Published in final edited form as:

Med Care. 2013 May ; 51(5): 454–460. doi:10.1097/MLR.0b013e31828d1251.

Impact of socioeconomic adjustment on physicians' relative cost of care

Abstract

Background—Ongoing efforts to profile physicians on their relative cost of care have been criticized because they do not account for differences in patients' socioeconomic status (SES). The importance of SES adjustment has not been explored in cost profiling applications that measure the costs using an episode of care framework.

Objectives—We assessed the relationship between SES and episode costs and the impact of adjusting for SES on physicians' relative cost rankings.

Research design—We analyzed claims submitted to three Massachusetts commercial health plans during calendar years 2004 and 2005. We grouped patients' care into episodes, attributed episodes to individual physicians, and standardized costs for price differences across plans. We accounted for differences in physicians' case mix using indicators for episode type and a patient's severity of illness. A patient's SES was measured using an index of 6 indicators based on the zip code in which the patient lived. We estimated each physician's case mix-adjusted average episode cost and percentile rankings with and without adjustment for SES.

Results—Patients in the lowest SES quintile had \$80 higher unadjusted episode costs, on average, than patients in the highest quintile. Nearly 70% of the variation in a physician's average episode costs was explained by case mix of their patients, while the contribution of SES was negligible. After adjustment for SES, only 1.1 percent of physicians changed relative cost rankings by more than two percentiles.

Conclusions—Accounting for patients' SES has little impact on physicians' relative cost rankings within an episode cost framework.

Keywords

Profiling; Benchmarking; Cost estimation; Socioeconomic status; Case mix adjustment

Introduction

Health plans have used physician-level cost profiling as the foundation for a variety of performance incentive programs that aim to identify and reward high value care.^{1,2} In a typical cost-profiling program, a physician's cost of care, typically measured on an episode of care or a per capita basis, is compared with that of members of his or her specialty, after adjusting for differences in case mix. Health plans may then use these data to reduce payments to high-cost providers or attempt to re-direct patients toward lower cost providers through the use of financial incentives.^{3,4}

During 2012, the Centers for Medicare and Medicaid Services (CMS) disseminated reports summarizing a physician's quality of care and relative resource use to nearly 20,000

physicians participating in the Medicare program as part of its ongoing Physician Feedback Program.⁵ By 2015, these data will determine the magnitude of a value-based payment modifier that will be phased into Medicare's physician fee schedule.⁵ While the specific methodologies for the feedback reports and payment modifier remain under development, CMS has recently chosen an episode grouper to be used for both initiatives.⁶

Many concerns have been expressed about the validity and reliability of physician cost profiling.^{7,8} One of the most prominent concerns is that cost profiles will be biased if they do not account for differences in the socioeconomic status (SES) of patients cared for by each physician. A number of studies over the past few decades have shown that patients with low SES tend to have a higher cost of care.⁹⁻¹¹ Low SES patients may face significant financial barriers to chronic disease care,¹² they may have lower social support to motivate them to access preventive care or to help them manage their chronic conditions,^{13,14} and they may be less likely to have a usual source of care.¹⁵ As a result, low SES patients have repeatedly been shown to have fewer office visits and to use less preventive care, but have higher hospitalization rates and a higher total cost of care than higher SES patients.⁹⁻¹¹

Physicians who care for a disproportionate number of low SES patients may therefore be penalized as "high cost," but may have limited ability to influence their patients' care-seeking behaviors or social context. Indeed, in the Affordable Care Act, Congress mandated that appropriate methodologies for SES adjustment be considered before physicians begin receiving their relative cost reports.¹⁶ Whether SES adjustment makes a difference in physician relative cost profiles based on an episode cost framework has not been previously explored.

In this study, we explored the relationship between SES and the cost of episodes of care assigned to individual physicians. We ranked physicians using a cost profiling methodology modeled after common current practice—adjusting for episode type, episode severity, and prices, but not SES. We then evaluated the impact of adding an adjustment for SES on physicians' relative cost rankings.

Methods

Data sources

We used a database containing all professional, facility, and pharmaceutical claims for patients continuously enrolled in one of three commercial health plans in the state of Massachusetts during calendar years 2004 and 2005. These three plans enrolled just over 3.8 million enrollees—approximately 84 percent of the commercially insured population in the state at the time. The database included claims from managed care, preferred provider organization, and indemnity product lines. We used a master physician database compiled by Massachusetts Health Quality Partners (MHQP) to link claims submitted by individual physicians across the three plans. Physician specialties were obtained from the Massachusetts Board of Registration as described in prior work.¹⁷

Constructing and Attributing Episodes of Care

We grouped patients' claims for related services into episodes of care using the Symmetry Episode Treatment Grouper®.¹⁸ An episode of care represents a bundle of services related to a specific chronic or acute condition that is delimited in time by 'clean periods' with no claims related to the service. The algorithm also generates a patient-level severity score (Episode Risk Group®) that takes into account each patient's age, gender, and co-morbidities. For each type of episode, patients are assigned up to one of four severity levels based on his or her risk score relative to all other patients assigned the same type of episode. For example, a patient might be assigned an episode of "benign hypertension without comorbidity, severity level 3". We use the term 'case mix' to refer to differences among physicians in both the types of episodes and severity of illness of their patients.

We calculated the cost of each episode by multiplying the number of units of each service included within the episode by the average price for each service. The average price for each service was defined as the average "allowed cost" for that service across the three plans. The allowed cost is the sum of the health plan reimbursement plus any patient co-payment. This approach standardizes cost estimates across plans and assures that relative cost estimates are not influenced by differences in reimbursement rates across plans. These methods are described more fully elsewhere.¹⁷ Alternative measures of relative resource use might involve actual payments to providers (which do not adjust for price differences) or charges (which may bear little resemblance to actual costs).

We assigned episodes of care and their associated costs to the physician having a plurality of professional costs (subject to a minimum of 30 percent of total professional costs) within the episode. This attribution rule is commonly used in physician profiling initiatives.¹⁹⁻²¹ We excluded 153,543 episodes from our sample (5 percent of all episodes) for patients who lived outside of Massachusetts and its bordering states (including Maine), who had inaccurate zip codes, or who had episode costs of zero dollars.

SES Index

Our SES index included 6 components: annual household income, education, unemployment, head-of-household status, receipt of public assistance, and poverty status (See Table 2 for detailed descriptions of each component). Bird et al.²² derived this index through factor analysis using an initial set of 12 indicators of SES. We used SES measures from the 2000 decennial census²³ reported at the level of zip code tabulation areas (ZCTA) as a proxy for an individual patient's SES. ZCTAs are roughly equivalent in size to zip codes,²⁴ and for simplicity, we use the term zip codes to refer to ZCTAs. Using Bird's method, scales of each SES measure were transformed so that higher values corresponded to higher SES. Each indicator was normalized to have a mean of zero and a standard deviation of one. These variables were then summed and renormalized. We defined "significant socioeconomic deprivation" as any patient with an SES Index less than -2, which corresponds to two standard deviations below the sample mean.

Estimating Relative Costs

Health plans typically create a physician cost profile by calculating an “observed” cost (defined as the total cost for all episodes assigned to each physician) and an “expected” cost (defined as the sum of the average cost of episodes of the same type assigned to physicians within the same specialty). Each physician is associated with an “observed-to-expected” ratio, which represents his or her relative cost of care. We used a similar approach in this analysis; however, we used a regression framework to enable adjustment of physicians’ relative cost estimates for patients’ SES. All regression models included physician fixed effects, and the coefficients on each of these terms provided an estimate of each physician’s average cost of care (relative to an omitted physician) adjusted for patients’ SES.

Statistical Analyses

We first explored the relationship between SES and episode costs by comparing mean unadjusted episode costs across quintiles of patients’ SES. These analyses neither adjusted for case mix nor SES.

Using multivariable regression models we then examined the amount of variation in episode costs explained by three sets of adjustment variables: case mix, SES, and physician effects. We included both linear and quadratic SES terms to permit a more flexible relationship between SES and cost. These analyses used multivariable linear regression models where the total price-standardized allowed cost of a given episode of care was the outcome variable. We used a log transformation—one of the two commonly used techniques (along with the gamma family of generalized linear models) to account for skew in the distribution of costs.

Finally, we estimated each physician’s relative cost of care, first without adjustment for SES, and then with adjustment. We then computed each physician’s relative cost ranking, measured in percentiles, and then calculated each physician’s change in percentile ranking following adjustment for SES.

All analyses were conducted by specialty to account for possible unmeasured differences in case mix for identical episodes treated by physicians of different specialties. We limited our analyses to the top 10 specialties by volume across the three health plans.

Sensitivity Analyses

To ensure that our results were robust across alternative model specifications, we examined the impact of using random effects for each physician rather than fixed effects, including interactions between SES and episode type indicators in each regression model, and using an alternative attribution rule that assigned episodes to the physician who had a plurality of visits rather than a plurality of costs.

To explore the sensitivity of our results to the SES profile of our patient sample we compared distributions of the 6 SES Index components for our sample of enrollees with the corresponding distributions for the overall adult population (aged 18-64) living in the same zip codes. We then simulated the addition of a very low SES population to our current sample and examined the impact on physicians’ relative cost rankings. We assumed that the

imputed population—equivalent to 10 percent of our original sample—had 50 percent lower SES index values than the patients in the lowest decile of the original sample; and had an identical case mix, sought care from the same physicians, and had either 5, 10, or 25 percent higher costs per episode than these patients.

Results

A total of 9,231 physicians were assigned at least one episode of care during the two-year study period. The physicians were predominantly male, board certified, and went to medical school in the U.S. (Table 1). Approximately half had been practicing for over 20 years. The most common specialties were internal medicine (32 percent of physicians), family medicine (12 percent), and OB/GYN (10 percent). Physicians were attributed an average of 227 episodes of care.

These physicians treated a total 785,726 patients, who were collectively responsible for nearly 2.1 million episodes of care during the two year study period. Low SES patients differed from high SES patients across each component of our SES index (Table 2). Compared to the highest SES quintile, patients in the lowest SES quintile lived in zip codes where the median household income was \$50,000 lower, the high school graduation rate was 22 percentage points lower, the prevalence of female-headed households with children was 7 percentage points higher, and unemployment, receipt of public assistance, and poverty were between 3 and 14 percentage points higher. Patients in the lowest SES quintile were 8 percentage points more likely to have at least one chronic condition, and had higher rates for each of 8 common chronic conditions. Overall, 5.9 percent of patients had an SES index less than 2 (indicating significant socioeconomic deprivation), while 2 percent of physicians had *mean* patient SES values of less than 2 (Appendix Figure 1).

Consistent with prior studies, patients in the lowest SES quintile had higher unadjusted episode costs (80 dollars higher or 15 percent) than patients in the highest SES quintile (Figure 1). This pattern was consistent for episodes attributed to physicians across a range of common specialties.

However, in adjusted analyses, SES explained very little variation in episode costs compared to other adjustment variables. Across the ten specialties we examined, case mix variables (including both episode type and severity of illness indicators) explained 69 percent of the variance in episode costs (Table 3). Variation between physicians explained a much smaller proportion of the total variance in episode costs, although there was some variation across specialties. By contrast, the effect of adding SES to the adjustment models was negligible and did not vary across specialties.

Adjusting for SES also had little impact on a physician's relative cost ranking (Figure 2). After implementing SES adjustment, only 1.1 percent of physicians changed rankings by more than two percentile points; 64 percent of physicians did not change rankings at all. This finding was consistent across the 10 most common specialties (Appendix Table 1).

Physicians who changed rankings by more than two percentile points were more likely to manage a disadvantaged population. Among these physicians, 36 percent had a mean patient

SES index value less than 2. However, even among physicians in this group, the vast majority had small changes in rankings; 29 percent did not change ranking, and 51 percent changed only 1 or 2 percentile points.

For each of three sensitivity analyses in which we varied the specification of our adjustment model, no more than 4.4 percent of physicians changed rankings by more than two percentile points (Appendix Table 2). When comparing the SES profile of our patient sample with that of the overall adult population living in the same regions, we found minor differences across each of the 6 SES components (Appendix Figure 2). For example, among individuals associated with the 10th percentile of the distribution for each component, patients in our sample lived in areas with \$5400 higher household incomes and had high school graduation rates that were 1.5 percentage points higher. All other differences at the 10th percentile were negligible. Adding a hypothetical population of very low SES patients to the analysis caused physicians' relative cost rankings to change little until the assumed relative cost for this population exceeded 110% of the lowest decile of our original sample. Under this assumption 7.4 percent of physicians changed relative cost rankings by more than 2 percentiles.

Discussion

The Affordable Care Act required an assessment of the impact of SES on physician cost profiles. This analysis would help address the concern that physicians who treat disadvantaged populations will be unfairly labeled as high cost. Surprisingly, we found that adjustment for SES resulted in very little impact on a physician's relative cost ranking. Only 1.1 percent of physicians changed ranks by more than two percentiles. These results were robust across a number of sensitivity analyses that tested different specifications of the adjustment model and after imputing a "missing" lower tail for the SES distribution of our sample.

The higher costs observed among low SES patients in unadjusted analyses were driven disproportionately by their greater prevalence of higher-severity episode types. Low SES patients were more likely to suffer from conditions that have a higher average cost. For example, low SES patients may have more episodes of diabetes *with complications* rather than diabetes *without complications* or any number of other less severe episode types. Because current episode cost profiling methodologies already address differences in conditions, further adjustment for SES appears to make little difference. After accounting for differences in episode type, severity of illness, and physician-to-physician variation, we found that SES explained little additional variation in episode costs—a finding that was consistent across the 10 most common specialties.

Another plausible cause for the lack of an effect of SES adjustment is limited variation between physicians in the average SES of their patient mix. If many physicians treat a mix of patients with both high and low levels of SES, the net effect of adjustment will be minimal. We found there was substantial variation in physicians' mean SES although only 2 percent treated a very low SES population.

Our findings are consistent with previous studies that used different methods. To our knowledge, this analysis is the first to explore the impact of SES adjustment on *episode costs* and their implications for physician relative cost rankings. Previous studies have mostly focused on the total cost of care over a defined period (typically a year) and found that lower SES patients have higher costs of care,⁹⁻¹¹ but that much of the impact of SES on resource use is diminished or eliminated entirely after adjusting for comorbidities.¹⁰ Also, previous analyses that have examined the relationship between SES and cost used relatively basic approaches for modeling the relationship between SES and cost and did not examine the impact of SES adjustment on physician relative cost rankings.⁹ We examined various model specifications including the inclusion of linear and quadratic interaction terms to allow a flexible relationship between episode type and SES and our analysis specifically focused on a profiling context. We also used a large state-wide multi-payer database—thus improving upon the smaller scale studies of the past.

We do recognize that for 1 percent of physicians, adjustment for SES did have an impact on their cost ranking. Health plans, CMS, and others who use episode groupers to create cost profiles will need to decide whether to adjust relative cost measures for these physicians. However, the magnitude of the shift in rankings is relatively minor—the maximum observed change was 9 percentile points—that even for these physicians, adjusting for SES is unlikely to trigger a change in classification from ‘high value’ to ‘low value.’ Nevertheless, such an adjustment will increase the face validity of relative cost reports among these physicians.

Our results should be interpreted in light of the following limitations. First, our claims database drew on a commercially insured population from a single state. While our simulation of a hypothetical, very low SES population suggested that our results are not likely to be highly biased, expanding this analysis beyond the commercially insured population should be a priority for future research. Second, we used ZCTA-level estimates of SES because patient-level data were not present in claims. We did not use smaller units (e.g., census block groups) because we did not have patients’ addresses. While more highly aggregated units of analysis could mask heterogeneity in patients’ SES, in practice, there are few differences between analyses that measures SES at the zip code level compared to smaller units of analysis.²⁵ Third, our results focused on a single episode grouper, although there are numerous commercial products available as well as the new episode grouper developed specifically for use by CMS. Validation analyses are critical to ensure that the indirect effects of SES (mediated through a higher severity of illness) are captured in the new grouper to guarantee the validity of the resulting relative cost estimates.

Conclusion

Physician relative cost rankings change very little following adjustment for patients’ SES. The vast majority of the differences in episode costs between high and low SES patients is due to differences in case mix, including both the prevalence of high-cost clinical conditions and, for patients with the same condition, their relative severity of illness. These factors are already accounted for in current cost profiling efforts and further adjustment for SES does not impact relative cost rankings to a degree that would change inferences about a physician’s relative cost of care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Appendix

Appendix Figure 1.

Distribution of SES Indexes for Included Episodes of Care and Physician-level Mean SES

Appendix Figure 2.

Distributions of SES Index Components for Included Patients and the Overall Adult Population

Note: Red denotes included patients. Blue denotes the overall adult population living in the same zip codes.

Appendix Table 1

Change in Physician Relative Cost Rankings Following Adjustment for SES, by Specialty and Overall

Specialty	Change in ranking, number of Physicians (Percent)				
	No change	1 Percentile	2 Percentiles	3-5 Percentiles	>5 Percentiles
Cardiology	502 (71)	194 (28)	9 (1)	-	-
Emergency Medicine	333 (47)	260 (37)	84 (12)	33 (5)	-
Family/General Practice	716 (68)	297 (28)	22 (2)	22 (2)	3 (<1)
General Surgery	449 (78)	127 (22)	2 (<1)	1 (<1)	-
Internal Medicine	2067 (70)	805 (27)	92 (3)	9 (<1)	-
Neurology	297 (69)	128 (30)	8 (2)	-	-

Specialty	Change in ranking, number of Physicians (Percent)				
	No change	1 Percentile	2 Percentiles	3-5 Percentiles	>5 Percentiles
OBGYN	535 (58)	330 (36)	50 (5)	4 (<1)	-
Ophthalmology	362 (66)	170 (31)	16 (3)	-	-
Orthopedic Surgery	327 (56)	202 (35)	41 (7)	10 (2)	-
Psychiatry	351 (48)	300 (41)	56 (8)	17 (2)	-
Overall	5939 (64)	2813 (30)	380 (4)	96 (1)	3 (<1)

Notes: Fixed effects analysis using an attribution rule based on plurality of costs.

Appendix Table 2

Sensitivity of Relative Cost Rankings to Changes in Model Specification

Specialty	Change in ranking, number of Physicians (Percent)				
	No change	1 Percentile	2 Percentiles	3-5 Percentiles	>5 Percentiles
Random effects analysis *					
Cardiology	523 (74)	178 (25)	4 (<1)	-	-
Emergency Medicine	320 (45)	246 (35)	99 (14)	45 (6)	-
Family/General Practice	678 (64)	323 (30)	29 (3)	29 (3)	1 (<1)
General Surgery	381 (66)	174 (30)	22 (4)	2 (<1)	-
Internal Medicine	2003 (67)	861 (29)	101 (3)	8 (<1)	-
Neurology	312 (72)	112 (26)	7 (2)	2 (<1)	-
OBGYN	523 (57)	331 (36)	60 (7)	5 (<1)	-
Ophthalmology	389 (71)	141 (26)	17(3)	1 (<1)	-
Orthopedic Surgery	289 (50)	215 (37)	54 (9)	21 (4)	1 (<1)
Psychiatry	263 (36)	290 (40)	98 (14)	71 (10)	2 (<1)
Overall	5681 (62)	2871 (31)	491 (5)	184 (2)	4 (<1)
Fixed effects analysis with SES, episode type interactions **					
Cardiology	502 (71)	194 (28)	9 (1)	-	-
Emergency Medicine	321 (45)	268 (38)	76 (11)	43 (6)	2 (<1)
Family/General Practice	626 (59)	340 (32)	49 (5)	29 (3)	16 (2)
General Surgery	350 (60)	177 (31)	33 (6)	9 (2)	10 (2)
Internal Medicine	1829 (62)	880 (30)	185 (6)	64 (2)	15 (<1)
Neurology	297 (69)	128 (30)	8 (2)	-	-
OBGYN	502 (55)	318 (35)	73 (8)	23 (3)	3 (<1)
Ophthalmology	324 (59)	177 (32)	36 (7)	9 (2)	2 (<1)
Orthopedic Surgery	288 (50)	219 (38)	52 (9)	19 (3)	2 (<1)
Psychiatry	300 (41)	301 (42)	85 (12)	36 (5)	2 (<1)
Overall	5339 (58)	3002 (33)	606 (7)	232 (3)	52 (<1)
Visit-based attribution rule ***					
Cardiology	571 (83)	118 (17)	-	-	-
Emergency Medicine	253 (36)	236 (34)	107 (15)	103 (15)	4 (<1)

Specialty	Change in ranking, number of Physicians (Percent)				
	No change	1 Percentile	2 Percentiles	3-5 Percentiles	>5 Percentiles
Family/General Practice	742 (71)	266 (26)	23 (2)	11 (1)	-
General Surgery	362 (66)	162 (30)	20 (4)	4 (<1)	-
Internal Medicine	1992 (69)	829 (29)	72 (2)	1 (<1)	-
Neurology	231 (54)	139 (33)	39 (9)	16 (4)	-
OBGYN	430 (48)	355 (40)	92 (10)	20 (2)	-
Ophthalmology	342 (63)	184 (34)	17(3)	2 (<1)	-
Orthopedic Surgery	421 (76)	132 (24)	3 (<1)	-	-
Psychiatry	182 (27)	237 (35)	124 (18)	111 (17)	18 (3)
Overall	5526 (61)	2658 (29)	497 (5)	268 (3)	129 (1)

* Physician effects were included as random effects rather than fixed effects. The base case attribution rule was used (plurality of costs).

** The base case attribution rule was used (plurality of costs).

*** Episodes were attributed to physicians based on a plurality of visits rather than a plurality of costs.

Appendix Table 3

Changes in Relative Cost Rankings After Adding a Very Low SES Population to the Patient Sample

Assumed relative cost for lowest SES patients	Change in Ranking, number of Physicians (Percent)				
	No change	1 Percentile	2 Percentiles	3-5 Percentiles	>5 Percentiles
Base case analysis	5939 (64)	2813 (30)	380 (4)	96 (1)	3 (<1)
5% higher episode costs	5922 (64)	2627 (28)	493 (5)	176 (2)	13 (<1)
10% higher episode costs	4414 (48)	3281 (36)	848 (9)	564 (6)	124 (1)
25% higher episode costs	2712 (29)	2348 (25)	1433 (16)	1973 (21)	765 (8)

Notes: Fixed effects analysis using an attribution rule based on plurality of costs.

References

1. American Medical Association. [Accessed 6/17/2012] A Comparison of Three Physician Profiling Programs. 2009. <http://www.ama-assn.org/ama/pub/physician-resources/practice-management-center/health-insurer-payer-relations/physician-efficiency-quality-data/profiling.page>
2. Robert Wood Johnson Foundation. [Accessed 6/17/2012] The Case for Public Reporting of Cost & Resource Use Measures. 2011. <http://www.rwjf.org/files/research/73714.caseforcost.pdf>
3. Rosenthal MB, Landrum MB, Meara E, Huskamp HA, Conti RM, Keating NL. Using performance data to identify preferred hospitals. *Health Serv Res.* Dec; 2007 42(6 Pt 1):2109–2119. discussion 2294-2323. [PubMed: 17995555]
4. Sinaiko AD, Rosenthal MB. Consumer experience with a tiered physician network: early evidence. *Am J Manag Care.* Feb; 2010 16(2):123–130. [PubMed: 20148617]
5. Centers for Medicare and Medicaid Services. [Accessed 1/3/2012] Physician Feedback/Value-Based Modifier Program. 2011. <https://www.cms.gov/PhysicianFeedbackProgram/>
6. de Brantes, F. [Accessed 7/2/2012] HCI3 Update from the Field: Another Page Has Turned. 2012. <http://www.hci3.org/content/hci3-update-field-another-page-has-turned>

7. Massachusetts Medical Society. [Accessed 1/3/2012] Comments to CMS on the Physician Value Based Payment Modifier. 2010. <http://www.massmed.org/AM/Template.cfm?Section=Home6&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=54221>
8. Adams JL, Mehrotra A, Thomas JW, McGlynn EA. Physician cost profiling--reliability and risk of misclassification. *N Engl J Med*. Mar 18; 2010 362(11):1014–1021. [PubMed: 20237347]
9. Franks P, Fiscella K, Beckett L, Zwanziger J, Mooney C, Gorthy S. Effects of patient and physician practice socioeconomic status on the health care of privately insured managed care patients. *Med Care*. Jul; 2003 41(7):842–852. [PubMed: 12835608]
10. Lemstra M, Mackenbach J, Neudorf C, Nannapaneni U. High health care utilization and costs associated with lower socio-economic status: results from a linked dataset. *Can J Public Health*. May-Jun;2009 100(3):180–183. [PubMed: 19507718]
11. Roos LL, Walld R, Uhanova J, Bond R. Physician visits, hospitalizations, and socioeconomic status: ambulatory care sensitive conditions in a canadian setting. *Health Serv Res*. Aug; 2005 40(4):1167–1185. [PubMed: 16033498]
12. Soumerai SB, Ross-Degnan D, Avorn J, McLaughlin T, Choodnovskiy I. Effects of Medicaid drug-payment limits on admission to hospitals and nursing homes. *N Engl J Med*. Oct 10; 1991 325(15):1072–1077. [PubMed: 1891009]
13. Rathore SS, Masoudi FA, Wang Y, et al. Socioeconomic status, treatment, and outcomes among elderly patients hospitalized with heart failure: findings from the National Heart Failure Project. *Am Heart J*. Aug; 2006 152(2):371–378. [PubMed: 16875925]
14. Epstein AM, Stern RS, Weissman JS. Do the poor cost more? A multihospital study of patients' socioeconomic status and use of hospital resources. *N Engl J Med*. Apr 19; 1990 322(16):1122–1128. [PubMed: 2108331]
15. Agency for Healthcare Research and Quality. National Healthcare Disparities Report. Rockville, MD: 2010.
16. U.S. Congress. Improvements to the Physician Feedback Program. 2010. Affordable Care Act, Section 3003.
17. Adams, JL.; Mehrotra, A.; Thomas, JW.; McGlynn, EA. Physician Cost Profiling—Reliability and Risk of Misclassification Detailed Methodology and Sensitivity Analyses: Technical Appendix. TR-799. Santa Monica, CA: 2010.
18. Symmetry™ Episode Treatment Groups®: Measuring Health Care with Meaningful Episodes of Care, version 6.0. Eden Prairie; Minnesota: 2007. Version version 6.0
19. Pham HH, Schrag D, O'Malley AS, Wu B, Bach PB. Care patterns in Medicare and their implications for pay for performance. *N Engl J Med*. Mar 15; 2007 356(11):1130–1139. [PubMed: 17360991]
20. Lake, T.; Colby, M.; Peter, S. Health Plans' Use of Physician Resource Use and Quality Measures. Mathematica Policy Research, Inc.; Washington, DC: 2007.
21. Mehrotra A, Adams JL, Thomas JW, McGlynn EA. The effect of different attribution rules on individual physician cost profiles. *Ann Intern Med*. May 18; 2010 152(10):649–654. [PubMed: 20479030]
22. Bird CE, Seeman T, Escarce JJ, et al. Neighbourhood socioeconomic status and biological 'wear and tear' in a nationally representative sample of US adults. *J Epidemiol Community Health*. Oct; 2010 64(10):860–865. [PubMed: 19759056]
23. U.S. Census Bureau. Census 2000 Summary File 1. United States: 2001.
24. U.S. Census Bureau. [Accessed 6/10/2012] ZIP Code Statistics. 2012. <http://www.census.gov/epcd/www/zipstats.html>
25. Fiscella K, Franks P. Impact of patient socioeconomic status on physician profiles: a comparison of census-derived and individual measures. *Med Care*. Jan; 2001 39(1):8–14. [PubMed: 11176539]

Figure 1. Unadjusted Cost per Episode of Care, by Quintile of Patients' SES Index

Notes: Each data point corresponds to the mean unadjusted cost per episode of care and is neither adjusted for case mix nor SES).

Figure 2. Change in Physicians' Relative Cost Rankings following Adjustment for Patients' SES Index

Notes: n refers to the number of physicians who changed relative cost rankings by the number of percentiles indicated.

Table 1**Characteristics of Physicians with at Least One Attributed Episode of Care**

	N (%)
Total number of physicians	9,231 (100)
Sex: Female	2,890 (32.5)
Male	5,992 (67.5)
Board Certification: Yes	8,100 (91.2)
No	782 (8.8)
Medical school: Domestic	7,430 (83.7)
International	1,452 (16.4)
Years in practice: <10	1,834 (20.7)
10-19	2,741 (30.9)
20-29	2,444 (27.5)
30-39	1,317 (14.8)
40-49	469 (5.3)
50 years	77 (0.9)
Specialty: Internal Medicine	2,973 (32.2)
Family/General Practice	1,060 (11.5)
Obstetrics and Gynecology	919 (10.0)
Psychiatry	724 (7.8)
Emergency Medicine	710 (7.7)
Cardiology	705 (7.6)
Orthopedic Surgery	580 (6.3)
General Surgery	579 (6.3)
Ophthalmology	548 (5.9)
Neurology	433 (4.7)
Number of attributed episodes, mean (SD)	227 (310)

Note: Four percent of physicians (2 percent of all episodes) were excluded from all analyses due to missing data on these characteristics.

Table 2

Characteristics of Patients Comprising the Lowest and Highest SES Quintiles, and Overall, among Patients with at Least One Completed Episode of Care

Characteristic	Lowest SES quintile N=157,609	Highest SES quintile N=156,440	Overall N=785,726
Age	45.5 (13.9)	46.2 (11.8)	45.8 (12.9)
Gender: Female, n (%)	89,462 (56.8%)	86,580 (55.3%)	441,727 (56.2%)
Male	68,147 (43.2%)	69,860 (44.7%)	343,999 (43.8%)
Socioeconomic Index*			
Median annual household income, in dollars	35,852 (6,392)	85,996 (16,864)	57,503 (19,223)
Percent of residents with less than high school diploma (age 25+)	26.7 (8.9)	4.9 (2.1)	13.5 (9.0)
Percent of male residents who are unemployed (age 16+)	4.9 (2.0)	1.8 (0.6)	3.1 (1.8)
Percent of households that are female headed with children	11.0 (4.3)	3.6 (0.6)	5.9 (3.4)
Percent of households with public assistance income	5.5 (2.5)	0.8 (0.4)	2.4 (2.1)
Percent of individuals with annual income below poverty	16.9 (6.3)	3.0 (1.2)	7.6 (6.1)
Composite Index	-1.6 (0.8)	1.1 (0.3)	0.0 (1.0)
Comorbidities: Asthma, n (%)**	4,271 (2.7%)	3,340 (2.1%)	19,600 (2.5%)
Type 2 diabetes	4,412 (2.8%)	1,767 (1.1%)	15,442 (2.0%)
Hyperlipidemia	6,840 (4.3%)	4,049 (2.6%)	27,771 (3.5%)
Hypertension (benign)	13,996 (8.9%)	7,304 (4.7%)	54,801 (7.0%)
Ischemic heart disease	2,880 (1.8%)	1,814 (1.2%)	12,516 (1.6%)
Congestive heart failure	472 (0.3%)	236 (0.2%)	1,774 (0.2%)
COPD	966 (0.6%)	565 (0.4%)	3,874 (0.5%)
At least one chronic condition	57,281 (36.3%)	43,960 (28.1%)	258,152 (32.9%)
Number of episodes, mean (SD)	3.7 (2.7)	3.7 (2.7)	3.7 (2.7)

Notes: Mean (SD) are reported unless otherwise indicated. All differences between quintiles are significant at the p<0.05 level.

* Measured at the level of Zip Code Tabulation Area

** All comorbidities are defined according to the presence of at least one episode of each type

Table 3

Variation in Episode Costs Explained by Case Mix, Physician, and SES Variables

Specialty	Percent variation in cost explained by the sequential addition of adjustment variables:		
	Case Mix	Adding Physician Effects	Adding SES Terms
Cardiology	77.3	−0.5	−0.01
Emergency Medicine	57.7	1.8	0.03
Family/General Practice	69.4	0.3	−0.02
General Surgery	73.2	−1.0	0.00
Internal Medicine	61.6	0.0	−0.03
Neurology	56.4	1.1	0.06
OBGYN	90.2	−0.8	0.00
Ophthalmology	73.4	0.3	0.00
Orthopedic Surgery	75.7	−0.3	0.01
Psychiatry	58.9	5.5	0.05
Weighted Mean	69.0	0.03	−0.02

Notes: Model parameters were added in the following order: 1) case mix variables (episode type and patient severity indicators), 2) physician fixed effects (indicators for individual physicians to whom each episode was attributed), and 3) SES terms (linear and quadratic). Values are in units of percentage points, and equivalent to the R^2 statistic (for the model with only case mix variables), and the change in R^2 values as physician effects and SES terms are added to the model.