exists across hospitals and that HMHs demonstrated both lower quality and value of care. These findings underscore that HMHs represent a key initial target for national policy efforts targeting pricing regulation, transparency, and quality improvement.

Author Affiliations: Department of Surgery, University of California, Los Angeles (Sakowitz, Bakhtiyar, Sanaiha, Vadlakonda, Coaston, Benharash); Department of Surgery, Massachusetts General Hospital, Boston (Sakowitz); Division of Cardiothoracic Surgery, Department of Surgery, University of Utah, Salt Lake City (Bakhtiyar); Center for Advanced Surgical and Interventional Technology (CASIT), David Geffen School of Medicine at UCLA, Los Angeles, California (Sanaiha, Benharash).

Corresponding Author: Peyman Benharash, MD, Department of Surgery, University of California, Los Angeles, 10833 Le Conte Ave, Los Angeles, CA 90095 (pbenharash@mednet.ucla.edu).

S urgical care now comprises nearly 20% of annual health care expenditures in the US, accounting for one-fifth of the gross domestic product.[1] While myriad factors may contribute to such burgeoning health care expenses, hospital price markup—the difference between what hospitals experience in costs and what they bill—has been identified as a potential driver.[2,3] Select regulated markets and public payers aside, hospitals set pricing based on *chargemaster* rates, which upcharge true costs based on center-specific accounting systems, payer mix, and surrounding market competition.[4,5] Despite increasing emphasis on cost containment, however, financial operations of US hospitals are presently not subject to federal or state regulation.

Critically, higher prices for inpatient care can have significant downstream financial implications. Increased costs could subsequently be passed on, in the form of higher health premiums, to insurance beneficiaries.[6,7] This trend has only accelerated since the adoption of regulated medical loss ratios for insurance providers through the Affordable Care Act.[8] Furthermore, the most vulnerable uninsured or underinsured patients may be subject to the full scope of hospital charges and could face subsequent threat of personal bankruptcy or financial toxicity.[4,9-11] Meanwhile, an arms race in hospital charges contributes to overall medical price inflation, without a clear end point in sight. Paradoxically, the US persistently demonstrates worse health outcomes despite 2-fold higher health care costs compared to its counterparts.[12-14]

In the current era of value-based health care delivery, both costs and quality have garnered increasing attention. However, few have examined contemporary practices in hospital price markup.[15] Prior studies have limited their scope to Medicare beneficiaries, focused on single centers and regions, or used older datasets, which may not reflect hospital billing practices in the post–Affordable Care Act era or the COVID-19 disease pandemic period.[16-21] A comprehensive understanding of the modern landscape of hospital price markup could guide interventions aimed at improving transparency and regulating expenditures.

In the present work, we evaluated national variation in hospital billing practices across the US. We secondarily aimed to determine whether hospital markup was associated with quality of care. We hypothesized the presence of significant variation in hospital markup across the US, with an inverse association between markup rates and risk-adjusted hospital quality.

Methods

Data Source and Study Cohort

We identified all elective adult (≥18 years) hospitalizations for abdominal aortic aneurysm repair, colectomy, isolated coronary artery bypass grafting, and hip replacement within the 2022 Nationwide Readmissions Database (NRD) using previously validated *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision (ICD-10)* codes.[22] These operations were selected to capture a broad range of patients and operations, having previously been used
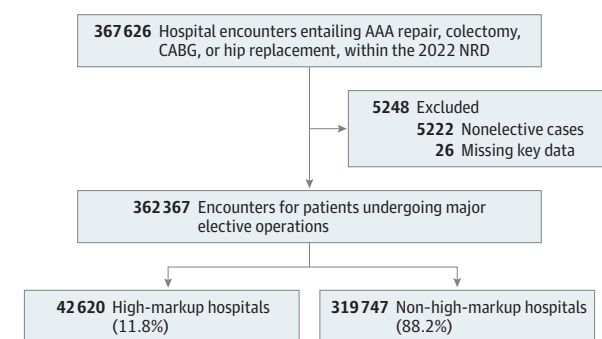
Key Points

Question How much do US hospitals mark up the cost of inpatient surgical treatment, and what is the association with resulting quality of care?

Findings In this national cross-sectional study of 1960 hospitals across the US, approximately 10% marked up the true cost of care by a median of 8.5-fold. Surgical care at such high-markup centers was associated with significantly greater adjusted risk of morbidity and readmissions.

Meaning High-markup hospitals are associated with significantly inferior quality and value of care and represent an important initial target for national policy aimed at promoting transparency and regulating hospital pricing.

Figure 1. Study CONSORT Diagram

In total, we identified approximately 367 626 records entailing elective admission for isolated coronary artery bypass grafting (CABG), colectomy, abdominal aortic aneurysm (AAA) repair, or hip replacement within the 2022 Nationwide Readmissions Database (NRD). Of these, 362 367 records met study inclusion criteria. Patients were stratified by care at high-markup hospitals or non–high-markup hospitals.

in assessments of hospital quality.[23,24] As the largest national readmissions repository, the NRD uses survey weighting methodology to accurately estimate approximately 60% of all hospitalizations in the US. Unique linkage numbers are used to track readmissions across NRD-participating hospitals within each calendar year. Records missing key data, including age, sex, or in-hospital mortality, were excluded from analysis (<1%) (**Figure 1**). This study followed Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.

Hospital Markup Ratio

Hospital-level variables were defined according to the NRD and included hospital teaching status, bed size, and ownership, comprising government, private nonprofit, and private investor–owned centers.[25] For each institution, we then computed the hospital markup ratio (MR). Briefly, hospitals are required to submit all-payer cost reports to Medicare each year describing hospital payer mix, charges, revenues, and expenses. The Healthcare Cost Report Information System for Medicare uses these data to compute specific cost to charge ratios for each institution.[26] These charges represent

the total amount billed by the hospital for inpatient care episodes, comprising anesthesia, operating room, and other relevant fees associated with patients' postoperative courses. Physician professional fees and noncovered charges are not included.

We obtained these cost to charge ratios in the NRD and subsequently computed an MR, defined as: MR = 1/(cost to charge ratio). In short, the MR represents the ratio of what a hospital billed for a care episode to the actual costs they incurred.[2] We further considered centers in the top decile of MR to represent high-markup hospitals (HMH). Patients were subsequently stratified by receipt of care at HMH vs non-HMH (**Figure 2**).

Variable Definitions and Study End Points

Patient and procedural factors were tabulated using the Healthcare Cost and Utilization Project data dictionary.[25] Burden of chronic disease was quantified using the van Walraven modification of the Elixhauser Comorbidity Index.[27] Previously published *ICD-10* codes were used to ascertain comorbidities and complications, as described elsewhere.[28] Nonhome discharge was defined to include discharge to acute care hospitals, intermediate care centers, or skilled nursing facilities.

We primarily sought to characterize hospital-level MR. We secondarily assessed the incidence of mortality, perioperative complications (cardiac, respiratory, infectious, kidney, thromboembolic, stroke, and infectious), nonhome discharge, and nonelective rehospitalization within 30 days of discharge.
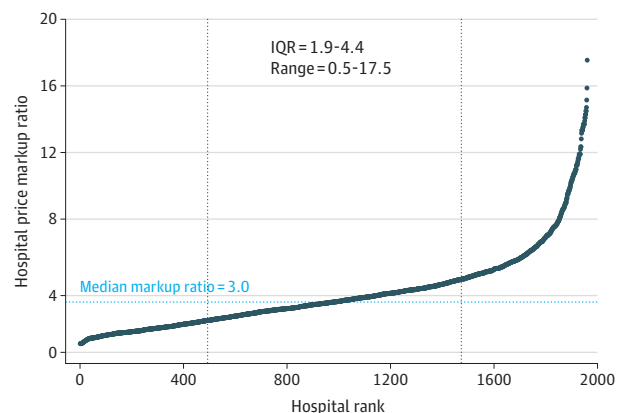
Statistical Analysis

Continuous data are reported as means with standard deviation, while categorical variables are described as group proportions. We developed hierarchical, multilevel multivariable models to examine the association of care at HMH with key end points while accounting for patient clustering across institutions.[29] For such models, the first level represented patient effects, while the second level accounted for hospital factors. Model covariates were automatically selected for inclusion using elastic net regularization, which applies a penalized, least-squares methodology to optimize model fit.[30] Variables included for risk adjustment included patient age, sex, Elixhauser Comorbidity Index, operation type, median household income, primary insurance coverage, year of hospitalization, and hospital teaching status.

Receiver operator characteristics and coefficient of determination were assessed to evaluate model performance for logistic and linear models, respectively. Model estimates are reported as adjusted odds ratios (AORs) or β coefficients, as appropriate.

Following our main analysis, we conducted 2 distinct sensitivity analyses. In the first, we separately considered the independent association of HMH status among patients treated at for-profit vs nonprofit centers. Second, we considered only patients treated at HMH and evaluated the association of for-profit hospital status with key study end points.

All statistical analyses were performed using Stata version 18.0 (StataCorp). Statistical significance was considered

Figure 2. Markup Ratio by Hospital

We identified significant variation in hospital markup ratios across the US. The median markup ratio was 3.0, with an interquartile range of 1.9-4.4. However, markup ratios ranged from 0.5-17.5.

at α = .05. Due to the deidentified nature of the NRD, this study was exempted from full review by the institutional review board at the University of California, Los Angeles. Data were analyzed from September 2024 to March 2025.
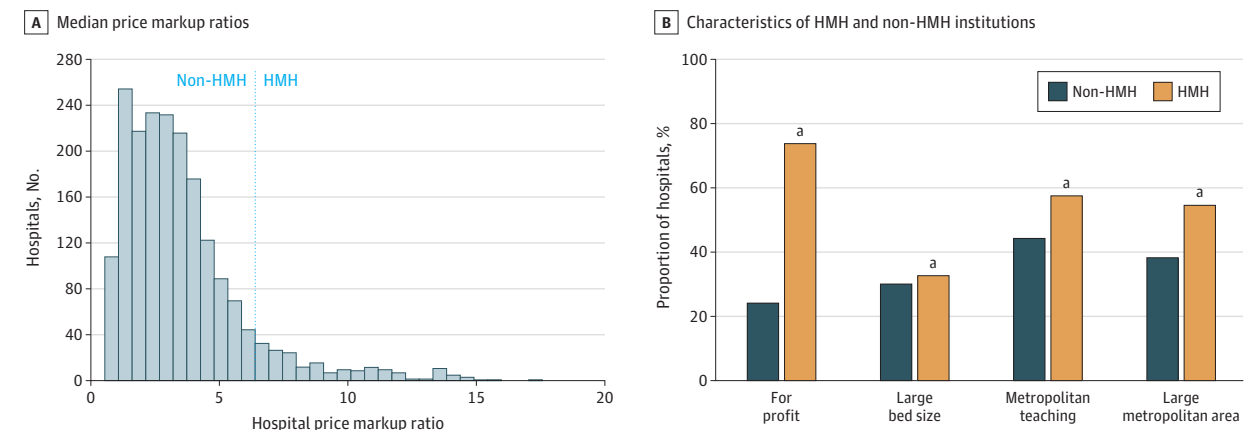
Results

Among 1960 unique institutions included for analysis, 194 were considered HMH. Across all centers, the median (IQR) hospital price MR was 3.0 (1.9-4.4), while among HMH, the median (IQR) MR was 8.5 (7.1-10.8) (**Figure 3**A).

Hospital and patient characteristics are comprehensively reported in the **Table**. On average, HMH were more frequently private, investor-owned facilities (73.7% vs 8.6%; *P* < .001) and larger bed size hospitals (33.0% vs 30.1%; *P* < .001) than non-HMH. HMH were also more commonly metropolitan teaching centers (57.7% vs 44.6%; *P* < .001) (Figure 3B).

Considering patient characteristics, patients receiving care at HMH were of clinically similar age, sex, and comorbidity burden relative to those receiving care at non-HMH. Overall mean (SD) patient age was 65.1 (12.7) years, and 174 067 patients (48.0%) were female. The HMH cohort more frequently underwent hip replacement (37.0% vs 31.0%) and less often colectomy (40.6% vs 46.1%; *P* = .02). Furthermore, patients treated at HMH were more commonly insured by Medicare compared to others (59.3% vs 55.4%; *P* = .009).

On bivariate comparison, mortality rates were comparable between groups (0.9% vs 0.7%; *P* = .04), but the HMH cohort faced greater incidence of perioperative complications (15.8% vs 13.3%; *P* < .001) (**Figure 4**A). Specifically, patients treated at HMH faced higher rates of cardiac (3.4% vs 2.8%; *P* = .02), respiratory (3.7% vs 2.5%; *P* < .001), infectious (1.8% vs 1.5%; *P* = .01), and kidney complications (9.1% vs 7.4%; *P* < .001). Interestingly, patients treated at HMH less commonly received a blood transfusion (4.2% vs 7.8%; *P* < .001). Considering resource use, the HMH cohort was more frequently discharged to nonhome facilities (11.7% vs 9.9%;

Figure 3. High-Markup Hospitals (HMH) and Non-HMH Markup Ratios and Characteristics

A, The median price markup ratio across centers was 3.0. Institutions in the top decile by markup ratio (markup ratio >6.37) were considered HMH, while all others were grouped as non-HMH. The vertical dotted line delineates the division between HMH and non-HMH. B, On average, HMH were more frequently for-profit institutions, large bed size hospitals, and teaching centers that were located in large metropolitan areas.

[a] P < .001.

$P < .001$) and experienced nonelective readmission within 30 days (7.8% vs 6.6%; $P < .001$).

Following comprehensive risk adjustment, care at HMH was associated with significantly greater odds of mortality (AOR, 1.45; 95% CI, 1.14-1.84; $P = .002$) and any major complication (AOR, 1.39; 95% CI, 1.28-1.50; $P < .001$). Specifically, treatment at HMH remained associated with higher likelihood of cardiac (AOR, 1.35; 95% CI, 1.17-1.55; $P < .001$), respiratory (AOR, 1.52; 95% CI, 1.31-1.77; $P < .001$), infectious (AOR, 1.37; 95% CI, 1.19-1.58; $P < .001$), and kidney sequelae (AOR, 1.53; 95% CI, 1.39-1.69; $P < .001$). Moreover, care at HMH was associated with higher likelihood of nonhome discharge (AOR, 1.18; 95% CI, 1.06-1.32; $P = .003$) and significantly greater odds of nonelective readmission within 30 days (AOR, 1.33; 95% CI, 1.24-1.42; $P < .001$) (Figure 4B).

We conducted a sensitivity analysis evaluating the impact of care at HMH, stratifying by for-profit and nonprofit status. Among patients treated at for-profit centers, HMH remained associated with significantly greater likelihood of in-hospital mortality (AOR, 1.82; 95% CI, 1.09-3.01; $P = .02$), morbidity (AOR, 1.38; 95% CI, 1.19-1.60; $P < .001$), and readmission (AOR, 1.16; 95% CI, 1.03-1.31; $P = .02$). Meanwhile, among those receiving care at nonprofit hospitals, HMH status was associated with comparable mortality (AOR, 0.97; 95% CI, 0.64-1.46; $P = .87$) but a near–statistically significant increase in the relative risk of complications (AOR, 1.13; 95% CI, 1.00-1.28; $P = .06$) and greater likelihood of readmission (AOR, 1.19; 95% CI, 1.07-1.31) compared to non-HMH (eFigure in Supplement 1).

We performed a second sensitivity analysis considering the independent association of for-profit status with outcomes among patients treated at HMH. Importantly, for-profit financial structure remained associated with significantly greater odds of in-hospital mortality (AOR, 1.82; 95% CI, 1.09-3.01; $P = .02$), any complication (AOR, 1.38; 95% CI, 1.19-1.60;

$P < .001$), and nonelective readmission (AOR, 1.16; 95% CI, 1.03-1.31; $P = .02$) relative to nonprofit centers.

Discussion

With inpatient operative expenditures exceeding $500 billion each year, efforts to regulate and curb excessive spending remain paramount. In this national study of major elective operations, we found significant variation in hospital cost markup across the US. While the median markup factor was 3, 10% of centers demonstrated a median 8-fold markup; of these, nearly 80 hospitals marked up their costs by more than 10-fold the estimated costs of care. High-markup centers were more often for-profit institutions located in large metropolitan regions. Finally, care at such institutions remained associated with significantly greater morbidity, with patients facing a more than 30% relative increase in the risk of postoperative complications. In the absence of standardized federal regulation of hospital pricing, our findings have significant implications toward national policy and practice.

Historically, hospital systems have argued that high markups are necessary to cover growing expenses in the face of thinning margins.[4,6] While many institutions face increasing financial pressures with growing numbers of underinsured patients, slow or even negative growth in Medicare and Medicaid reimbursement since passage of the Balanced Budget Act and then the Affordable Care Act has compounded the issue.[31,32] In response, hospitals were traditionally thought to dynamically shift costs to either privately insured or uninsured patients and mark up their billed charges to maximize extractable revenue.[33,34] Notably, one study found the delta between hospital charges and net revenue to average approximately 250%,[4] although more recent reports have questioned the extent of cost shifting in modern practice.[35,36] How-

Table. Demographic, Clinical, and Hospital Characteristics, Stratified by High-Markup Hospital (HMH) Status

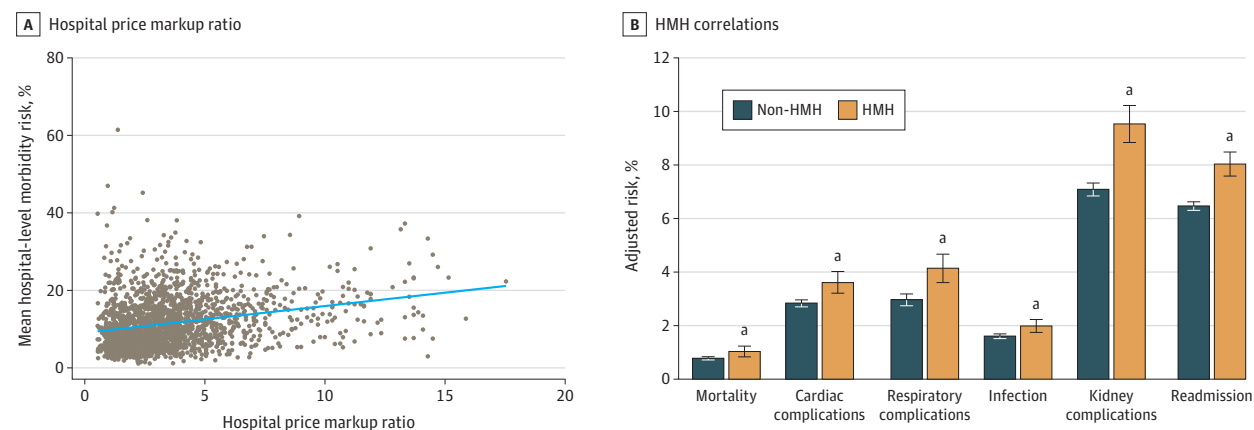| Characteristic	No. (%)[a]		P value[a]
	Non-HMH (n = 319 747)	HMH (n = 42 620)	
Patient characteristics			
Age, mean (SD), y	65.1 (12.7)	65.5 (12.8)	<.001
Sex			
Female	153 175 (47.9)	20 892 (49.0)	.14
Male	166 572 (52.1)	21 728 (51.0)	
Elixhauser Comorbidity Index, mean (SD)	2.8 (1.8)	2.7 (1.8)	<.001
Operation type			
Abdominal aortic aneurysm repair	1761 (0.6)	219 (0.5)	
Colectomy	147 427 (46.1)	17 296 (40.6)	.02
Coronary artery bypass grafting	71 400 (22.3)	9325 (21.9)	
Hip replacement	99 159 (31.0)	15 779 (37.0)	
Community income percentile			
>75th	79 698 (25.2)	8604 (20.4)	
51st-75th	80 793 (25.5)	10 340 (24.5)	.05
26th-50th	83 368 (26.3)	11 932 (28.3)	
0-25th	72 891 (23.0)	11 353 (26.9)	
Insurance coverage			
Private	107 287 (33.6)	13 001 (30.5)	
Medicare	176 919 (55.4)	25 256 (59.3)	.009
Medicaid	23 119 (7.2)	2800 (6.6)	
Other payer	12 045 (3.8)	1548 (3.6)	
Residence in a rural or urban area			
Central counties of metropolitan areas of ≥1 million population	61 131 (19.1)	11 888 (27.9)	
Fringe countries of metropolitan areas of ≥1 million population	91 335 (28.6)	11 739 (27.6)	
Counties in metropolitan areas of 250 000-999 999 population	70 875 (22.2)	10 399 (24.4)	.006
Counties in metropolitan areas of 50 000-249 999 population	34 076 (10.7)	3703 (8.7)	
Micropolitan counties	33 006 (10.3)	2756 (6.5)	
Not metropolitan or micropolitan	28 832 (9.0)	2095 (4.9)	
Hospital characteristics			
Hospitals	1766 (90.1)	194 (9.9)	NA
Hospital bed size			
Large	531 (30.1)	64 (33.0)	
Medium	468 (26.5)	81 (41.7)	<.001
Small	767 (43.4)	49 (25.3)	
Hospital ownership			
Government	306 (17.3)	<11 (NA)	
Private, nonprofit	1308 (74.1)	47 (24.2)	<.001
Private, investor owned	152 (8.6)	143 (73.7)	
Hospital teaching status			
Nonmetropolitan	538 (30.5)	11 (5.7)	
Metropolitan nonteaching	440 (24.9)	71 (36.6)	<.001
Metropolitan teaching	788 (44.6)	112 (57.7)	
Rural or urban designation			
Large metropolitan area (≥1 million residents)	678 (38.4)	106 (54.6)	
Small metropolitan area (<1 million residents)	550 (31.1)	77 (39.7)	<.001
Micropolitan area	299 (16.9)	<11 (NA)	
Nonurban residual	239 (13.5)	<11 (NA)	

Abbreviation: NA, not available.

[a] Reported as number with group proportion (%) unless otherwise noted. Statistical significance was set at α = .05.

ever, these challenges do not explain the significant variation in hospital markup, which we found to range from 0.5 to 17.5 across centers. In fact, we found hospitals in the top decile by cost to charge ratio to mark up their costs by a median of approximately 8 times. We did not observe a substantial difference in the proportion of Medicare patients between HMH and other centers, suggesting no apparent basis for variation in cost-shifting practices.

Efforts to regulate hospital markups have attracted media attention, lawsuits, and activism but ultimately have had limited effect.[11] Currently, only 2 states—Maryland and West Virginia—regulate hospital pricing.[5,37] As such, the large majority of centers have the flexibility to determine their own pricing policies, based on health system priorities, health care costs, diagnosis or operative volume, and case mix. Importantly, the Affordable Care Act limited what nonprofit hospitals could

Figure 4. Hospital Markup Ratios and Quality of Care

A, We identified a correlation between increasing hospital price markup ratios and institutional major morbidity rates ($r = 0.25$). B, Following comprehensive risk adjustment for patient, operative, and hospital factors, care at high-markup hospitals (HMH) remained associated with significantly greater risk of in-hospital mortality and cardiac, respiratory, infectious, and kidney complications, as well as nonelective readmission within 30 days of discharge.
[a] $P < .01$.

charge to uninsured or out-of-network patients, but such restrictions did not apply to for-profit institutions.[38] It is of particular interest, therefore, that approximately 74% of HMH were private and investor owned. In fact, when we examined for-profit hospitals specifically, we found a median markup of 6.3—more than double the national average. Perhaps unsurprisingly, prior literature has described hospital markup as a critical contributor to profitability, with each point increase in MR being associated with a $112 incremental increase in profits per discharge.[39] Whether to increase leverage from private payers or maximize their revenue from out-of-network or uninsured patients, these institutions appear to have excessively raised their MRs, and now benefit with more than $300 higher per-discharge profit.

In the contemporary era of health care corporatization and the incursion of private equity into surgical care, nearly all health systems face increasing pressure on their bottom line and are forced to intensify their focus on revenue generation.[40-42] Therefore, it is also important that our study documents higher median cost to charge ratios compared to prior reports.[5,19,20] In fact, while Bai and Anderson[2] found that 50 centers were charging more than 9-fold the true cost of care, we found nearly 100 hospitals demonstrated such MRs. Notably, the 50 most expensive hospitals in our study marked up expenses by a median factor of 13. Altogether, it appears that there is a considerable trend toward increasing hospital markups across the US that warrants both increased attention and regulation.

Ultimately, however, pricing is rarely discussed with patients in the preoperative phase. Moreover, given the inequitable burden low-income or uninsured patients would undoubtedly face from such discussions,[43] we argue that the incorporation of hospital fees into shared patient-clinician health care decision-making would not be appropriate. This is especially significant given the lack of transparency in hospital accounting practices, episodic costs of inpatient care, variation in coding and billing practices, and the potential for bundled

services.[39] In this fundamentally asymmetric information environment, patients and clinicians do not have the resources to make fully informed choices regarding hospital fees, and nor should they.[2,44] Instead, national policy-level changes are needed to correct this market and regulatory failure. Specific cost nuances aside, institutional performance and risks should be comprehensively discussed and hospital financial structure noted as part of physician referral and counseling. Given the growing influx of private equity investment into surgical care,[45] public reporting around MRs and correlations with performance may contribute to transparency in preoperative decision-making and serve as a stimulus for local efforts—in addition to federal policy—to improve care outcomes.

Indeed, national regulation is needed not only to reduce unnecessary cost burdens on the health system, but also because treatment at high-markup centers appears to be associated with unnecessarily high morbidity. Importantly, we found care at HMH to be associated with significantly greater likelihood of perioperative complications. This association remained true following comprehensive risk adjustment for patient, procedural, and institutional factors, including hospital teaching status, ownership, rural location, and bed size. It is plausible that factors intrinsic to high-markup centers, including in-house care pathways and processes, diagnostic algorithms, and nurse to patient ratios, may influence the risk of morbidity. Our findings, therefore, raise a fundamental issue for quality intervention: high-markup centers appear to yield not only lower quality of care, but also significantly lower value. As such, we call for evaluation of these institutions as a first step. Currently, the Centers for Medicare & Medicaid Services require hospitals to share pricing information and cost to charge ratios in Medicare cost reports.[46,47] Yet, low compliance, inconsistent data presentation, and inadequate enforcement have limited the effectiveness of the price transparency rule.[48-50] In an effort to enhance transparency for all parties, hospitals should ideally report both their cost to charge ratios and their chargemasters pub-

licly and consistently, in an easy-to-access format. Enforced public disclosure may encourage hospitals to reevaluate and potentially reign in MRs, but disclosure would also offer regulators the opportunity to more carefully assess care processes and outcomes at such centers.[51-53] Moreover, low participation in national registries, including Vizient and the American College of Surgeons National Surgical Quality Improvement Program,[54,55] may place for-profit centers at higher risk of poor performance due to a lack of benchmarking. Participation of such institutions in national repositories should be encouraged, as the reporting and ongoing evaluation of morbidity rates and costs will provide the foundation for efforts to improve care safety and quality. Finally, we underscore that any policy change cannot be 1-sided. Rather than target high MRs alone as an isolated symptom, regulation must also address diminishing margins and inadequate reimbursement from payers. Commercial insurers should be required to report their reimbursement rates and to submit claims data to be published in all-payer registries.[56] Within the current hospital billing landscape, health systems and payers operate within an umbra of secrecy, leaving insurance beneficiaries and patients responsible for paying the price. Identifying high-markup, low-value hospitals and regulating pricing practices may represent an initial approach to lowering expenditures and protecting patients, but more transparent, fair, and equal billing practices could create a more effective system for all.

Limitations

There are several important limitations to acknowledge. The NRD is a nationally representative dataset, which permitted a large-scale analysis of hospital pricing policies. However, we could not access the hospital chargemaster, and privately negotiated agreements or discounts between insurance providers and hospitals are not detailed. Despite this, cost to charge ratios remain important, as they provide centers both leverage during billing negotiations as well as a higher starting point for discussions regarding reimbursement.[5] As the NRD does not report hospital identifying information, we could not examine the geographical variation of HMH. However, one prior investigation found the 50 hospitals with highest MRs to be spread across 13 states, with 76% located in the South.[2] The NRD records only a single cost to charge ratio for each participating center, so we could not ascertain differences in markup across hospital departments. Yet, we recognize markup may vary across hospital services. Hospital financial data regarding fixed, variable, or outpatient costs were similarly not available. While we could identify for-profit centers, we could not parse those specifically backed by private equity. As private equity acquisition has been previously associated with hospital-acquired adverse events,[57] future work should seek to evaluate markup practices and associated outcomes specifically among these institutions. Finally, granular data related to patient disease burden, timing or onset of symptoms, and operative time were not detailed. Despite these limitations, we applied advanced statistical methods to a large national dataset to consider hospital MRs across the US and their association with patient clinical outcomes.

Conclusions

In conclusion, in this cross-sectional study, we identified dramatic variation in hospital markup for major elective operations across the US, such that 20% of centers charged more than 4-fold the total cost of inpatient hospitalizations, and 10% charged more than 8-fold. Moreover, HMH were associated with significantly inferior patient outcomes and demonstrated both lower quality and value of care. Our findings highlight these centers as an important initial target for both further evaluation of in-hospital care processes and pathways contributing to inferior outcomes, as well as new opportunity for quality improvement. However, our work further calls for national discussion surrounding hospital markup and the careful implementation of policies to promote price transparency and better regulate hospital pricing.

REFERENCES

1. Muñoz E, Muñoz W III, Wise L. National and surgical health care expenditures, 2005-2025. *Ann Surg*. 2010;251(2):195-200. doi:10.1097/SLA.0b013e3181cbcc9a

2. Bai G, Anderson GF. Extreme markup: the fifty US hospitals with the highest charge-to-cost ratios. *Health Aff (Millwood)*. 2015;34(6):922-928. doi:10.1377/hlthaff.2014.1414

3. White C, Reschovsky JD, Bond AM. Understanding differences between high- and low-price hospitals: implications for efforts to rein in costs. *Health Aff (Millwood)*. 2014;33(2):324-331. doi:10.1377/hlthaff.2013.0747

4. Tompkins CP, Altman SH, Eilat E. The precarious pricing system for hospital services. *Health Aff (Millwood)*. 2006;25(1):45-56. doi:10.1377/hlthaff.25.1.45

5. Bai G, Anderson GF. US hospitals are still using chargemaster markups to maximize revenues. *Health Aff (Millwood)*. 2016;35(9):1658-1664. doi:10.1377/hlthaff.2016.0093

6. McKinney RM. Pricing of hospital services: issues and some propositions. *J Hosp Mark*. 1990;4(1):55-69. doi:10.1300/J043v04n01_06

7. Murray R. Hospital charges and the need for a maximum price obligation rule for emergency department & out-of-network care. Health Affairs. Accessed March 1, 2025. doi:10.1377/forefront.20130516.031255

8. McCue MJ, Hall MA. Insurers' responses to regulation of medical loss ratios. *Issue Brief (Commonw Fund)*. 2012;26:1-13.

9. Melnick GA, Fonkych K. Hospital pricing and the uninsured: do the uninsured pay higher prices? *Health Aff (Millwood)*. 2008;27(2)(suppl 1):w116-w122. doi:10.1377/hlthaff.27.2.w116

10. Himmelstein DU, Lawless RM, Thorne D, Foohey P, Woolhandler S. Medical bankruptcy: still common despite the Affordable Care Act. *Am J Public Health*. 2019;109(3):431-433. doi:10.2105/AJPH.2018.304901

11. Anderson GF. From 'soak the rich' to 'soak the poor': recent trends in hospital pricing. *Health Aff (Millwood)*. 2007;26(3):780-789. doi:10.1377/hlthaff.26.3.780

12. Papanicolas I, Woskie LR, Jha AK. Health care spending in the United States and other high-income countries. *JAMA*. 2018;319(10):1024-1039. doi:10.1001/jama.2018.1150

13. Barber RM, Fullman N, Sorensen RJD, et al; GBD 2015 Healthcare Access and Quality Collaborators. Electronic address: cjlm@uw.edu; GBD 2015 Healthcare Access and Quality Collaborators. Healthcare Access and Quality Index based on mortality from causes amenable to personal health care in 195 countries and territories, 1990-2015: a novel analysis from the Global Burden of Disease Study 2015. *Lancet*. 2017;390(10091):231-266. doi:10.1016/S0140-6736(17)30818-8

14. Anderson GF, Frogner BK. Health spending in OECD countries: obtaining value per dollar. *Health Aff (Millwood)*. 2008;27(6):1718-1727. doi:10.1377/hlthaff.27.6.1718

15. The Dartmouth Atlas of Health Care website archive (effective June 30, 2024). Dartmouth Atlas Project. Accessed February 22, 2025. https://www.dartmouthatlas.org/

16. Sinsky C, Linzer M. Practice and policy reset post-COVID-19: reversion, transition, or transformation? *Health Aff (Millwood)*. 2020;39(8):1405-1411. doi:10.1377/hlthaff.2020.00612

17. Knechtle WS, Perez SD, Medbery RL, et al. The association between hospital finances and complications after complex abdominal surgery: deficiencies in the current health care reimbursement system and implications for the future. *Ann Surg*. 2015;262(2):273-279. doi:10.1097/SLA.0000000000001042

18. Eappen S, Lane BH, Rosenberg B, et al. Relationship between occurrence of surgical complications and hospital finances. *JAMA*. 2013;309(15):1599-1606. doi:10.1001/jama.2013.2773

19. Gani F, Ejaz A, Makary MA, Pawlik TM. Hospital markup and operation outcomes in the United States. *Surgery*. 2016;160(1):169-177. doi:10.1016/j.surg.2016.03.014

20. Gani F, Makary MA, Pawlik TM. The price of surgery: markup of operative procedures in the United States. *J Surg Res*. 2017;208:192-197. doi:10.1016/j.jss.2016.09.032

21. Cerullo M, Chen SY, Dillhoff M, Schmidt CR, Canner JK, Pawlik TM. Variation in markup of general surgical procedures by hospital market concentration. *Am J Surg*. 2018;215(4):549-556. doi:10.1016/j.amjsurg.2017.10.028

22. Birkmeyer JD, Gust C, Baser O, Dimick JB, Sutherland JM, Skinner JS. Medicare payments for common inpatient procedures: implications for episode-based payment bundling. *Health Serv Res*. 2010;45(6 pt 1):1783-1795. doi:10.1111/j.1475-6773.2010.01150.x

23. Birkmeyer JD, Gust C, Dimick JB, Birkmeyer NJO, Skinner JS. Hospital quality and the cost of inpatient surgery in the United States. *Ann Surg*. 2012;255(1):1-5. doi:10.1097/SLA.0b013e3182402c17

24. Sheetz KH, Chhabra K, Nathan H, Dimick JB. The quality of surgical care at hospitals associated with America's highest-rated medical centers. *Ann Surg*. 2020;271(5):862-867. doi:10.1097/SLA.0000000000003195

25. Healthcare Cost and Utilization Project. NRD description of data elements. Agency for Healthcare Research and Quality. Accessed March 15, 2022. https://www.hcup-us.ahrq.gov/db/nation/nrd/nrddde.jsp

26. Cost reports. Centers for Medicare & Medicaid Services. Accessed April 15, 2025. https://www.cms.gov/data-research/statistics-trends-and-reports/cost-reports

27. van Walraven C, Austin PC, Jennings A, Quan H, Forster AJ. A modification of the Elixhauser comorbidity measures into a point system for hospital death using administrative data. *Med Care*. 2009;47(6):626-633. doi:10.1097/MLR.0b013e31819432e5

28. Sakowitz S, Bakhtiyar SS, Vadlakonda A, Ali K, Sanaiha Y, Benharash P. Failure to rescue among octogenarians undergoing cardiac surgery in the United States. *Surgery*. 2023;174(4):893-900. doi:10.1016/j.surg.2023.06.028

29. Alexandrescu R, Bottle A, Jarman B, Aylin P. Classifying hospitals as mortality outliers: logistic versus hierarchical logistic models. *J Med Syst*. 2014;38(5):29. doi:10.1007/s10916-014-0029-x

30. Zou H, Hastie T. Regularization and variable selection via the elastic net. *J R Stat Soc Series B Stat Methodol*. 2005;67(2):301-320. doi:10.1111/j.1467-9868.2005.00503.x

31. Haglin JM, Eltorai AEM, Richter KR, Jogerst K, Daniels AH. Medicare reimbursement for general surgery procedures: 2000 to 2018. *Ann Surg*. 2020;271(1):17-22. doi:10.1097/SLA.0000000000003289

32. Weeks WB, Cao SY, Smith J, Wang H, Weinstein JN. Trends in characteristics of adults enrolled in traditional fee-for-service Medicare and Medicare Advantage, 2011-2019. *Med Care*. 2022;60(3):227-231. doi:10.1097/MLR.0000000000001680

33. Zwanziger J, Bamezai A. Evidence of cost shifting in California hospitals. *Health Aff (Millwood)*. 2006;25(1):197-203. doi:10.1377/hlthaff.25.1.197

34. Reinhardt UE. The pricing of U.S. hospital services: chaos behind a veil of secrecy. *Health Aff (Millwood)*. 2006;25(1):57-69. doi:10.1377/hlthaff.25.1.57

35. White C. Contrary to cost-shift theory, lower Medicare hospital payment rates for inpatient care lead to lower private payment rates. *Health Aff (Millwood)*. 2013;32(5):935-943. doi:10.1377/hlthaff.2012.0332

36. White C, Wu VY. How do hospitals cope with sustained slow growth in Medicare prices? *Health Serv Res*. 2014;49(1):11-31. doi:10.1111/1475-6773.12101

37. Murray R. Setting hospital rates to control costs and boost quality: the Maryland experience. *Health Aff (Millwood)*. 2009;28(5):1395-1405. doi:10.1377/hlthaff.28.5.1395

38. Bai G. California's Hospital Fair Pricing Act reduced the prices actually paid by uninsured patients. *Health Aff (Millwood)*. 2015;34(1):64-70. doi:10.1377/hlthaff.2014.1072

39. Bai G, Anderson GF. A more detailed understanding of factors associated with hospital profitability. *Health Aff (Millwood)*. 2016;35(5):889-897. doi:10.1377/hlthaff.2015.1193

40. Sakowitz S, Bakhtiyar SS, Sienna NS, et al. Perspectives, experiences, and opportunities of academic surgeons in the era of health care corporatization. *Ann Surg*. 2025;282(1):1-10. doi:10.1097/SLA.0000000000006630

41. Cutler DM, Scott Morton F. Hospitals, market share, and consolidation. *JAMA*. 2013;310(18):1964-1970. doi:10.1001/jama.2013.281675

42. Barbash GI, Friedman B, Glied SA, Steiner CA. Factors associated with adoption of robotic surgical technology in US hospitals and relationship to radical prostatectomy procedure volume. *Ann Surg*. 2014;259(1):1-6. doi:10.1097/SLA.0b013e3182a5c8b8

43. Scott AR, Rush AJ III, Naik AD, Berger DH, Suliburk JW. Surgical follow-up costs disproportionately impact low-income patients. *J Surg Res*. 2015;199(1):32-38. doi:10.1016/j.jss.2015.04.013

44. Richman BD, Hall MA, Schulman KA. Overbilling and informed financial consent--a contractual solution. *N Engl J Med*. 2012;367(5):396-397.

45. Diaz A, Mead M, Rohde S, Kunnath N, Dimick JB, Ibrahim AM. Hospitals acquired by private equity firms: increased postoperative mortality for common inpatient surgeries. *Health Aff (Millwood)*. 2025;44(5):554-562. doi:10.1377/hlthaff.2024.01102

46. Hospitals. Centers for Medicare & Medicaid Services. Accessed March 3, 2025. https://www.cms.gov/priorities/key-initiatives/hospital-price-transparency/hospitals

47. H.R.5378 - 118th Congress (2023-2024): Lower Costs, More Transparency Act. Congress.gov. Accessed April 15, 2025. https://www.congress.gov/bill/118th-congress/house-bill/5378

48. Henderson MA, Mouslim MC. Low compliance from big hospitals on CMS's Hospital Price Transparency Rule. Health Affairs. doi:10.1377/forefront.20210311.899634

49. Lu AJ, Chen EM, Vutam E, Brandt J, Sadda P. Price transparency implementation: accessibility of hospital chargemasters and variation in hospital pricing after CMS mandate. *Healthc (Amst)*. 2020;8(3):100443. doi:10.1016/j.hjdsi.2020.100443

50. Arvisais-Anhalt S, McDonald S, Park JY, Kapinos K, Lehmann CU, Basit M. Survey of hospital chargemaster transparency. *Appl Clin Inform*. 2021;12(2):391-398. doi:10.1055/s-0041-1729168

51. Reinhardt UE. Health care price transparency and economic theory. *JAMA*. 2014;312(16):1642-1643. doi:10.1001/jama.2014.14276

52. Whaley C, Schneider Chafen J, Pinkard S, et al. Association between availability of health service prices and payments for these services. *JAMA*. 2014;312(16):1670-1676. doi:10.1001/jama.2014.13373

53. Cutler DM. Who benefits from health system change? *JAMA*. 2014;312(16):1639-1641. doi:10.1001/jama.2014.13491

54. Sheils CR, Dahlke AR, Kreutzer L, Bilimoria KY, Yang AD. Evaluation of hospitals participating in the American College of Surgeons National Surgical Quality Improvement Program. *Surgery*. 2016;160(5):1182-1188. doi:10.1016/j.surg.2016.04.034

55. Osborne NH, Nicholas LH, Ryan AM, Thumma JR, Dimick JB. Association of hospital participation in a quality reporting program with surgical outcomes and expenditures for Medicare beneficiaries. *JAMA*. 2015;313(5):496-504. doi:10.1001/jama.2015.25

56. Koller CF, Khullar D. The commercial differential for hospital prices: responses from states and employers. *JAMA*. 2019;322(8):723-724. doi:10.1001/jama.2019.9275

57. Kannan S, Bruch JD, Song Z. Changes in hospital adverse events and patient outcomes associated with private equity acquisition. *JAMA*. 2023;330(24):2365-2375. doi:10.1001/jama.2023.23147