Published in final edited form as:
Health Aff (Millwood). 2012 November ; 31(11): 2453–2463. doi:10.1377/hlthaff.2011.0252.

Physicians with the least experience have higher cost profiles than do physicians with the most experience

Ateev Mehrotra[1], **Rachel O. Reid**[2], **John L. Adams**[3], **Mark W. Friedberg**[4], **Elizabeth A. McGlynn**[5], and **Peter S. Hussey**[6]

[1]Ateev Mehrotra is an associate professor of medicine, Division of General Internal Medicine, University of Pittsburgh School of Medicine, and a policy analyst at the RAND Corporation in Pittsburgh, Pennsylvania.

[2]Rachel O. Reid is a medical student at the University of Pittsburgh.

[3]John L. Adams is principal senior statistician at the Kaiser Permanente Center for Effectiveness and Safety Research, in Pasadena, California.

[4]Mark W. Friedberg is a natural scientist at the RAND Corporation, a practicing general internist, and a clinical instructor at Brigham and Women's Hospital and Harvard Medical School, in Boston, Massachusetts.

[5]Elizabeth A. McGlynn is director of the Kaiser Permanente Center for Effectiveness and Safety Research, in Pasadena, California.

[6]Peter S. Hussey is a policy researcher at the RAND Corporation in Arlington, Virginia.

Abstract

Health plans and Medicare are using cost profiles to identify high-cost physicians in the hope of lowering total health care spending, but it is unclear which types of physicians will be most affected. Using cost profiles created from health plan claims, we examined which physician characteristics are associated with higher costs. Our strongest association was related to a physician's year of experience. Compared to the most experienced physicians, the least experienced physicians had 13 percent higher overall costs. We found no association between costs and other factors such as malpractice claims, disciplinary action, board certification status, and the size of the group in which the physician practices. While winners and losers are inevitable in any cost profiling effort, physicians with less experience are more likely to be negatively affected by policies that utilize cost profiles. For example, they could be excluded from high-value networks or receive lower payments under Medicare's planned value-based payment program. Further, our results raise the possibility that the more costly practice style of newly trained physicians may be a driver of rising health care costs.

BACKGROUND

Commercial health plans and government payers are increasingly using physician cost profiling to control health care spending. A cost profile compares a physician's resource use to his or her peers, accounting for differences in patient case-mix.(1) Health plans are using cost profiles–sometimes accompanied by quality profiles--for public reporting or to create selective or tiered networks of providers. The Affordable Care Act will accelerate the use of cost profiles as it mandates that Medicare produce physician cost profiles by 2012,(2) which

Corresponding author: Ateev Mehrotra, MD, MPH RAND Corporation 4570 Fifth Avenue, Suite 600 Pittsburgh, PA 15213 mehrotra@rand.org.

may be used as a basis for adjusting a physician's reimbursement via Medicare's new value-based payment modifier.

Despite the growing use of physician cost profiles, the individual physician characteristics that are associated with cost profile performance are unknown. Understanding the characteristics of physicians who are low and high cost can help policy makers understand who will benefit or lose from policy interventions that use cost profiling. To the extent that physicians can adopt certain characteristics such as becoming board certified), this knowledge could also inform efforts to achieve better cost profiles.

To our knowledge, no previous research has examined the relationship between physician characteristics and the cost profiles that are in current use. Prior work has been limited to examinations of the association between physician characteristics and use of specific services such as laboratory testsor the clinical decisions made in hypothetical clinical scenarios.(3-14) Here, in a large sample of Massachusetts physicians, we examined the relationship between publicly available physician characteristics and performance on cost profiles.

METHODS

We created individual cost profiles for physicians in our sample; we then linked the cost profiles to information about physician characteristics in a separate database. Finally, we evaluated associations between physician characteristics and performance on the cost profiles.

PATIENT AND PHYSICIAN SAMPLE

Details on our patient and physician samples are available elsewhere.(15) In brief, physician performance scores were created using de-identified aggregated insurance claims from 1.13 million patients, ages 18 to 65, who were continuously enrolled in one of four Massachusetts commercial health plans in 2004-5. We used unique physician identifiers created by the Massachusetts Health Quality Partners to aggregate claims at the physician level across the four health plans. We then divided the non-inpatient claims into distinct categories, using the Berenson-Eggers type of service code system as detailed in the Appendix, and included inpatient claims in the cost profiles as a separate inpatient care category.

We used publicly available physician characteristics from the Massachusetts Board of Registration in Medicine in our models. Details on how the physician characteristics were selected are available in the Appendix.

For each physician, we classified his or her practice setting into three categories: solo or small group(1-19 physicians), medium sized group(≥20), or large group(≥200). Group participation was determined using the Massachusetts Health Quality Partners database, which defines a physician group as a set of physicians that jointly contract with health plans and share resources and leadership (e.g. medical directors).(16)

Massachusetts Health Quality Partners maintains an annually updated roster of physicians in each group.(17) Some physicians (n=1241), mostly specialists, practiced in multiple groups. Allocation of their claims to specific groups was not possible because the claim does not indicate at which site the care was provided. For these physicians, we randomly assigned the physicians to one of the groups in which they practice. We also combined solo and small group physicians into one category because few physicians in Massachusetts were in small groups. Groups were labeled as academic if they were affiliated with a hospital that is a member of the Council of Teaching Hospitals.

MEASURING RELATIVE COSTS OF PHYSICIANS USING COST PROFILES

The methodology we used to create cost profiles is described in greater detail in previous work.(15, 18) It was designed to replicate the cost profiling methods commonly used by health plans. In brief, we took the following steps.

Construct episodes of care—We used Episode Treatment Groups® software to aggregate each patient's claims into clinically related episodes of care (Version 6.0, Ingenix, Eden Prairie, Minnesota). The 600-plus episode types created by the software are based on condition (e.g., diabetes vs. heart failure), severity of illness (e.g., diabetes with comorbidity and diabetes without comorbidity), and inclusion of procedures (e.g., tonsil inflammation with and without surgery). This separation of episodes based on severity of illness and use of a procedure, in theory, allows for comparison of costs within a more homogeneous set of episodes.

Calculate each episode's observed costs—The cost of each patient episode was calculated by summing the standardized costs of each service multiplied by the number of times the service was provided within the episode. Details on how we standardized costs for each service are provided in the Appendix.

Assign episodes to physicians—The total cost of an episode of care was attributed to the physician who had billed the greatest fraction (minimum 30 percent) of professional costs within the episode. This appears to be the most common rule used by health plans(19) and the default rule we have used in all of our prior work.(18, 19) In sensitivity analyses we examined whether our results were robust depending on the manner in which care was attributed to a physician, with two less commonly used attribution rules.(20)

Calculate "expected" costs—For each type of episode (e.g., uncomplicated diabetes) the expected cost was the mean cost across all episodes among physicians of the same specialty adjusted for patient age, gender, and co-morbidities. Therefore, all comparisons of costs occurred among physicians of the same specialty; no costs were compared across physicians of different specialties. We used Symmetry's Episode Risk Groups® to quantify patient severity for each episode based on co-morbidities.

Construct composite cost profile—We calculated a ratio based on all episodes attributed to each physician. The composite cost profile ratio is the sum of observed costs over the sum of expected costs.

CLASSIFYING CLAIMS AND EPISODES INTO CATEGORIES

DATA ANALYSIS—We created multivariate linear regression models to examine the associations between physician characteristics and cost profile scores. The unit of analysis was the individual physician; the dependent variable was the log-transformed composite cost profile. The explanatory variables included: type of degree (MD or DO), gender of physician, board-certification status, years of experience, where the physician went to medical school, whether physician has had a malpractice or disciplinary claim, size of the group in which the physician practices, and number of episodes attributed to the physician as a measure of patient volume. Physicians were weighted by the inverse of the standard error of their cost profile; on average, this reduced the weight given to physicians with a low volume of cases contributing to their cost profile score. We present the difference in scores attributable to each characteristic by the regression model. These coefficients can be interpreted as the percent difference in overall costs associated with that characteristic. More details on our models are provided in the Appendix.

We conducted a number of exploratory analyses to further investigate the observed link between cost profiles and experience. To examine whether cost profile differences were explained by different types of care, we ran four different versions of the regression model: all care, acute care, chronic care, and preventive care. We also examined per-episode costs for four specific types of episodes: hypertension, skin inflammation, benign neoplasm of breast, and preventive health examination. We chose these four conditions because they were common episode types and represent a range of conditions assigned to primary care physicians and specialists. Sensitivity analyses available in the Appendix present separate results based on types of physicians and attribution rules. To examine whether new patient visits might be driving associations observed, we looked at the association between experience and fraction of all evaluation and management visits billed by a physician that were for new patient visits.

RESULTS

PHYSICIAN SAMPLE

Of the physicians in the Massachusetts Health Quality Partners database, 12,724 physicians in 27 selected specialties practiced in Massachusetts and had a physician cost score. We excluded physicians who could not be linked the Massachusetts Board database (n=590), those still in training (n=5), and those with invalid data (n=13). The remaining 12,116 physicians were the basis of our analysis. These physicians had 2,861,093 episodes assigned to them, an average of 236.1 episodes per physician (range, 1-3,581). Physicians in some specialties such as dermatology have high numbers of episodes because an episode can be composed of a single visit.

PHYSICIAN CHARACTERISTICS IN SAMPLE

Most physicians were male (69.8 percent), board certified (92.1 percent), domestically trained (83.5 percent), and in possession of an allopathic medical degree (97.8 percent) [Exhibit 1]. Physicians spanned a wide breadth of experience in practice; 15.9 percent had less than ten years and 7.5 percent had forty or more years of experience. Few made payments on malpractice claims in the last decade (9.5 percent), and fewer had board disciplinary actions against them in that time (0.9 percent). Almost one-quarter of physicians (23.6 percent) were internists [Exhibit 2].

ASSOCIATION BETWEEN PHYSICIAN CHARACTERISTICS AND OVERALL COST PROFILE SCORES

In our multivariate model, the strongest association was between less experience and higher cost profile scores. Compared to physicians with >40 years of experience, physicians with <10, 10-19, 20-29, 30-39 years of experience had 13.2 percent, 10.0 percent, 6.5 percent, and 2.5 percent higher cost profile scores, respectively (Exhibit 3). A weak association existed between volume of care (as measured by number of episodes assigned to physician) and cost profile scores; each one hundred additional episodes was associated with 0.3 percent lower scores, p=0.004. There was no association between overall cost profile scores and other physician characteristics, including malpractice claims, disciplinary action, gender, size of physician group, and board certification status.

ASSOCIATION BETWEEN PHYSICIAN CHARACTERISTICS AND COST PROFILE SCORES FOR SPECIFIC CARE TYPES

For each physician, we also created separate cost profile scores for acute, chronic, and preventive care. Compared to physicians with over forty years of experience, less experienced physicians had higher acute-care cost profile scores and higher chronic disease

care cost profile scores (Exhibit 3). In contrast, for preventive care, there was no association between experience and cost profile scores. Female physicians had 9.0 percent higher prevention cost profile scores than male physicians ($p<0.0001$).

MECHANISMS THAT MIGHT EXPLAIN ASSOCIATIONS BETWEEN PHYSICIAN EXPERIENCE AND COST PROFILE SCORES

We conducted a number of exploratory sub-analyses to better understand the observed association between experience and cost profile scores, recognizing that the cross-sectional nature of this study limits to some degree our ability to explicate this finding.

First, to determine if our findings could be explained by the mix of conditions treated by physicians, we conducted sensitivity analyses (Supplemental Table 2 in Appendix) to examine the association between experience and cost profile scores in four select conditions. For hypertension, skin inflammation, benign neoplasm of the breast, we generally observed the same inverse association between experience and cost profile scores as in the pooled all-condition analyses. However, this association was not evident for preventive health examinations.

Next, we conducted several analyses to test for differences in practice patterns that might explain our findings. For each episode assigned to a physician, we calculated the fraction of total costs for each type of service. We examined the association between average fraction of spending on each type of service and years of experience. There were no notable differences in average fraction of episode costs spent on laboratory tests, imaging, procedures, or prescriptions [Exhibit 4]. However, the average costs for an episode varies by experience category. This means that while the *fraction of the total costs* for a given cost category is similar, the actual dollars spent, both overall and within each category, do vary across categories of experience.

Lastly, we examined cost profiles based on patient costs per capita. The episode grouping algorithm used to calculate the cost scores reported above relies on diagnosis codes and other information from claims, and therefore claims coding practices could affect physician cost scores. Patient costs per capita will not be affected by issues in episode grouping algorithms as they capture all costs for a patient and does not depend on diagnosis codes. As in the episode-based analyses, costs were lower for more-experienced physicians. Mean per-capita patient costs for patients cared for by physicians with <10, 10-19, 20-29, 30-39, and >40 years of experience were $14,906, $15,623, $14,066, $12,028, and $10,104 respectively ($p<0.01$ for ANOVA test of difference between years of experience) The higher mean patient costs observed among physicians with less experience appears to be driven by high cost outlier patients. We categorized the physicians into different levels of experience and pooled all the patients cared for by physicians at each level of experience. When we examined the cost distribution of patients cared for by physicians at different levels of experience, median costs were similar, but the 95^{th} percentiles of patients' costs were much higher among physicians with less experience.[Appendix Supplemental Figure 1]

DISCUSSION

We find a large and monotonic association between greater physician experience and lower cost profiles. The finding suggests that less-experienced physicians will, on average, be negatively affected by policies that utilize physician cost profiles. For example, it is more likely that less-experienced physicians will be excluded from high-value networks or receive lower payments under Medicare's Value-Based Payment Modifier program slated to begin in 2015. This is a provocative finding that warrants further examination.

There are two potential explanations for this finding: first, that less-experienced physicians have different, more costly practice patterns than more-experienced physicians, and second, that less-experienced physicians tend to treat sicker, more complex patients and that the risk-adjustments used in cost profiles do not adequately adjust for this. Our results could not confirm or refute either type of explanation.

Less-experienced physicians may follow more-costly practice patterns than more-experienced physicians for several reasons. Recently trained physicians may be more familiar, and therefore more likely to utilize, newer and more expensive treatment modalities. It is also possible that lack of experience and uncertainty translates into more aggressive care. It is hard to know what to expect in the longer-term with regard to the costliness of younger physicians' practice. It is conceivable that as they gain more experience, these same physicians may develop less-costly practice patterns, with their costliness decreasing over time relative to their initial years of practice.

On the other hand, the cost differences could represent a cohort effect; these same physicians may remain more costly than previous generations of physicians, even when they reach the same levels of experience. If the latter is true, our results support the interest in training post-graduate physicians on their responsibility to be good stewards of health care resources.(21)

Previous studies on the relationship between practice patterns and physician experience are mixed. Several studies have found lower rates of diagnostic testing among more experienced physicians.(14, 22) For example, less-experienced physicians are more likely to order unnecessary imaging when seeing a patient with back pain.(22) On the other hand, other research has found the opposite relationship.(4, 9, 11) For example, less experienced physicians are *less likely* to order a test or referral when presented with a clinical scenario where there is uncertainty in the care plan.(11) In contrast to these prior studies, we did not see any systematic difference in our analyses in fraction of spending on imaging or other tests.

Less-experienced physicians are likely to have shorter relationships with their patients. This, in theory, could drive increased costs because physicians may provide more services to newer patients as they establish the clinical relationship.(23) While we could not directly measure length of patient relationship, our rough proxy for length of relationship, the fraction of a physician's evaluation and management visits that was for new patients, was not strongly associated with experience.

The association between experience and cost profiles could be a measurement artifact.(24) For example, more experienced physicians may code more diagnoses on billing forms or order more tests. In both cases, this might perversely improve cost profile scores. Listing more diagnoses could trigger more episodes per patient and therefore make per episode costs lower. Similarly, ordering a negative stress test might trigger a particularly low-cost coronary artery disease episode that includes only that service.(25) Our results did not support either of these ideas. If they were driving the differences, one would expect equal or higher overall per-patient costs among more-experienced physicians. We did not find this is the case.

The other possibility is that less-experienced physicians have higher cost profiles because they treat more complex, high-risk patients. Cost profiling methodology includes a number of steps to address differences in case mix. A physician's costs for an episode are compared to other physicians of the same specialty. There are typically different episode-types for episodes with and without a procedure as well as risk adjustment based on age, gender, and co-morbidities. Nonetheless, our finding that less-experienced physicians have higher costs

could stem from a failure of the risk adjustment model to account for patient factors that cannot be captured by health plan claims. As illustrated in the Appendix, more high-cost outlier patients seem to be assigned to less-experienced physicians. For example, more-experienced physicians might selectively choose patients who are more compliant or less demanding, or high-risk patients may choose less-experienced physicians or lack access to more-experienced physicians. On the other hand, the high-cost outliers could signal that for a small fraction of patients, less-experienced physicians are more aggressive with their care.

It is notable that we found no relationship between malpractice claims and cost profiles. Our finding is consistent with numerous previous studies(6, 26) which have suggested that all physicians – not just those who have had malpractice claims -- practice more aggressively in states with higher malpractice claims. Furthermore, while there is growing policy interest in creating incentives for physicians to join larger integrated groups or Accountable Care Organizations to decrease costs,(27) we did not find any statistically significant association between larger group size and lower costs. The possibility that physicians' choice of practice setting moderates the relationship between experience and cost profiles was also not supported in our analyses; we observe an association even when controlling for physician group participation, size of physician group, and academic affiliation.

One limitation of our study is we did not include measurement of quality of care. It is unknown whether the cost profiles reported here are associated with quality performance. Previous work has found that more experienced physicians deliver lower quality care.(28) Thus, the lower costs among physicians with more experience might represent omissions of necessary care. The caveat is that there is often a small and weak relationship between quality and spending. Providing higher quality of care may be unlikely to drive increased spending. (29)

Our study has a number of other important limitations. Of note, our study was limited to Massachusetts, a state with a high density of physicians and academic medical centers, and higher costs of care than the national average.(30, 31) It is possible that in another setting we would have observed different relationships.

In this paper, we present the relationship between experience and costs aggregated across *all* specialties. But as we detail in our Appendix, there is notable variation across specialties. For example, the cost difference between the least and most experienced physicians in cardiology is greater than 40 percent, while in psychiatry there is no significant difference. We have observed associations in a cross-sectional study and, therefore, cannot address causality; it is possible that the associations observed represent cohort effects. For example, it is theoretically possible that the observed association is driven by more expensive physicians selectively retiring from clinical practice at an earlier point in their careers.

We used standardized costs for each service when we created the cost profiles. This allowed us to focus on differences in utilization of services across physicians that might drive cost variation. Overall spending, however, is a function of both utilization and reimbursement. One limitation of focusing on utilization is that we cannot assess whether there are differences across physicians in reimbursement.

Finally, we cannot fully explain the mechanism by which more experienced physicians have lower costs. For example, we do not know whether there are differences in where the physicians were trained (e.g., possibly more-experienced physicians were trained in an academic settings) or payment model (e.g., younger physicians are more likely to work in capitated environments). These might explain the differences we observe.

There are several policy implications of this work. First, it highlights that there will be systematic losers and winners in any cost-profiling effort undertaken. In particular, it seems that less-experienced physicians are more likely to be penalized by cost-profiling policies. If this is driven by the methodology behind how cost profiles are created, then our results call for addressing this bias via further development of equitable and robust episode grouping and attribution methodologies. If less-experienced physicians' higher cost-profile scores are, in fact, driven by actual differences in how they practice, then our results create a need to explain why such differences in practice patterns exist.

These analyses may lead to cost-cutting interventions such as training medical residents in appropriate resource utilization. Therefore, our finding should trigger more work on this topic before implementing any such policies. We should look more closely at whether this relationship holds in additional studies. If it does, we should conduct more intensive analysis on what exactly is driving these experience-based cost differences.

In summary, we find that physicians with more experience have substantially lower cost profiles. It is possible that one driver of rising health care costs is that newly trained physicians have a more costly practice style.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

References

1. Sandy LG, Rattray MC, Thomas JW. Episode-based physician profiling: a guide to the perplexing. J Gen Intern Med. Sep; 2008 23(9):1521–4. [PubMed: 18546048]
2. Patient Protection and Affordable Care Act. One Hundred Eleventh Congress; 2010. H.R. 3590
3. Baigelman W, Weld L, Coldiron JS. Relationship between practice characteristics of primary care internists and unnecessary hospital days. American Journal Of Medical Quality: The Official Journal Of The American College Of Medical Quality. Fall;1994 9(3):122–8. 1994. [PubMed: 7950484]
4. O'Neill L, Kuder J. Explaining variation in physician practice patterns and their propensities to recommend services. Med Care Res Rev. Jun; 2005 62(3):339–57. [PubMed: 15894708]
5. Sood R, Sood A, Ghosh AK. Non-evidence-based variables affecting physicians' test-ordering tendencies: a systematic review. The Netherlands Journal Of Medicine. 2007; 65(5):167–77. [PubMed: 17519512]
6. Baldwin LM, Hart LG, Lloyd M, Fordyce M, Rosenblatt RA. Defensive medicine and obstetrics. JAMA: The Journal Of The American Medical Association. 1995; 274(20):1606–10. [PubMed: 7474245]
7. Meyer CM, Ladenson PW, Scharfstein JA, Danese MD, Powe NR. Evaluation of common problems in primary care: effects of physician, practice, and financial characteristics. The American Journal Of Managed Care. 2000; 6(4):457–69. [PubMed: 10977453]
8. Pham HH, Landon BE, Reschovsky JD, Wu B, Schrag D. Rapidity and modality of imaging for acute low back pain in elderly patients. Arch Intern Med. May 25; 2009 169(10):972–81. [PubMed: 19468091]
9. Stafford RS, Misra B. Variation in routine electrocardiogram use in academic primary care practice. Arch Intern Med. Oct 22; 2001 161(19):2351–5. [PubMed: 11606151]
10. Rosen MP, Davis RB, Lesky LG. Utilization of outpatient diagnostic imaging. Does the physician's gender play a role? J Gen Intern Med. Jul.1997 12(7):407. [PubMed: 9229278]
11. Landon BE, Reschovsky J, Reed M, Blumenthal D. Personal, organizational, and market level influences on physicians' practice patterns: results of a national survey of primary care physicians. Med Care. Aug; 2001 39(8):889–905. [PubMed: 11468507]

12. Gold M, Greenlick M. Effect of hospital-based primary care setting on internists' use of inpatient hospital resources. Med Care. Feb; 1981 19(2):160–71. [PubMed: 7206849]
13. Rich EC, Hillson SD, Dowd B, Morris N. Specialty differences in the 'July Phenomenon' for Twin Cities teaching hospitals. Med Care. Jan; 1993 31(1):73–83. [PubMed: 8417272]
14. McGillivray DL, Roberts-Brauer R, Kramer MS. Diagnostic test ordering in the evaluation of febrile children. Physician and environmental factors. Am J Dis Child. Aug; 1993 147(8):870–4. [PubMed: 8352221]
15. Adams, JL.; Mehrotra, A.; Thomas, JW.; McGlynn, EA. Physician Cost Profiling - Reliability and Risk of Misclassification. Detailed Methodology and Sensitivity Analyses; RAND2010; Santa Monica CA.
16. Friedberg MW, Coltin KL, Pearson SD, Kleinman KP, Zheng J, Singer JA, et al. Does affiliation of physician groups with one another produce higher quality primary care? J Gen Intern Med. Oct; 2007 22(10):1385–92. [PubMed: 17594130]
17. Mehrotra A, Adams JL, Thomas JW, McGlynn EA. Cost profiles: should the focus be on individual physicians or physician groups? Health Aff (Millwood). Aug; 2010 29(8):1532–8. [PubMed: 20679658]
18. 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):1014–21. [PubMed: 20237347]
19. 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):649–54. [PubMed: 20479030]
20. Mehrotra A, Adams J, Thomas J, EA M. The Impact of Different Attribution Rules on Individual Physician Cost Profiles. Annals of Internal Medicine. 2010; 152:649–54. [PubMed: 20479030]
21. Lesser CS, Lucey CR, Egener B, Braddock CH 3rd, Linas SL, Levinson W. A behavioral and systems view of professionalism. Jama. Dec 22; 2010 304(24):2732–7. [PubMed: 21177508]
22. Pham HH, Landon BE, Reschovsky JD, Wu B, Schrag D. Rapidity and modality of imaging for acute low back pain in elderly patients. Archives Of Internal Medicine. 2009; 169(10):972–81. [PubMed: 19468091]
23. Weiss LJ, Blustein J. Faithful patients: the effect of long-term physician-patient relationships on the costs and use of health care by older Americans. Am J Public Health. Dec; 1996 86(12):1742–7. [PubMed: 9003131]
24. MedPAC. Using episode groupers to assess physician resource use; Report to the Congress: Increasing the Value of Medicare; 2006;
25. Medicare Payment Advisory Commission. Using episode groupers to assess physician resource use; Report to the Congress: Increasing the Value of Medicare; Washington, DC. Medicare Payment Advirory Commission; 2006. p. 1-27.
26. Studdert DM, Mello MM, Sage WM, DesRoches CM, Peugh J, Zapert K, et al. Defensive medicine among high-risk specialist physicians in a volatile malpractice environment. JAMA: The Journal Of The American Medical Association. 2005; 293(21):2609–17. [PubMed: 15928282]
27. Tollen L. Physician Organization in Relation to Quality and Efficiency of Care: A Synthesis of Recent Literature: Commonwealth Fund. 2008
28. Choudhry NK, Fletcher RH, Soumerai SB. Systematic review: the relationship between clinical experience and quality of health care. Ann Intern Med. Feb 15; 2005 142(4):260–73. [PubMed: 15710959]
29. Skinner J, Chandra A, Goodman D, Fisher ES. The elusive connection between health care spending and quality. Health Aff (Millwood). Jan-Feb;2009 28(1):w119–23. [PubMed: 19056756]
30. Health Resources and Services Administration. The. Massachusetts Health Workforce: Highlights from the Health Workforce Profile. Available from: ftp://ftp.hrsa.gov/bhpr/workforce/summaries/Massachusetts03.pdf
31. Center for Medicare and Medicaid Services. National health Expenditure Fact Sheet.

Exhibit 1

Characteristics of the Physician Sample

M.D. CHARACTERISTICS	N	%
DEGREE		
D.O.	266	2.2%
M.D.	11,850	97.8%
GENDER		
Male	8,463	69.8%
Female	3,653	30.2%
BOARD CERTIFICATION STATUS		
No Certification	962	7.9%
Board Certified	11,154	92.1%
YEARS OF EXPERIENCE		
<10 Years	1,927	15.9%
10-19 Years	3,749	30.9%
20-29 Years	3,446	28.4%
30-39 Years	2,086	17.2%
≥40 Years	908	7.5%
MEDICAL SCHOOL LOCATION		
Domestic	10,117	83.5%
International	1,999	16.5%
MALPRACTICE CLAIMS		
No Claims Paid in Last 10 years	10,970	90.5%
1+ Claims Paid in Last 10 Years	1,146	9.5%
DISCPLINARY ACTIONS		
No Disciplinary Actions in Last 10 yrs	12,001	99.1%
1+ Disciplinary Actions in Last 10yrs	115	0.9%
ACADEMIC AFFILIATION		
Not Affiliated with an Academic Institution	7,814	64.5%
Affiliated with an Academic Institution	4,302	35.5%
NUMBER OF PHYSICIANS IN GROUP		
>200 physicians in group	4,271	35.3%
20-200 physicians in group	4,472	36.9%
Solo Practice or <20 physicians in group	3,373	27.8%

SOURCE: The information in this exhibit is derived from the authors' own analyses and data from the Massachusetts Board of Medicine

Exhibit 2

Breakdown of Care by Physician Specialty

Physician Specialty	n	Fraction of all physicians (%)	Episodes assigned to specialty	Fraction of all episodes (%)	Avg Episodes/ Physician
Allergy and Immunology	93	0.8%	18,356	0.6%	197.4
Cardiology	695	5.7%	72,714	2.5%	104.6
Cardiothoracic Surgery	94	0.8%	2,348	0.1%	25.0
Dermatology	332	2.7%	247,366	8.6%	745.1
Emergency Medicine	678	5.6%	64,977	2.3%	95.8
Endocrinology	162	1.3%	17,995	0.6%	111.1
Family/General Practice	1,012	8.4%	405,111	14.2%	400.3
Gastroenterology	417	3.4%	110,814	3.9%	265.7
General Surgery	555	4.6%	65,078	2.3%	117.3
Hematology/Oncology	299	2.5%	18,274	0.6%	61.1
Infectious Diseases	231	1.9%	25,233	0.9%	109.2
Internal Medicine	2,857	23.6%	996,780	34.8%	348.9
Nephrology	193	1.6%	14,390	0.5%	74.6
Neurological Surgery	104	0.9%	4,256	0.1%	40.9
Neurology	420	3.5%	32,516	1.1%	77.4
Obstetrics and Gynecology	899	7.4%	298,559	10.4%	332.1
Ophthalmology	513	4.2%	169,017	5.9%	329.5
Oral & Maxillofacial Surgery	13	0.1%	866	0.0%	66.6
Orthopedic Surgery	558	4.6%	69,684	2.4%	124.9
Otolaryngology	218	1.8%	59,636	2.1%	273.6
Physical Medicine & Rehabilitation	137	1.1%	6,965	0.2%	50.8
Plastic Surgery	117	1.0%	14,861	0.5%	127.0
Psychiatry	706	5.8%	9,942	0.3%	14.1
Pulmonary & Critical Care	356	2.9%	44,992	1.6%	126.4
Rheumatology	174	1.4%	34,402	1.2%	197.7
Urology	211	1.7%	49,082	1.7%	232.6
Vascular Surgery	72	0.6%	6,879	0.2%	95.5
Overall	12,116		2,861,093		236.1

Source: Authors' own analyses

Exhibit 3

Associations Between Physician Characteristics and Costs, Overall and by Type of Care*

	Overall		Acute Care		Chronic Care		Preventive Care	
n, Physicians	12,116		11,427		10,269		7,168	
n, Episodes	2,861,093		2,857,995		2,747,629		2,540,984	
Mean Number of Episodes per Physician	236.1		250.1		267.6		354.5	
Parameter	**Mean**	**p-value**	**Mean**	**p-value**	**Mean**	**p-value**	**Mean**	**p-value**
M.D. vs. D.O.	0.9%	0.64	−1.3%	0.61	2.7%	0.27	0.8%	0.62
Female vs. Male	1.2%	0.14	−1.3%	0.22	0.7%	0.46	9.0%	<.0001
Board Certified vs. No Certification	1.1%	0.39	4.4%	0.04**	−2.8%	0.16	2.1%	0.14
Years of Experience								
<10 Years	13.2%	<.0001	15.4%	<.0001	16.6%	<.0001	−7.2%	0.002
10-19 Years	10.0%	<.0001	9.7%	<.0001	16.5%	<.0001	−6.5%	0.002
20-29 Years	6.5%	<.0001	6.2%	0.00	10.7%	<.0001	−6.2%	0.004
30-39 Years	2.5%	0.05**	−1.2%	0.51	11.0%	<.0001	−3.6%	0.08
≥40 Years	ref	.	ref	.	ref	.	ref	.
Domestic Medical School vs. Int'l Medical School	0.6%	0.50	0.5%	0.74	1.7%	0.16	0.6%	0.57
1+ Paid Malpractice Claims vs. None	1.1%	0.26	2.5%	0.07	−1.4%	0.32	0.0%	0.98
1+ Disciplinary Actions vs. None	−4.4%	0.18	−3.6%	0.30	−5.1%	0.20	5.0%	0.16
Academic Affiliation vs. None	1.5%	0.46	2.1%	0.39	1.4%	0.59	3.0%	0.21
Size of physician group								
>200 physicians in group	1.7%	0.41	2.2%	0.39	−1.1%	0.71	2.6%	0.25
20-200 physicians in group	0.4%	0.70	0.8%	0.50	−1.8%	0.24	0.2%	0.91
Solo Practice or <20 physicians in group	ref	.	ref	.	ref	.	ref	.
Each Additional 100 Attributed Episodes to Physician	−0.3%	0.004	−0.3%	0.001	0.1%	0.36	−0.2%	0.25

SOURCE: The information in this exhibit is derived from the authors' own analyses

*NOTES: Results of multivariate model with covariates as listed in table. The percentages displayed in the table can be interpreted as the percent difference in overall costs associated with that characteristic. For example, in the Overall column, physicians with less than 10 years of experience have 13.2 percent higher costs than physicians with 40 or more years of experience.

**These differences should not be considered statistically significant. As detailed in text, we have controlled for multiple comparisons. Our false detection rate is 0.0214 Source: authors' own analyses

Exhibit 4

Breakdown of Cost Differences by Years of Experience

	Years of Experience of Physician				
	<10	**11-20**	**21-30**	**31-39**	**≥40**
Components of cost profiles					
Observed Costs of Episodes Assigned (average dollars across episodes assigned to physicians)	$ 594	$ 693	$ 647	$ 644	$ 622
Expected Costs of Episodes Assigned (average dollars across episodes assigned to physicians)	$ 555	$ 674	$ 650	$ 673	$ 691
Cost Ratio (average cost ratio across physicians which reflects observed over expected costs)	1.07	1.03	1.00	0.96	0.90
Characteristics of patient population					
ERG risk score (median) **	1.10	1.12	1.12	1.13	1.14
Average Patient Age	44.3	45.9	46.8	48.2	48.8
Fraction of visits that are new patient visits (average)	8.0%	6.3%	5.7%	6.5%	7.6%
Breakdown of observed costs for episodes by type of service * (Dollar sum reflects average amount of money in episodes spent on that type of service. Percentage reflects average fraction of episode costs spent on that type of service)					
Evaluation and Management Visits	$ 136 (42%)	$ 140 (36%)	$ 136 (37%)	$ 141 (36%)	$ 144(38%)
Procedures	$ 59(18%)	$ 72 (19%)	$ 70 (19%)	$ 70 (18%)	$ 65 (17%)
Imaging	$ 47(14%)	$ 77 (20%)	$ 67(18%)	$ 76(20%)	$ 70(18%)
Rx	$ 41(12%)	$ 44 (11%)	$ 43(12%)	$ 44 (11%)	$ 44 (12%)
Lab Tests	$ 37 (11%)	$ 41 (11%)	$ 41(11%)	$ 41 (11%)	$ 47 (12%)
Other	$ 6 (2%)	$ 9 (2%)	$ 13 (4%)	$ 15 (4%)	$ 10 (3%)

SOURCE: The information in this exhibit is derived from the authors' own analyses

* NOTES: limited to non-inpatient claims and episodes with no Winsorization therefore sum of costs for each type of service are less than observed costs across all episodes

** ERG risk score is assigned to each patient for predicted costs based on age, gender, and co-morbidities. A higher number is assigned to more costly patients.