

Primary Care's Effects on Costs in the US Veterans Health Administration, 2016–2019: an Observational Cohort Study



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BACKGROUND: Enhancing primary care is a promising strategy for improving the efficiency of health care. Previous studies of primary care's effects on health expenditures have mostly relied on ecological analyses comparing region-wide expenditures rather than spending for individual patients.

OBJECTIVE: To compare overall medical expenditures for individual patients enrolled vs. those not enrolled in primary care in the Veterans Health Administration (VHA).

DESIGN: Cohort study with stratification for clinical risk and multivariable linear regression models adjusted for clinical and demographic confounders of expenditures.

PARTICIPANTS: In total, 6,009,973 VHA patients in fiscal year (FY) 2019—5,410,034 enrolled with a primary care provider (PCP) and 599,939 without a PCP—and similar numbers in FYs 2016–2018.

MAIN MEASURES: Total annual cost per patient to the VHA (including VHA payments to non-VHA providers) stratified by a composite health risk score previously shown to predict VHA expenditures, and multivariate models additionally adjusted for VHA regional differences, patients' demographic characteristics, non-VHA insurance coverage, and driving time to the nearest VHA facility. Sensitivity analyses explored different modeling strategies and risk adjusters, as well as the inclusion of expenditures by the Medicare program that covers virtually all elderly VHA patients for care not paid for by the VHA.

KEY RESULTS: Within each health-risk decile, non-PCP patients had higher outpatient, inpatient, and total costs than those with a PCP. After adjustment for health risk and other factors, lack of a PCP was associated 27.4% higher VHA expenditures, \$3274 per patient annually ($p < .0001$). Sensitivity analyses using different risk adjusters and including Medicare's spending for VHA patients yielded similar results.

CONCLUSIONS: In the VHA system, primary care is associated with substantial cost savings. Investments in primary care in other settings might also be cost-effective.

KEY WORDS: primary care; health care costs; Veterans Health Administration.

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INTRODUCTION

Other affluent nations spend far less on health care than the USA but devote a much larger share of spending to primary care.¹ The USA has fewer primary care clinicians and more specialists per capita than most peer nations,^{2,3} and provides a smaller proportion of medical services in the primary care setting.³ Government policy and market forces have widened the compensation gap between specialists and primary care providers,⁴ and policymakers have shown little appetite for major new investments in primary care.

While several lines of evidence suggest that robust primary care leads to lower health care spending,^{5–8} uncertainty persists. Most of the evidence comes from studies of cross-national or US region-level correlations between measures of primary care delivery and health care costs, which may be confounded by unmeasured differences between nations or US regions. A few studies have documented lower patient-level costs of care in primary (vs. specialty) care settings for specific conditions,^{7,9,10} but the population-wide generalizability of these findings is unclear. Some older analyses found that primary care reduced preventable hospitalizations and emergency department visits,^{7,11} but savings from such reductions might be offset by increased utilization of other services, such as outpatient visits. Moreover, recent studies suggest that additional investments in primary care in the USA (e.g., through medical homes) may not lower overall costs.^{12,13}

We analyzed comprehensive patient-level data on veterans cared for in the US Veterans Health Administration (VHA), the nation's largest integrated health system, to explore the effects of enrollment with a primary care clinician on health care expenditures. VHA providers and administrative staff generally recommend PCP enrollment to all VHA users, but enrollment is not mandatory.

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METHODS

Data Sources and Study Population

We linked fiscal year 2016–2019 patient-level data from multiple components of the VHA's Corporate Data Warehouse (CDW), a comprehensive nationwide data system. The CDW includes data on veterans cared for by both VHA providers and non-VHA providers that is paid for by the VHA, including clinical information (e.g., diagnoses and procedures), patients' demographics, private and Medicare health insurance coverage, travel time to hospitals, costs, and PCP enrollment status (see [Appendix](#) for details). We also obtained FY 2018 data—the most recent available—on payments by the traditional (i.e., non-Medicare Advantage) Medicare program on behalf of VHA patients.

Our sample includes all veteran patients with at least one clinical encounter with a VHA provider during fiscal years (FY) 2016–2019. We excluded non-veteran patients (e.g., employees), and patients missing diagnosis or cost data (5.8% of veteran VHA users).

Study Variables

Our main outcome for analyses of the entire sample is total VHA costs, including costs for inpatient stays, outpatient care, prescription drugs, long-term care services, and VHA payments to outside providers. For the subgroup analysis of veterans enrolled in both the VHA and Medicare in FY 2018, our outcome is the sum of VHA costs plus Medicare payments. All costs were inflated to 2019 dollars using the Medical Care Component of the Consumer Price Index (CPI).¹⁴

A patient was classified as enrolled with a PCP if the patient had a designated primary care provider in the Primary Care Management Module (PCMM), a system used by PCPs throughout the VHA to follow and manage their patient panels. Per VHA policy, patients who had not visited their PCP for the past 24 months were automatically disenrolled and classified as having no PCP.

Severity of illness—a major determinant of care use and hence cost—was assessed using the VHA's Case-mix for Performance Management (CPM) risk score. This risk score, which is based on patients' age, gender, and coded diagnoses (grouped into 762 categories), is designed to predict VHA costs and has been shown to outperform alternative case-mix adjustment models for that task.¹⁵

Other variables included age; gender (binary in our VHA dataset); marital status (yes or no); race/ethnicity (White, Black, and "other" including Native American, Latino, Asian, or unknown); whether the veteran had any private insurance; whether they were enrolled in Medicare; driving time from their residence to the nearest VHA facility able to provide primary care; and service-connected disability rating (in percentage and dichotomized as above or below 70%). The extent of service-connected disability (which ranges from 0 to 100%)

is formally determined by the VHA based on both the severity of disability and the degree to which it was acquired during military service. Although the VHA provides free care for low-income veterans and for all service-connected conditions (e.g., combat injuries), higher levels of service-connected disability can entitle veterans to care for all medical needs, as well as additional services such as transportation reimbursement, and a waiver of some cost-sharing.

Statistical Analysis

We first compared the characteristics and total VHA costs for patients with and without PCPs, and compared costs stratified by CPM risk score decile and percentile. We repeated the risk-stratified analysis by year and by age, above or below 65 (an indicator of Medicare eligibility, and hence increased access to non-VHA care) to verify consistency.

We next constructed multivariate linear regression models to assess the effect of having a PCP on costs controlling for potential confounders, as detailed in the [Appendix](#). In addition to the CPM risk score, our main models controlled for year, age (in years and in six categories), gender, race, marital status, service-connected disability, enrollment in Medicare and private insurance, and driving time to the nearest VHA facility. To account for differences in VHA hospital characteristics (e.g., teaching status, the availability of expensive services, urban/rural location, and practice patterns), we included fixed effects for each of the VHA's 140 regional hospitals.

We also performed a subgroup analysis of veterans enrolled in both the VHA and Medicare in 2018, defining costs as the sum of VHA expenditures plus Medicare expenditures on behalf of VHA patients.

In sensitivity analyses, we repeated our main analysis of the pooled data using random effects for hospitals, and used five alternative risk predictors in place of the CPM risk score: two based on the number of diagnoses for each patient; two based on the Clinical Classifications Software Refined (CCSR) groups; and one comparing costs in the last 6 months of life among decedents with and without a PCP.

We also conducted several sensitivity analyses to explore potential sources of bias. To assess whether visiting a PCP was associated with more complete coding of diagnoses (which could inflate risk scores and hence artifactually decrease risk-adjusted cost), we compared the risk scores and costs of those with vs. without a PCP visit during 2019 among all patients who were enrolled in primary care. In the entire cohort, we compared mental health and long-term care use among PCP and non-PCP patients to explore whether patients needing these services selectively enrolled (or avoided enrollment) with PCPs. We assessed potential confounding due to non-PCP patients "dropping in" to VHA care for expensive, elective hospitalizations (e.g., for surgical procedures) by comparing hospitalization rates for PCP vs. non-PCP patients stratified by 264 major diagnoses. Additionally, we performed a two-stage residual inclusion analysis, an instrumental variable

method designed to uncover possible unmeasured confounders that has been used by economists for many years and has recently seen increasing use by health services researchers.^{16,17} (See [Appendix](#) for detailed sensitivity analyses.)

,4).

RESULTS

Our sample included 5,825,290 veterans who received VHA care in FY 2016, 5,857,189 in FY 2017, 5,922,863 in FY 2018, and 6,009,973 in FY 2019. Table 1 displays the characteristics of the 2019 sample—of whom 5,410,034 had a PCP and 599,939 did not. Characteristics of VHA patients in other years (many of whom were also included in the 2019 cohort) were similar. Relative to those lacking a PCP, veterans enrolled with a PCP were older, more likely to be White, married, and to have a higher service-connected disability rating. Patients with a PCP were also more likely to be enrolled in Medicare, but less likely to have private insurance. Although veterans with PCPs had a 32% higher mean health risk score, their costs exceeded those of veterans lacking PCPs by only 23% in unadjusted analyses.

Table 2 shows costs to the VHA (for FY 2016–2019) overall, and for specific types of service (e.g., inpatient or outpatient care) for patients with and without a PCP, after stratification by risk decile. As expected, costs increased sharply with risk score decile. Within each risk decile, costs

Table 1 Characteristics of Veteran Patients With and Without a Primary Care Provider in the US Veterans Health Administration (FY 2019)

Characteristics	With PCP (n = 5,410,034)		Without PCP (n = 599,939)	
	Mean	Standard deviation	Mean	Standard deviation
Age (years)	61.8	16.8	59.2	20.99
Gender (female)	9%	0.28	8%	0.27
Marital status (married)	56%	0.50	49%	0.5
Racial status (White)	75%	0.43	67%	0.47
Racial status (Black)	18%	0.38	16%	0.37
Racial status (other)	7%	0.26	17%	0.37
Disability rating (%)	32.9	37.64	25.0	34.44
Disability rating 70%+	27%	0.44	19%	0.39
No private health insurance	36%	0.48	48%	0.5
Enrolled in Medicare	46%	0.50	33%	0.47
Drive time to closest VHA PCP (min)	22	17	20	17
CPM risk score	104	53	79	46
Average per patient total cost	\$12,728	\$30,555	\$10,348	\$39,690

Notes: FY, fiscal year; PCP, enrolled with a Veterans Health Administration primary care provider

for veterans with a PCP were lower than those of non-PCP patients, by between 26 and 38%. Both outpatient and inpatient costs were higher for non-PCP patients in every risk decile. Similar patterns were present in every year of data when analyzed separately, and when patients were stratified by individual risk score percentiles rather than deciles ([Appendix Exhibits A1 and A2](#)⁶). The association of primary care with lower total costs persisted in analyses stratified by age above and below 65 ([Appendix Exhibit A3](#)).

Table 3 presents our main result, the cost differences associated with primary care using pooled 2016–2019 data, controlling for multiple potential confounders. Lack of a PCP was associated with higher costs of \$3274 (95% CI \$3249.7–3297.5) per person, a difference of 27.4% ($p < .0001$). Results were similar when adjusted models were fitted separately for each year ([Appendix Exhibit A4](#)).

In the subgroup analysis of patients dually enrolled in the VHA and Medicare, non-PCP patients had higher (unadjusted) Medicare expenditures, whether measured per-Medicare enrollee (\$4607 vs. \$3890) or per user of Medicare-paid services (\$15,068 vs. \$13,386) ([Appendix Exhibit A5](#)¹⁶). In the multivariate model, adjusted total costs (VHA + Medicare expenditures) were \$3730 higher per non-PCP patient than for those with PCPs ([Table 4](#)).

In supplementary analyses, we found no evidence that recent visits to a PCP caused increased coding. The 456,789 veterans with a designated PCP whom they did not visit in 2019 had slightly higher average risk scores (89.5 vs. 82.1) than those with a designated PCP whom they visited. Additionally, among PCP patients, those without a PCP visit during the year incurred higher costs than those who made at least one visit, a finding consistent with our finding that PCP use may reduce costs (see [Appendix](#)).

Diagnosed mental illness (which might raise care costs) was not more common in patients lacking a PCP (see [Appendix](#)). Although long-term care use was slightly higher among the non-PCP patients, the difference was too small to explain our cost findings (see [Appendix](#)). Comparisons of hospitalization rates stratified by specific diagnoses showed no evidence of non-PCP patients selectively “dropping in” to VHA care for expensive hospitalizations ([Appendix Exhibit A6](#)).

Sensitivity analyses using four alternative diagnosis-based risk adjusters yielded slightly higher estimates of PCP-related cost savings (see [Appendix](#)). The analysis of decedents’ costs in the last 6 months of life yielded smaller (16.1%) proportional, but larger (\$19,511) absolute cost savings associated with having a PCP than our main model (see [Appendix](#)).

Finally, the two-stage residual inclusion model assessing potential unobserved confounders yielded estimates almost identical to our main models ([Appendix Exhibits A7 and A8](#)¹⁶), as did models using random, rather than fixed hospital effects (see [Appendix](#)).

Table 2 Annual Costs to the Veterans Health Administration for Patients With and Without a Primary Care Provider by Risk Decile, Fiscal Years 2016–2019

Risk groups	Number of patients			VA inpatient cost			VA outpatient cost			Community care cost			Prescription drug cost			Total cost	
	With PCP	Without PCP		With PCP	Without PCP		With PCP	Without PCP		With PCP	Without PCP		With PCP	Without PCP		With PCP	Without PCP
1	1,597,370	765,886	\$67	\$295	\$1,124.87	\$47.14	\$59.69	\$23.64	\$96.72	\$1,071.68	\$1,479.28						
2	1,901,766	461,956	\$75	\$472	\$1,345.11	\$88.59	\$180.31	\$64.76	\$154.85	\$1,508.95	\$2,184.08						
3	2,098,022	265,534	\$49	\$586	\$1,913.62	\$134.68	\$466.39	\$138.99	\$227.30	\$2,097.75	\$3,346.78						
4	2,186,755	176,695	\$48	\$666	\$2,642.96	\$198.91	\$590.67	\$253.40	\$315.85	\$2,889.98	\$4,689.46						
5	2,221,288	142,203	\$69	\$950	\$3,622.99	\$473.57	\$774.62	\$408.61	\$441.34	\$3,991.31	\$6,398.07						
6	2,242,974	120,667	\$119	\$1,617	\$5,980.45	\$447.24	\$1,033.25	\$562.94	\$607.77	\$5,525.78	\$8,631.14						
7	2,253,216	110,738	\$268	\$2,884	\$8,086.87	\$698.42	\$1,483.59	\$966.54	\$872.28	\$7,891.82	\$12,454.58						
8	2,253,025	109,115	\$706	\$5,279	\$9,952.52	\$1,127.95	\$2,032.23	\$1,547.57	\$1,310.56	\$11,817.60	\$18,538.74						
9	2,249,374	114,783	\$2,483	\$10,670	\$15,245.37	\$2,206.05	\$2,915.93	\$2,583.49	\$2,136.43	\$19,934.46	\$29,955.01						
10	2,227,474	135,708	\$23,015	\$42,984	\$30,071.45	\$7,611.71	\$7,993.03	\$5,400.66	\$4,800.14	\$60,121.91	\$81,048.96						

Notes: FY, fiscal year; PCP, enrolled with a Veterans Health Administration primary care provider

DISCUSSION

The VHA cares for more than 6 million veteran patients annually at a cost of nearly \$80 billion.¹⁸ Among VHA patients, enrollment in primary care was associated with lower inpatient, outpatient, and total costs for patients at every level of measurable health risk. Our analyses suggest that primary care reduced the VHA's costs by about one-quarter, equivalent to \$3274 in 2019. The association of PCP enrollment with lower costs persisted in an analysis that encompassed Medicare's expenditures as well as VHA costs.

Ours is the first study we are aware of that uses detailed, individual patient data from a large cohort to assess the effects of primary care on health care costs. The cost savings associated with primary care persisted in models using different risk adjusters, subgroups, and methods to control for hospital-level effects. Analyses exploring alternative explanations for the savings associated with PCP enrollment uncovered no evidence for such explanations.

Table 3 Multivariate Linear Model Estimate of PCP Effect on VHA Costs, Pooled Data, Fiscal Years 2016–2019 (N = 23,634,549)

Variable	Parameter estimate	95% confidence interval		p value
		Lower bound	Upper bound	
Intercept	−21,407.00	−21,510.9	−21,303.1	<.0001
No PCP	3,273.64	3,249.7	3,297.5	<.0001
Age in years	−116.81	−118.5	−115.1	<.0001
Age ≥ 35 and < 45	548.23	509.9	586.6	<.0001
Age ≥ 45 and < 55	1,780.00	1,731.9	1,828.1	<.0001
Age ≥ 55 and < 65	2,840.15	2,779.0	2,901.3	<.0001
Age ≥ 65 and < 75	4,088.72	4,013.1	4,164.3	<.0001
Age ≥ 75	6,356.02	6,258.5	6,453.5	<.0001
Gender (female)	−894.01	−920.2	−867.8	<.0001
Marital status (married)	−850.83	−865.6	−836.0	<.0001
Racial status (White)	−975.80	−995.3	−956.3	<.0001
Racial status (Black)	−1,296.39	−1,322.2	−1,270.6	<.0001
Disability rating (%)	−9.35	−9.7	−8.9	<.0001
Disability rating 70%+	388.75	354.9	422.6	<.0001
No private health insurance	577.47	557.2	597.7	<.0001
Enrolled in Medicare	700.69	676.6	724.8	<.0001
Drive time to closest VHA	−5.26	−5.7	−4.8	<.0001
CPM risk score	385.26	385.1	385.4	<.0001
FY 2017	201.78	182.1	221.5	<.0001
FY 2018	806.96	787.2	826.7	<.0001
FY 2019	1,289.17	1,269.3	1,309.0	<.0001

Notes: PCP, enrolled with a Veterans Health Administration primary care provider. The fixed effects of the 140 hospitals are not shown. Reference groups were age < 35, racial status (other), and FY 2016

Table 4 Multivariate Linear Model Estimate of the Effect of Having a PCP on Costs Incurred by the VHA Plus Medicare, Fiscal Year 2018 (N = 1,730,948)

Variable	Parameter estimate	95% confidence interval		p value
		Lower bound	Upper bound	
Intercept	−800.43	−1,622.56	21.69	0.056
No PCP	3,708.55	3,532.73	3,884.37	<.0001
Age	93.31	82.06	104.55	<.0001
Age ≥ 35 and < 45	−12,383.00	−13,164.43	−11,601.57	<.0001
Age ≥ 45 and < 55	−10,657.00	−11,395.66	−9,918.34	<.0001
Age ≥ 55 and < 65	−10,168.00	−10,922.59	−9,413.41	<.0001
Age ≥ 65 and < 75	−11,192.00	−12,000.58	−10,383.42	<.0001
Age ≥ 75	−7,503.58	−8,431.70	−6,575.46	<.0001
Gender (female)	−3,072.27	−3,354.77	−2,789.77	<.0001
Marital status (married)	−2,685.77	−2,795.80	−2,575.75	<.0001
Racial status (White)	−12,971.00	−13,110.11	−12,831.89	<.0001
Racial status (Black)	−12,503.00	−12,718.19	−12,287.81	<.0001
Disability rating (%)	−9.01	−12.08	−5.95	<.0001
Disability rating 70%+	1,696.31	1,430.93	1,961.70	<.0001
No private health insurance	−770.99	−927.03	−614.96	<.0001
Drive time to closest VHA PCP (min)	−22.51	−25.39	−19.63	<.0001
CPM risk score	426.27	425.44	427.10	<.0001

Notes: The fixed effects of the 140 hospitals are not shown here. Age < 35 and racial status (other) were used as reference groups

Our findings are consistent with those of previous studies that relied on regional variations in primary care and health care spending. In a comparison of 13 industrialized countries, stronger primary care infrastructure was correlated with lower costs as well as better health outcomes.⁶ Conversely, US regions with lower primary care physician/population ratios have higher health care expenditures and mortality rates, as well as more preventable hospitalizations.^{19–21} They are also consistent with an early study of the VHA's implementation of enhanced primary care, which found a modest increase in primary care use and decreases in avoidable hospitalizations and outpatient visits to mental health providers.²²

Several studies have found that for US patients with some conditions, care by PCPs (vs. specialists) is associated with less testing, fewer procedures, and lower expenditures.^{5,7,9–11} An early study using data from the National Medical Expenditure Survey found that individuals whose personal physician was a PCP had lower annual expenditures than those who cited a specialist as their personal physician or saw many different physicians.²³ That study and others suggested that primary care reduced preventable emergency department visits and hospitalizations.^{24–29}

Our analysis is restricted to cost outcomes, and provides no information on the quality of care, a vital issue. As in any comparative cohort study, we cannot exclude potential, unmeasured confounders—particularly the possibility that the observed cost differences are attributable to differences in patients' care seeking behaviors and preferences. However, to account for the large cost differences we observed, confounders would have to be strongly associated with both eschewing PCP enrollment and with cost, and be consistent across hospitals, patient health-risk strata, age groups, and diagnoses—a situation that seems unlikely given the findings of the two-stage residual inclusion model.

While we had complete data on VHA-paid costs (including those delivered by private providers but paid for by the VHA), and those paid by the traditional Medicare program, we had no data on costs incurred by other insurers, or by patients themselves. However, it seems unlikely that veterans with a VHA PCP (who presumably had a stronger connection to the VHA system than patients lacking a VHA PCP) received a larger share of their care from non-VHA-paid providers. Indeed, it seems likely that the opposite is true—i.e., that patients lacking a VHA PCP receive more of their care outside of the VHA system—a possibility supported by our finding that patients lacking a PCP incurred higher Medicare expenditures. Furthermore, the cost-saving effect of having a PCP remained large among veterans over 65, an exogenous marker for Medicare eligibility and hence financial access to non-VHA care.

The VHA system differs in important ways from civilian-sector care, perhaps limiting the generalizability of our findings. Veterans are all adults, mostly (91%) male, and were uniformly fit and healthy in young adulthood when they entered the military. More distinctly, virtually all VHA clinicians are salaried and have no financial incentives to limit care or to provide low-value care, and the VHA's nationally interoperable electronic medical record may minimize duplicative services.

In the absence of a large-scale randomized controlled trial—which seems unlikely to be carried out—our individual patient-level cohort study provides the best available evidence on the effects of primary care on overall health system costs.

Our data do not speak to how PCP enrollment reduces costs. It is possible that PCPs cut costs through a sparser practice style, improved prevention, and better coordination of care. Alternatively, PCPs might inappropriately restrict access to specialized care, although salaried VHA providers have no financial incentives to do so.

Our study provides evidence that primary care reduces overall health care costs for VHA enrollees. Together with evidence that primary care reduces costs and improves health and longevity in non-VHA settings,^{5,6,19} our findings suggest the wisdom of augmenting the resources for primary care. Policymakers could increase the supply of primary care providers by redirecting Medicare funding for graduate medical education—the main source of funding for residency programs—from specialist to primary care training programs

and increasing support for training primary care nurse practitioners and physician assistants. Reducing fee—and hence income—disparities between primary care and specialist practitioners would encourage trainees to choose (and remain in) primary care fields. Our findings may also encourage leaders of health systems to consider providing additional support for primary care in order to increase efficiency.

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Declarations:

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REFERENCES

- Jabbarpour Y, Greiner A, Jetty A, et al. (2020) Investing in Primary Care: A State-level Analysis. PCPCC. July 2019. Accessed at <https://www.pcpcc.org/resource/investing-primary-care-state-level-analysis> on September 1, 2020
- Papanicolaos I, Woskie LR, Jha AK. Health Care Spending in the United States and Other High-Income Countries. *JAMA*. 2018;319(10):1024-1039 doi:<https://doi.org/10.1001/jama.2018.1150>
- Koller CF, Khullar D. Primary Care Spending Rate - A Lever for Encouraging Investment in Primary Care. *N Engl J Med*. 2017;377(18):1709-1711 doi:<https://doi.org/10.1056/NEJMp1709538>
- Lasser KE, Woolhandler S, Himmelstein DU. Sources of U.S. physician income: the contribution of government payments to the specialist-generalist income gap. *J Gen Intern Med*. 2008;23(9):1477-81. <https://doi.org/10.1007/s11606-008-0660-7>.
- Shi L. Primary Care, Specialty Care, and Life Chances. *International Journal of Health Services*. 24(3), 431-458. <https://doi.org/10.2190/BDUU-JQJD-BVEX-N90B>
- Starfield B, Shi L. Policy relevant determinants of health: an international perspective. *Health Policy*. 2002;60(3):201-218. [https://doi.org/10.1016/s0168-8510\(01\)00208-1](https://doi.org/10.1016/s0168-8510(01)00208-1)
- Friedberg MW, Hussey PS, Schneider EC. Primary care: a critical review of the evidence on quality and costs of health care. *Health Affairs*. 2010;29(5):766-72. doi: <https://doi.org/10.1377/hlthaff.2010.0025>
- Reschovsky JD, Ghosh A, Stewart K, et al. Paying more for primary care: can it help bend the Medicare cost curve?. *Issue Brief (Commonw Fund)*. 2012;5:1-12
- Shekelle PG, Markovich M, Louie R. Comparing the costs between provider types of episodes of back pain care. *Spine (Phila Pa 1976)*. 1995;20(2):221-227 doi:<https://doi.org/10.1097/00007632-199501150-00018>
- Maeng DD, Yan X, Graf TR, et al. Value of Primary Care Diabetes Management: Long-Term Cost Impacts. *American Journal of Managed Care*. 2016;22(3):e88-e94
- Starfield B, Shi L, Macinko J. Contribution of primary care to health systems and health. *Milbank Q*. 2005;83(3):457-502. doi: <https://doi.org/10.1111/j.1468-0009.2005.00409.x>
- Nichols DE, Haber SG, Romaine MA. Multi-Payer Advanced Primary Care Practice Evaluation Team. Changes in Utilization and Expenditures for Medicare Beneficiaries in Patient-centered Medical Homes: Findings From the Multi-Payer Advanced Primary Care Practice Demonstration. *Med Care*. 2018 Sep;56(9):775-783. doi: <https://doi.org/10.1097/MLR.0000000000000966>.
- Romaine MA, Keyes V, Parish WJ, Kim K. Impact of Medical Homes on Expenditures and Utilization for Beneficiaries With Behavioral Health Conditions. *Psychiatr Serv*. 2018;69(8):871-878. doi: <https://doi.org/10.1176/appi.ps.201700433>.
- Bureau of Labor Statistics, U.S. Department of Labor, The Economics Daily, Consumer Price Index: 2019 in review. Accessed at <https://www.bls.gov/opub/ted/2020/consumer-price-index-2019-in-review.htm> on August 07, 2021.
- Gao J, Moran E, Almenoff, PL. Case-Mix for Performance Management: A Risk Algorithm Based on ICD-10-CM. *Medical Care*. 2018;56(6):537-543. doi: <https://doi.org/10.1097/MLR.0000000000000913>
- Terza JV, Basu A, Rathouz PJ. Two-stage residual inclusion estimation: addressing endogeneity in health econometric modeling. *J Health Econ*. 2008;27(3):531-543. doi: <https://doi.org/10.1016/j.jhealeco.2007.09.009>
- Pizer S. An Intuitive Review of Methods for Observational Studies of Comparative Effectiveness. *Health Serv Outcomes Res Method*. 2009;9(1):54-68. doi: <https://doi.org/10.1007/s10742-009-0045-3>
- Department of Veterans Affairs. Volume II Medical Programs and Information Technology Programs. February 2020. Accessed at <https://www.va.gov/budget/docs/summary/fy2021VABudgetVolumeIIMedicalProgramsAndInformationTechnology.pdf> on August 21, 2020.
- Macinko J, Starfield B, Shi L. Quantifying the health benefits of primary care physician supply in the United States. *Int J Health Serv*. 2007;37(1):111-26. doi: <https://doi.org/10.2190/3431-G6T7-37M8-P224>.
- Parchman ML, Culler SD. Preventable hospitalizations in primary care shortage areas. An analysis of vulnerable Medicare beneficiaries. *Arch Fam Med*. 1999;8(6):487-91. doi: <https://doi.org/10.1001/archfam.8.6.487>
- Basu S, Berkowitz SA, Phillips RL. Association of Primary Care Physician Supply With Population Mortality in the United States, 2005-2015. *JAMA Intern Med*. 2019;179(4):506-514. doi: <https://doi.org/10.1001/jamainternmed.2018.7624>
- Hebert PL, Liu CF, Wong ES, Hernandez SE, Batten A, Lo S, Lemon JM, Conrad DA, Grembowski D, Nelson K, Fihn SD. Patient-centered medical home initiative produced modest economic results for Veterans Health Administration, 2010-12. *Health Aff (Millwood)*. 2014;33(6):980-7.
- Franks P, Fiscella K. Primary care physicians and specialists as personal physicians. Health care expenditures and mortality experience. *J Fam Pract*. 1998;47(2):105-9.
- Hochheiser LI, Woodward K, Charney E. Effect of the neighborhood health center on the use of pediatric emergency departments in Rochester, New York. *N Engl J Med*. 1971;285(3):148-52. doi: <https://doi.org/10.1056/NEJM197107152850305>.
- Hurley RE, Freund DA, Taylor DE. Emergency room use and primary care case management: evidence from four Medicaid demonstration programs. *Am J Public Health*. 1989;79(7):843-6. doi: <https://doi.org/10.2105/ajph.79.7.843>
- Parchman ML, Culler S. Primary care physicians and avoidable hospitalizations. *J Fam Pract*. 1994;39(2):123-8
- Bindman AB, Grumbach K, Osmond D. Preventable hospitalizations and access to health care. *JAMA*. 1995;274(4):305-11
- Edwards ST, Saha S, Prentice JC, et al. Preventing Hospitalization with Veterans Affairs Home-Based Primary Care: Which Individuals Benefit Most? *J Am Geriatr Soc*. 2017;65(8):1676-1683. doi: <https://doi.org/10.1111/jgs.14843>
- O'Malley AS, Rich EC, Shang L, et al. New approaches to measuring the comprehensiveness of primary care physicians. *Health Serv Res*. 2019;54(2):356-366. doi: <https://doi.org/10.1111/1475-6773.13101>

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