Medicare Spending, The Physician Workforce, And Beneficiaries' Quality Of Care

Areas with a high concentration of specialists also show higher spending and less use of high-quality, effective care.

by Katherine Baicker and Amitabh Chandra

ABSTRACT: The quality of care received by Medicare beneficiaries varies across areas. We find that states with higher Medicare spending have lower-quality care. This negative relationship may be driven by the use of intensive, costly care that crowds out the use of more effective care. One mechanism for this trade-off may be the mix of the provider workforce: States with more general practitioners use more effective care and have lower spending, while those with more specialists have higher costs and lower quality. Improving the quality of beneficiaries' care could be accomplished with more effective use of existing dollars.

RECENT RESEARCH HAS FOUND large and persistent differences across states in the quality of care that Medicare beneficiaries receive.[1] One way to measure these differences is through differences in the use of effective, high-quality care, such as the administration of beta-blockers after heart attacks, mammograms for older women, influenza vaccines, or eye exams for diabetics. These procedures are relatively inexpensive, are known to have desirable medical benefits, and are rarely contraindicated. It is therefore puzzling that the use of these procedures varies so widely between states; for example, in 2000 the use of beta-blockers within twenty-four hours of admission for patients with heart attacks and without contraindications ranged from 50 percent in Alabama to 86 percent in New Hampshire.[2]

In this paper, we first determine whether quality differences can be explained by differences in Medicare spending. That is, are states where there is more spending per Medicare beneficiary also more likely to provide effective care? Clearly, spending more is unlikely to cause lower-quality care but rather serves as a

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marker for a particular style of health care provision or use of resources. Something in the underlying infrastructure or allocation of resources may drive both higher spending and lower quality of care. We next examine whether high-spending states provide more care along other dimensions, such as multiple specialist consultations, hospitalizations, and use of intensive care units (ICUs) in the last six months of life. Prior research has shown that end-of-life care is extraordinarily costly but not correlated with the underlying sickness of the population, patient outcomes, or patient satisfaction.[3] Finally, we explore potential mechanisms through which intensive care might crowd out high-quality care. We analyze the effect of the underlying physician workforce (generalists versus specialists) on both spending and quality differences across states.

Study Data And Methods

■ **Empirical design.** We first examined the relationship between the provision of high-quality care for Medicare beneficiaries and Medicare spending at the state level. We performed this analysis at the state level mainly because of the availability of external state quality measures, but also because the states serve as useful proxies for geographic variation in care.[4]

We explored the determinants of state spending and quality using generalized least squares regressions weighted by the size of the Medicare population in each state (although unweighted regressions provide similar results). These cross-section results are not sensitive to the price and demographic adjustments described below, or to the exclusion of Medicare home health spending, which was dramatically curtailed by the Balanced Budget Act (BBA) of 1997.[5] Neither are the results affected by the choice of year of the quality measures (1998–99 or 2000–01) or by the inclusion of state-level health maintenance organization (HMO) enrollment and the rate of heart attack discharges (adjusted for the age, sex, and race of the state population).

To assess whether these findings are driven by unmeasured differences in the underlying sickness of state populations, we used a subset of four highly informative quality measures that were available for both 1995 and 1999 from Medicare claims data from the *Dartmouth Atlas* project: beta-blockers administered at discharge, mammography every two years for women ages 65–69, and hemoglobin (HbA1c) monitoring and annual eye exams for diabetics. We analyzed the relationship between changes in the use of these quality measures and changes in spending within each state. This technique eliminates unobserved confounders that are fixed over time (for example, fixed differences in demographic structure, patients' severity of illness, or reliance on outpatient clinics), although unobserved state-level confounders that change over time may still affect these results. We also included changes in the level of HMO enrollment among Medicare beneficiaries and the rate of heart attack discharges.

We used similar methods to examine whether higher Medicare spending is a

marker for a different pattern of spending. We analyzed the relationship between spending and end-of-life care, such as the fraction of patients admitted to the ICU and the number of days spent in the hospital. Although this care may be costly and have less observed impact on health, it may be highly valued by patients, so we also analyzed the effect of spending on patient satisfaction.

Finally, we explored one of the mechanisms that may be responsible for the trade-off between high-quality health care and costly end-of-life care: the composition of the medical workforce. We regressed spending per Medicare beneficiary and overall quality rank on the number of specialists, general practitioners, and registered nurses per capita, controlling for the total number of physicians per capita, to explore the effect of changing the composition of the medical workforce.

■ **Data.** *Quality measures.* This study uses the twenty-four quality measures developed by the Medicare Quality Improvement Organization (QIO) and computed at the state level by Steve Jencks for 2000–01.[6] These measures use samples of patient discharge records for the treatment of six common medical conditions (acute myocardial infarction, breast cancer, diabetes mellitus, heart failure, pneumonia, and stroke) and capture interventions and evaluations "for which there is strong scientific evidence and professional consensus that the process of care either directly improves outcomes or is a necessary step in a chain of care that does so," such as the prescription of warfarin for atrial fibrillation or biennial eye examination for diabetics.[7] Detailed risk adjustment is thus not critical for these measures, as few patients are contraindicated for these procedures. Jencks and colleagues ranked states for each measure and averaged the ranks (weighting each measure equally) to compute each state's overall quality rank.

Medicare spending and use measures. We calculated Medicare reimbursement per beneficiary at the state level using Medicare claims data from the *Dartmouth Atlas* projects; we included spending for fee-for-service (FFS) Medicare beneficiaries.[8] This spending is adjusted in three ways. First, spending is adjusted for inflation using the Consumer Price Index (CPI).[9] Second, differences in state price levels are taken into account using a state-specific cost-of-living adjustment.[10] Third, spending is adjusted for the age, sex, and race of the states' Medicare populations.

We used several other measures computed from the Medicare claims data, including the number of days Medicare beneficiaries in their last six months of life spent in a hospital and what fraction of these beneficiaries are admitted to the ICU. These measures abstract from unmeasured illness confounders by focusing on the deceased. Other research has established that such care is pervasive in areas that have a lot of beds, specialists, and health care facilities and has also demonstrated that its provision does not improve patient outcomes or satisfaction.[11] In some specifications we controlled for the number of acute myocardial infarction (AMI) discharges and AMI mortality in each state, adjusted for the age, sex, and race composition of the population, also computed from the claims data.

Satisfaction measures and HMO penetration rates. Patient satisfaction measures come

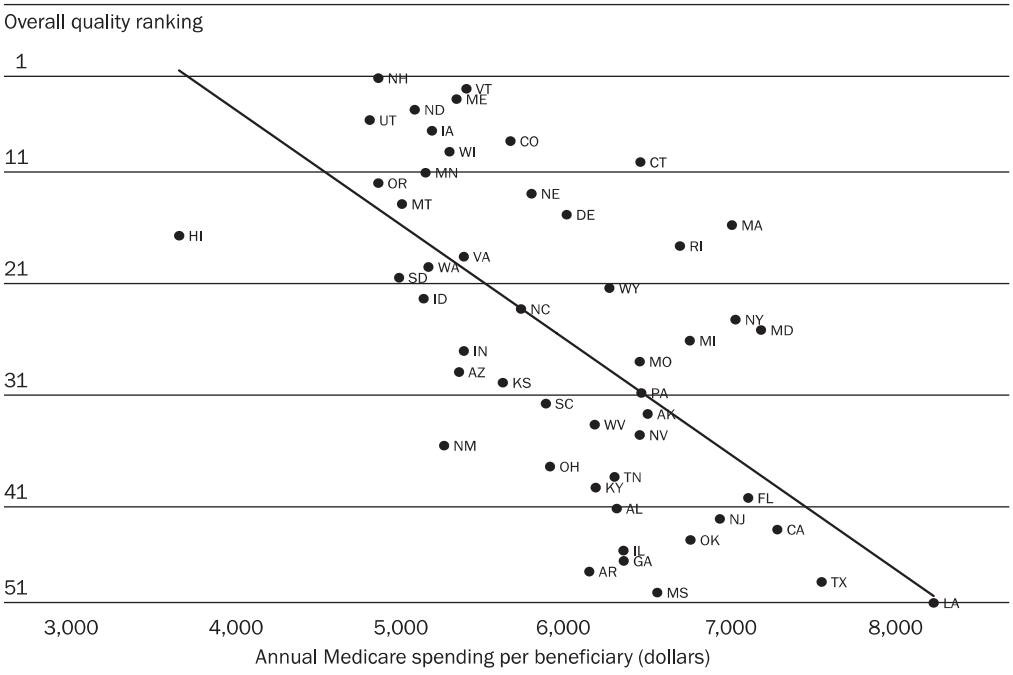
from the 1992–1995 Medicare Current Beneficiary Survey (MCBS). We used measures of overall satisfaction, satisfaction with access to care, and satisfaction with providers' technical proficiency. We also used these data to compute state-specific measures of Medicare HMO enrollment.

Workforce measures. Data on the number of specialists, general practitioners, and registered nurses (RNs) were obtained from the 2003 Area Resource File (ARF).[12] The ARF gathers information from the American Medical Association (AMA) Physician Masterfile and the County Hospital File and is reported at the county level. We summed county-level data into state measures. We computed per capita workforce measures for each state by dividing state physician workforce counts by population counts from the 2000 census.

Study Results

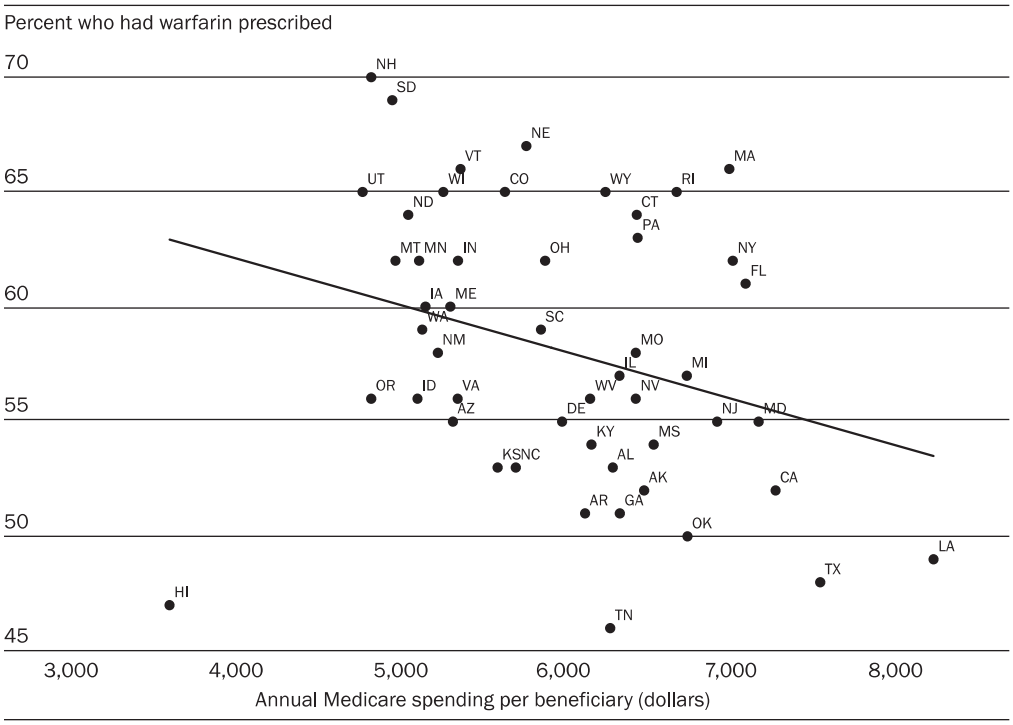
Higher spending is associated with lower quality of care as seen in Exhibits 1–3. These relationships are statistically significant: Spending is not merely uncorrelated with the quality of care provided.[13] Exhibit 4 quantifies the relationship between an increase in spending of $1,000 per beneficiary (roughly the rise in average spending from 1995 to 1999) and the twenty-four individual quality measures,

EXHIBIT 1
Relationship Between Quality And Medicare Spending, As Expressed By Overall Quality Ranking, 2000–2001



SOURCES: Medicare claims data; and S.F. Jencks et al., "Change in the Quality of Care Delivered to Medicare Beneficiaries, 1998–1999 to 2000–2001," *Journal of the American Medical Association* 289, no. 3 (2003): 305–312.
NOTE: For quality ranking, smaller values equal higher quality.

EXHIBIT 2
Relationship Between Quality And Medicare Spending, As Expressed By Percentage Of Beneficiaries With Atrial Fibrillation Who Had Warfarin Prescribed, 2000–2001



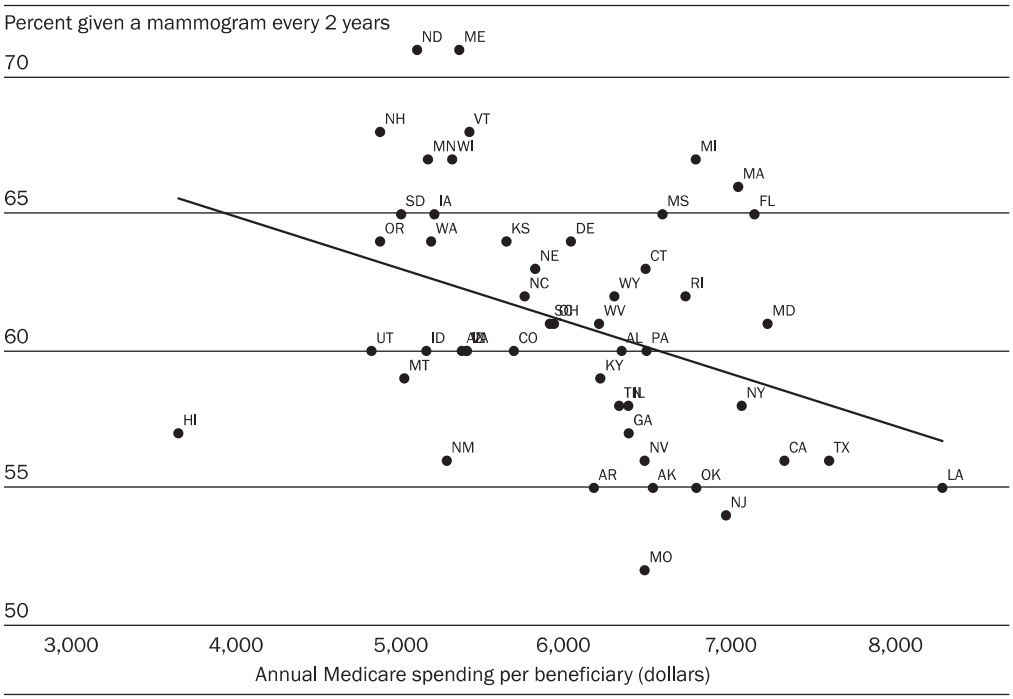
SOURCES: Medicare claims data; and S.F. Jencks et al., "Change in the Quality of Care Delivered to Medicare Beneficiaries, 1998–1999 to 2000–2001," *Journal of the American Medical Association* 289, no. 3 (2003): 305–312.
NOTE: Higher values indicate higher quality.

as well as end-of-life care and patient satisfaction. For convenience, we also report (from the work of Jencks and colleagues) the percentage of Medicare beneficiaries nationwide who received the indicated evaluation/intervention in 2000. The effect of increased spending on fifteen of the measures is estimated to be negative and statistically significant, and there is no statistical effect on the remaining nine. The first row demonstrates that a state spending $1,000 more per beneficiary dropped almost ten positions in overall quality ranking ($p < .001$). Similarly, states spending $1,000 more per Medicare beneficiary had beta-blocker usage rates at discharge that were 3.5 percentage points lower ($p < .02$), and mammography rates that were 2.1 percentage points lower ($p < .01$) than the average usage in 2000.[14]

We also explored the role of two other covariates. We included the fraction of Medicare beneficiaries enrolled in HMOs and discharges for heart attacks (or AMIs) adjusted for age, sex, and race. HMO enrollment may affect the cost and quality of care provided, and AMI discharges capture an important component of the overall health of the Medicare population. The results were not affected by the inclusion of these variables.

To ensure that these results are not the artifact of omitted variables, such as the

EXHIBIT 3
Relationship Between Quality And Medicare Spending, As Expressed By Percentage Of Female Beneficiaries Ages 52–69 Given A Mammogram Every Two Years, 2000–2001



SOURCES: Medicare claims data; and S.F. Jencks et al., "Change in the Quality of Care Delivered to Medicare Beneficiaries, 1998–1999 to 2000–2001," *Journal of the American Medical Association* 289, no. 3 (2003): 305–312.
NOTE: Higher values indicate higher quality.

possibility that some states have (unobserved) systematically different patients than others, the same relationship is illustrated in changes: Do states that increase their spending also improve their quality of care? The results in Exhibit 5 show that there is no correlation between changes in the use of high-quality care and changes in Medicare spending. The negative association between spending and quality persists; states that increased spending reduced their usage of beta-blockers, mammograms, and annual eye exams for diabetics.

Although this method eliminates all confounders that are fixed over time by differencing them away, we may not have accounted for some state-specific factors that change over time. Here, too, we included the change in the fraction of beneficiaries enrolled in an HMO (which increased substantially over this period) and the change in adjusted discharges for AMI (which would proxy for an overall change in the health of the state population). The bottom panel of Exhibit 5 shows that the inclusion of these measures does not affect the reported coefficients: There is still no correlation between quality of care and Medicare spending. Together, these results also validate the claim that the quality measures are not sensitive to risk adjustment.

EXHIBIT 4
Effect Of Raising Spending Per Medicare Beneficiary By $1,000 On Beneficiaries' Quality Of Care, 2000–2001

	Average usage in 2000–01	Effect of raising spending by $1,000 per beneficiary	*P* value
Overall quality			
Overall quality ranking	25	−10	.000
Inpatient setting[a]			
Patients with AMI and no contraindications			
Percent receiving aspirin within 24 hours of admission	83.8%	−1.6%	.023
Percent receiving aspirin at discharge	84.2%	−3.6%	.001
Percent receiving beta-blockers within 24 hours of admission	68.7%	−2.0%	.098
Percent prescribed beta-blocker at discharge	78.4%	−3.5%	.013
Percent receiving ACE inhibitor at discharge for patients with LVEF <40%	71.1%	−3.2%	.009
Percent receiving smoking cessation advice during hospitalization	39.5%	−6.8%	.000
Time to angioplasty (minutes)	112.6	−0.6	.906
Time to thrombolytic therapy (minutes)	49.2	1.9	.526
Patients with heart failure			
Percent having left ventricular ejection fraction evaluated	71.1%	0.2%	.905
Percent having ACE inhibitor at discharge (if LVEF <40%)	65.4%	−0.7%	.629
Patients with stroke			
Percent prescribed warfarin (if atrial fibrillation present)	57.3%	−2.4%	.043
Percent receiving antithrombolytic (if acute stroke or transient ischemic attack)	82.5%	−2.3%	.013
Percent in whom sublingual nifedimine was avoided (if acute stroke)	98.7%	−0.4%	.158
Patients with pneumonia			
Percent receiving antibiotic within 8 hours of arrival at hospital	85.1%	−2.0%	.005
Percent receiving antibiotic that is consistent with current recommendations	84.1%	−0.7%	.065
Percent in whom blood culture is drawn before antibiotic prescribed (if drawn)	81.1%	−2.1%	.001
Percent screened for, or given, influenza vaccine	24.1%	−4.9%	.006
Percent screened for, or given, pneumococcal vaccine	22.6%	−3.8%	.012
Any setting[a]			
Patients over age 65			
Percent receiving influenza immunization	71.7%	−2.3%	.000
Percent receiving pneumococcal immunization at least once ever	64.1%	−1.3%	.025
Patients ages 52–69 (female)			
Percent receiving mammogram at least every 2 years	60.3%	−2.1%	.009
Patients with diabetes			
Percent having HbA1c evaluated	77.4%	−3.2%	.000
Percent having eye exam every 2 years	69.8%	−1.3%	.181
Percent having lipid profiles checked every 2 years	74.1%	1.1%	.234
End-of-life care			
Patients who died			
Number of hospital days in last 6 months of life	10.9	1.3	.006
Percent admitted to an ICU or CCU in last 6 months of life	34.3%	3.9%	.000

Where does the money in high-spending states go, if not to highly effective care? It seems to be spent on expensive health care that has not been shown to have a positive effect on patient satisfaction or health outcomes. Exhibit 4 shows a positive relationship between Medicare spending and the percentage of Medicare

EXHIBIT 4
Effect Of Raising Spending Per Medicare Beneficiary By $1,000 On Beneficiaries' Quality Of Care, 2000–2001 (cont.)

	Average usage in 2000–01	Effect of raising spending by $1,000 per beneficiary	*P* value
Patient satisfaction			
Patients in MCBS (scale of 0, worst, to 100, best)			
Overall satisfaction with health care provided	73.8	−0.6	.284
Satisfaction with technical skill of providers	75.1	0.3	.707
Satisfaction with access to care	68.2	−0.9	.286

SOURCES: See below.

NOTES: Reported estimates are obtained from a regression of the rate at which a specific quality measure in 2000–01 was used on spending per beneficiary. Quality measures are obtained from S.F. Jencks et al., "Quality of Medical Care Delivered to Medicare Beneficiaries," *Journal of the American Medical Association* 284, no. 13 (2000): 1670–1676; and S.F. Jencks, E.D. Huff, and T. Cuerdon, "Change in the Quality of Care Delivered to Medicare Beneficiaries, 1998–1999 to 2000–2001," *Journal of the American Medical Association* 289, no. 3 (2003): 305–312. Spending numbers and ineffective care rates are obtained from the *Dartmouth Atlas of Health Care* project. Satisfaction measures come from the 1992–1995 Medicare Current Beneficiary Survey (MCBS). The regression weights each state by the number of Medicare beneficiaries. $1,000 represents the average change in spending between 1995 and 1999. AMI is acute myocardial infarction. ACE is angiotensin-converting enzyme. LVEF is left ventricular ejection fraction. ICU is intensive care unit. CCU is cardiac care unit.

[a] Items in this category make up the twenty-four quality indicators as defined by the Medicare Quality Improvement Organization (QIO).

beneficiaries who were admitted to the ICU (or the number of days beneficiaries spent in the hospital) during their last six months of life. Medicare patients in

EXHIBIT 5
Effect Of Increasing Spending Per Medicare Beneficiary By $1,000 On Beneficiaries' Quality Of Care, Using Changes In Care And Spending Between 1995 And 1999

	Effect of increasing spending by $1,000 per beneficiary (%)	*P* value
Baseline first-differences specification		
Percent prescribed beta-blocker at discharge (if AMI)	−10.8	.000
Percent having HbA1c evaluated (if diabetic)	−1.5	.369
Percent having eye exam (if diabetic)	−0.1	.923
Percent receiving mammogram (if female)	−0.4	.747
Adding controls for risk and HMO penetration		
Percent prescribed beta-blocker at discharge (if AMI)	−9.7	.000
Percent having HbA1c evaluated (if diabetic)	−0.5	.749
Percent having eye exam (if diabetic)	0.3	.789
Percent receiving mammogram (if female)	−0.1	.935

SOURCES: See below.

NOTES: Reported estimates are obtained from a regression of the change in the rate at which a specific quality measure was used on the change in spending per beneficiary between 1995 and 1999. Quality measures are restricted to those for which data on quality and spending were available in both 1995 and 1999 in the *Dartmouth Atlas of Health Care* project. The regression weights each state by the number of Medicare beneficiaries. $1,000 represents the average change in spending between 1995 and 1999. The lower panel adds controls for state-specific changes in health maintenance organization (HMO) penetration and state-specific risk adjustment based on changes in acute myocardial infarction (AMI) discharges (adjusted for age, sex, and race of the population).

states that spent $1,000 more per beneficiary spent an average of 1.3 more days in the hospital ($p < .01$) and were 3.9 percent more likely to be admitted to an ICU ($p < .005$).[15] These increases do not seem to be associated with higher levels of patient satisfaction. As shown at the bottom of Exhibit 4, spending is uncorrelated with several different measures of patient satisfaction.

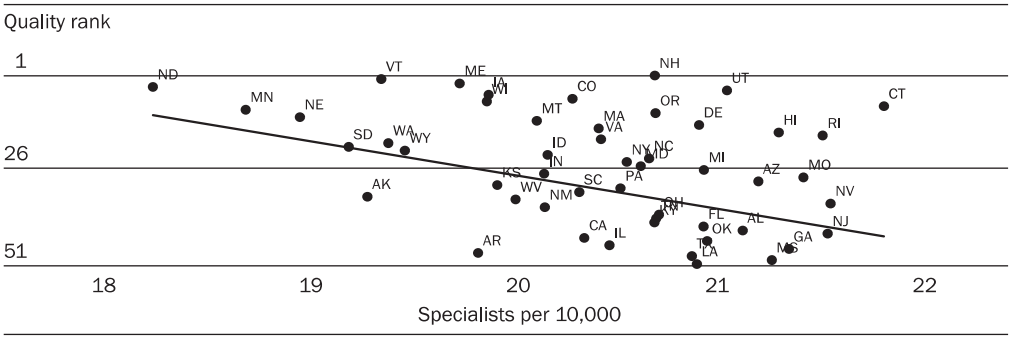
What causes some states to be high spenders and provide lower-quality care, while others are low spenders and provide higher-quality care? One possibility is the composition of the medical workforce. Exhibits 6–11 examine this hypothesis, illustrating the relationship between the medical workforce, spending, and quality. The exhibits adjust for the total number of physicians in a state and study the effect of specialists (Exhibits 6 and 7), general practitioners (Exhibits 8 and 9), and nurses (Exhibits 10 and 11) per capita on overall quality rank and Medicare spending. We are thus examining the effect of changing the composition of the medical workforce, holding the overall size of the physician workforce constant. Together, these workforce measures can explain 42 percent of state-level variation in Medicare spending per beneficiary. These exhibits show that states where more physicians are general practitioners show greater use of high-quality care and lower cost per beneficiary. Increasing the number of general practitioners in a state by 1 per 10,000 population (while decreasing the number of specialists to hold constant the total number of physicians) is associated with a rise in that state's quality rank of more than 10 places ($p < .0005$) as well as a reduction in overall spending of $684 per beneficiary ($p < .0005$). Conversely, states where more physicians are specialists have lower-quality care and higher cost per beneficiary. The estimated effect of increasing the fraction of specialists by 1 per 10,000 is a drop in overall quality rank of almost 9 places ($p < .005$) and an increase in spending of $526 per beneficiary ($p < .004$). The supply of nurses does not seem to affect either the use of high-quality care or total spending.

It is possible that although areas with more specialists do not provide higher-quality care along these dimensions, they may be better at the treatment of more acute conditions.[16] It is also possible that areas "specialize" in different types of care: Some areas specialize in primary care, while others may specialize in the delivery of technologically aggressive care for heart attacks.[17] We do not find evidence of this here: States with more specialists have neither lower mortality rates from all causes nor reduced post-AMI mortality.[18]

Discussion And Policy Implications

States that spend more per Medicare beneficiary are not states that provide higher quality care. In fact, additional spending is positively correlated with end-of-life care but negatively correlated with the use of effective care. While higher spending per se is unlikely to cause a drop in the use of high-quality care, it seems to be a marker for a particular pattern of care. Our analysis suggests that the mix of the physician workforce plays a critical role in the use of highly effective care.

EXHIBIT 6
Relationship Between Provider Workforce And Quality: Specialists Per 10,000 And Quality Rank In 2000

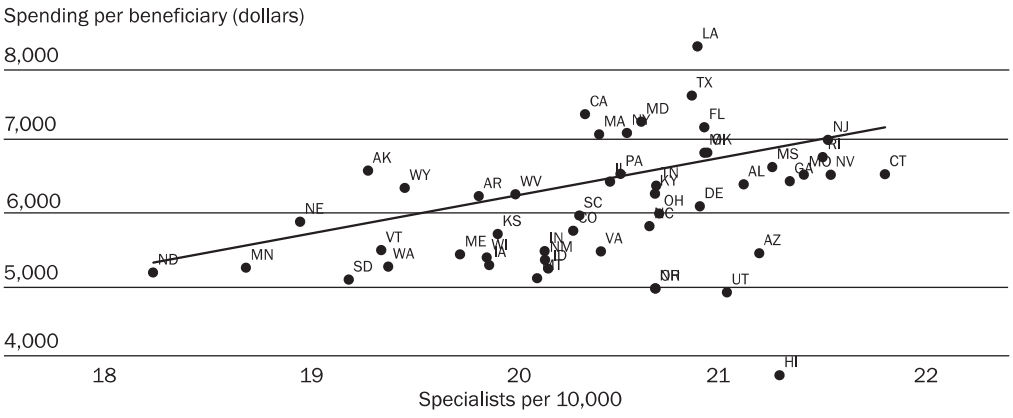


SOURCES: Medicare claims data; and Area Resource File, 2003.
NOTES: For quality ranking, smaller values indicate higher quality. Total physicians held constant.

States with relatively more general practitioners have both higher rates of use of effective care and lower spending. Surprisingly, we find no relationship between nurses and the provision of high-quality care.

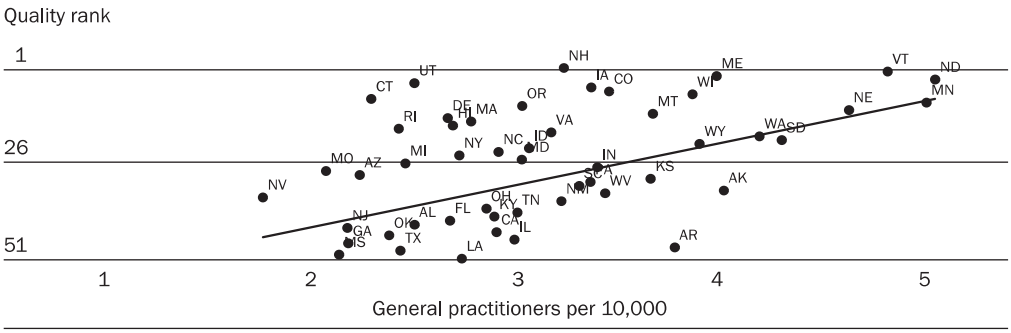
Given the reliance on cross-area variation in spending and quality, inferences about causal mechanisms should be made with great caution. First, ecological inferences always raise concerns about omitted variables, such as risk adjustment or legal environment. This is unlikely to be a problem in this analysis, for three reasons. First, the QIO quality measures were specifically selected to be robust to the absence of risk adjustment. Second, for incomplete risk adjustment to drive the cross-section results in Exhibit 4, it must also be the case that sicker patients medically require less of the "high-quality" care—a highly unlikely scenario.

EXHIBIT 7
Relationship Between Provider Workforce And Medicare Spending: Specialists Per 10,000 And Spending Per Beneficiary In 2000



SOURCES: Medicare claims data; and Area Resource File, 2003.
NOTE: Total physicians held constant.

EXHIBIT 8
Relationship Between Provider Workforce And Quality: General Practitioners Per 10,000 And Quality Rank In 2000

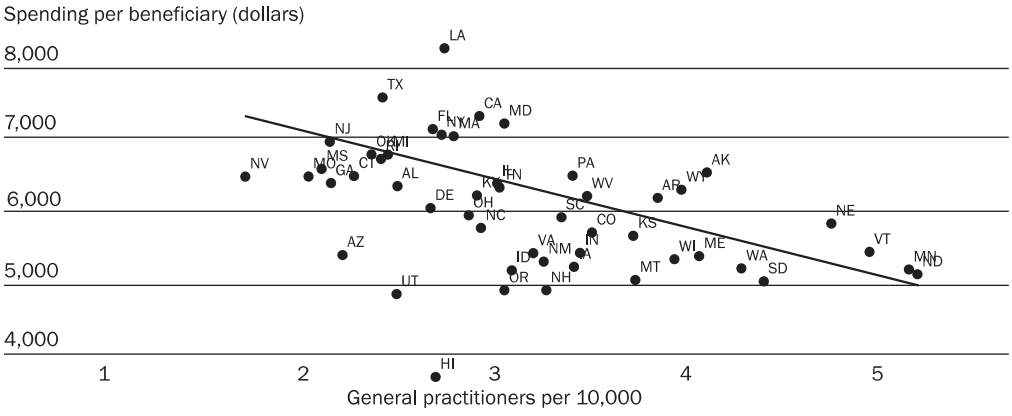


SOURCES: Medicare claims data; and Area Resource File, 2003.
NOTES: For quality ranking, smaller values indicate higher quality. Total physicians held constant.

Third, the results are equally strong in the within-state panel-data analysis summarized in Exhibit 5, which controls for any persistent differences in illness in state populations, malpractice laws, or regulations.

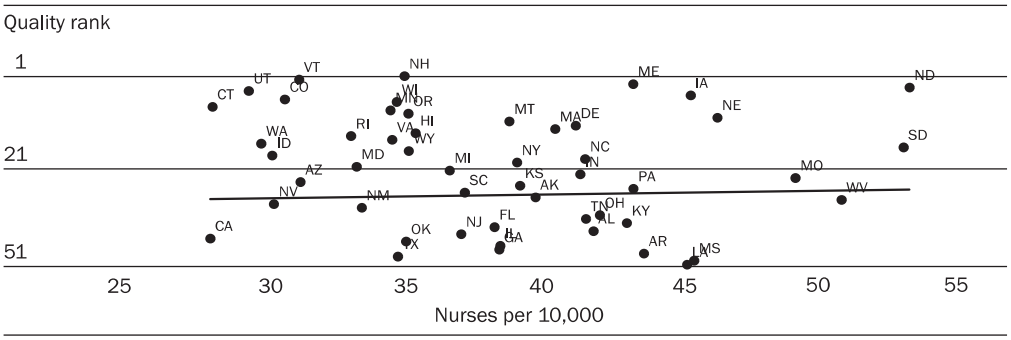
A second concern might be that specialists locate in areas where patients are sicker and that sicker patients are more likely to be hospitalized for longer stays or admitted to the ICU. If this were true, then the positive relationship between specialists and end-of-life spending could be spurious. Here, too, several factors limit this potential bias. First, examining care that is based only on the sample of deceased people implicitly controls for the underlying sickness of the patient population. Furthermore, other researchers have found that underlying population risk does not seem to drive the presence of specialists and that outcomes are not im-

EXHIBIT 9
Relationship Between Provider Workforce And Medicare Spending: General Practitioners Per 10,000 And Spending Per Beneficiary In 2000



SOURCES: Medicare claims data; and Area Resource File, 2003.
NOTE: Total physicians held constant.

EXHIBIT 10
Relationship Between Provider Workforce And Quality: Nurses Per 10,000 And Quality Rank In 2000

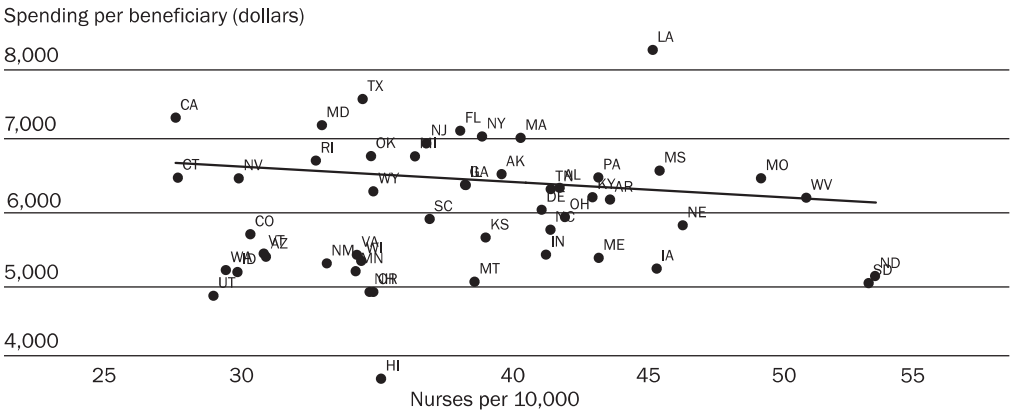


SOURCES: Medicare claims data; and Area Resource File, 2003.
NOTES: For quality ranking, smaller values indicate higher quality. Total physicians held constant.

proved by increased access to these specialists. In particular, in the area of neonatology, specialists are associated with neither higher risk nor lower mortality.[19] The results on the ineffectiveness of specialists for the provision of high-quality care are thus consistent with the findings of a broader literature.

What, then, are the policy implications of the negative relationship between spending and quality? It clearly does not suggest that we mandate lower spending, because it is probably not spending per se that reduces quality. Spending captures many aspects of local health care delivery systems, such as physician practice styles, composition of the medical workforce, and capacity constraints. Therefore, naïve policies that simply target spending could have the undesirable effect of reducing the quality of care in high-spending states even more. Also, the quality

EXHIBIT 11
Relationship Between Provider Workforce And Medicare Spending: Nurses Per 10,000 And Spending Per Beneficiary In 2000



SOURCES: Medicare claims data; and Area Resource File, 2003.
NOTE: Total physicians held constant.

measures we use do not capture the totality of health care provision. Although specialists may not drive the provision of effective care, they often provide better care in their area of specialty.[20] This suggests that specialists are clustered in areas where costly intensive care crowds out high-quality care and that one mechanism for this is a lesser presence of general practitioners. Encouraging greater access to general practitioners, or involving specialists in the provision of effective care, could improve the overall quality of care received by elderly Americans.

With Medicare's mounting fiscal crisis, understanding the relationship between the variation in Medicare spending and beneficiaries' quality of care is critical. The negative relationship we found between spending and quality and the factors that drive it are of immediate concern. Policies that improve quality of care (such as establishing national practice benchmarks for basic quality measures) need not be costly and could even improve Medicare's financial solvency.[21]

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NOTES

1. S.F. Jencks et al., "Quality of Medical Care Delivered to Medicare Beneficiaries," *Journal of the American Medical Association* 284, no. 13 (2000): 1670–1676; S.F. Jencks, E.D. Huff, and T. Cuerdon, "Change in the Quality of Care Delivered to Medicare Beneficiaries, 1998–1999 to 2000–2001," *Journal of the American Medical Association* 289, no. 3 (2003): 305–312; E.A. McGlynn et al., "The Quality of Health Care Delivered to Adults in the United States," *New England Journal of Medicine* 348, no. 26 (2003): 2635–2645; E.S. Fisher and J.S. Skinner, "Comparing the Health Care of States," *Providence Journal-Bulletin*, 17 March 2001; E.S. Fisher et al., "The Implications of Regional Variations in Medicare Spending, Part 1: The Content, Quality, and Accessibility of Care," *Annals of Internal Medicine* 138, no. 4 (2003): 273–287; and E.S. Fisher et al., "The Implications of Regional Variations in Medicare Spending, Part 2: Health Outcomes and Satisfaction with Care," *Annals of Internal Medicine* 138, no. 4 (2003): 288–298.
2. Jencks et al., "Quality of Medical Care"; and Jencks et al., "Change in the Quality of Care."
3. Fisher et al., "The Implications of Regional Variations in Medicare Spending, Part 1"; Fisher et al., "The Implications of Regional Variations in Medicare Spending, Part 2"; and J.E. Wennberg, E.S. Fisher, and J.S. Skinner, "Geography and the Debate over Medicare Reform," *Health Affairs*, 13 February 2002, content.healthaffairs.org/cgi/content/abstract/hlthaff.w2.96 (3 March 2004).
4. An alternative geographic unit of analysis is the Hospital Referral Region (HRR) constructed by the *Dartmouth Atlas of Health Care*. These (smaller) regions capture the geographic level at which health care for the Medicare population is delivered. In parallel work we have performed similar analyses for the subset of quality indicators that we could construct at the HRR level. K. Baicker and A. Chandra, "The Productivity of Physician Specialization: Evidence from the Medicare Program," *American Economic Review* (forthcoming). This analysis yielded similar results.
5. H.L. Komisar, "Rolling Back Medicare Home Health," *Health Care Financing Review* 24, no. 2 (2002): 33–55.
6. Jencks et al., "Quality of Medical Care"; and Jencks et al., "Change in the Quality of Care."
7. Jencks et al., "Change in the Quality of Care," 1670.
8. J.E. Wennberg and M.M. Cooper, eds., *The Dartmouth Atlas of Health Care 1999* (Chicago: American Hospital Association, 1999); J.E. Wennberg and M.M. Cooper, eds., *The Dartmouth Atlas of Health Care 1996* (Chicago: American Hospital Association, 1998); and D.E. Wennberg and J.D. Birkmeyer, eds., *The Dartmouth Atlas of Cardiovascular Health Care* (Chicago: American Hospital Publishing, 2000).
9. Bureau of Labor Statistics, Inflation Calculator, data.bls.gov/cgi-bin/cpicalc.pl (3 March 2004); and U.S.

Census Bureau, "Resident Population of the Fifty States, the District of Columbia, and Puerto Rico," 1 April 2000, www.census.gov/population/www/cen2000/respop.html (3 March 2004).

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11. Fisher et al., "The Implications of Regional Variations in Medicare Spending, Part 1"; Fisher et al., "The Implications of Regional Variations in Medicare Spending, Part 2"; and Wennberg et al., "Geography and the Debate over Medicare Reform."
12. National Center for Health Workforce Analysis, Area Resource File, U.S. Department of Health and Human Services, 2003.
13. We focused on quality rank because of the attention given to this statistic in the original Jencks papers. However, since small differences in the overall index could result in large differences in the final ranking, we studied the relationship between spending and an index of quality usage. We constructed this index by summing the usage rate of each quality measure (weighting each measure equally). We ignored the time to PTCA and thrombolytic therapy since these measures are inversely correlated with quality. Our index is virtually identical to the Jencks rankings. A regression of our index on average spending predicts that a spending increase of $1,000 is correlated with a decline of 0.7 standard deviation in the value of the index. Exhibits 1–3 illustrate the relationship between spending and two subcomponents of the quality index, and Exhibit 4 shows the regression estimates for all subcomponents.
14. In Exhibits 1–3 it can be seen that the inclusion of Hawaii reduces the magnitude of the estimated relationship; eliminating Hawaii results in an even stronger negative relationship between quality and spending.
15. Fisher et al., "The Implications of Regional Variations in Medicare Spending, Part 1"; and Fisher et al., "The Implications of Regional Variations in Medicare Spending, Part 2" demonstrate that the correlation between end-of-life spending and average per capita Medicare spending is 0.83. A large portion of the estimated relationship is therefore driven by end-of-life spending. Since additional dollars are always spent on the margin, it makes sense to include end-of-life spending in total spending.
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17. A. Chandra and D. Staiger, "Network Externalities in Health Care: Evidence from Variation in the Treatment of Acute Myocardial Infarction" (Working Paper, Department of Economics, Dartmouth College, Hanover, New Hampshire, 2003).
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