Delivery of Preventive Services to Older Adults by Primary Care Physicians

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Context Rates of preventive services remain below national goals.

Objective To identify characteristics of physicians and their practices that are associated with the quality of preventive care their patients receive.

Design Cross-sectional analysis of data on US physician respondents to the 2000-2001 Community Tracking Study Physician Survey linked to claims data on Medicare beneficiaries they treated in 2001. Physician variables included training and qualifications and sex. Practice setting variables included practice type, size, sources of revenue, and access to information technology. Analyses were adjusted for patient demographics and comorbidity, as well as community characteristics.

Setting and Participants Primary care delivered by 3660 physicians providing usual care to 24 581 Medicare beneficiaries aged 65 years and older.

Main Outcome Measures Proportion of eligible beneficiaries receiving each of 6 preventive services: diabetic monitoring with hemoglobin A_{1c} measurement or eye examinations, screening for colon or breast cancer, and vaccination for influenza or pneumococcus in 2001.

Results Overall, the proportion of beneficiaries receiving services was below national goals. Physician and, more consistently, practice-level characteristics were both associated with differences in the delivery of services. The strongest associations were with practice type and the percentage of practice revenue derived from Medicaid. For instance, beneficiaries receiving usual care in practices with less than 6% of revenue from Medicaid were more likely than those with more than 15% of revenue derived from Medicaid to receive diabetic eye examinations (48.9% vs 43%; $P = .02$), hemoglobin A_{1c} monitoring (61.2% vs 48.4%; $P < .001$), mammograms (52.1% vs 38.9%; $P < .001$), colon cancer screening (10.0% vs 8.5%; $P = .60$), and influenza (50.2% vs 39.2%; $P < .001$) and pneumococcal (8.2% vs 6.4%; $P < .001$) vaccinations. Other variables associated with delivery of preventive services after adjustment for patient and geographic factors included obtaining usual health care from a physician who worked in group practices of 3 or more, who was a graduate of a US or Canadian medical school, or who reported availability of information technology to generate preventive care reminders or access treatment guidelines.

Conclusions Delivery of routine preventive services is suboptimal for Medicare beneficiaries. However, patients treated within particular practice settings and by particular subgroups of physicians are at particular risk of low-quality care. Profiling these practices may help develop tailored interventions that can be directed to sites where the opportunities for quality improvement are greatest.

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IT IS WELL ESTABLISHED THAT MANY US patients receive suboptimal care and that subgroups disadvantaged on the basis of demographic or socioeconomic characteristics are at special risk.[1,2] Even among advantaged patients, the quality of US health care has been shown to lag well below national goals.[3,4] In the landmark Community Quality Index study, McGlynn et al[3] and Kerr et al[5] documented not only that quality of care is suboptimal, but that quality problems are not limited to a specific set of conditions or communities.

An emerging body of literature now suggests that quality of care may vary in association with the characteristics of individual physicians and their practices.[4,6,7] Lurie et al[8] reported differences in cervical and breast cancer screening by physician sex, while O'Malley and Mandelblatt[9] found that patients at community health centers were as likely as those in private physicians' offices to receive preventive services, but these associations have not been examined for a nationally representative group of physicians.[8-12]

We studied the relationship between attributes of physicians and their practices, such as experience, training, sex, and practice setting, and the extent to which their Medicare patients received preventive services. We hypothesized that patients treated by less well-trained physicians, or in less

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well-equipped health care settings, would be less likely to receive preventive care services.

METHODS

Sources of Data

Physician Data. The Community Tracking Study (CTS) Physician Survey is a biannual, nationally representative telephone survey of nonfederal US physicians conducted in 60 randomly selected metropolitan statistical areas and supplemented by a national sample. Primary care physicians are oversampled. In Round 3 (2000-2001), the response rate was 59%. (Details of the survey have previously been published and are available at http://www.hschange.org/index.cgi?data=04.) The survey included physicians who reported at least 20 hours per week of direct patient care in an office- or hospital-based practice, including Bureau of Primary Health Care sites. Residents and fellows and certain specialties such as pathology or anesthesiology were excluded. Physicians received a letter beforehand describing the purpose of the survey, and interviewers accepted physicians' willingness to complete interviews as implicit consent.

Patient Visit Data. The Medicare program provides insurance for 97% of individuals aged 65 years and older in the United States. In 2001, the program covered 40 million persons, 86% of whom were enrolled under Part A and B indemnity insurance, for which physicians submit detailed claims for rendered services to the Centers for Medicare & Medicaid Services for reimbursement.[13] Our data were obtained from the 2001 5% Carrier File, which contains complete claims histories for physicians' professional services on a 5% representative sample of Medicare beneficiaries who had both Part A and Part B coverage. We limited our analysis to beneficiaries aged 65 years and older as of January 2001.

Linkage of Data Sources and Identification of the Usual Source of Care

Data on physicians and patient visits were linked through the "performing physician" Unique Physician Identification Number (UPIN), which is recorded on all claims submitted to the Medicare program.[14] The usual-source-of-care physician was defined as the physician who provided the greatest number of evaluation and management services to a particular beneficiary in 2001 (based on the Berenson-Eggers type of service codes as previously reported).[7] In the case of a tie between physicians, we defined the usual-source-of-care physician as the physician with the highest total amount of paid claims for that beneficiary. Our analysis then focused on those beneficiaries for whom the identified physician was categorized as a traditional primary care physician—a general internist, general practitioner, or family practitioner—and who responded to Round 3 of the CTS. This approach was described and validated by Weiner et al.[12] To ensure that our findings were not a byproduct of the particular selection procedure we used, we tested the effect on our findings of (1) including the percentage of a beneficiary's evaluation and management visits that were with the usual-source-of-care physician as a covariate; (2) limiting the population to beneficiaries who had at least 5 evaluation and management visits with their usual-source-of-care physician; (3) defining usual-source-of-care physicians as physicians providing the majority (≥50%) of a patient's visits for evaluation and management; and (4) assigning a CTS usual source of care to any patient who saw at least 1 CTS primary care physician in 2001, whether or not they provided the plurality of the patient's care (the fewer than 10% of beneficiaries who had visits with >1 CTS primary care physician were randomly assigned to 1 physician). Analyses using these alternative methods of assignment yielded substantively similar results.

Preventive Services

We evaluated beneficiaries' Medicare claims to determine delivery of diabetic monitoring (hemoglobin A_{1c} testing, eye examinations), cancer screening (colonoscopy/sigmoidoscopy, mammography), and vaccinations (influenza and pneumococcal) during 2001. The methods used to identify these events have been previously described and evaluated by other investigators, and the codes and eligibility criteria are listed in TABLE 1.[15-17] Based on the recommended frequencies for each of the 6 services,[18-21] we report the expected annual rates that should be observed given 100% compliance in Table 1. We excluded fecal occult blood testing (FOBT) from our primary analysis because its documentation in claims is less reliable than for sigmoidoscopy or colonoscopy,[15] and because its effectiveness outside research settings has been questioned[22,23]; however, in subsequent analyses, we determined that our findings would not have been altered had we decided to include FOBT as an outcome.

Characteristics of Physicians and Their Practices

We characterized physicians by their (1) training, qualifications, and number of years in practice; (2) sex; and (3) practice setting. Training and qualifications included physician self-reported primary specialty (general internal medicine or family practice/general practice); board certification in their primary specialty; and whether their medical school education was completed in the United States (including Puerto Rico) or Canada, rather than another country. Practice setting variables included practice type and size (solo/2-person, small group of 3-10 physicians, medium/large groups of ≥11 physicians, and all other practice types) and payer mix, including the percentage of practice revenue derived from Medicare, Medicaid, and managed care. Practices were also characterized based on physicians' survey responses to 2 questions about whether computers or other information technology was available to (1) generate physician reminders about preventive services, or (2) to obtain information about treatment alternatives or recommended guidelines. We used a composite variable that dichotomized

these responses as "neither" compared with "1 or both," but our results did not change in analyses using a separate variable for each information technology tool. Practice location was characterized as urban (00-03) or rural (04-09) based on metropolitan statistical area codes in the 2001 Area Resource File.

Patient and Community Characteristics as Covariates

Patient characteristics were ascertained from Medicare files and included age as a continuous variable, sex, race/ethnicity (white, black, other), and comorbidity based on the index described by Klabunde et al.[24] Community variables were derived from 2000 US Bureau of the Census data in the Area Resources File and included median household income of residents aged 65 years and older in the beneficiary's ZIP code; percentage of adults aged 25 years and older in the county who completed 12 or more years of schooling; and in the model for delivery of mammography, the number of radiologists per 1000 capita in the county.

Statistical Analysis

Individual beneficiaries were the unit of analysis. Each patient was assigned to a single usual-source-of-care physician, but each physician could serve as the usual source of care for multiple beneficiaries. Reported percentages are therefore weighted to represent estimates for the national population of Medicare beneficiaries aged 65 years and older, using CTS survey weights to take into account the complex physician sampling strategy.

We used logistic regression to analyze the association between physician and practice characteristics and beneficiary delivery of each of the 6 preventive services. We used SUDAAN software to adjust estimates and variances given the complex survey sampling strategy and the clustering of beneficiaries within physicians.[25] This study was approved by the institutional review contractor for Mathematica Inc. $P = .05$ was set as significant.

RESULTS

Physician and Patient Populations

Of 12 406 physicians who responded to the CTS survey, 8517 (83%) had claims represented in the 5% Carrier File. Of these, 3660 (22%) were both traditional primary care physicians (general internal medicine or family/general practice) and served as the usual

Table 1. Preventive Services—Identification in Claims

Preventive Service Delivery	Eligibility Criteria	Expected Proportion Receiving Service in 1 Year, %*	Observed Proportion of Beneficiaries Receiving Service in 2001, %
Diabetic eye examination *CPT* codes: 92002-92014, 92225, 92250 *ICD-9-CM* codes: 95.02, 95.03, 95.11, V72.0, V80.2	Medicare beneficiaries ≥65 y diagnosed with diabetes by *ICD-9-CM* code 250.00 through 250.91	100	47.9
Hemoglobin A_{1c} monitoring *CPT* codes: 83036, 82985	Medicare beneficiaries ≥65 y diagnosed with diabetes by *ICD-9-CM* code 250.00 through 250.91	100	55.9
Mammography *CPT* codes: 76090-76092 *ICD-9-CM* code: 87.37	Women aged 65-74 y; exclude those with cancer diagnoses *ICD-9-CM* or V codes: 174, 174.0 thru 174.6, 174.8, 174.9, V10.3	100	46.7
Colon cancer screening Screening colonoscopy only *CPT* codes: 45355, 45378, G0105 *ICD-9-CM* codes: 45.22, 45.23, 45.42, 45.43 Other colonoscopy *CPT* codes: 45379, 45380, 45382-45385 *ICD-9-CM* codes: 45.25, 45.41 Screening sigmoidoscopy only *CPT* codes: 45330, G0104 *ICD-9-CM* codes: 45.24, 48.22, 48.23, 48.36 Other sigmoidoscopy *CPT* codes: 45331-45334, 45337-45339 *ICD-9-CM* codes: 48.24, 48.26, 48.35	Age 65-79 y; exclude those with cancer diagnoses *ICD-9-CM* or V codes: 153, 154.0, 154.1, V10.05, V10.06	10 (colonoscopy) and 20 (sigmoidoscopy)†	9.04
Influenza vaccination *CPT* codes: 90658, G0008 *ICD-9-CM* code: V04.81	Age ≥65 y	100	46.5
Pneumococcal vaccination *CPT* codes: 90732, G0009 *ICD-9-CM* code: V03.82	Age ≥65 y	10	8.0

Abbreviations: *CPT*, *Current Procedural Terminology*; *ICD-9-CM*, *International Classification of Diseases, Ninth Revision, Clinical Modification*.
*Data represent the expected rate of the incident episode of beneficiaries receiving the service. Guidelines recommend hemoglobin A_{1c} monitoring for diabetic patients every 3 months, while those for pneumococcal vaccination recommend an interval of 10 years. Rates are for the entire population of eligible beneficiaries.
†Recommended colon cancer screening frequency is dependent on the screening modality and is every 10 years for colonoscopy vs every 5 years for sigmoidoscopy.

source of care for at least 1 of 24 581 beneficiaries (FIGURE). The mean number of evaluation and management visits with the usual-source-of-care physician for these beneficiaries was 4.5 (range: 1-47), representing a median of 70% (interquartile range, 50%-100%) of each beneficiary's total evaluation and management visits.

The 24 581 beneficiaries derived from a population of 1 332 985 Medicare beneficiaries aged 65 years and older who had at least 1 claim in the 2001 5% Carrier File. The beneficiaries included in our study were largely similar to the 1 308 404 beneficiaries not included along the dimensions of mean age (75.4 vs 75.6 years), race (88.2% vs 87.4% white and 7.6% vs 7.4% black), sex (63.5% vs 60.4% female), median income in the ZIP code ($49 944 vs $47 903), and comorbidity score (0.55 vs 0.54). Our study population was also similar to the 15 435 beneficiaries aged 65 years and older who saw a CTS primary care physician for evaluation and management at least once in 2001 but for whom that physician was not their usual source of care (data not shown).

Receipt of Services

In 2001, the proportions of eligible beneficiaries receiving the 6 recommended preventive services were 47.9% for diabetic eye examinations, 55.9% for hemoglobin A_{1c} monitoring, 46.7% for mammography, 9.0% for colon cancer screening, 46.5% for influenza vaccination, and 8.0% for pneumococcal vaccination.

Although preventive care increased in conjunction with median income in beneficiaries' ZIP codes, it was suboptimal even among beneficiaries living in areas with the highest incomes. A total of 53.2% of beneficiaries residing in ZIP codes in the highest-income tercile received diabetic eye examinations vs 44.9% for those in the lowest-income tercile. The analogous comparisons were 59.5% vs 50.9% for hemoglobin A_{1c} monitoring, 50.8% vs 39.8% for mammography, 10.3% vs 8.0% for colon cancer screening, 50.8% vs 41.5% for influenza vaccination, and 8.7% vs 7.3% for pneumococcal vaccination.

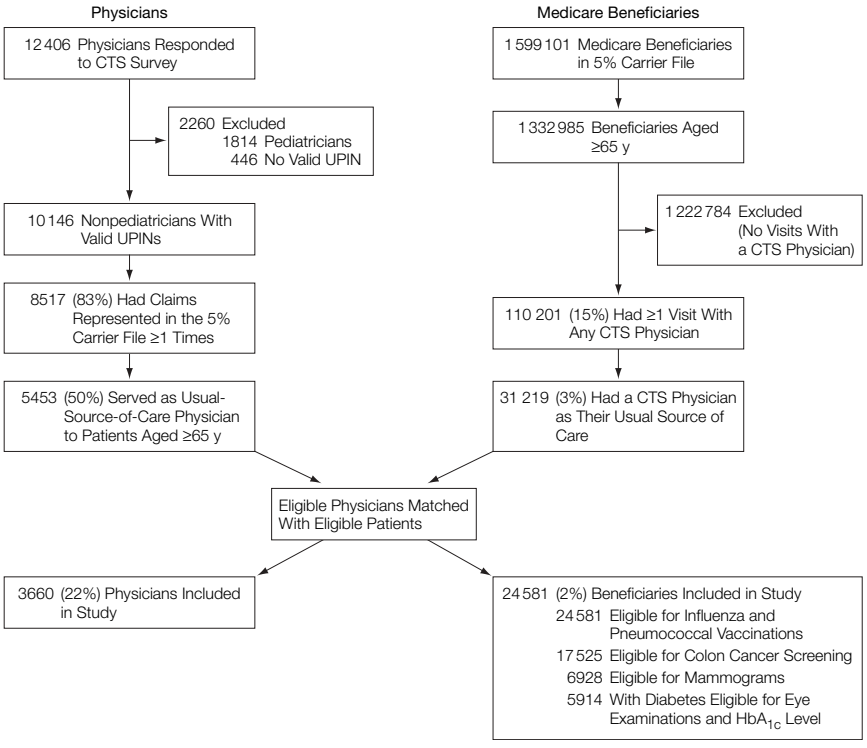
Physician Characteristics and Delivery of Preventive Services

Physician Training, Experience, and Delivery of Preventive Services. Physician training was consistently associated with better delivery of preventive services (TABLE 2). Beneficiaries with board-certified physicians as their usual source of care were more likely to receive each of the preventive services evaluated except for diabetic eye examinations. Similarly, beneficiaries cared for by physicians who graduated from US or Canadian medical schools were more likely to receive each preventive service ($P<.05$ for all comparisons except hemoglobin A_{1c} monitoring). The comparative advantage for beneficiaries with general internists as their usual source of care rather than family/general practitioners was seen for diabetic eye examinations, mammograms, colon cancer screening, and pneumococcal vaccination. We found no association between delivery of services and the number of years that the usual-source-of-care physician had been in practice.

Physician Sex and Delivery of Preventive Services. Sex of the physician was not associated with delivery of services, except that beneficiaries with female physicians as their usual source of care were more likely to receive mammograms and less likely to receive influenza vaccination than those whose physician was male.

Physician's Practice Setting and Delivery of Preventive Services. For

Figure. Study Populations



The figure shows unweighted frequencies and weighted percentages (for physicians, Community Tracking Study [CTS] survey weights were applied; for patients, the CTS survey weight for their usual-source-of-care physician and a factor of 20 were applied. If a patient saw more than 1 CTS physician, the weighted population is based on a randomly selected CTS physician weight). The usual-source-of-care physician was defined as the physician who filed claims for the plurality of evaluation and management visits for each patient. Eligibility criteria for each preventive service are detailed in Table 1. HbA_{1c} indicates glycosylated hemoglobin; UPIN, Unique Physician Identification Number.

each of the 6 preventive services, beneficiaries treated by physicians in group practices (≥3 physicians) were more likely to receive the service than those in other types of practices; there was no clear relationship between increased group size and delivery of services. Similarly, beneficiaries cared for in practices with lower relative Medicaid revenues were significantly more likely to receive each of the services, with a consistent graded relationship between the percentage of practice revenues derived from Medicaid and lower likelihood of service delivery ($P<.05$ for all comparisons between lowest and highest revenue terciles except for colon cancer screening). We found that availability of information technology to access clinical guidelines or to generate reminders for preventive care was associated with delivery of diabetic eye examinations and pneumococcal vaccination, but not other services (Table 2). Neither urban vs rural practice location nor the percentage of practice revenue derived from managed care or Medicare seemed to influence delivery of services (data not shown).

Adjusted Analyses

The bivariate findings in Table 2 largely persisted in multivariable analyses adjusting for patient and community characteristics, although some estimates were amplified and others attenuated (TABLE 3). Associations between having a board-certified usual-source-of-care physician and delivery of each service except for the 2 cancer screening services, and those between being cared for in a group practice and delivery of influenza and pneumococcal vaccinations and colon cancer screening were no longer statistically significant.

Table 2. Proportion of Medicare Beneficiaries Receiving Recommended Preventive Services by the Characteristics of Their Usual Source of Care*

Physician and Practice Characteristic	Frequency, %†	Proportion of Medicare Beneficiaries Receiving Preventive Care, %					
		Eye Examination for Diabetics	Hemoglobin A_{1c} Monitoring	Mammograms	Colon Cancer Screening	Influenza Vaccination	Pneumococcal Vaccination
Sex							
Male	85.7	47.7	56.6	46.1	9.1	47.6	7.9
Female	14.3	49.0	51.9	50.0‡	8.7	43.0‖	8.0
Years in practice							
0-10	29.4	46.4	56.8	45.3	5.8	44.5	8.0
11-20	36.0	47.9	54.3	46.2	6.2	47.0	8.6
>20	34.6	49.1	56.9	48.8	5.5	47.9‡	7.4
Specialty							
General internist	56.6	50.0	56.9	50.5	7.8	46.7	8.5
Family/general practitioner	43.4	44.9‡	54.5	42.4‖	9.9‖	46.4	7.4‡
Board certification							
Yes	84.8	48.7	57.1	48.5	9.5	47.4	8.3
No	15.2	43.4	48.8‡	36.5§	6.5‡	41.7‡	6.5§
Site of medical school graduation							
United States or Canada	82.6	49.0	56.8	48.2	9.3	47.9	8.4
Other	17.4	43.0§	52.3	39.7§	7.7‡	40.0‖	6.3§
Practice type							
Solo/2-person	44.5	46.9‡	52.3‖	42.5‖	8.4§	44.6§	7.0§
Small group	22.2	53.4	68.6	49.2	9.3	48.1	9.1
Medium/large group	11.4	46.5	70.1	60.5	11.4	52.6	8.6
All other¶	21.9	45.1	44.0	45.6	8.8	45.8	8.7
Practice revenue from Medicaid, %							
0-5	52.4	48.9	61.2	52.1	10.0	50.2	8.2
6-15	30.1	49.2	52.0§	43.3‖	7.8‖	44.4§	6.8‖
16-100	17.5	43.0‡	48.4‖	38.9‖	8.5	39.2‖	6.4‖
Information technology access to guidelines or reminders							
Yes	55.3	49.9	57.0	48.3	5.8	47.0	8.6
No	44.7	45.4§	54.6	46.0	5.9	46.0	7.2§

*Percentages are weighted with the Community Tracking Study survey weight for the usual-source-of-care physician. *P* values are for comparison to first category for ordinal variables and for group comparisons for nonordinal variables (practice type).
†Represents the frequency of each usual-source-of-care characteristic among beneficiaries in the study sample.
‡$P<.05$.
§$P<.01$.
‖$P<.001$.
¶Includes medical schools, hospital-based practices, group/staff model health maintenance organizations, community health centers, and other miscellaneous practice settings.

Our results did not change appreciably when we expanded the population to all beneficiaries who had at least 1 visit with any CTS physician, or when we limited the population to only beneficiaries who had at least 5 visits with their CTS usual-source-of-care physician, although statistical significance levels changed for some associations (sample sizes of physicians were reduced by >50% in the latter case). Neither did our results change when we redefined the usual-source-of-care physician as the physician with whom a beneficiary had the majority (≥50%) of outpatient visits. Results were also similar when we used FOBT, sigmoidoscopy, and colonsocopy as separate outcome variables for colon cancer screening were no longer statistically significant.

COMMENT

We evaluated the delivery of preventive services to Medicare beneficiaries who had a usual source of care to determine whether differences between primary care physicians or their practice settings influence quality of care. We focused on preventive care because of its importance in health promotion, and because the best approach for improving delivery of preventive services has not been clarified. We found that the delivery of preventive services falls well short of the ideal in important and routinely encountered clinical scenarios. Consistent with prior reports, all of the proportions of beneficiaries receiving each of the services are lower than desired based on clinical guidelines (Table 1).[18-21,26-32] Moreover, we found that there were large variations in the quality of care for beneficiaries contingent on the characteristics of the treating physicians and their practices.

The most substantial differences were those seen at the practice level.

Beneficiaries who had usual-source-of-care physicians in group practices were more likely to receive preventive services than those treated in solo/2-person practices or institution-based practices. Our results support hypotheses that group practices in general may deliver higher quality of care,[33-35] although contrary to commentators who conjecture that particularly large group practices provide higher quality care,[34] we did not find such a graded relationship. Explanations for the shortfalls in small practices are not readily apparent. Large practices may have an easier time obtaining access to resources and management systems, such as financial incentives, data collection systems to support physician profiling, or the availability of ancillary staff.[36,37] Some studies suggest that large practices may also place more emphasis on quality monitoring, reporting, and improvement.[38]

Table 3. Physician and Practice Characteristics and Delivery of Preventive Services: Multivariate Logistic Regressions

Physician/Practice Characteristic	Adjusted Odds Ratio (95% Confidence Interval)*					
	Diabetic Eye Examinations	Hemoglobin A_{1c} Testing	Mammogram	Colon Cancer Screening	Influenza Vaccination	Pneumococcal Vaccination
Sex						
Male	1.00	1.00	1.00	1.00	1.00	1.00
Female	1.19 (0.93-1.51)	0.96 (0.73-1.28)	1.33 (1.05-1.68)	0.90 (0.74-1.09)	0.82 (0.72-0.93)	0.98 (0.83-1.17)
Specialty						
General internist	1.00	1.00	1.00	1.00	1.00	1.00
Family/general practitioner	0.81 (0.67-0.97)	1.11 (0.90-1.37)	0.83 (0.72-0.97)	0.86 (0.75-0.99)	1.08 (0.95-1.21)	0.95 (0.82-1.10)
Board certification						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.12 (0.90-1.40)	1.22 (0.89-1.68)	1.34 (1.04-1.71)	1.27 (1.04-1.57)	1.08 (0.92-1.26)	1.06 (0.86-1.32)
Site of medical school graduation						
United States/Canada	1.00	1.00	1.00	1.00	1.00	1.00
Other	0.82 (0.68-0.99)	0.91 (0.70-1.18)	0.78 (0.63-0.98)	0.92 (0.76-1.12)	0.82 (0.71-0.94)	0.74 (0.59-0.93)
Practice type						
Solo/2-person	1.00	1.00	1.00	1.00	1.00	1.00
Small group	1.12 (0.84-1.49)	1.90 (1.45-2.48)	1.13 (0.89-1.44)	0.97 (0.78-1.22)	1.01 (0.89-1.15)	1.19 (0.99-1.44)
Medium/large group	0.81 (0.59-1.10)	1.91 (1.40-2.60)	1.40 (1.10-1.77)	1.12 (0.90-1.38)	1.22 (0.98-1.50)	1.16 (0.95-1.42)
All other practice types	0.84 (0.73-0.96)	0.68 (0.51-0.90)	1.03 (0.86-1.23)	0.91 (0.75-1.10)	1.03 (0.90-1.18)	1.21 (1.02-1.45)
Practice revenue from Medicaid, %						
0-5	1.00	1.00	1.00	1.00	1.00	1.00
6-15	1.12 (0.97-1.29)	0.74 (0.60-0.92)	0.81 (0.71-0.92)	0.87 (0.75-1.00)	0.85 (0.75-0.95)	0.76 (0.65-0.89)
16-100	1.04 (0.83-1.29)	0.73 (0.57-0.95)	0.76 (0.62-0.94)	1.09 (0.91-1.31)	0.77 (0.68-0.87)	0.73 (0.60-0.89)
Information technology for guidelines or reminders						
No	1.00	1.00	1.00	1.00	1.00	1.00
Yes	1.21 (1.08-1.35)	1.13 (0.97-1.33)	1.07 (0.96-1.20)	0.96 (0.84-1.09)	1.02 (0.93-1.13)	1.21 (1.06-1.38)

*Adjusted for physician sex, number of years in practice, specialty, board certification, and site of medical school graduation; practice type; percentage of practice revenue derived from managed care, Medicare, and Medicaid; urban/rural location; beneficiary age, race, sex, and Klabunde comorbidity score; median household income in beneficiary's ZIP code, percentage of adult population in county with 12 or more years of education, and the percentage of visits that were with the usual-source-of-care physician. Models for mammography also adjusted for the per capita count of clinical care radiologists in the metropolitan statistical area.

We found a consistent inverse association between lower percentage of practice revenue derived from Medicaid and delivery of preventive services. It may be that this association reflects socioeconomic differences between patients or practice settings not captured in our analyses. However, another possibility worth considering is that there are spillover effects of Medicaid participation on the quality of care delivered to other patients, due to both the detrimental effects of lower levels of reimbursement on the practice system (such as the need for a higher volume of visits to achieve revenue goals) and the greater challenges inherent in caring for disadvantaged patients. If these spillover effects are present, then concerns raised about the potential negative impact of pay-for-performance on practices treating a larger share of disadvantaged patients may be realized.[39]

We also found that information technology facilitating access to clinical guidelines or generating physician reminders for preventive services conferred only a limited advantage in delivery of those services. This finding contrasts with other studies demonstrating higher rates of preventive care when physicians use computer-based reminder systems.[40,41] Our results, like those of Gann et al,[33] may more accurately reflect the effectiveness of such information technology tools in typical care situations. We note that on the survey, physicians reported only whether information technology tools were available in their practice, not whether they actually used them.

Physicians who were board certified in their primary specialty were more likely to deliver preventive services. These findings strengthen those of the systematic review by Sharp et al,[42] demonstrating the direct association between quality and board certification. Although viewed as important by the public and often required for hospital privileges, certification is currently not included as a condition for physician participation in many large insurers, including the traditional fee-for-service Medicare program.[43] The practical implications of such a requirement could be substantial in terms of the effect on access. Physicians who are not board certified made up 15% of the physicians in our study, and these physicians disproportionately provide care to black patients.[7] Our results suggest, however, that certification may be an important marker of quality and should be considered as a quality assurance measure.

General internists delivered some preventive services more often than did family or general practitioners, a set of findings not entirely explained by differences in practice setting or other covariates. General internists seemed in particular to be more likely to deliver those services that require referral to specialists—endoscopy for colon cancer screening, mammography, and diabetic eye examinations. There was no real difference for services typically delivered in the primary care physician office—vaccinations and hemoglobin A_{1c} evaluation. These results are consistent with earlier studies.[11,44] Yet there has been little discussion in the literature to date of potential reasons for this difference across primary care specialties, for which preventive services delivery is a central tenet of care. Our findings suggest that family and general practitioners, when referring their patients to subspecialists for preventive care, may have either less established subspecialist referral networks or may in general have patients who are more reluctant to pursue subspecialty evaluation.

We also found that beneficiaries treated by physicians graduating from a US or Canadian medical school rather than a medical school in another country were more likely to receive each of the 6 preventive services. These results add to emerging literature on the relationship between country of medical school education and the quality of care delivered but do not establish a definitive relationship. In a systematic review, Mick and Comfort[45] found little evidence for a quality difference between US and foreign graduates, noting that most studies lacked detailed data on patient and practice characteristics. Other studies have noted that international medical graduates have extremely heterogeneous backgrounds,[46] and our findings mask such variation.

Our study should be viewed within the context of its limitations. Our approach to identifying beneficiaries' usual-source-of care physicians, although previously validated, is likely imperfect. We evaluated the robustness of our findings by using some reasonable alternatives, and we did not see meaningful alterations in our reported effects, but we cannot be certain that the physicians in our analysis considered themselves to be the source of primary care for the beneficiaries in our study. Second, we had incomplete data on patient socioeconomic status, and we lacked data on beneficiaries' care preferences and their rates of refusal of preventive services. Third, our reliance on claims data to measure delivery of services may have introduced bias in cases where inaccuracies or incompleteness in claims are associated with important physician or practice characteristics, such as practice type (eg, if large group practices are more or less efficient at filing Medicare claims) or percentage of revenue derived from Medicaid (eg, if practices with high Medicaid volume practices have less administrative infrastructure for filing claims). One potential critique of our findings is that claims do not adequately capture services rendered. Busy physician practices may be lax about coding for services such as influenza vaccination that are associated with modest levels of reimbursement. However, we would expect such a phenomenon to vary by both the reimbursement amount (endoscopies are more expensive than hemoglobin A_{1c} testing) and whether the primary care physician usually performed the service (vaccinations vs mammography). That our findings were consistent across both categories of services suggests that we are capturing true associations, not ones reflecting differences in billing.

Fourth, although nationally representative, the survey sample size limits our power to detect urban vs rural differences, as rural physicians were not oversampled. Regarding colon cancer screening, as it is difficult to measure ideal adherence to guidelines when physicians can choose from many combinations of different testing modalities, the endoscopy rates we report should be interpreted only as measures of relative performance. Finally, claims will not capture delivery of some preventive services, such as some mammograms delivered through community outreach programs. However, a large number of these programs do bill Medicare for these services when the patient is a beneficiary, and so many of these events have been captured in our study.

Prior studies have reported that the delivery of preventive services remains below national goals; our results confirm this conclusion.[3,47] We found that this shortfall is neither uniform for all beneficiaries nor explained entirely by characteristics of the beneficiaries such as their race or income level. Rather, it appears that some beneficiaries are treated in practice settings or by physicians who deliver preventive services at particularly low rates. Our results suggest that these variations in quality are substantial and seem to be greatly influenced by the structure and revenue sources of physician practices. If we can understand the mechanisms underlying these relationships, it would be much easier to identify the key leverage points for quality improvement.

Author Contributions: Dr Pham had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Pham, Hargraves, Bach.
Acquisition of data: Pham, Bach.
Analysis and interpretation of data: Pham, Schrag, Hargraves, Bach.
Drafting of the manuscript: Pham, Schrag,
Critical revision of the manuscript for important intellectual content: Pham, Schrag, Hargraves, Bach.
Statistical analysis: Pham, Bach.
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I am enough of an artist to draw freely upon my imagination. Imagination is more important than knowledge. Knowledge is limited. Imagination encircles the world.
—Albert Einstein (1879-1955)