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Analysis of Variation in Charges and Prices Paid for Vaginal and Cesarean Section Births: A Cross-Sectional Study

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Abstract

Objective: To examine the between-hospital variation of charges and discounted prices for uncomplicated vaginal and cesarean section deliveries, and determine the institutional and market-level characteristics that influence adjusted charges.

Design, Setting, and Participants: Using data from the California Office of Statewide Health Planning and Development (OSHPD), we conducted a cross-sectional study of all privately insured patients admitted to California hospitals in 2011 for uncomplicated vaginal delivery (DRG 775) or uncomplicated cesarean section (DRG 766).

Outcome Measures: Hospital charges and discounted prices adjusted for each patient's clinical and demographic characteristics.

Results: We analyzed 76,766 vaginal deliveries and 32,660 cesarean sections in California in 2011. After adjusting for patient demographic and clinical characteristics, we found that the average California woman could be charged as little as $3,296 or as much as $37,227 for a vaginal delivery, and $8,312 - $70,908 for a cesarean section depending on which hospital she was admitted to. The discounted prices were, on average, 37% of the charges. We found that hospitals in markets with middling competition had significantly lower adjusted charges for vaginal deliveries, while hospitals with higher wage indices and case mixes, as well as for-profit hospitals, had higher adjusted charges. Government hospitals charged significantly less for cesarean sections, while hospitals in markets with higher uninsurance rates charged more. However, the institutional and market level factors included in our models explained only 35-36% of the between-hospital variation in charges.

Conclusions: These results indicate that charges and discounted prices for two common, relatively homogeneous diagnosis groups – uncomplicated vaginal delivery and cesarean section – vary widely between hospitals and are not well explained by observable patient or hospital characteristics.

Article Summary

Article focus:

- Wide variation in both hospital charges and payment rates has been documented by past studies. However, few studies attempt to explain such variation for episodes of care.
- We aimed to (1) document the variation in charges and discounted prices between California hospitals for the same, average woman's hospital stay for a vaginal birth or cesarean section, and (2) analyze whether hospital or market characteristics could explain that between-hospital variation in charges.

Key messages:

- After adjusting for patient clinical and demographic characteristics, charges for the average California mother's uncomplicated vaginal birth ranged from $3,296 to $37,227 depending on which of the 198 hospitals she visited; adjusted charges for cesarean sections ranged from $8,312 to $70,908.
- Discounted prices were 37% of charges, on average (range: 5% - 92%)
- For-profit hospitals, hospitals in areas with high costs of living, and hospitals with more severe case-mixes charged more than their counterparts; however, only 35-36% of charges were explained by the observable hospital and market characteristics in our models.

Strengths and limitations of this study:

- Uses a comprehensive dataset of all visits to California hospitals and links to patient and institutional characteristics, allowing for isolation of between-hospital variation and analysis over a complete population.
- Limitations include use of aggregate discount rates to estimate discounted prices paid, potential residual patient-level variation in care intensity, and inability to completely capture hospital quality.

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Competing Interests:

None of the authors have any competing interests to report.

BACKGROUND

Healthcare expenditures in 2011 totaled $2.7 trillion dollars - 17.7% of US GDP – and are projected to rise steeply in future years.[1] Unlike most other industries, the way healthcare is priced and paid for is notoriously opaque, making it difficult for patients to act as consumers.[2] At a time when out of pocket payments for healthcare are increasing,[3] and growing numbers of "consumer directed" high deductible health plans put more pressure on patients to make cost-efficient healthcare decisions,[4 5] the opacity of the system is becoming an even greater concern.

Recently, hospital charges have come to the forefront of political, popular, and medical discourse due to their seemingly inexplicable magnitude and devastating effects on specific patients.[6-8] While insurers typically negotiate lower reimbursements, these full, inflated charges are still billed to the 22% of American adults aged 19-64 who are uninsured and to privately insured patients receiving care out of network,[9 10] contributing to the 57% of US bankruptcies that are due to medical bills.[11] Further, charges are the basis of price negotiations with many private insurers,[7 12 13] involved in inpatient diagnosis group weighting and outlier payments by Medicare,[14-17] and used in calculations of uncompensated care, which affect hospital non-profit status.[18 19]

Yet despite their consistent use in many forms of healthcare price setting and hospital bills, charges appear to be nearly random, and are either based on outdated, historical methods or set using opaque idiosyncratic proprietary formulas.[12 13 20] One hospital administrator called his hospital's method of setting charges "madness."[21] The academic literature has supported this assumption; studies have documented the wide variation in hospital and physician charges and payment rates for the average inpatient stay.[22] Past economics literature has attempted to discern some method to charge setting by documenting the relationship between hospital payment rates

and industry organization, and has found for example that less competitive markets have higher predicted prices.[23 24] These studies, however, have mostly addressed broad price indexes based on aggregate hospital charges.

Given the wide range of procedures and diagnoses that comprise hospitals' inpatient censuses, it is important to evaluate specific, common episodes of care that should have less variation in charges, and are more relevant to patients presenting with a complaint and no knowledge of the specific services they will need. An ideal service is childbirth, the most common reason for hospitalizations in the US, [25] accounting for 4.2 million inpatient stays and $16.1 billion in hospital costs in 2008.[26] Recently, a study by Truven Health Analytics looked at both charges and discounted prices nationally for vaginal and cesarean childbirth using their own proprietary database of paid medical claims, finding significant variation of both charge and reimbursement.[27] However, the study does not address the possible sources of the variation in charges that it documents.

In this study, we sought to fill this gap by documenting and attempting to explain between-hospital variation in charges for the same, average woman's inpatient stay for vaginal birth or cesarean section in California – relatively homogeneous episodes of care. We first predict charges and estimated prices paid at each hospital after adjusting for patient characteristics, and then determine if hospital or market-level characteristics can explain some of this charge variation.

METHODS

Data Source

We used the 2011 California Office of Statewide Health Planning and Development (OSHPD) Patient Discharge Public Data Set (PDD) to perform our cross-sectional analysis. The

OSHPD PDD captures patient demographic and clinical information, along with charges, for each inpatient encounter at California hospitals. OSHPD masks selective patient information in this public dataset to prevent identification of individuals pursuant to the California Health Data and Advisory Council Consolidation Act, Health and Safety Code section 128675 et seq. Our study was exempt from review by the Committee on Human Research at the University of California, San Francisco because we used a public data source that was masked for identifiers.

To capture hospital-level characteristics, we used OSHPD's hospital financial and utilization files for 2011. We also used the 2009 Area Resources File,[28] the most currently available year, to obtain county-level area percent of uninsurance and poverty, and the Impact Files from the Centers for Medicare & Medicaid Services (CMS), to obtain hospital wage index.[29]

Sample Selection

We limited our study to adult women (≥ 18 years old) who were admitted for diagnosis-related group (DRG) of 775 (uncomplicated vaginal delivery) or 766 (uncomplicated Cesarean section) at short-term general California hospitals. We also only included privately insured women, as our estimated discount rate only applies to them. Patients admitted to federal hospitals (e.g. Veterans Administration hospitals) are not in our data as OSHPD reporting requirements do not apply to such hospitals. Also, women who receive care through the Kaiser Permanente network are absent, as they do not report charges to the state.

To restrict our sample to a relatively healthy and more homogenous population, we excluded patients who died in the hospital or who did not have a routine discharge. We further excluded patients without a valid age group or gender recorded, as we could not accurately adjust for their demographic predictors of charge. We also excluded patients with invalid charges, those

receiving charity care, and those with charges exceeding the cell size limit. Finally, we excluded patients visiting hospitals that did not report a wage index. See Figure 1 for a full description of the applied exclusions.

Outcome

Our first outcome was hospital charges, which are the total dollar amounts billed by the hospital for each admission, excluding physician fees. These charges reflect the hospital's full, established rates before contractual adjustments and prepayments.

Our secondary outcome was estimated discounted prices, or the amounts which hospitals received from private insurers for the services their enrollees received. We obtained this by multiplying the hospital charge by the average hospital discount for privately insured patients. As done in previous literature, this discount factor for privately insured patients was calculated using the formula: (gross inpatient revenue + gross outpatient revenue - contractual adjustments)/(gross inpatient revenue + gross outpatient revenue).[23 30] We obtained these amounts through the 2011 OSHPD financial files for each hospital.

Statistical analysis

Our analysis is similar to the two-stage approach used by previous economic analyses.[31] We performed separate analysis for each DRG. In the first stage, to control for patient-level variation in charges, we regressed raw charges on patient characteristics including age (in two categories: 18-34, and ≥ 35), number of conditions present on admission, Charlson comorbidities, and length of stay. Because length of stay is often right-skewed, we transformed it to log (length of stay + 1). We included three different types of private insurance, including two forms of

managed care (Knox-Keene/Medi-Cal County Organized Health System, or other), and traditional private coverage. To control for unobservable within-hospital factors that could affect variation, we also included a dummy variable for each hospital.

From this regression, we then calculated a given hospital's adjusted charge for the average statewide patient for that DRG, where the adjusted charges represented standardized log charge/(day + 1). This gave us a single adjusted charge for each hospital, representing the predicted charge for a patient with the same, average clinical and demographic characteristics, which we then used as the dependent variable in our second-stage regression.

In the second stage, we regressed our adjusted charges on hospital and market level factors cited by previous literature as related to broad price indices,[23 31 32] to determine which characteristics explain observed between-hospital variation in charges for childbirth. Hospital-level factors included ownership (not-for-profit, for-profit, government), teaching status, urban/rural location, capacity (number of licensed beds), patient payer mix (proportion Medicare, Medicaid), and case-mix (which was used to adjust the average cost per patient for a given hospital relative to the adjusted average cost for other hospitals).[33] We also incorporated three quality measures from the Agency for Healthcare Research Quality's Inpatient Quality Indicators (IQIs): cesarean delivery rate, vaginal birth after cesarean rate (uncomplicated), and primary caesarian delivery rate.[34] These utilization indicators are intended to capture either over-use of procedures found to be unnecessary or low quality, or under-use of procedures with merit, such as vaginal birth after prior cesarean delivery.[35] We further incorporated market-level factors including wage index, percent uninsured in the county, percent below the poverty line in the county, as well as the system-wide Herfindahl-Hirschman Index (HHI).

The HHI is a widely used economic measure of degree of competition faced by a company, or in this case hospital, within its market.[36] It is calculated as the sum of the squares of market shares for each hospital in a given market. Higher HHIs are associated with less competition, while lower HHIs indicate more competitive markets. We calculated these shares of patients directly from the hospital discharge data. Our HHI calculation also accounts for membership in a hospital system, which has been shown to influence hospital price setting.[32]

RESULTS

Sample

We analyzed a sample of 76,766 uncomplicated vaginal deliveries, and 32,660 uncomplicated cesarean sections in 2011 across California. As shown in Table 1, 78.4% of women with uncomplicated vaginal deliveries were between the ages of 18-34, and 97.9% had a Charlson comorbidity index of 0, indicating that they were relatively healthy. The length of stay for 77.8% of these women was less than 3 days. For the 32,660 women with uncomplicated Cesarean sections (Table 2), the majority (69.5%) were again between ages 18-34, almost all (97.2%) had a Charlson comorbidity index of 0, and 77.5% had a hospital stay between 3 to 6 days. For both DRGs, the majority of hospitals were not-for-profit, non-teaching hospitals located in urban areas.

Charges

We found that the raw charges for uncomplicated vaginal birth ranged from $3,344 to $43,715, with a median charge of $15,278 (IQR $7,981). Once adjusted for patient clinical and demographic characteristics, charges for the average patient ranged from $3,296 to $37,227,

depending on which of the 198 hospitals she visited (median $14,620; IQR $7,643). For uncomplicated Cesarean sections, the raw charges ranged from $7,905 to $72,569, with a median charge of $27,517 (IQR $14,206). Adjusted charges ranged from $8,312 to $70,908 with a median charge of $27,481 (IQR $12,525), again for a patient with the same average characteristics.

Estimated discounted price

Discounted prices paid by private insurers ranged from 5% to 92% of the charge, with an average of 37%. Discounted prices for vaginal deliveries ranged from $835 to $12,873 (median $5,123; IQR $3,827), and prices for cesarean sections varied from $1,135 to $28,105 (median $9,640; IQR $6,631). For vaginal births, the largest difference between a hospital's adjusted charge and estimated discount price was $29,217, where it charged $33,593 for an average patient, almost eight times the $4,376 it finally received from insurers. The smallest difference was just $920, where the hospital's average charge ($11,251) was a mere 109% higher than its estimated price ($10,332). For uncomplicated Cesarean sections, the differences were even more dramatic – one hospital charged 1899% of what it typically received, while another charged 124%. Figure 2 illustrates the differences between the adjusted charges and discounted prices for each hospital in our dataset for the two conditions.

Hospital and market-level factors

In the multivariate model using adjusted charges across hospitals as the dependent variable, for uncomplicated vaginal delivery, hospitals with for-profit ownership, severe case-mixes, and high wage indices charged significantly more than their counterparts (Table 3).

For uncomplicated Cesarean section (Table 4), again charge was associated with ownership. Government-owned hospitals had 14.6% lower charges (95% CI -29.8, 0.6), while for-profit hospitals had 17.2% higher charges (95% CI 3.2, 31.2) than non-profit hospitals. This implies that if the mean charge for uncomplicated Cesarean section, $29,480, was offered at a non-profit hospital, the adjusted charge in a government hospital would be $25,176 and the adjusted charge in a for-profit hospital would be $34,551. Also similar to our findings with uncomplicated vaginal births, hospitals with higher labor costs (wage index) had higher charges. The case-mix was no longer predictive, but a higher rate of percent uninsured in the county was significantly correlated with higher charges. Though the significance was marginal, the proportion of patients covered by Medicare was also associated with higher charges.

DISCUSSION

Our results demonstrate the wide variability of charges and prices for childbirth between hospitals, even after controlling for patient characteristics, and point to specific institutional and market-level factors that affect those standardized charges. Even after adjusting for patient demographic and clinical characteristics, we found that charges for vaginal births ranged from $3,296 to $37,227, and charges for cesarean sections ranged from $8,312 to $70,908, depending only on which hospital the average California woman giving birth visited. That implies that, after adjusting for patient characteristics, the highest hospital charge was more than 11 times that of the lowest hospital charge for vaginal births, and more than 8.5 times that of the lowest hospital charge for cesarean section births. Without adjusting for patient characteristics, the hospital with the highest charges would charge about 13 times more than the hospital with the lowest charges for vaginal births, and about 9 times more than the hospital with the lowest charges for cesarean

sections. While the variation of adjusted charges is, as expected, smaller than the variation in raw charges between hospitals, the very small difference between the two implies that service-intensity and patient observable factors provide little explanation for variation in charges between hospitals.

Our findings show that some hospital and market-level factors, on the other hand, do clearly impact the differences in charges between hospitals. We find a positive relationship between charges for childbirth and hospital wage index, case-mix index, for-profit ownership and county percent uninsured. However, it is probably more notable how *few* of the hospital and market-level regressors are significant in explaining the variation. Our vaginal and cesarean delivery models account for only 36% and 35%, respectively, of the variation observed between hospitals in adjusted charges. This implies that either the variation is a result of (a) unobservable hospital characteristics or (b) pure noise.

Based on findings from past literature, we hypothesize that the pure noise explanation is more likely. A MedPAC study of hospitals found that many items on chargemasters were based on historical prices, which were formulated before it was possible to accurately estimate costs.[20] Even today, the survey found that only a third of hospitals reported any concern regarding covering operating costs when updating their chargemasters. Rather, most were concerned with conforming to regulations and maintaining their overall bottom line.[20] Today, even for new services providers are not incentivized to set charges based on costs, because third party payments are largely not based on true costs for a given service.[12 22] This therefore precludes a valuable correlation between cost and charge and thus an anchor on which charge variation would be limited.[12] In addition, the current miscorrelation is exacerbated by simplistic "updates" in the form of across the board percentage increases of charges, often resulting in certain services

subsidizing others to manage the overall solvency of the hospital or department.[12 20 37] Thus, our results again confirm the documented lack of comprehensible or at least measurable sense in the chargemaster system.

The troubling part of this largely random variation is that charges do still matter to patients and to hospitals in many ways. The 41.9 million uninsured Americans, along with privately insured patients visiting an out of network hospital may be faced with the full charges for their care, which are typically so high that few patients can pay them, resulting in need for charity care, sliding scale payments, or often bad debt on the patient's part.[13 38] In addition, as some private insurers still negotiate discounts off charges, especially in fee for service systems, and use charges to benchmark the relative weights of their prospective payment systems, higher charges can lead to higher out of pocket payments for patients.[3 12 13] Medicare also compares charges between DRG groups modified by cost-to-charge ratios calculated at the cost center level to determine the relative weight of DRG's and identify qualifying outlier payments within DRGs.[14-17] Finally, many hospitals use charges to calculate their uncompensated care costs, which affect their not-for-profit and hence tax exempt status. In fact, the IRS found that 18-20% of hospitals include the difference between charges and allowed payments by private insurers, and 50% include the difference between charges and payments received from the uninsured in their uncompensated care calculations.[18 19]

A secondary finding in this study is the large discrepancy between hospitals' predicted charges and their estimated discounts. Our finding of an average 37% discount is supported by previous literature showing that private insurers pay on average 39% of the charge for hospital inpatient services.[39 40] We estimated median payments of $5,123 for vaginal and $9,640 for cesarean section births, slightly lower than the Truven estimates of $8,519 and $12,894,

respectively.[27] The difference between the adjusted charge and discounted price estimates what could be considered "excess charges", and in 2011 sums to $1.36 billion dollars for all uncomplicated vaginal and cesarean births in California ($760.1 million for uncomplicated vaginal deliveries; $601.1 million for uncomplicated cesarean sections).

Past literature has speculated two reasons for high charges relative to reimbursements. First is the change in Medicare's reimbursement protocol from the historical cost-plus reimbursement system to today's prospective payment system.[37] Because providers were paid a percentage above the charged rate, it was in the providers' financial interest to maintain exorbitant charges, a practice that has persisted despite the change in reimbursement. Second, in fee for service payments for which reimbursements are simple discounts of charges, hospitals are incentivized to raise their charges in an effort to increase reimbursement. Finally, hospitals may be setting artificially inflated charges to increase the nominal value of their uncompensated care indices, which are based on charges.[19 41]

Limitations of Research

There are several limitations of this study. First, we used DRGs to determine what constituted an episode of care. The MS-DRG system was designed to classify patients into groups based on likely utilization of services and accumulation of costs. However, because the administrative data we used does not provide charge itemization, it is very likely that some women received greater "intensity" of services in unobservable ways. For instance, if one woman received an epidural, and another woman did not, we might expect the woman with the epidural to have higher charges. As much as possible, we are minimizing fallout from this limitation by using observable attributes of the episode (e.g. length-of-stay, discharge, comorbidities) in our

first-stage regression, which should absorb some of the patient-level differences in care intensity. It is possible, however, that if unobservable patient characteristics affecting intensity of care are correlated with hospital characteristics, we might expect our second stage estimates to be biased. On the other hand, if treatment intensity is a hospital- level characteristic, then our analysis does accurately capture this.

Second, our brief analysis of discounted prices is limited by the fact that we must estimate discount rates, since insurers and providers carefully guard their actual payment rates as proprietary. The financial data we used is self-reported, and thus the accuracy of our estimates is dependent on the accuracy of hospital reporting to OSHPD. However, inaccuracies are not a big concern as OSHPD performs systematic financial audits of their data. Further, the discount rates are hospital-wide and aggregate across all insurers, while negotiations regarding discount rates granted by a given hospital may vary widely by particular insurer and according to DRG or cost center. It is partly because of this significant limitation that we chose to focus our main results on charges and the factors affecting them. That said, our estimated prices were roughly consistent with the Truven study, which did have access to claims-based prices paid. [27] In addition, discounted rates negotiated by insurers have been found to be broadly applied to wide swaths of services, as the main goal of such negotiations is overall solvency.[42] Further, modifications to charges at the aggregate level are regularly used in institutional practice, such as cost to charge ratios used by Centers for Medicare and Medicaid Services (CMS) to estimate outlier payments, which have been shown to be imperfect but generally appropriate estimates of cost.[43]

Third, our study only examines charges in California. Though California is a large, diverse state, our results cannot be generalized to the entire nation. Last, our study could not examine the full effect of quality of care on hospital price premiums, though we included select quality

indicators. However, it is difficult to imagine that these variations could be attributed entirely to quality, given numerous studies demonstrating that both charges and payments are unrelated to quality, which we similarly found in our analysis of three quality measures.[44 45]

CONCLUSIONS

For the same average patient in California, we find that charges for uncomplicated vaginal delivery ranged from $3,296 to $37,227 (median: $14,620), and charges for uncomplicated cesarean section ranged from $8,312 to $70,908 (median: $27,481) depending on which hospital she visited. Hospital ownership, case-mix, wage index, percent uninsured in the county, and market competitiveness had a significant impact on these adjusted charges. Estimated discounted prices averaged 37% of the adjusted charges. Our findings indicate that the charge faced by a patient for a common obstetrical procedure is significantly influenced by institutional and market-level factors outside of her own presentation, but that the majority of variation in charges between hospitals she could visit remains unexplained. Our results also suggest significant room for improved methodologies, incentives, and policy interventions for accurately estimating and presenting charges and ultimate costs.

Authors' Contributions

RYH conceived of the study, obtained the data, directed and interpreted the analyses, and helped draft and edit the manuscript. YAA helped conceive the study design, analyzed the data, interpreted the results, and edited the manuscript. EW analyzed the data and interpreted the results, and helped with editing of the manuscript. EG conducted background research, helped in interpreting the results, drafted the manuscript, and assisted in editing. All authors have read and approved the final manuscript.

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REFERENCES:

1. Centers for Medicare and Medicaid Service, Office of the Actuary. *National Health Expenditure Projections 2011-2021;* 2011.

2. Government Accountability Office (GAO). Meaningful Price Information Is Difficult for Consumers to Obtain Prior to Receiving Care. GAO-11-791; 2011.

3. Truffer CJ, Keehan S, Smith S, Cylus J, Sisko A, Poisal JA, et al. Health spending projections through 2019: the recession's impact continues. *Health Aff(Millwood)* 2010;**29**:522-29.

4. The Kaiser Family Foundation, Health Research & Educational Trust. Employer Health Benefits 2012 Annual Survey; 2012.

5. Robinson JC, Ginsburg PB. Consumer-driven health care: promise and performance. *Health Aff(Millwood)* 2009;**28**:w272-81.

6. Brill S. Bitter Pill: Why Medical Bills Are Killing Us. *TIME Magazine.* Feb 20, 2013.

7. Selberg J, Marks CM. A Problem Too Big to See: The Sobering Reality of Hospital Pricing: Institute for Healthcare Improvement, 2013.

8. Salam R. Guest Post by Oren Cass: What Steven Brill Gets Wrong on U.S. Health Care Costs. *The National Review Online.* Feb 28, 2013.

9. Anderson GF. From 'Soak The Rich' To 'Soak The Poor': Recent Trends In Hospital Pricing. *Health Aff (Millwood)* 2007;**26**:780-89.

10. DeNavas-Walt C, Proctor B, Smith J. Income, Poverty, and Health Insurance Coverage in he United States: 2011. *Current Population Reports*. U.S. Census Bureau. Washington, D.C.; 2012.

11. Himmelstein DU, Thorne D, Warren E, Woolhandler S. Medical Bankruptcy in the United States, 2007: Results of a National Study. *Am J Med* 2009;**122**:741-46.

12. Ginsburg PB, Grossman JM. When the price isn't right: how inadvertent payment incentives drive medical care. *Health Aff (Millwood)* 2005:W5.

13. Reinhardt UE. The Pricing Of U.S. Hospital Services: Chaos Behind A Veil Of Secrecy. *Health Aff (Millwood)* 2006;**25**:57-69.

14. Medicare Program; Change in Methodology for Determining Payment for Extraordinarily High-Cost Cases (Cost Outliers) Under the Acute Care Hospital Inpatient and Long-Term Care Hospital Prospective Payment Systems; Final Rule. 68 *Federal Register* 110. (June 9, 2003):34494-504.

15. Medicare Program; Changes to the Hospital Inpatient Prospective Payment Systems and Fiscal Year 2007 Rates; Fiscal Year 2007 Occupational Mix Adjustment to Wage Index;

Health Care Infrastructure Improvement Program; Selection Criteria of Loan Program for Qualifying Hospitals Engaged in Cancer-Related Health Care and Forgiveness of Indebtedness; and Exclusion of Vendor Purchases Made Under the Competitive Acquisition Program (CAP) for Outpatient Drugs and Biologicals Under Part B for the Purpose of Calculating the Average Sales Price (ASP); Final Rules & Interim Final Rule With Comment Period. 71 *Federal Register* 160. (August 18, 2006):47870 -8351.

16. Medicare Program; Proposed Changes to the Hospital Inpatient Prospective Payment Systems and Fiscal Year 2009 Rates; Proposed Changes to Disclosure of Physician Ownership in Hospitals and Physician Self-Referral Rules; Proposed Collection of Information Regarding Financial Relationships Between Hospitals and Physicians; Proposed Rule. 73 *Federal Register* 84. (April 30, 2008):23542-47.

17. Carter GM, Rogowski JA. The Hospital Relative Value Method as an Alternative for Recalibrating DRG Relative Weights: RAND/UCLA/Harvard Center for Health Care Financing Policy Research; 1993.

18. Internal Revenue Service. IRS Exempt Organizations (TE/GE) Hospital Compliance Project Final Report; 2006:98.

19. Capps C, David G, Carlton D. Antitrust Treatment of Nonprofits: Should Hospitals Receive Special Care? *University of Chicago George J. Stigler Center for the Study of the Economy and the State Working Paper.* 2010.

20. Dobson AJ, DaVanzo J, Doherty J, Tanamor M. A Study of Hospital Charge Setting Practices: Lewin Group; 2005.

21. Lagnado L. California Hospitals Open Books, Showing Huge Price Differences. *Wall Street Journal.* December 27, 2004.

22. Ginsburg PB. Wide variation in hospital and physician payment rates evidence of provider market power: Center for Studying Health System Change; 2010.

23. Gaynor M, Vogt WB. Competition among hospitals: National Bureau of Economic Research Working Paper #9471; 2003.

24. Melnick GA, Zwanziger J, Bamezai A, Pattison R. The effects of market structure and bargaining position on hospital prices. *J Health Econ* 1992;**11**:217-33.

25. Vashi AA, Fox JP, Carr BG, D'Onofrio G, Pines JM, Ross JS, et al. Use of hospital-based acute care among patients recently discharged from the hospital. *JAMA* 2013;**309**:364-71.

26. Podulka J, Stranges E, Steiner C. Hospitalizations Related to Childbirth, 2008: Statistical Brief #110: Agency for Healthcare Research and Quality; 2011.

27. Truven Health Analytics. The Cost of Having a Baby in the United States; 2013.

28. Health Resources and Services Administration. Area Resource File; 2009.

29. Centers for Medicare and Medicaid Services. Historical Impact Files; 2011.

30. Dranove D, Lindrooth R, White WD, Zwanziger J. Is the impact of managed care on hospital prices decreasing? *J Health Econ* 2008;**27**:362-76.

31. Keeler E, Melnick G, Zwanziger J. The changing effects of competition on non-profit and for-profit hospital pricing behavior. *J Health Econ* 1999;**18**:69-86.

32. Melnick G, Keeler E. The effects of multi-hospital systems on hospital prices. *J Health Econ* 2007;**26**:400-13.

33. California Office of Statewide Health Planning and Development. Calculation of the Office of Statewide Health Planning and Development's (OSHPD) Case Mix Index (CMI). http://www.oshpd.ca.gov/HID/Products/PatDischargeData/CaseMixIndex/CMI/ExampleCalculation.pdf (accessed 15 March 2013)

34. Agency for Healthcare Research and Quality. Inpatient Quality Indicators Technical Specifications, Version 4.4, 2012. (accessed 15 March 2013): http://www.qualityindicators.ahrq.gov/Modules/IQI_TechSpec.aspx

35. Davies SM, Geppert JJ, McClellan M, McDonald KM, Romano PS, Shojania KG. Refinement of the HCUP Quality Indicators: Agency for Healthcare Research and Quality. AHRQ Publication No. 01-0035, 2001.

36. US Department of Justice and the Federal Trade Commission. Horizontal Merger Guidelines., 2010. http://www.justice.gov/atr/public/guidelines/hmg-2010.html (accessed 15 March 2013)

37. Kaplan RS, Porter ME. How to solve the cost crisis in health care. *Harvard Business Review* 2011;**89**:46-52.

38. Reinhardt U. What Hospitals Charge the Uninsured. *The New York Times.* New York, NY; March 15, 2013. In: *Economix* [blog]. http://economix.blogs.nytimes.com/2013/03/15/what-hospitals-charge-the-uninsured/ (accessed 1 April 2013)

39. Ginsburg PB. Shopping for price in medical care. *Health Aff (Millwood)* 2007;**26**:w208-16.

40. Tompkins CP, Altman SH, Eilat E. The precarious pricing system for hospital services. *Health Aff (Millwood)* 2006;**25**:45-56.

41. David G, Helmchen LA. The Role of Task Adhesion in Limiting Specialization along the Medical Care Continuum. *Labour* 2011;**25**:24-44.

42. Reinhardt U. How Do Hospials Get Paid? A Primer. *The New York Times* New York, NY; January 23, 2009. In *Economix* [blog]. http://economix.blogs.nytimes.com/2009/01/23/how-do-hospitals-get-paid-a-primer/ (accessed 1 April 2013)

43. Shwartz M, Young DW, Siegrist R. The ratio of costs to charges: how good a basis for estimating costs? *Inquiry* 1995;32(4):476-81.

44. Commonwealth of Massachusetts Division of Health Care Finance and Policy. Recommendations of the Special Commission on Provider Price Reform; 2011.

45. Massachusetts Attorney General. Examination of Health Care Cost Trends and Cost Drivers: Report for Annual Public Hearing; 2011.

Tables

Table 1. Characteristics of study sample for uncomplicated vaginal deliveries (DRG 775)

PATIENT-LEVEL CHARACTERISTICS (n=76,766)			
Age categories	**N**	**Percent**	
18-34	60,175	78.39%	
35-64	16,591	21.61%	
Sex			
Male	0	0.00%	
Female	76,766	100.00%	
Private Insurance Type			
Managed Care-Knox Keene	34,387	44.79%	
Managed Care-Other	36,414	47.44%	
Traditional Coverage	5,965	7.77%	
Charlson Comorbidity Index			
0	75,182	97.94%	
1	1,555	2.03%	
2	29	0.03%	
Length of Stay			
Less than 3 days	59,724	77.80%	
3-6 days	16,826	21.92%	
Greater than 6 days	216	0.28%	
HOSPITAL-LEVEL CHARACTERISTICS (n=198)			
Ownership			
Government	32	16.16%	
NFP	127	64.14%	
FP	39	19.70%	
Location			
Urban	174	87.88%	
Rural	24	12.12%	
Teaching Status			
Yes	20	10.10%	
No	178	89.90%	
Casemix (severity)	**N**	**Mean**	**SD**
Low	66	1.283	0.121
Medium	66	1.555	0.053
High	66	1.787	0.138
Capacity			
Licensed Beds	198	280.45	180.366
Payer Mix			
% Medicare	198	37.79%	12.38%
% Medicaid	198	28.13%	15.68%

MARKET-LEVEL CHARACTERISTICS			
	N	**Mean**	**SD**
Wage Index			
Low	121	1.196	0.007
Medium	12	1.223	0.01
High	65	1.486	0.142
Herfindahl-Hirschman Index			
Low	67	1178	629
Medium	70	3351	721
High	61	6831	1986
% Without Insurance	198	18.31%	3.77%
% Below Poverty Line	198	13.80%	4.41%

Table 2. Characteristics of study sample for uncomplicated vaginal deliveries (DRG 775)

PATIENT-LEVEL CHARACTERISTICS (n=32,660)			
Age categories	**N**	**Percent**	
18-34	22,694	69.49%	
35-64	9,966	30.51%	
Sex			
Male	0	0.00%	
Female	32,660	100.00%	
Private Insurance Type			
Managed Care-Knox Keene	14,696	45.00%	
Managed Care-Other	15,237	46.65%	
Traditional Coverage	2,727	8.35%	
Charlson Comorbidity Index			
0	31,756	97.23%	
1	894	2.74%	
2	10	0.03%	
Length of Stay			
Less than 3 days	7,172	21.96%	
3-6 days	25,325	77.54%	
Greater than 6 days	163	0.50%	
HOSPITAL-LEVEL CHARACTERISTICS (n=195)			
Ownership			
Government	30	15.38%	
NFP	127	64.14%	
FP	38	19.49%	
Location			
Urban	171	87.69%	
Rural	24	12.31%	
Teaching Status			
Yes	18	9.23%	
No	177	90.77%	
Casemix (severity)	**N**	**Mean**	**SD**
Low	65	1.287	0.125
Medium	65	1.559	0.052
High	65	1.789	0.138
Capacity			
Licensed Beds	195	279.672	180.807
Payer Mix			
% Medicare	195	37.94%	12.06%
% Medicaid	195	27.96%	15.64%

MARKET-LEVEL CHARACTERISTICS			
Wage Index	**N**	**Mean**	**SD**
Low	119	1.196	0.007
Medium	12	1.223	0.01
High	64	1.484	0.142
Herfindahl-Hirschman Index			
Low	72	1283	713
Medium	59	3440	591
High	64	6809	2115
% Without Insurance	195	18.30%	3.66%
% Below Poverty Line	195	13.77%	4.43%

Table 3. Regression of adjusted charges on hospital and market characteristics for uncomplicated vaginal deliveries

	Multiplicative increase for each unit change in predictor	95% CI lower bound	95% CI upper bound	p-value
HOSPITAL-LEVEL CHARACTERISTICS				
Ownership				
Government	-0.096	-0.249	0.057	0.217
NFP	Reference			
FP	0.198	0.0475	0.348	0.01
Teaching Status				
Yes	-0.049	-0.317	0.22	0.719
No	Reference			
MSA				
Urban	Reference			
Rural	0.022	-0.144	0.19	0.849
Casemix (severity)				
Low	Reference			
Medium	0.104	-0.044	0.252	0.166
High	0.196	0.044	0.349	0.012
Capacity				
Licensed beds	0.0003	-0.0001	0.0007	0.234
Payer Mix				
Proportion Medicare	0.263	-0.352	0.878	0.4
Proportion Medicaid	-0.002	-0.442	0.437	0.992
Quality Indicators				
Cesarean delivery rate	-0.097	-2.407	2.212	0.934
Vaginal birth after cesarean rate (uncomplicated)	0.415	-0.528	1.357	0.386
Primary cesarean delivery rate	0.208	-2.32	2.737	0.871
MARKET-LEVEL CHARACTERISTICS				
Wage Index				
Low	Reference			
Medium	0.202	0.0276	0.376	0.023
High	0.409	0.271	0.547	0
Herfindahl-Hirschman Index (System-wide)				
Low	Reference			
Medium	0.012	-0.116	0.139	0.857
High	0.005	-0.14	0.149	0.951
% Without Insurance	-0.012	-0.033	0.009	0.259
% Below Poverty Line	0.013	-0.005	0.032	0.153

Table 4. Regression of adjusted charges on hospital and market characteristics for uncomplicated cesarean sections

	Multiplicative increase for each unit change in predictor	95% CI lower bound	95% CI upper bound	p-value
HOSPITAL-LEVEL CHARACTERISTICS				
Ownership				
Government	-0.146	-0.298	0.006	0.06
NFP	Reference			
FP	0.172	0.032	0.312	0.016
Teaching Status				
Yes	0.062	-0.187	0.311	0.626
No	Reference			
MSA				
Urban	Reference			
Rural	0.088	-0.081	0.257	0.304
Casemix (severity)				
Low	Reference			
Medium	0.087	-0.052	0.225	0.218
High	0.123	-0.019	0.265	0.088
Capacity				
Licensed beds	-0.0002	-0.0006	0.0002	0.363
Payer Mix				
Proportion Medicare	0.491	-0.004	0.986	0.052
Proportion Medicaid	0.112	-0.354	0.578	0.636
Quality Indicators				
Cesarean delivery rate	0.491	-1.659	2.642	0.653
Vaginal birth after cesarean rate (uncomplicated)	0.508	-0.315	1.332	0.225
Primary cesarean delivery rate	-1.192	-2.65	2.262	0.877
MARKET-LEVEL CHARACTERISTICS				
Wage Index				
Low	Reference			
Medium	0.258	0.067	0.449	0.008
High	0.378	0.26	0.497	0
Herfindahl-Hirschman Index (System-wide)				
Low	Reference			
Medium	-0.079	-0.196	0.037	0.183
High	0.012	-0.116	0.14	0.855
% Without Insurance	-0.0003	-0.02	0.019	0.025
% Below Poverty Line	-0.002	-0.019	0.015	0.813

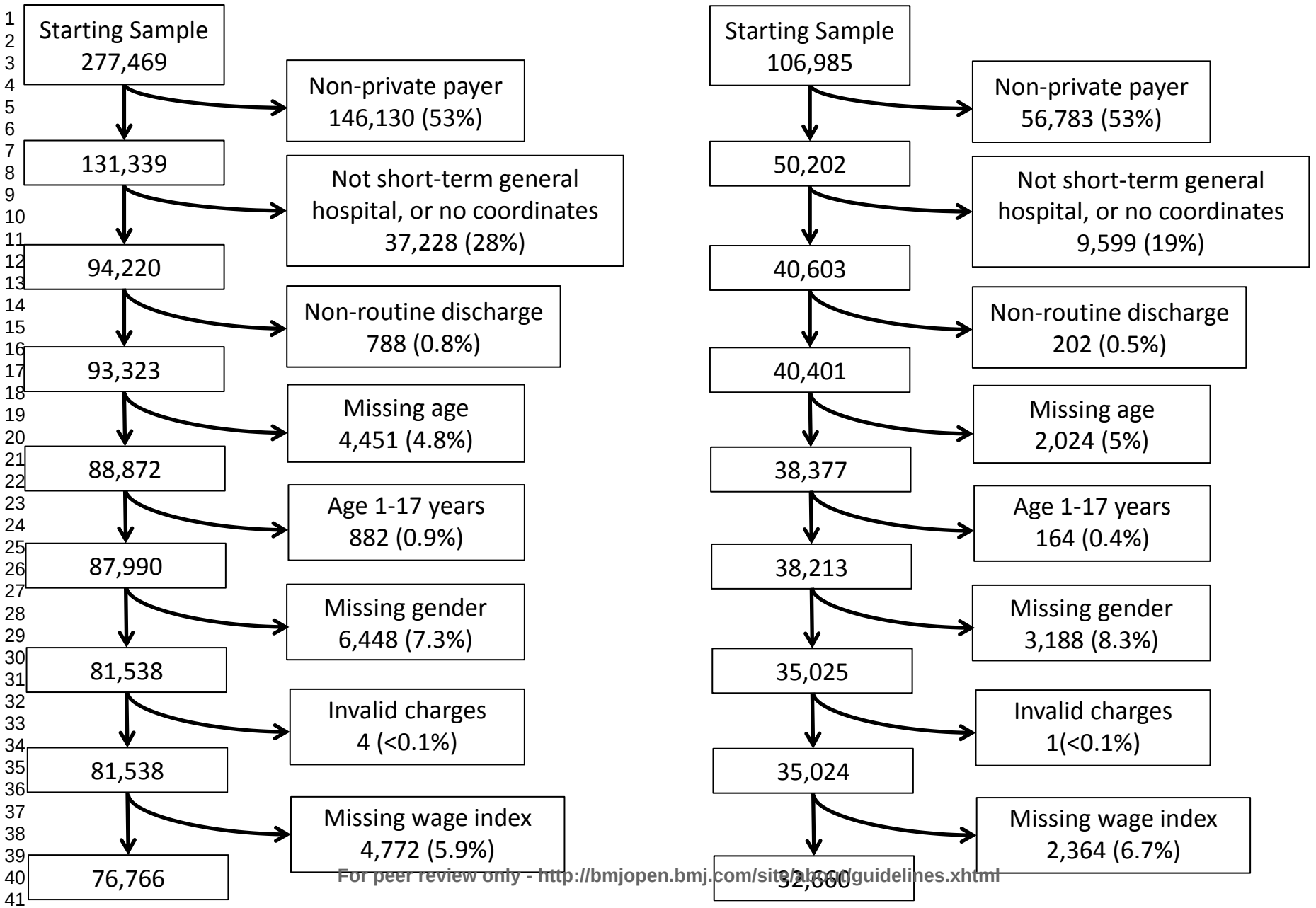
Figure Titles & Legends:

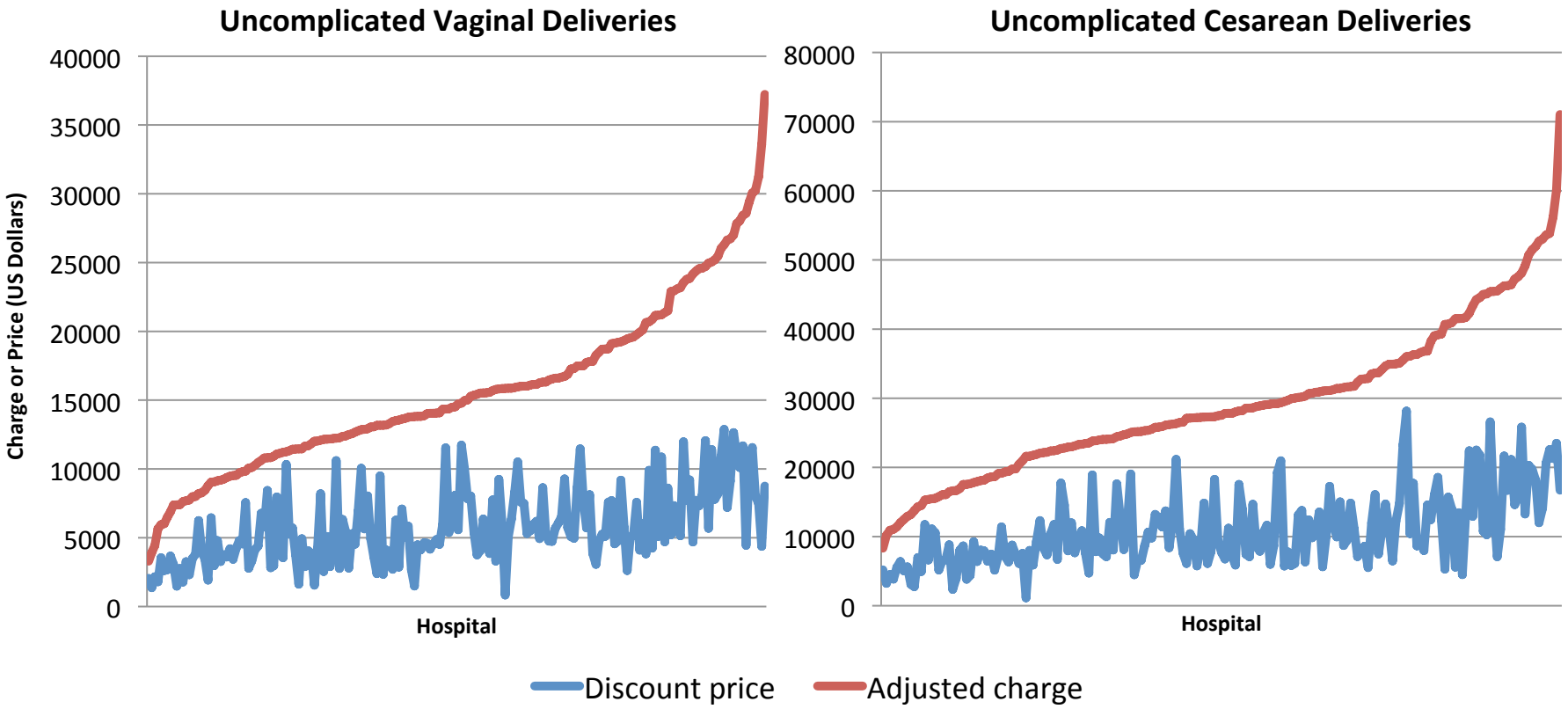
Figure 1. Sample Selection

(no legend)

Figure 2. Adjusted charges and discount prices for uncomplicated vaginal deliveries across California hospitals, 2011

(no legend)




Uncomplicated Vaginal Deliveries
Uncomplicated Cesarean Deliveries
Charge or Price (US Dollars)
40000
35000
30000
25000
20000
15000
10000
5000
0
80000
70000
60000
50000
40000
30000
20000
10000
0
Hospital
Hospital
Discount price
Adjusted charge

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5&6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9
Bias	9	Describe any efforts to address potential sources of bias	8-9
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	7-8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10, Figure 1
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	Figure 1 (excluded – no other missing)
Outcome data	15*	Report numbers of outcome events or summary measures	10-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-12
		(*b*) Report category boundaries when continuous variables were categorized	23-28
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	4

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Analysis of Variation in Charges and Prices Paid for Vaginal and Cesarean Section Births: A Cross-Sectional Study

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Analysis of Variation in Charges and Prices Paid for Vaginal and Cesarean Section Births: A Cross-Sectional Study

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Abstract

Objective: To examine the between-hospital variation of charges and discounted prices for uncomplicated vaginal and cesarean section deliveries, and determine the institutional and market-level characteristics that influence adjusted charges.

Design, Setting, and Participants: Using data from the California Office of Statewide Health Planning and Development (OSHPD), we conducted a cross-sectional study of all privately insured patients admitted to California hospitals in 2011 for uncomplicated vaginal delivery (DRG 775) or uncomplicated cesarean section (DRG 766).

Outcome Measures: Hospital charges and discounted prices adjusted for each patient's clinical and demographic characteristics.

Results: We analyzed 76,766 vaginal deliveries and 32,660 cesarean sections in California in 2011. After adjusting for patient demographic and clinical characteristics, we found that the average California woman could be charged as little as $3,296 or as much as $37,227 for a vaginal delivery, and $8,312 - $70,908 for a cesarean section depending on which hospital she was admitted to. The discounted prices were, on average, 37% of the charges. We found that hospitals in markets with middling competition had significantly lower adjusted charges for vaginal deliveries, while hospitals with higher wage indices and case mixes, as well as for-profit hospitals, had higher adjusted charges. Hospitals in markets with higher uninsurance rates charged significantly less for cesarean sections, while for-profit hospitals and hospitals with higher wage indices charged more. However, the institutional and market level factors included in our models explained only 35-36% of the between-hospital variation in charges.

Conclusions: These results indicate that charges and discounted prices for two common, relatively homogeneous diagnosis groups – uncomplicated vaginal delivery and cesarean section – vary widely between hospitals and are not well explained by observable patient or hospital characteristics.

Article Summary

Article focus:

- Wide variation in both hospital charges and payment rates has been documented by past studies. However, few studies attempt to explain such variation for episodes of care.
- We aimed to (1) document the variation in charges and discounted prices between California hospitals for the same, average woman's hospital stay for a vaginal birth or cesarean section, and (2) analyze whether hospital or market characteristics could explain that between-hospital variation in charges.

Key messages:

- After adjusting for patient clinical and demographic characteristics, charges for the average California mother's uncomplicated vaginal birth ranged from $3,296 to $37,227 depending on which of the 198 hospitals she visited; adjusted charges for cesarean sections ranged from $8,312 to $70,908.
- Discounted prices were 37% of charges, on average (range: 5% - 92%)
- For-profit hospitals, hospitals in areas with high costs of living, and hospitals with more severe case-mixes charged more than their counterparts; however, only 35-36% of charges were explained by the observable hospital and market characteristics in our models.

Strengths and limitations of this study:

- Uses a comprehensive dataset of all visits to California hospitals and links to patient and institutional characteristics, allowing for isolation of between-hospital variation and analysis over a complete population.
- Limitations include use of aggregate discount rates to estimate discounted prices paid, potential residual patient-level variation in care intensity, and inability to completely capture hospital quality.

BACKGROUND

United States healthcare expenditures totaled $2.7 trillion dollars in 2011 - 17.7% of US GDP – and are projected to rise steeply in future years.[1] Unlike most other industries, the way healthcare is priced and paid for is notoriously opaque, making it difficult for patients to act as educated, price-comparing consumers.[2] At a time when out of pocket payments for healthcare are increasing,[3] and growing numbers of "consumer directed" high deductible health plans put more pressure on patients to make cost-efficient healthcare decisions,[4 5] the opacity of healthcare pricing is increasingly concerning.

Recently, hospital charges have come to the forefront of political, popular, and medical discourse due to their inexplicable magnitude and devastating effects on specific patients.[6-8] While insurers typically negotiate lower reimbursements, these full, inflated charges are still billed to the 22% of American adults aged 19-64 who are uninsured and to privately insured patients receiving care out of network,[9 10] contributing in large part to the 57% of US bankruptcies that result from medical bills.[11] Further, charges indirectly affect healthcare pricing for all patients. Many private insurers use charges are the basis of price negotiations;[7 12 13] Medicare uses charges in determining inpatient diagnosis group weighting and outlier payments,[14-17] and also must adapt their prices to private-sector prices.[18] In addition, hospitals use charges in calculations of uncompensated care, which affect their non-profit status and thus many aspects of their business model, participating insurance plans, and prices.[19 20]

Yet despite their consistent use in many forms of healthcare price setting and hospital bills, charges appear to be nearly random, and are either based on outdated, historical methods or set using idiosyncratic, proprietary formulas.[12 13 21] One hospital administrator called his hospital's

method of setting charges "madness."[22] The academic literature has supported this assumption; studies have documented the wide variation in hospital and physician charges and payment rates for the average inpatient stay.[23] Past economics literature has attempted to discern some method to charge setting by documenting the relationship between hospital payment rates and industry organization, and has found for example that less competitive markets have higher predicted prices.[24 25] These studies, however, have mostly addressed broad price indices based on aggregate hospital charges.

Given the wide range of procedures and diagnoses that comprise hospitals' inpatient censuses, it is important to evaluate specific, common episodes of care that should have less variation in charges, and are more relevant to patients presenting with a complaint and no knowledge of the specific services they will need. An ideal service is childbirth, the most common reason for hospitalizations in the US,[26] accounting for 4.2 million inpatient stays and $16.1 billion in hospital costs in 2008.[27] Recently, a study by Truven Health Analytics looked at both charges and discounted prices nationally for vaginal and cesarean childbirth using their own proprietary database of paid medical claims, finding significant variation in both charges and reimbursements.[28] However, the study does not address the possible sources of the variation in charges that it documents.

In this study, we sought to fill this gap by documenting and attempting to explain between-hospital variation in charges for the same, average woman's inpatient stay for vaginal birth or cesarean section in California – relatively homogeneous episodes of care. Our analysis is based on the theory that the variation in charges for these homogeneous episodes of care, once adjusted for patient characteristics, is potentially explained by measurable hospital and market characteristics that govern hospital charge-setting behavior. We first predict charges and

estimated prices paid at each hospital after adjusting for patient characteristics, and then explore whether hospital or market-level characteristics can explain some of this charge variation.

METHODS

Data Source

We used the 2011 California Office of Statewide Health Planning and Development (OSHPD) public Patient Discharge Public Data Set (PDD) to perform our cross-sectional analysis. The OSHPD PDD captures patient demographic and clinical information, along with charges, for each inpatient encounter at California hospitals. Our study was exempt from review by the Committee on Human Research at the University of California, San Francisco because we used a public data source that was masked for identifiers.[1]

To capture hospital-level characteristics, we used OSHPD's hospital financial and utilization files for 2011. We also used the 2009 Area Resources File,[29] the most currently available year, to obtain county-level area percent of uninsurance and poverty, and the Impact Files from the Centers for Medicare & Medicaid Services (CMS), to obtain a hospital wage index.[30]

Sample Selection

We limited our study to adult women (≥ 18 years old) who were admitted for diagnosis-related group (DRG) 775 (uncomplicated vaginal delivery) or 766 (uncomplicated cesarean section) at short-term general California hospitals. We also only included privately insured

[1] OSHPD masks selective patient information in this public dataset to prevent identification of individuals pursuant to the California Health Data and Advisory Council Consolidation Act, Health and Safety Code section 128675 et seq.

women (47.5% of DRG 775; 47.1% of DRG 766), as our estimated discount rate only applies to them. Patients admitted to federal hospitals (e.g. Veterans Administration hospitals) are not in our data as OSHPD reporting requirements do not apply to such hospitals. Also, privately insured women who receive care through the Kaiser Permanente network were excluded, as Kaiser hospitals do not report charges to the state (29.4% of DRG 775; 19.7% of DRG 766).

To restrict our sample to a relatively healthy and more homogenous population, we excluded patients who died in the hospital or who did not have a routine discharge. We further excluded patients without a valid age group or gender recorded, as we could not accurately adjust for their demographic predictors of charge. We also excluded patients with invalid charges, those receiving charitable care, and those with charges too large to fit within the charge variable's character limit. Finally, we excluded patients visiting hospitals that did not report a wage index. See Figure 1 for a full description of the applied exclusions.

Outcome

Our first outcome was hospital charges, which are the total dollar amounts billed by the hospital for each admission, excluding physician fees. These charges reflect the hospital's full, established rates before contractual adjustments and prepayments.

Our secondary outcome was estimated discounted prices, or the amounts which hospitals received from private insurers for the services their enrollees received. We obtained this by multiplying the total charge billed to the patient with the hospital's discount rate for privately insured patients. As done in previous literature, the discount rate for privately insured patients at each hospital was calculated using the formula: (gross inpatient revenue + gross outpatient

revenue - contractual adjustments)/(gross inpatient revenue + gross outpatient revenue).[24 31] We obtained these amounts through the 2011 OSHPD financial files for each hospital.

Statistical analysis

Our analysis is similar to the two-stage approach used by previous economic analyses.[24 32] The approach first separates out patient-level charge variation within each hospital and estimates childbirth charges for the average California woman at each hospital, and then looks at the independent influence of the hospital and market characteristics on variation in those estimated charges across hospitals. Estimates from this two-stage approach can be mapped to estimates from hierarchical models, in the sense that they allow for random effects in the intercept coefficient. However, for our purposes, the two-stage model is preferable because we are interested in explaining variation in *expected* charges using observable hospital characteristics. For all analyses, charges are logged to account for the right skew. We performed separate analysis for each DRG.

In the first stage, to control for patient-level variation in charges, we regressed logged raw charges on patient characteristics shown in previous literature to be correlated with charges for the price indices and line item charges.[33 34] Patient characteristics included age (in two categories: 18-34, and ≥ 35), number of conditions present on admission, Charlson comorbidities, and length of stay. We chose the 18-34 and ≥ 35 maternal age groups because 35 years old is the cutoff at which the American Congress of Obstetricians and Gynecologists generally defines "advanced maternal age," which has been associated with increased risk of complications for both the mother and the infant.[35-37] Because length of stay is also often right-skewed, we transformed it to log (length of stay + 1). We included three different types of private insurance, including two forms

of managed care (Knox-Keene/Medi-Cal County Organized Health System, or other), and traditional private coverage. To control for unobservable within-hospital factors that could affect variation, we also included a dummy variable for each hospital. Errors from this regression are clustered at the hospital level. Results of these regressions are shown in Supplementary Tables 1 & 2.

From this regression, we then calculated a given hospital's adjusted charge for the average statewide patient for that DRG, where the adjusted charges represented standardized log charge/(day + 1). This gave us a single adjusted charge per day for each hospital, representing the predicted charge for a patient with the same, average clinical and demographic characteristics, which we then used as the dependent variable in our second-stage regression.

In the second stage, we regressed our adjusted logged charges on hospital and market level factors cited by previous literature as related to broad price indices,[24 32 38] to determine which characteristics explain observed between-hospital variation in charges for childbirth. Hospital-level factors included ownership (not-for-profit, for-profit, government), teaching status, urban/rural location, capacity (number of licensed beds), patient payer mix (proportion Medicare, Medicaid), and case-mix (which was used to adjust the average cost per patient for a given hospital relative to the adjusted average cost for other hospitals).[39] We also incorporated three quality measures from the Agency for Healthcare Research Quality's Inpatient Quality Indicators (IQIs): cesarean delivery rate, vaginal birth after cesarean rate (uncomplicated), and primary caesarian delivery rate.[40] These utilization indicators are intended to capture either over-use of procedures found to be unnecessary or low quality, or under-use of procedures with merit, such as vaginal birth after prior cesarean delivery.[41] We further incorporated market-level factors

including the wage index, percent uninsured in the county, percent below the poverty line in the county, as well as the system-wide Herfindahl-Hirschman Index (HHI).

The HHI is a widely used economic measure of the degree of competition faced by a company, or in this case hospital, within its market.[42] It is calculated as the sum of the squares of market shares for each hospital in a given market. Higher HHIs are associated with less competition, while lower HHIs indicate more competitive markets. We calculated these shares of patients directly from the hospital discharge data. Our HHI calculation also accounts for membership in a hospital system, which has been shown to influence hospital price setting.[38]

RESULTS

Sample

We analyzed a sample of 76,766 uncomplicated vaginal deliveries, and 32,660 uncomplicated cesarean sections in 2011 across 198 and 195 California hospitals, respectively. As shown in Table 1, 78.4% of women with uncomplicated vaginal deliveries were between the ages of 18-34, and 97.9% had a Charlson comorbidity index of 0, indicating that they were relatively healthy. The length of stay for 77.8% of these women was less than 3 days. For the 32,660 women with uncomplicated cesarean sections (Table 2), the majority (69.5%) were again between ages 18-34, almost all (97.2%) had a Charlson comorbidity index of 0, and 77.5% had a hospital stay between 3 to 6 days. For both DRGs, the majority of hospitals were not-for-profit, non-teaching hospitals located in urban areas.

Charges

We found that the raw charges for uncomplicated vaginal birth ranged from $3,344 to $43,715, with a median charge of $15,278 (IQR $7,981). Once adjusted for patient clinical and demographic characteristics, charges for the average patient ranged from $3,296 to $37,227, depending on which of the 198 hospitals she visited (median $14,620; IQR $7,643). For uncomplicated cesarean sections, the raw charges ranged from $7,905 to $72,569, with a median charge of $27,517 (IQR $14,206). Adjusted charges ranged from $8,312 to $70,908 with a median charge of $27,481 (IQR $12,525), again for a patient with the same average characteristics.

Estimated discounted price

Discounted prices paid by private insurers ranged from 5% to 92% of the charge, with an average of 37%. Discounted prices for vaginal deliveries ranged from $835 to $12,873 (median $5,123; IQR $3,827), and prices for cesarean sections varied from $1,135 to $28,105 (median $9,640; IQR $6,631). For vaginal births, the largest difference between a hospital's adjusted charge and estimated discount price was $29,217, where it charged $33,593 for an average patient, almost eight times the $4,376 it finally received from insurers. The smallest difference was just $920, where the hospital's average charge ($11,251) was a mere 109% higher than its estimated price ($10,332). For uncomplicated cesarean sections, the differences were even more dramatic – one hospital charged 1899% of what it typically received, while another charged 124%. Figure 2 illustrates the differences between the adjusted charges and discounted prices for each hospital in our dataset for the two conditions.

Hospital and market-level factors

In the multivariate model using adjusted charges across hospitals as the dependent variable, for uncomplicated vaginal delivery, hospitals with for-profit ownership, severe case-mixes, and high wage indices charged significantly more than their counterparts (Table 3).

For uncomplicated cesarean section (Table 4), again charge was associated with ownership. Government-owned hospitals had 14.6% lower charges (95% CI -29.8, 0.6), while for-profit hospitals had 17.2% higher charges (95% CI 3.2, 31.2) than non-profit hospitals. This implies that if the mean charge for uncomplicated cesarean section, $29,480, was offered at a non-profit hospital, the adjusted charge in a government hospital would be $25,176 and the adjusted charge in a for-profit hospital would be $34,551. Also similar to our findings with uncomplicated vaginal births, hospitals with higher labor costs (wage index) had higher charges. The case-mix was no longer predictive, but a higher rate of percent uninsured in the county was significantly correlated with lower charges. Though the significance was marginal, the proportion of patients covered by Medicare was also associated with higher charges.

DISCUSSION

Our results demonstrate the wide variability of charges and prices for childbirth between hospitals, even after controlling for patient characteristics, and point to specific institutional and market-level factors that affect those standardized charges. Even after adjusting for patient demographic and clinical characteristics, we found that charges for vaginal births ranged from $3,296 to $37,227, and charges for cesarean sections ranged from $8,312 to $70,908, depending only on which hospital the average California woman giving birth visited. That implies that, after adjusting for patient characteristics, the highest hospital charge was more than 11 times that of the lowest hospital charge for vaginal births, and more than 8.5 times that of the lowest hospital

charge for cesarean section births. Without adjusting for patient characteristics, the hospital with the highest charges would charge about 13 times more than the hospital with the lowest charges for vaginal births, and about 9 times more than the hospital with the lowest charges for cesarean sections. While the variation of adjusted charges is, as expected, smaller than the variation in raw charges between hospitals, the very small difference between the two implies that service-intensity and patient observable factors provide little explanation for variation in charges between hospitals.

Our findings show that some hospital and market-level factors, on the other hand, do clearly impact the differences in charges between hospitals. We find a positive relationship between charges for childbirth and hospital wage index, case-mix index, and for-profit ownership. However, it is probably more notable how *few* of the hospital and market-level regressors are significant in explaining the variation. Our vaginal and cesarean delivery models account for only 36% and 35%, respectively, of the variation observed between hospitals in adjusted charges. This implies that either the variation is a result of (a) unobservable hospital characteristics or (b) pure noise.

Based on findings from the existing literature, we hypothesize that the variation we find is more likely random than due to unobservable hospital characteristics. A MedPAC study of hospitals found that many items on chargemasters were based on historical prices, which were formulated before it was possible to accurately estimate costs.[21] Even today, the survey found that only a third of hospitals reported any concern regarding covering operating costs when updating their chargemasters. Rather, most were concerned with conforming to regulations and maintaining their overall bottom line.[21] Today, even for new services providers are not incentivized to set charges based on costs, because third party payments are largely not based on true costs for a

given service.[12 23] This therefore precludes a valuable correlation between cost and charge and thus an anchor on which charge variation would be limited.[12] In addition, the current lack of correlation between cost and charge is exacerbated by simplistic "updates" in the form of across the board percentage increases of charges, often resulting in certain services subsidizing others to manage the overall solvency of the hospital or department.[12 21 43] Thus, our results again confirm the documented lack of comprehensible or at least measurable sense in the chargemaster system.

The troubling part of this largely random variation is that charges do still matter to patients and to hospitals in many ways. The 41.9 million uninsured Americans, along with privately insured patients visiting an out-of-network hospital may be faced with the full charges for their care, which are typically so high that few patients can pay them, resulting in need for charity care, sliding scale payments, or often bad debt on the patient's part.[13 44] In addition, as some private insurers still negotiate discounts off charges, especially in fee-for-service systems, and use charges to benchmark the relative weights in their prospective payment systems, higher charges can lead to higher out of pocket payments for patients.[3 12 13] Medicare also compares charges between DRG groups modified by cost-to-charge ratios calculated at the cost center level to determine the relative weight of DRG's and identify qualifying outlier payments within DRGs.[14-17] Finally, many hospitals use charges to calculate their uncompensated care costs, which affect their not-for-profit and hence tax exempt status. In fact, the IRS found that 18-20% of hospitals include the difference between charges and allowed payments by private insurers, and 50% include the difference between charges and payments received from the uninsured in their uncompensated care calculations.[19 20]

A secondary finding in this study is the large discrepancy between hospitals' predicted charges and their estimated discounts. Our finding that insurers pay on average 37% of charges is

supported by previous literature showing that private insurers pay on average 39% of the charge for hospital inpatient services.[45 46] We estimated median payments of $5,123 for vaginal and $9,640 for cesarean section births, slightly lower than the Truven estimates of $8,519 and $12,894, respectively.[28] The difference between the adjusted charge and discounted price estimates what could be considered "excess charges", and in 2011 sums to $1.36 billion dollars for all uncomplicated vaginal and cesarean births in California ($760.1 million for uncomplicated vaginal deliveries; $601.1 million for uncomplicated cesarean sections).

Past literature has speculated two reasons for high charges relative to reimbursements. First is the change in Medicare's reimbursement protocol from the historical cost-plus reimbursement system to today's prospective payment system.[43] Because providers were paid a percentage above the charged rate, it was in the providers' financial interest to maintain exorbitant charges, a practice that has persisted despite the change in reimbursement. Second, in fee-for-service payments for which reimbursements are simple discounts of charges, hospitals are incentivized to raise their charges in an effort to increase reimbursement. Finally, hospitals may be setting artificially inflated charges to increase the nominal value of their uncompensated care indices, which are based on charges.[20 47]

Limitations of Research

There are several limitations of this study. First, we used DRGs to determine what constituted an episode of care. The MS-DRG system was designed to classify patients into groups based on likely utilization of services and accumulation of costs. However, because the administrative data we used does not provide charge itemization, it is very likely that some women received greater "intensity" of services in unobservable ways. For instance, if one woman

received an epidural, and another woman did not, we might expect the woman with the epidural to have higher charges. As much as possible, we are minimizing fallout from this limitation by using observable attributes of the episode (e.g. length-of-stay, discharge, comorbidities) in our first-stage regression, which should absorb some of the patient-level differences in care intensity. It is possible, however, that if unobservable patient characteristics affecting intensity of care are correlated with hospital characteristics, we might expect our second stage estimates to be biased. On the other hand, if treatment intensity is a hospital-level characteristic, then our analysis does accurately capture this.

Second, our brief analysis of discounted prices is limited by the fact that we must estimate discount rates, since insurers and providers carefully guard their actual payment rates as proprietary. The financial data we used is self-reported, and thus the accuracy of our estimates is dependent on the accuracy of hospital reporting to OSHPD. However, inaccuracies are not a big concern as OSHPD performs systematic financial audits of their data. Further, the discount rates are hospital-wide and aggregate across all insurers, while negotiations regarding discount rates granted by a given hospital may vary widely by particular insurer and according to DRG or cost center. It is partly because of this significant limitation that we chose to focus our main results on charges and the factors affecting them. That said, our estimated prices were roughly consistent with the Truven study, which did have access to claims-based prices paid. [28] In addition, discounted rates negotiated by insurers have been found to be broadly applied to wide swaths of services, as the main goal of such negotiations is overall solvency.[48] Further, modifications to charges at the aggregate level are regularly used in institutional practice, such as cost to charge ratios used by Centers for Medicare and Medicaid Services (CMS) to estimate outlier payments, which have been shown to be imperfect but generally appropriate estimates of cost.[49]

Third, our study only examines charges in California. Though California is a large, diverse state, our results cannot be generalized to the entire nation. Last, our study could not examine the full effect of quality of care on hospital price premiums, though we included select quality indicators. However, it is difficult to imagine that these variations could be attributed entirely to quality, given numerous studies demonstrating that both charges and payments are unrelated to quality, which we similarly found in our analysis of three quality measures.[50 51]

CONCLUSIONS

For the same average patient in California, we find that charges for uncomplicated vaginal delivery ranged from $3,296 to $37,227 (median: $14,620), and charges for uncomplicated cesarean section ranged from $8,312 to $70,908 (median: $27,481) depending on which hospital she visited. Hospital ownership, case-mix, wage index, percent uninsured in the county, and market competitiveness had a significant impact on these adjusted charges. Estimated discounted prices averaged 37% of the adjusted charges. Our findings indicate that the charge faced by a patient for a common obstetrical procedure is significantly influenced by institutional and market-level factors outside of her own presentation, but that the majority of variation in charges between hospitals she could visit remains unexplained. Our results also suggest significant room for improved methodologies, incentives, and policy interventions for accurately estimating and presenting charges and ultimate costs.

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Authors' Contributions

RYH conceived of the study, obtained the data, directed and interpreted the analyses, and helped draft and edit the manuscript. YAA helped conceive the study design, analyzed the data, interpreted the results, and edited the manuscript. EW contributed to methodological design, analyzed the data and interpreted the results, and helped with editing of the manuscript. All authors have read and approved the final manuscript.

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Competing Interests:

None of the authors have any competing interests to report

Data Sharing Statement

All datasets used in this study are available to the public through the California Office of Statewide Health Planning and Development (OSHPD), either by download or by request at: http://oshpd.ca.gov.

REFERENCES:

1. Office of the Actuary. National Health Expenditure Projections 2011-2021: Centers for Medicare and Medicaid Services, 2011.

2. Government Accountability Office (GAO). Meaningful Price Information Is Difficult for Consumers to Obtain Prior to Receiving Care. GAO-11-791; 2011.

3. Truffer CJ, Keehan S, Smith S, et al. Health spending projections through 2019: the recession's impact continues. *Health Aff (Millwood)* 2010;29(3):522-29.

4. The Kaiser Family Foundation, Health Research & Educational Trust. Employer Health Benefits 2012 Annual Survey, 2012.

5. Robinson JC, Ginsburg PB. Consumer-driven health care: promise and performance. *Health Aff (Millwood)* 2009;28(2):w272-81.

6. Brill S. Bitter Pill: Why Medical Bills Are Killing Us. *TIME Magazine* Feb 20, 2013.

7. Selberg J, Marks CM. A Problem Too Big to See: The Sobering Reality of Hospital Pricing: Institute for Healthcare Improvement; 2013.

8. Salam R. Guest Post by Oren Cass: What Steven Brill Gets Wrong on U.S. Health Care Costs. *The National Review Online.* Feb 28, 2013.

9. Anderson GF. From 'Soak The Rich' To 'Soak The Poor': Recent Trends In Hospital Pricing. *Health Aff (Millwood)* 2007;26(3):780-89.

10. DeNavas-Walt C, Proctor B, Smith J. Income, Poverty, and Health Insurance Coverage in he United States: 2011. In: Bureau UC, editor. *Current Population Reports*. Washington, D.C., 2012.

11. Himmelstein DU, Thorne D, Warren E, et al. Medical Bankruptcy in the United States, 2007: Results of a National Study. *Am J Med* 2009;122(8):741-46.

12. Ginsburg PB, Grossman JM. When the price isn't right: how inadvertent payment incentives drive medical care. *Health Aff (Millwood)* 2005:W5.

13. Reinhardt UE. The Pricing Of U.S. Hospital Services: Chaos Behind A Veil Of Secrecy. *Health Aff (Millwood)* 2006;25(1):57-69.

14. Medicare Program; Change in Methodology for Determining Payment for Extraordinarily High-Cost Cases (Cost Outliers) Under the Acute Care Hospital Inpatient and Long-Term Care Hospital Prospective Payment Systems; Final Rule. 68 *Federal Register* 110. (June 9, 2003): 34494-504.

15. Medicare Program; Changes to the Hospital Inpatient Prospective Payment Systems and Fiscal Year 2007 Rates; Fiscal Year 2007 Occupational Mix Adjustment to Wage Index;

Health Care Infrastructure Improvement Program; Selection Criteria of Loan Program for Qualifying Hospitals Engaged in Cancer-Related Health Care and Forgiveness of Indebtedness; and Exclusion of Vendor Purchases Made Under the Competitive Acquisition Program (CAP) for Outpatient Drugs and Biologicals Under Part B for the Purpose of Calculating the Average Sales Price (ASP); Final Rules & Interim Final Rule With Comment Period. 71 *Federal Register* 160. (August 18, 2006): 47870 -8351.

16. Medicare Program; Proposed Changes to the Hospital Inpatient Prospective Payment Systems and Fiscal Year 2009 Rates; Proposed Changes to Disclosure of Physician Ownership in Hospitals and Physician Self-Referral Rules; Proposed Collection of Information Regarding Financial Relationships Between Hospitals and Physicians; Proposed Rule. 73 *Federal Register* 84. (April 30, 2008): 23542-47.

17. Carter GM, Rogowski JA. The Hospital Relative Value Method as an Alternative for Recalibrating DRG Relative Weights: RAND/UCLA/Harvard Center for Health Care Financing Policy Research, 1993.

18. Reinhardt UE. The disruptive innovation of price transparency in health care. *JAMA* 2013;310(18):1927-28.

19. Internal Revenue Service. IRS Exempt Organizations (TE/GE) Hospital Compliance Project Final Report, 2006:98.

20. Capps C, David G, Carlton D. Antitrust Treatment of Nonprofits: Should Hospitals Receive Special Care? *University of Chicago George J. Stigler Center for the Study of the Economy and the State Working Paper.* 2010(232).

21. Dobson AJ, DaVanzo J, Doherty J, et al. A Study of Hospital Charge Setting Practices: Lewin Group, 2005.

22. Lagnado L. California Hospitals Open Books, Showing Huge Price Differences. *Wall Street Journal.* December 27, 2004.

23. Ginsburg PB. Wide variation in hospital and physician payment rates evidence of provider market power: Center for Studying Health System Change; 2010.

24. Gaynor M, Vogt WB. Competition among hospitals. *RAND J Econ* 2003;34(4):764-85.

25. Melnick GA, Zwanziger J, Bamezai A, et al. The effects of market structure and bargaining position on hospital prices. *J Health Econ* 1992;11(3):217-33.

26. Vashi AA, Fox JP, Carr BG, et al. Use of hospital-based acute care among patients recently discharged from the hospital. *JAMA* 2013;309(4):364-71.

27. Podulka J, Stranges E, Steiner C. Hospitalizations Related to Childbirth, 2008: Statistical Brief #110: Agency for Healthcare Research and Quality, 2011.

28. Truven Health Analytics. The Cost of Having a Baby in the United States, 2013.

29. Health Resources and Services Administration. Area Resource File: US Department of Health and Human Services; 2009.

30. Centers for Medicare and Medicaid Services. Historical Impact Files: US Department of Health and Human Services; 2011.

31. Dranove D, Lindrooth R, White WD, et al. Is the impact of managed care on hospital prices decreasing? *J Health Econ* 2008;27(2):362-76.

32. Keeler E, Melnick G, Zwanziger J. The changing effects of competition on non-profit and for-profit hospital pricing behavior. *J Health Econ* 1999;18(1):69-86.

33. Lynk WJ. One DRG, One Price? The Effect of Patient Condition on Price Variation within DRGs and across Hospitals. *Int J Health Care Finance Econ* 2001;1(2):111-37.

34. Hsia RY, Kothari AH, Srebotnjak T, et al. Health Care as a" Market Good"? Appendicitis as a Case Study. *Arch Intern Med* 2012;172(10):818-819.

35. Cleary-Goldman J, Malone FD, Vidaver J, et al. Impact of maternal age on obstetric outcome. *Obstet Gynecol* 2005;105(5, Part 1):983-90.

36. Berkowitz GS, Skovron ML, Lapinski RH, et al. Delayed Childbearing and the Outcome of Pregnancy. *N Engl J Med* 1990;322(10):659-64.

37. American College of Obstetricians and Gynecologists. Screening for Fetal Chromosomal Abnormalities. *Practice Bulletin*, No. 77; 2007.

38. Melnick G, Keeler E. The effects of multi-hospital systems on hospital prices. *J Health Econ* 2007;26(2):400-13.

39. California Office of Statewide Health Planning and Development. Calculation of the Office of Statewide Health Planning and Development's (OSHPD) Case Mix Index (CMI).

40. Agency for Healthcare Research and Quality. Inpatient Quality Indicators Technical Specifications, Version 4.4, 2012.

41. Davies SM, Geppert JJ, McClellan M, et al. Refinement of the HCUP Quality Indicators: Agency for Healthcare Research and Quality. AHRQ Publication No. 01-0035; 2001.

42. US Department of Justice and the Federal Trade Commission. Horizontal Merger Guidelines., 2010.

43. Kaplan RS, Porter ME. How to solve the cost crisis in health care. *Harvard Business Review* 2011;89(9):46-52.

44. Reinhardt U. What Hospitals Charge the Uninsured. *The New York Times* March 15, 2013.

45. Ginsburg PB. Shopping for price in medical care. *Health Aff (Millwood)* 2007;26(2):w208-16.

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

47. David G, Helmchen LA. The Role of Task Adhesion in Limiting Specialization along the Medical Care Continuum. *Labour* 2011;25(1):24-44.

48. Reinhardt U. How Do Hospials Get Paid? A Primer. *The New York Times* January 23, 2009.

49. Shwartz M, Young DW, Siegrist R. The ratio of costs to charges: how good a basis for estimating costs? *Inquiry* 1995;32(4):476-81.

50. Commonwealth of Massachusetts Division of Health Care Finance and Policy. Recommendations of the Special Commission on Provider Price Reform, 2011.

51. Massachusetts Attorney General. Examination of Health Care Cost Trends and Cost Drivers: Report for Annual Public Hearing, 2011.

Tables

Table 1. Characteristics of study sample for uncomplicated vaginal deliveries (DRG 775)

PATIENT-LEVEL CHARACTERISTICS (n=76,766)			
Age categories	**N**	**Percent**	
18-34	60,175	78.39%	
35-64	16,591	21.61%	
Sex			
Male	0	0.00%	
Female	76,766	100.00%	
Private Insurance Type			
Managed Care-Knox Keene	34,387	44.79%	
Managed Care-Other	36,414	47.44%	
Traditional Coverage	5,965	7.77%	
Charlson Comorbidity Index			
0	75,182	97.94%	
1	1,555	2.03%	
2	29	0.03%	
Length of Stay			
Less than 3 days	59,724	77.80%	
3-6 days	16,826	21.92%	
Greater than 6 days	216	0.28%	
HOSPITAL-LEVEL CHARACTERISTICS (n=198)			
Ownership			
Government	32	16.16%	
NFP	127	64.14%	
FP	39	19.70%	
Location			
Urban	174	87.88%	
Rural	24	12.12%	
Teaching Status			
Yes	20	10.10%	
No	178	89.90%	
Casemix (severity)	**N**	**Mean**	**SD**
Low	66	1.283	0.121
Medium	66	1.555	0.053
High	66	1.787	0.138
Capacity			
Licensed Beds	198	280.45	180.366
Payer Mix			
% Medicare	198	37.79%	12.38%
% Medicaid	198	28.13%	15.68%

MARKET-LEVEL CHARACTERISTICS			
	N	**Mean**	**SD**
Wage Index			
Low	121	1.196	0.007
Medium	12	1.223	0.01
High	65	1.486	0.142
Herfindahl-Hirschman Index			
Low	67	1178	629
Medium	70	3351	721
High	61	6831	1986
% Without Insurance	198	18.31%	3.77%
% Below Poverty Line	198	13.80%	4.41%

Table 2. Characteristics of study sample for uncomplicated cesarean sections (DRG 766)

PATIENT-LEVEL CHARACTERISTICS (n=32,660)			
Age categories	**N**	**Percent**	
18-34	22,694	69.49%	
35-64	9,966	30.51%	
Sex			
Male	0	0.00%	
Female	32,660	100.00%	
Private Insurance Type			
Managed Care-Knox Keene	14,696	45.00%	
Managed Care-Other	15,237	46.65%	
Traditional Coverage	2,727	8.35%	
Charlson Comorbidity Index			
0	31,756	97.23%	
1	894	2.74%	
2	10	0.03%	
Length of Stay			
Less than 3 days	7,172	21.96%	
3-6 days	25,325	77.54%	
Greater than 6 days	163	0.50%	
HOSPITAL-LEVEL CHARACTERISTICS (n=195)			
Ownership			
Government	30	15.38%	
NFP	127	64.14%	
FP	38	19.49%	
Location			
Urban	171	87.69%	
Rural	24	12.31%	
Teaching Status			
Yes	18	9.23%	
No	177	90.77%	
Casemix (severity)	**N**	**Mean**	**SD**
Low	65	1.287	0.125
Medium	65	1.559	0.052
High	65	1.789	0.138
Capacity			
Licensed Beds	195	279.672	180.807
Payer Mix			
% Medicare	195	37.94%	12.06%
% Medicaid	195	27.96%	15.64%

MARKET-LEVEL CHARACTERISTICS			
Wage Index	**N**	**Mean**	**SD**
Low	119	1.196	0.007
Medium	12	1.223	0.01
High	64	1.484	0.142
Herfindahl-Hirschman Index			
Low	72	1283	713
Medium	59	3440	591
High	64	6809	2115
% Without Insurance	195	18.30%	3.66%
% Below Poverty Line	195	13.77%	4.43%

Table 3. Regression of adjusted charges on hospital and market characteristics for uncomplicated vaginal deliveries

	Multiplicative increase for each unit change in predictor	95% CI lower bound	95% CI upper bound	p-value
HOSPITAL-LEVEL CHARACTERISTICS				
Ownership				
Government	-0.096	-0.249	0.057	0.217
NFP	Reference			
FP	0.198	0.0475	0.348	0.010
Teaching Status				
Yes	-0.049	-0.317	0.22	0.719
No	Reference			
MSA				
Urban	Reference			
Rural	0.022	-0.144	0.19	0.849
Casemix (severity)				
Low	Reference			
Medium	0.104	-0.044	0.252	0.166
High	0.196	0.044	0.349	0.012
Capacity				
Licensed beds	0.0003	-0.0001	0.0007	0.234
Payer Mix				
Proportion Medicare	0.263	-0.352	0.878	0.400
Proportion Medicaid	-0.002	-0.442	0.437	0.992
Quality Indicators				
Cesarean delivery rate	-0.097	-2.407	2.212	0.934
Vaginal birth after cesarean rate (uncomplicated)	0.415	-0.528	1.357	0.386
Primary cesarean delivery rate	0.208	-2.32	2.737	0.871
MARKET-LEVEL CHARACTERISTICS				
Wage Index				
Low	Reference			
Medium	0.202	0.0276	0.376	0.023
High	0.409	0.271	0.547	<0.001
Herfindahl-Hirschman Index (System-wide)				
Low	Reference			
Medium	0.012	-0.116	0.139	0.857
High	0.005	-0.14	0.149	0.951
% Without Insurance	-0.012	-0.033	0.009	0.259
% Below Poverty Line	0.013	-0.005	0.032	0.153

Table 4. Regression of adjusted charges on hospital and market characteristics for uncomplicated cesarean sections

	Multiplicative increase for each unit change in predictor	95% CI lower bound	95% CI upper bound	p-value
HOSPITAL-LEVEL CHARACTERISTICS				
Ownership				
Government	-0.146	-0.298	0.006	0.060
NFP	Reference			
FP	0.172	0.032	0.312	0.016
Teaching Status				
Yes	0.062	-0.187	0.311	0.626
No	Reference			
MSA				
Urban	Reference			
Rural	0.088	-0.081	0.257	0.304
Casemix (severity)				
Low	Reference			
Medium	0.087	-0.052	0.225	0.218
High	0.123	-0.019	0.265	0.088
Capacity				
Licensed beds	-0.0002	-0.0006	0.0002	0.363
Payer Mix				
Proportion Medicare	0.491	-0.004	0.986	0.052
Proportion Medicaid	0.112	-0.354	0.578	0.636
Quality Indicators				
Cesarean delivery rate	0.491	-1.659	2.642	0.653
Vaginal birth after cesarean rate (uncomplicated)	0.508	-0.315	1.332	0.225
Primary cesarean delivery rate	-1.192	-2.65	2.262	0.877
MARKET-LEVEL CHARACTERISTICS				
Wage Index				
Low	Reference			
Medium	0.258	0.067	0.449	0.008
High	0.378	0.26	0.497	<0.001
Herfindahl-Hirschman Index (System-wide)				
Low	Reference			
Medium	-0.079	-0.196	0.037	0.183
High	0.012	-0.116	0.14	0.855
% Without Insurance	-0.0003	-0.02	0.019	0.025
% Below Poverty Line	-0.002	-0.019	0.015	0.813

Figure Titles & Legends:

Figure 1. Sample selection

(no legend)

Figure 2. Adjusted charges and discount prices for uncomplicated vaginal deliveries and uncomplicated cesarean sections across California hospitals, 2011

(no legend)

Analysis of Variation in Charges and Prices Paid for Vaginal and Cesarean Section Births:

A Cross-Sectional Study

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Abstract

Objective: To examine the between-hospital variation of charges and discounted prices for uncomplicated vaginal and cesarean section deliveries, and determine the institutional and market-level characteristics that influence adjusted charges.

Design, Setting, and Participants: Using data from the California Office of Statewide Health Planning and Development (OSHPD), we conducted a cross-sectional study of all privately insured patients admitted to California hospitals in 2011 for uncomplicated vaginal delivery (DRG 775) or uncomplicated cesarean section (DRG 766).

Outcome Measures: Hospital charges and discounted prices adjusted for each patient's clinical and demographic characteristics.

Results: We analyzed 76,766 vaginal deliveries and 32,660 cesarean sections in California in 2011. After adjusting for patient demographic and clinical characteristics, we found that the average California woman could be charged as little as $3,296 or as much as $37,227 for a vaginal delivery, and $8,312 - $70,908 for a cesarean section depending on which hospital she was admitted to. The discounted prices were, on average, 37% of the charges. We found that hospitals in markets with middling competition had significantly lower adjusted charges for vaginal deliveries, while hospitals with higher wage indices and case mixes, as well as for-profit hospitals, had higher adjusted charges. Hospitals in markets with higher uninsurance rates ~~Government hospitals~~ charged significantly less for cesarean sections, while for-profit hospitals and hospitals with higher wage indices ~~hospitals in markets with higher uninsurance rates~~ charged more. However, the institutional and market level factors included in our models explained only 35-36% of the between-hospital variation in charges.

Conclusions: These results indicate that charges and discounted prices for two common, relatively homogeneous diagnosis groups – uncomplicated vaginal delivery and cesarean section – vary widely between hospitals and are not well explained by observable patient or hospital characteristics.

Article Summary

Article focus:

- Wide variation in both hospital charges and payment rates has been documented by past studies. However, few studies attempt to explain such variation for episodes of care.
- We aimed to (1) document the variation in charges and discounted prices between California hospitals for the same, average woman's hospital stay for a vaginal birth or cesarean section, and (2) analyze whether hospital or market characteristics could explain that between-hospital variation in charges.

Key messages:

- After adjusting for patient clinical and demographic characteristics, charges for the average California mother's uncomplicated vaginal birth ranged from $3,296 to $37,227 depending on which of the 198 hospitals she visited; adjusted charges for cesarean sections ranged from $8,312 to $70,908.
- Discounted prices were 37% of charges, on average (range: 5% - 92%)
- For-profit hospitals, hospitals in areas with high costs of living, and hospitals with more severe case-mixes charged more than their counterparts; however, only 35-36% of charges were explained by the observable hospital and market characteristics in our models.

Strengths and limitations of this study:

- Uses a comprehensive dataset of all visits to California hospitals and links to patient and institutional characteristics, allowing for isolation of between-hospital variation and analysis over a complete population.
- Limitations include use of aggregate discount rates to estimate discounted prices paid, potential residual patient-level variation in care intensity, and inability to completely capture hospital quality.

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Competing Interests:

None of the authors have any competing interests to report.

BACKGROUND

United States h~~H~~ealthcare expenditures ~~in 2011~~ totaled $2.7 trillion dollars in 2011 - 17.7% of US GDP – and are projected to rise steeply in future years.[1] Unlike most other industries, the way healthcare is priced and paid for is notoriously opaque, making it difficult for patients to act as educated, price-comparing consumers.[2] At a time when out of pocket payments for healthcare are increasing,[3] and growing numbers of "consumer directed" high deductible health plans put more pressure on patients to make cost-efficient healthcare decisions,[4 5] the opacity of ~~the system~~healthcare pricing is- increasingly concerning~~becoming an even greater concern~~.

Recently, hospital charges have come to the forefront of political, popular, and medical discourse due to their ~~seemingly~~ inexplicable magnitude and devastating effects on specific patients.[6-8] While insurers typically negotiate lower reimbursements, these full, inflated charges are still billed to the 22% of American adults aged 19-64 who are uninsured and to privately insured patients receiving care out of network,[9 10] contributing in large part to the 57% of US bankruptcies that ~~are due to~~result from medical bills.[11] Further, charges indirectly affect healthcare pricing for all patients. ~~charges are the basis of price negotiations with~~ M~~m~~any private insurers use charges are the basis of price negotiations;~~,~~[7 12 13] ~~involved in inpatient diagnosis group weighting and outlier payments by~~ Medicare uses charges in determining inpatient diagnosis group weighting and outlier payments.~~;~~[14-17] and also must adapt their prices to private-sector prices.~~;~~[18] -In addition,~~and~~ hospitals use charges~~d~~ in calculations of uncompensated care, which affect ~~hospital~~ their non-profit status and thus many aspects of their business model, participating insurance plans, and prices.[19 20]

Yet despite their consistent use in many forms of healthcare price setting and hospital bills, charges appear to be nearly random, and are either based on outdated, historical methods or set

using ~~opaque~~ idiosyncratic, proprietary formulas.[12 13 21] One hospital administrator called his hospital's method of setting charges "madness."[22] The academic literature has supported this assumption; studies have documented the wide variation in hospital and physician charges and payment rates for the average inpatient stay.[23] Past economics literature has attempted to discern some method to charge setting by documenting the relationship between hospital payment rates and industry organization, and has found for example that less competitive markets have higher predicted prices.[24 25] These studies, however, have mostly addressed broad price ~~indexes~~indices based on aggregate hospital charges.

Given the wide range of procedures and diagnoses that comprise hospitals' inpatient censuses, it is important to evaluate specific, common episodes of care that should have less variation in charges, and are more relevant to patients presenting with a complaint and no knowledge of the specific services they will need. An ideal service is childbirth, the most common reason for hospitalizations in the US,[26] accounting for 4.2 million inpatient stays and $16.1 billion in hospital costs in 2008.[27] Recently, a study by Truven Health Analytics looked at both charges and discounted prices nationally for vaginal and cesarean childbirth using their own proprietary database of paid medical claims, finding significant variation in~~of~~ both charges and reimbursements.[28] However, the study does not address the possible sources of the variation in charges that it documents.

In this study, we sought to fill this gap by documenting and attempting to explain between-hospital variation in charges for the same, average woman's inpatient stay for vaginal birth or cesarean section in California – relatively homogeneous episodes of care. Our analysis is based on the theory that the variation in charges for these homogeneous episodes of care, once adjusted for patient characteristics, is potentially ~~predicted~~explained by measurable hospital and

market characteristics that ~~may~~ govern hospital charge-setting behavior. We first predict charges and estimated prices paid at each hospital after adjusting for patient characteristics, and then ~~determine~~ explore whether ~~if~~ hospital or market-level characteristics can explain some of this charge variation.

METHODS

Data Source

We used the 2011 California Office of Statewide Health Planning and Development (OSHPD) public Patient Discharge Public Data Set (PDD) to perform our cross-sectional analysis. The OSHPD PDD captures patient demographic and clinical information, along with charges, for each inpatient encounter at California hospitals. ~~OSHPD masks selective patient information in this public dataset to prevent identification of individuals pursuant to the California Health Data and Advisory Council Consolidation Act, Health and Safety Code section 128675 et seq.~~ Our study was exempt from review by the Committee on Human Research at the University of California, San Francisco because we used a public data source that was masked for identifiers.[1]

To capture hospital-level characteristics, we used OSHPD's hospital financial and utilization files for 2011. We also used the 2009 Area Resources File,[29] the most currently available year, to obtain county-level area percent of uninsurance and poverty, and the Impact Files from the Centers for Medicare & Medicaid Services (CMS), to obtain a hospital wage index.[30]

[1] OSHPD masks selective patient information in this public dataset to prevent identification of individuals pursuant to the California Health Data and Advisory Council Consolidation Act, Health and Safety Code section 128675 et seq.

Sample Selection

We limited our study to adult women (≥ 18 years old) who were admitted for diagnosis-related group (DRG) ~~of~~ 775 (uncomplicated vaginal delivery) or 766 (uncomplicated c~~C~~esarean section) at short-term general California hospitals. We also only included privately insured women (47.5% of DRG 775; 47.1% of DRG 766), as our estimated discount rate only applies to them. Patients admitted to federal hospitals (e.g. Veterans Administration hospitals) are not in our data as OSHPD reporting requirements do not apply to such hospitals. Also, privately insured women who receive care through the Kaiser Permanente network ~~are absent~~were excluded, as ~~they~~ Kaiser hospitals do not report charges to the state (29.4% of DRG 775; 19.7% of DRG 766).

To restrict our sample to a relatively healthy and more homogenous population, we excluded patients who died in the hospital or who did not have a routine discharge. We further excluded patients without a valid age group or gender recorded, as we could not accurately adjust for their demographic predictors of charge. We also excluded patients with invalid charges, those receiving charitable~~y~~ care, and those with charges too large to fit within the charge variable's character limit~~exceeding the cell size limit~~. Finally, we excluded patients visiting hospitals that did not report a wage index. See Figure 1 for a full description of the applied exclusions.

Outcome

Our first outcome was hospital charges, which are the total dollar amounts billed by the hospital for each admission, excluding physician fees. These charges reflect the hospital's full, established rates before contractual adjustments and prepayments.

Our secondary outcome was estimated discounted prices, or the amounts which hospitals received from private insurers for the services their enrollees received. We obtained this by

multiplying the total ~~hospital~~ charge billed to the patient ~~by~~ with the ~~hospital's average hospital~~ discount rate for privately insured patients. As done in previous literature, the~~is~~ discount ~~factor~~ rate for privately insured patients at each hospital was calculated using the formula: (gross inpatient revenue + gross outpatient revenue - contractual adjustments)/(gross inpatient revenue + gross outpatient revenue).[24 31] We obtained these amounts through the 2011 OSHPD financial files for each hospital.

Statistical analysis

Our analysis is similar to the two-stage approach used by previous economic analyses.[24 32] The approach first separates out patient-level charge variation within each hospital and estimates childbirth charges for the average California woman at each hospital, and then looks at the independent influence of the hospital and market characteristics on variation in those estimated charges across hospitals. Estimates from ~~A~~this two-stage approach can be mapped to estimates from ~~accomplishes the same clustering of charges by hospital as~~ hierarchical model~~ings~~, in the sense that they allow for random effects in the intercept coefficient. However, for our purposes, the two-stage model is ~~but is~~ preferable because we are interested in explaining variation in *expected* charges using observable hospital characteristics. ~~… The approach first separates out charge variation within each hospital and estimate charges for childbirth for a woman with identical observable characteristics at each hospital. Then, using the one observation of charge for the theoretical identical and average woman for each hospital, the independent influence of the hospital characteristics on charges can be determined.~~ For all analyses, charges are logged to account for the right skew. We performed separate analysis for each DRG.

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In the first stage, to control for patient-level variation in charges, we regressed logged raw charges on patient characteristics shown in previous literature to be correlated with charges for the price indices and line item charges.[33 34] ~~For all analyses, charges are logged to account for the right skew. These~~Patient characteristics included~~ing~~ age (in two categories: 18-34, and ≥ 35), number of conditions present on admission, Charlson comorbidities, and length of stay. We chose the 18-34 and ≥ 35 maternal age groups because 35 years old is the cutoff at which the American Congress of Obstetricians and Gynecologists generally defines "advanced maternal age," which has been associated with increased risk of complications for both the mother and the infant.[35-37] Because length of stay is also often right-skewed, we transformed it to log (length of stay + 1). We included three different types of private insurance, including two forms of managed care (Knox-Keene/Medi-Cal County Organized Health System, or other), and traditional private coverage. To control for unobservable within-hospital factors that could affect variation, we also included a dummy variable for each hospital. Errors from this regression are clustered at the hospital level. Results of these regressions are shown in Supplementary Tables 1 & 2.

From this regression, we then calculated a given hospital's adjusted charge for the average statewide patient for that DRG, where the adjusted charges represented standardized log charge/(day + 1). This gave us a single adjusted ~~-~~charge per day for each hospital, representing the predicted charge for a patient with the same, average clinical and demographic characteristics, which we then used as the dependent variable in our second-stage regression.

In the second stage, we regressed our adjusted logged charges on hospital and market level factors cited by previous literature as related to broad price indices,[24 32 38] to determine which characteristics explain observed between-hospital variation in charges for childbirth. Hospital-level factors included ownership (not-for-profit, for-profit, government), teaching status,

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urban/rural location, capacity (number of licensed beds), patient payer mix (proportion Medicare, Medicaid), and case-mix (which was used to adjust the average cost per patient for a given hospital relative to the adjusted average cost for other hospitals).[39] We also incorporated three quality measures from the Agency for Healthcare Research Quality's Inpatient Quality Indicators (IQIs): cesarean delivery rate, vaginal birth after cesarean rate (uncomplicated), and primary caesarian delivery rate.[40] These utilization indicators are intended to capture either over-use of procedures found to be unnecessary or low quality, or under-use of procedures with merit, such as vaginal birth after prior cesarean delivery.[41] We further incorporated market-level factors including the wage index, percent uninsured in the county, percent below the poverty line in the county, as well as the system-wide Herfindahl-Hirschman Index (HHI).

The HHI is a widely used economic measure of the degree of competition faced by a company, or in this case hospital, within its market.[42] It is calculated as the sum of the squares of market shares for each hospital in a given market. Higher HHIs are associated with less competition, while lower HHIs indicate more competitive markets. We calculated these shares of patients directly from the hospital discharge data. Our HHI calculation also accounts for membership in a hospital system, which has been shown to influence hospital price setting.[38]

RESULTS

Sample

We analyzed a sample of 76,766 uncomplicated vaginal deliveries, and 32,660 uncomplicated cesarean sections in 2011 across 198 and 195 California hospitals, respectively. As shown in Table 1, 78.4% of women with uncomplicated vaginal deliveries were between the ages of 18-34, and 97.9% had a Charlson comorbidity index of 0, indicating that they were relatively

healthy. The length of stay for 77.8% of these women was less than 3 days. For the 32,660 women with uncomplicated cCesarean sections (Table 2), the majority (69.5%) were again between ages 18-34, almost all (97.2%) had a Charlson comorbidity index of 0, and 77.5% had a hospital stay between 3 to 6 days. For both DRGs, the majority of hospitals were not-for-profit, non-teaching hospitals located in urban areas.

Charges

We found that the raw charges for uncomplicated vaginal birth ranged from $3,344 to $43,715, with a median charge of $15,278 (IQR $7,981). Once adjusted for patient clinical and demographic characteristics, charges for the average patient ranged from $3,296 to $37,227, depending on which of the 198 hospitals she visited (median $14,620; IQR $7,643). For uncomplicated cCesarean sections, the raw charges ranged from $7,905 to $72,569, with a median charge of $27,517 (IQR $14,206). Adjusted charges ranged from $8,312 to $70,908 with a median charge of $27,481 (IQR $12,525), again for a patient with the same average characteristics.

Estimated discounted price

Discounted prices paid by private insurers ranged from 5% to 92% of the charge, with an average of 37%. Discounted prices for vaginal deliveries ranged from $835 to $12,873 (median $5,123; IQR $3,827), and prices for cesarean sections varied from $1,135 to $28,105 (median $9,640; IQR $6,631). For vaginal births, the largest difference between a hospital's adjusted charge and estimated discount price was $29,217, where it charged $33,593 for an average patient, almost eight times the $4,376 it finally received from insurers. The smallest difference was just

$920, where the hospital's average charge ($11,251) was a mere 109% higher than its estimated price ($10,332). For uncomplicated cCesarean sections, the differences were even more dramatic – one hospital charged 1899% of what it typically received, while another charged 124%. Figure 2 illustrates the differences between the adjusted charges and discounted prices for each hospital in our dataset for the two conditions.

Hospital and market-level factors

In the multivariate model using adjusted charges across hospitals as the dependent variable, for uncomplicated vaginal delivery, hospitals with for-profit ownership, severe case-mixes, and high wage indices charged significantly more than their counterparts (Table 3).

For uncomplicated cCesarean section (Table 4), again charge was associated with ownership. Government-owned hospitals had 14.6% lower charges (95% CI -29.8, 0.6), while for-profit hospitals had 17.2% higher charges (95% CI 3.2, 31.2) than non-profit hospitals. This implies that if the mean charge for uncomplicated cCesarean section, $29,480, was offered at a non-profit hospital, the adjusted charge in a government hospital would be $25,176 and the adjusted charge in a for-profit hospital would be $34,551. Also similar to our findings with uncomplicated vaginal births, hospitals with higher labor costs (wage index) had higher charges. The case-mix was no longer predictive, but a higher rate of percent uninsured in the county was significantly correlated with lowerhigher charges. Though the significance was marginal, the proportion of patients covered by Medicare was also associated with higher charges.

DISCUSSION

Our results demonstrate the wide variability of charges and prices for childbirth between hospitals, even after controlling for patient characteristics, and point to specific institutional and market-level factors that affect those standardized charges. Even after adjusting for patient demographic and clinical characteristics, we found that charges for vaginal births ranged from $3,296 to $37,227, and charges for cesarean sections ranged from $8,312 to $70,908, depending only on which hospital the average California woman giving birth visited. That implies that, after adjusting for patient characteristics, the highest hospital charge was more than 11 times that of the lowest hospital charge for vaginal births, and more than 8.5 times that of the lowest hospital charge for cesarean section births. Without adjusting for patient characteristics, the hospital with the highest charges would charge about 13 times more than the hospital with the lowest charges for vaginal births, and about 9 times more than the hospital with the lowest charges for cesarean sections. While the variation of adjusted charges is, as expected, smaller than the variation in raw charges between hospitals, the very small difference between the two implies that service-intensity and patient observable factors provide little explanation for variation in charges between hospitals.

Our findings show that some hospital and market-level factors, on the other hand, do clearly impact the differences in charges between hospitals. We find a positive relationship between charges for childbirth and hospital wage index, case-mix index, and for-profit ownership ~~and county percent uninsured~~. However, it is probably more notable how *few* of the hospital and market-level regressors are significant in explaining the variation. Our vaginal and cesarean delivery models account for only 36% and 35%, respectively, of the variation observed between hospitals in adjusted charges. This implies that either the variation is a result of (a) unobservable hospital characteristics or (b) pure noise.

Based on findings from ~~past literature~~the existing literature, we hypothesize that~~-~~ the variation we find is more likely random than due to unobservable hospital characteristics~~the pure noise explanation is more likely~~. A MedPAC study of hospitals found that many items on chargemasters were based on historical prices, which were formulated before it was possible to accurately estimate costs.[21] Even today, the survey found that only a third of hospitals reported any concern regarding covering operating costs when updating their chargemasters. Rather, most were concerned with conforming to regulations and maintaining their overall bottom line.[21] Today, even for new services providers are not incentivized to set charges based on costs, because third party payments are largely not based on true costs for a given service.[12 23] This therefore precludes a valuable correlation between cost and charge and thus an anchor on which charge variation would be limited.[12] In addition, the current ~~miscorrelation~~ lack of correlation between cost and charge is exacerbated by simplistic "updates" in the form of across the board percentage increases of charges, often resulting in certain services subsidizing others to manage the overall solvency of the hospital or department.[12 21 43] Thus, our results again confirm the documented lack of comprehensible or at least measurable sense in the chargemaster system.

The troubling part of this largely random variation is that charges do still matter to patients and to hospitals in many ways. The 41.9 million uninsured Americans, along with privately insured patients visiting an out-of-network hospital may be faced with the full charges for their care, which are typically so high that few patients can pay them, resulting in need for charity care, sliding scale payments, or often bad debt on the patient's part.[13 44] In addition, as some private insurers still negotiate discounts off charges, especially in fee-for-service ~~(FFS)~~ systems, and use charges to benchmark the relative weights ~~of~~ in their prospective payment systems, higher charges can lead to higher out of pocket payments for patients.[3 12 13] Medicare also compares

charges between DRG groups modified by cost-to-charge ratios calculated at the cost center level to determine the relative weight of DRG's and identify qualifying outlier payments within DRGs.[14-17] Finally, many hospitals use charges to calculate their uncompensated care costs, which affect their not-for-profit and hence tax exempt status. In fact, the IRS found that 18-20% of hospitals include the difference between charges and allowed payments by private insurers, and 50% include the difference between charges and payments received from the uninsured in their uncompensated care calculations.[19 20]

A secondary finding in this study is the large discrepancy between hospitals' predicted charges and their estimated discounts. Our finding ~~of~~ that insurers pay o~~a~~n average 37% ~~discount~~ of charges is supported by previous literature showing that private insurers pay on average 39% of the charge for hospital inpatient services.[45 46] We estimated median payments of $5,123 for vaginal and $9,640 for cesarean section births, slightly lower than the Truven estimates of $8,519 and $12,894, respectively.[28] The difference between the adjusted charge and discounted price estimates what could be considered "excess charges", and in 2011 sums to $1.36 billion dollars for all uncomplicated vaginal and cesarean births in California ($760.1 million for uncomplicated vaginal deliveries; $601.1 million for uncomplicated cesarean sections).

Past literature has speculated two reasons for high charges relative to reimbursements. First is the change in Medicare's reimbursement protocol from the historical cost-plus reimbursement system to today's prospective payment system.[43] Because providers were paid a percentage above the charged rate, it was in the providers' financial interest to maintain exorbitant charges, a practice that has persisted despite the change in reimbursement. Second, in fee-~~-~~for-service payments for which reimbursements are simple discounts of charges, hospitals are incentivized to raise their charges in an effort to increase reimbursement. Finally, hospitals may

be setting artificially inflated charges to increase the nominal value of their uncompensated care indices, which are based on charges.[20 47]

Limitations of Research

There are several limitations of this study. First, we used DRGs to determine what constituted an episode of care. The MS-DRG system was designed to classify patients into groups based on likely utilization of services and accumulation of costs. However, because the administrative data we used does not provide charge itemization, it is very likely that some women received greater "intensity" of services in unobservable ways. For instance, if one woman received an epidural, and another woman did not, we might expect the woman with the epidural to have higher charges. As much as possible, we are minimizing fallout from this limitation by using observable attributes of the episode (e.g. length-of-stay, discharge, comorbidities) in our first-stage regression, which should absorb some of the patient-level differences in care intensity. It is possible, however, that if unobservable patient characteristics affecting intensity of care are correlated with hospital characteristics, we might expect our second stage estimates to be biased. On the other hand, if treatment intensity is a hospital--level characteristic, then our analysis does accurately capture this.

Second, our brief analysis of discounted prices is limited by the fact that we must estimate discount rates, since insurers and providers carefully guard their actual payment rates as proprietary. The financial data we used is self-reported, and thus the accuracy of our estimates is dependent on the accuracy of hospital reporting to OSHPD. However, inaccuracies are not a big concern as OSHPD performs systematic financial audits of their data. Further, the discount rates are hospital-wide and aggregate across all insurers, while negotiations regarding discount rates

granted by a given hospital may vary widely by particular insurer and according to DRG or cost center. It is partly because of this significant limitation that we chose to focus our main results on charges and the factors affecting them. That said, our estimated prices were roughly consistent with the Truven study, which did have access to claims-based prices paid. [28] In addition, discounted rates negotiated by insurers have been found to be broadly applied to wide swaths of services, as the main goal of such negotiations is overall solvency.[48] Further, modifications to charges at the aggregate level are regularly used in institutional practice, such as cost to charge ratios used by Centers for Medicare and Medicaid Services (CMS) to estimate outlier payments, which have been shown to be imperfect but generally appropriate estimates of cost.[49]

Third, our study only examines charges in California. Though California is a large, diverse state, our results cannot be generalized to the entire nation. Last, our study could not examine the full effect of quality of care on hospital price premiums, though we included select quality indicators. However, it is difficult to imagine that these variations could be attributed entirely to quality, given numerous studies demonstrating that both charges and payments are unrelated to quality, which we similarly found in our analysis of three quality measures.[50 51]

CONCLUSIONS

For the same average patient in California, we find that charges for uncomplicated vaginal delivery ranged from $3,296 to $37,227 (median: $14,620), and charges for uncomplicated cesarean section ranged from $8,312 to $70,908 (median: $27,481) depending on which hospital she visited. Hospital ownership, case-mix, wage index, percent uninsured in the county, and market competitiveness had a significant impact on these adjusted charges. Estimated discounted prices averaged 37% of the adjusted charges. Our findings indicate that the charge faced by a

patient for a common obstetrical procedure is significantly influenced by institutional and market-level factors outside of her own presentation, but that the majority of variation in charges between hospitals she could visit remains unexplained. Our results also suggest significant room for improved methodologies, incentives, and policy interventions for accurately estimating and presenting charges and ultimate costs.

Authors' Contributions

RYH conceived of the study, obtained the data, directed and interpreted the analyses, and helped draft and edit the manuscript. YAA helped conceive the study design, analyzed the data, interpreted the results, and edited the manuscript. EW contributed to methodological design, analyzed the data and interpreted the results, and helped with editing of the manuscript. ~~EG conducted background research, helped in interpreting the results, drafted the manuscript, and assisted in editing.~~ All authors have read and approved the final manuscript.

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REFERENCES:

1. Office of the Actuary. National Health Expenditure Projections 2011-2021: Centers for Medicare and Medicaid Services, 2011.

2. Government Accountability Office (GAO). Meaningful Price Information Is Difficult for Consumers to Obtain Prior to Receiving Care. GAO-11-791; 2011.

3. Truffer CJ, Keehan S, Smith S, Cylus J, Sisko A, Poisal JA, et al. Health spending projections through 2019: the recession's impact continues. *Health Aff (Millwood)* 2010;29(3):522-29.

4. The Kaiser Family Foundation, Health Research & Educational Trust. Employer Health Benefits 2012 Annual Survey, 2012.

5. Robinson JC, Ginsburg PB. Consumer-driven health care: promise and performance. *Health Aff (Millwood)* 2009;28(2):w272-81.

6. Brill S. Bitter Pill: Why Medical Bills Are Killing Us. *TIME Magazine* Feb 20, 2013.

7. Selberg J, Marks CM. A Problem Too Big to See: The Sobering Reality of Hospital Pricing: Institute for Healthcare Improvement; 2013.

8. Salam R. Guest Post by Oren Cass: What Steven Brill Gets Wrong on U.S. Health Care Costs. *The National Review Online.* Feb 28, 2013.

9. Anderson GF. From 'Soak The Rich' To 'Soak The Poor': Recent Trends In Hospital Pricing. *Health Aff (Millwood)* 2007;26(3):780-89.

10. DeNavas-Walt C, Proctor B, Smith J. Income, Poverty, and Health Insurance Coverage in he United States: 2011. In: Bureau UC, editor. *Current Population Reports*. Washington, D.C., 2012.

11. Himmelstein DU, Thorne D, Warren E, Woolhandler S. Medical Bankruptcy in the United States, 2007: Results of a National Study. *Am J Med* 2009;122(8):741-46.

12. Ginsburg PB, Grossman JM. When the price isn't right: how inadvertent payment incentives drive medical care. *Health Aff (Millwood)* 2005:W5.

13. Reinhardt UE. The Pricing Of U.S. Hospital Services: Chaos Behind A Veil Of Secrecy. *Health Aff (Millwood)* 2006;25(1):57-69.

14. Medicare Program; Change in Methodology for Determining Payment for Extraordinarily High-Cost Cases (Cost Outliers) Under the Acute Care Hospital Inpatient and Long-Term Care Hospital Prospective Payment Systems; Final Rule. 68 *Federal Register* 110. (June 9, 2003): 34494-504.

15. Medicare Program; Changes to the Hospital Inpatient Prospective Payment Systems and Fiscal Year 2007 Rates; Fiscal Year 2007 Occupational Mix Adjustment to Wage Index;

Health Care Infrastructure Improvement Program; Selection Criteria of Loan Program for Qualifying Hospitals Engaged in Cancer-Related Health Care and Forgiveness of Indebtedness; and Exclusion of Vendor Purchases Made Under the Competitive Acquisition Program (CAP) for Outpatient Drugs and Biologicals Under Part B for the Purpose of Calculating the Average Sales Price (ASP); Final Rules & Interim Final Rule With Comment Period. 71 *Federal Register* 160. (August 18, 2006): 47870 -8351.

16. Medicare Program; Proposed Changes to the Hospital Inpatient Prospective Payment Systems and Fiscal Year 2009 Rates; Proposed Changes to Disclosure of Physician Ownership in Hospitals and Physician Self-Referral Rules; Proposed Collection of Information Regarding Financial Relationships Between Hospitals and Physicians; Proposed Rule. 73 *Federal Register* 84. (April 30, 2008): 23542-47.

17. Carter GM, Rogowski JA. The Hospital Relative Value Method as an Alternative for Recalibrating DRG Relative Weights: RAND/UCLA/Harvard Center for Health Care Financing Policy Research, 1993.

18. Reinhardt UE. The disruptive innovation of price transparency in health care. *JAMA* 2013;310(18):1927-28.

19. Internal Revenue Service. IRS Exempt Organizations (TE/GE) Hospital Compliance Project Final Report, 2006:98.

20. Capps C, David G, Carlton D. Antitrust Treatment of Nonprofits: Should Hospitals Receive Special Care? *University of Chicago George J. Stigler Center for the Study of the Economy and the State Working Paper.* 2010(232).

21. Dobson AJ, DaVanzo J, Doherty J, Tanamor M. A Study of Hospital Charge Setting Practices: Lewin Group, 2005.

22. Lagnado L. California Hospitals Open Books, Showing Huge Price Differences. *Wall Street Journal.* December 27, 2004.

23. Ginsburg PB. Wide variation in hospital and physician payment rates evidence of provider market power: Center for Studying Health System Change; 2010.

24. Gaynor M, Vogt WB. Competition among hospitals. *RAND J Econ* 2003;34(4):764-85.

25. Melnick GA, Zwanziger J, Bamezai A, Pattison R. The effects of market structure and bargaining position on hospital prices. *J Health Econ* 1992;11(3):217-33.

26. Vashi AA, Fox JP, Carr BG, D'Onofrio G, Pines JM, Ross JS, et al. Use of hospital-based acute care among patients recently discharged from the hospital. *JAMA* 2013;309(4):364-71.

27. Podulka J, Stranges E, Steiner C. Hospitalizations Related to Childbirth, 2008: Statistical Brief #110: Agency for Healthcare Research and Quality, 2011.

28. Truven Health Analytics. The Cost of Having a Baby in the United States, 2013.

29. Health Resources and Services Administration. Area Resource File: US Department of Health and Human Services; 2009.

30. Centers for Medicare and Medicaid Services. Historical Impact Files: US Department of Health and Human Services; 2011.

31. Dranove D, Lindrooth R, White WD, Zwanziger J. Is the impact of managed care on hospital prices decreasing? *J Health Econ* 2008;27(2):362-76.

32. Keeler E, Melnick G, Zwanziger J. The changing effects of competition on non-profit and for-profit hospital pricing behavior. *J Health Econ* 1999;18(1):69-86.

33. Lynk WJ. One DRG, One Price? The Effect of Patient Condition on Price Variation within DRGs and across Hospitals. *Int J Health Care Finance Econ* 2001;1(2):111-37.

34. Hsia RY, Kothari AH, Srebotnjak T, Maselli J. Health Care as a" Market Good"? Appendicitis as a Case Study. *Arch Intern Med* 2012;172(10):818-819.

35. Cleary-Goldman J, Malone FD, Vidaver J, Ball RH, Nyberg DA, Comstock CH, et al. Impact of maternal age on obstetric outcome. *Obstet Gynecol* 2005;105(5, Part 1):983-90.

36. Berkowitz GS, Skovron ML, Lapinski RH, Berkowitz RL. Delayed Childbearing and the Outcome of Pregnancy. *N Engl J Med* 1990;322(10):659-64.

37. American College of Obstetricians and Gynecologists. Screening for Fetal Chromosomal Abnormalities. *Practice Bulletin*, No. 77; 2007.

38. Melnick G, Keeler E. The effects of multi-hospital systems on hospital prices. *J Health Econ* 2007;26(2):400-13.

39. California Office of Statewide Health Planning and Development. Calculation of the Office of Statewide Health Planning and Development's (OSHPD) Case Mix Index (CMI).

40. Agency for Healthcare Research and Quality. Inpatient Quality Indicators Technical Specifications, Version 4.4, 2012.

41. Davies SM, Geppert JJ, McClellan M, McDonald KM, Romano PS, Shojania KG. Refinement of the HCUP Quality Indicators: Agency for Healthcare Research and Quality. AHRQ Publication No. 01-0035; 2001.

42. US Department of Justice and the Federal Trade Commission. Horizontal Merger Guidelines., 2010.

43. Kaplan RS, Porter ME. How to solve the cost crisis in health care. *Harvard Business Review* 2011;89(9):46-52.

44. Reinhardt U. What Hospitals Charge the Uninsured. *The New York Times* March 15, 2013.

45. Ginsburg PB. Shopping for price in medical care. *Health Aff (Millwood)* 2007;26(2):w208-16.

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

47. David G, Helmchen LA. The Role of Task Adhesion in Limiting Specialization along the Medical Care Continuum. *Labour* 2011;25(1):24-44.

48. Reinhardt U. How Do Hospials Get Paid? A Primer. *The New York Times* January 23, 2009.

49. Shwartz M, Young DW, Siegrist R. The ratio of costs to charges: how good a basis for estimating costs? *Inquiry* 1995;32(4):476-81.

50. Commonwealth of Massachusetts Division of Health Care Finance and Policy. Recommendations of the Special Commission on Provider Price Reform, 2011.

51. Massachusetts Attorney General. Examination of Health Care Cost Trends and Cost Drivers: Report for Annual Public Hearing, 2011.

Tables

Table 1. Characteristics of study sample for uncomplicated vaginal deliveries (DRG 775)

PATIENT-LEVEL CHARACTERISTICS (n=76,766)			
Age categories	**N**	**Percent**	
18-34	60,175	78.39%	
35-64	16,591	21.61%	
Sex			
Male	0	0.00%	
Female	76,766	100.00%	
Private Insurance Type			
Managed Care-Knox Keene	34,387	44.79%	
Managed Care-Other	36,414	47.44%	
Traditional Coverage	5,965	7.77%	
Charlson Comorbidity Index			
0	75,182	97.94%	
1	1,555	2.03%	
2	29	0.03%	
Length of Stay			
Less than 3 days	59,724	77.80%	
3-6 days	16,826	21.92%	
Greater than 6 days	216	0.28%	
HOSPITAL-LEVEL CHARACTERISTICS (n=198)			
Ownership			
Government	32	16.16%	
NFP	127	64.14%	
FP	39	19.70%	
Location			
Urban	174	87.88%	
Rural	24	12.12%	
Teaching Status			
Yes	20	10.10%	
No	178	89.90%	
Casemix (severity)	**N**	**Mean**	**SD**
Low	66	1.283	0.121
Medium	66	1.555	0.053
High	66	1.787	0.138
Capacity			
Licensed Beds	198	280.45	180.366
Payer Mix			
% Medicare	198	37.79%	12.38%

% Medicaid	198	28.13%	15.68%
MARKET-LEVEL CHARACTERISTICS			
	N	**Mean**	**SD**
Wage Index			
Low	121	1.196	0.007
Medium	12	1.223	0.01
High	65	1.486	0.142
Herfindahl-Hirschman Index			
Low	67	1178	629
Medium	70	3351	721
High	61	6831	1986
% Without Insurance	198	18.31%	3.77%
% Below Poverty Line	198	13.80%	4.41%

Table 2. Characteristics of study sample for uncomplicated ~~vaginal deliveries~~cesarean sections (DRG 766~~75~~)

PATIENT-LEVEL CHARACTERISTICS (n=32,660)			
Age categories	**N**	**Percent**	
18-34	22,694	69.49%	
35-64	9,966	30.51%	
Sex			
Male	0	0.00%	
Female	32,660	100.00%	
Private Insurance Type			
Managed Care-Knox Keene	14,696	45.00%	
Managed Care-Other	15,237	46.65%	
Traditional Coverage	2,727	8.35%	
Charlson Comorbidity Index			
0	31,756	97.23%	
1	894	2.74%	
2	10	0.03%	
Length of Stay			
Less than 3 days	7,172	21.96%	
3-6 days	25,325	77.54%	
Greater than 6 days	163	0.50%	
HOSPITAL-LEVEL CHARACTERISTICS (n=195)			
Ownership			
Government	30	15.38%	
NFP	127	64.14%	
FP	38	19.49%	
Location			
Urban	171	87.69%	
Rural	24	12.31%	
Teaching Status			
Yes	18	9.23%	
No	177	90.77%	
Casemix (severity)	**N**	**Mean**	**SD**
Low	65	1.287	0.125
Medium	65	1.559	0.052
High	65	1.789	0.138
Capacity			
Licensed Beds	195	279.672	180.807
Payer Mix			
% Medicare	195	37.94%	12.06%

% Medicaid	195	27.96%	15.64%
MARKET-LEVEL CHARACTERISTICS			
Wage Index	**N**	**Mean**	**SD**
Low	119	1.196	0.007
Medium	12	1.223	0.01
High	64	1.484	0.142
Herfindahl-Hirschman Index			
Low	72	1283	713
Medium	59	3440	591
High	64	6809	2115
% Without Insurance	195	18.30%	3.66%
% Below Poverty Line	195	13.77%	4.43%

Table 3. Regression of adjusted charges on hospital and market characteristics for uncomplicated vaginal deliveries

	Multiplicative increase for each unit change in predictor	95% CI lower bound	95% CI upper bound	p-value
HOSPITAL-LEVEL CHARACTERISTICS				
Ownership				
Government	-0.096	-0.249	0.057	0.217
NFP	Reference			
FP	0.198	0.0475	0.348	0.010
Teaching Status				
Yes	-0.049	-0.317	0.22	0.719
No	Reference			
MSA				
Urban	Reference			
Rural	0.022	-0.144	0.19	0.849
Casemix (severity)				
Low	Reference			
Medium	0.104	-0.044	0.252	0.166
High	0.196	0.044	0.349	0.012
Capacity				
Licensed beds	0.0003	-0.0001	0.0007	0.234
Payer Mix				
Proportion Medicare	0.263	-0.352	0.878	0.400
Proportion Medicaid	-0.002	-0.442	0.437	0.992
Quality Indicators				
Cesarean delivery rate	-0.097	-2.407	2.212	0.934
Vaginal birth after cesarean rate (uncomplicated)	0.415	-0.528	1.357	0.386
Primary cesarean delivery rate	0.208	-2.32	2.737	0.871
MARKET-LEVEL CHARACTERISTICS				
Wage Index				
Low	Reference			
Medium	0.202	0.0276	0.376	0.023
High	0.409	0.271	0.547	<0.001
Herfindahl-Hirschman Index (System-wide)				
Low	Reference			
Medium	0.012	-0.116	0.139	0.857
High	0.005	-0.14	0.149	0.951
% Without Insurance	-0.012	-0.033	0.009	0.259
% Below Poverty Line	0.013	-0.005	0.032	0.153

Table 4. Regression of adjusted charges on hospital and market characteristics for uncomplicated cesarean sections

	Multiplicative increase for each unit change in predictor	95% CI lower bound	95% CI upper bound	p-value
HOSPITAL-LEVEL CHARACTERISTICS				
Ownership				
Government	-0.146	-0.298	0.006	0.060
NFP	Reference			
FP	0.172	0.032	0.312	0.016
Teaching Status				
Yes	0.062	-0.187	0.311	0.626
No	Reference			
MSA				
Urban	Reference			
Rural	0.088	-0.081	0.257	0.304
Casemix (severity)				
Low	Reference			
Medium	0.087	-0.052	0.225	0.218
High	0.123	-0.019	0.265	0.088
Capacity				
Licensed beds	-0.0002	-0.0006	0.0002	0.363
Payer Mix				
Proportion Medicare	0.491	-0.004	0.986	0.052
Proportion Medicaid	0.112	-0.354	0.578	0.636
Quality Indicators				
Cesarean delivery rate	0.491	-1.659	2.642	0.653
Vaginal birth after cesarean rate (uncomplicated)	0.508	-0.315	1.332	0.225
Primary cesarean delivery rate	-1.192	-2.65	2.262	0.877
MARKET-LEVEL CHARACTERISTICS				
Wage Index				
Low	Reference			
Medium	0.258	0.067	0.449	0.008
High	0.378	0.26	0.497	<0.001
Herfindahl-Hirschman Index (System-wide)				
Low	Reference			
Medium	-0.079	-0.196	0.037	0.183
High	0.012	-0.116	0.14	0.855
% Without Insurance	-0.0003	-0.02	0.019	0.025
% Below Poverty Line	-0.002	-0.019	0.015	0.813

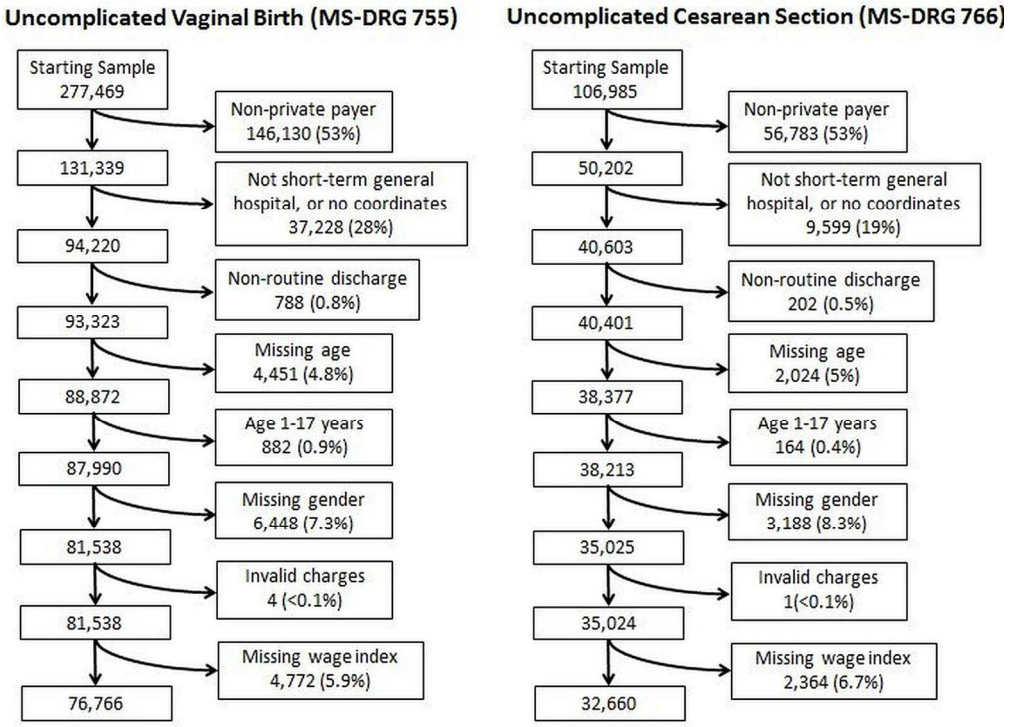
Figure Titles & Legends:

Figure 1. Sample ~~s~~Selection

(no legend)

Figure 2. Adjusted charges and discount prices for uncomplicated vaginal deliveries and uncomplicated cesarean sections across California hospitals, 2011

(no legend)



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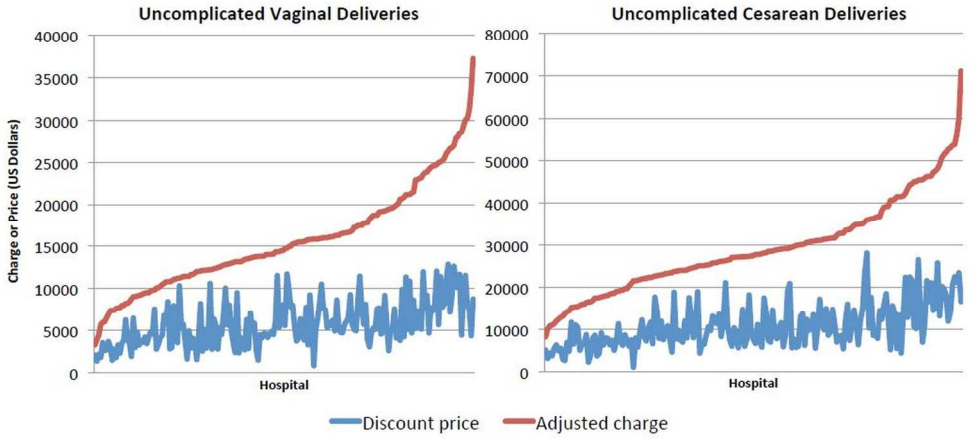

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Supplementary Table 1. First-stage regression of log raw charges on patient characteristics for uncomplicated vaginal deliveries (DRG 775)

	Multiplicative increase for each unit change in predictor	95% CI lower bound	95% CI upper bound	p-value
PATIENT-LEVEL CHARACTERISTICS				
Charlson Comorbidities	0.013	0.003	0.024	0.012
Log Length of Stay (days)	0.869	0.830	0.908	<0.001
No. Conditions Present on Admission	0.023	0.021	0.026	<0.001
Age				
18-34 years	0.033	0.027	0.039	<0.001
35-64 years	Reference			
Insurance Type				
Managed Care – Knox-Keene/Medi-Cal County Organized Health System	Reference			
Managed Care – Other	0.006	0.000	0.010	0.022
Traditional Coverage	-0.000	-0.009	0.008	0.927

Supplementary Table 2. First-stage regression of log raw charges on patient characteristics for uncomplicated cesarean sections (DRG 766)

	Multiplicative increase for each unit change in predictor	95% CI lower bound	95% CI upper bound	p-value
PATIENT-LEVEL CHARACTERISTICS				
Charlson Comorbidities	0.011	0.001	0.022	0.026
Log Length of Stay (days)	0.740	0.709	0.771	<0.001
No. Conditions Present on Admission	0.014	0.011	0.016	<0.001
Age				
18-34 years	0.022	0.017	0.028	<0.001
35-64 years	Reference			
Insurance Type				
Managed Care – Knox-Keene/Medi-Cal County Organized Health System	Reference			
Managed Care – Other	-0.004	-0.009	0.000	0.069
Traditional Coverage	0.002	-0.007	0.011	0.686

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5&6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9
Bias	9	Describe any efforts to address potential sources of bias	8-9
Study size	10	Explain how the study size was arrived at	6-7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	7-8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	10, Figure 1
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	Figure 1 (excluded – no other missing)
Outcome data	15*	Report numbers of outcome events or summary measures	10-11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11-12
		(*b*) Report category boundaries when continuous variables were categorized	23-28
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	15-16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	4

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.