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DOI: 10.1377/hlthaff.2018.05158
HEALTH AFFAIRS 38,
NO. 1 (2019): 68–75

CONSIDERING HEALTH SPENDING

What's Been The Bang For The Buck? Cost-Effectiveness Of Health Care Spending Across Selected Conditions In The US

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ABSTRACT The continued rise in health care spending has led to an intense debate among policy makers and other health care stakeholders on how to best manage increasing costs, leading to a focus on cost increases with little consideration of the associated change in outcomes. We identified the extent to which increased medical intervention spending on seven prevalent chronic conditions in the US over a twenty-year period has been a good investment. The results provide disease-level cost-effectiveness ratios for comparing changes in medical care spending to changes in health outcomes for patients diagnosed with one of the conditions. This study has two key findings: First, dollars spent on medical care can be a source of high value creation, and such investment should continue. Second, significant variability in value exists across diseases, which highlights the need for disease-specific spending approaches.

The Centers for Medicare and Medicaid Services (CMS) recently reported that health care spending rose 4.3 percent in 2016 to $3.3 trillion, or approximately 17.9 percent of the gross domestic product.[1] Looking ahead, CMS indicates that the year-over-year increase in overall spending was projected to be 4.6 percent in 2017 and to remain at an average of 5.5 percent per year through 2026.[2] Although the projected growth rate is relatively modest compared with that of the late 1990s and early 2000s, the rise in health care spending has sparked an intense debate among policy makers and other health care stakeholders on how best to manage increasing health care costs.[3]

A recurring theme in the ongoing debate is a focus on cost increases with little consideration of the associated change in outcomes. The cost side of the value equation for innovations in health care is often apparent; however, the benefit side of, or outcome component in, the value equation may be more opaque.[4] As a result, the focus may be disproportionately on controlling costs. Recognizing both increased costs and enhanced benefits results in a more balanced assessment of value, which is necessary to avoid misinformed policies and barriers to clinical advances.

Improved health care outcomes can result from innovations in both nonmedical interventions (such as educational programs and lifestyle changes) and medical interventions (including surgical procedures and improved diagnostics, medical devices, or biopharmaceuticals). Both types of interventions affect the incidence, prevalence, severity, and outcomes of specific diseases. Nonmedical interventions are particularly important for disease prevention and may also reduce disease severity at diagnosis, thus reducing negative disease outcomes and improving outcomes after diagnosis. For instance, both smoking cessation programs and dietary intervention programs have been shown to improve health. For example, the National Institutes of Health's Dietary Approaches to Stop Hypertension (DASH) plan has been demonstrated to reduce risk factors for heart disease while also improving insulin resistance, hyperlipidemia, and obesity in patients with diabetes.[5] Medical interventions are particularly important for disease treatment after diagnosis but may also reduce incidence through chemoprophylaxis and vaccination. While nonmedical and medical interventions can improve health outcomes, poor individual health behaviors such as lack of physical activity, poor nutrition, tobacco use, and overconsumption of alcohol have resulted in increased incidence of common chronic conditions in the US (for example, heart disease, stroke, lung cancer, type 2 diabetes, obesity, and arthritis).[6]

This study focused on the relationship between medical care costs and disease outcomes after diagnosis. The objective of the study was to identify whether increased medical intervention spending on prevalent chronic conditions with a significant impact on mortality and morbidity in the US over a twenty-year period has been a good investment. We explored this question by estimating changes in both costs and burden of disease from mortality and morbidity over a twenty-year period among conditions that were responsible for high US rates of mortality and morbidity in 1996. The results of this study provide disease-level cost-effectiveness ratios that compare the changes in medical care spending and those in health outcomes for people diagnosed with these conditions in the US.

Study Data And Methods

We used national-level data from the Centers for Disease Control and Prevention (CDC) for 1990–2013; the Global Burden of Disease Study, a comprehensive regional and global program of research on disease burden that is regularly updated as new data and epidemiological studies are made available, for 1990, 1995, and 2015; and the Medical Expenditure Panel Survey (MEPS), a nationally representative survey of US households, for 1996 and 2015. National-level statistics were used to identify and select conditions responsible for high mortality and morbidity within the US.[7–9] Data from the CDC and the Global Burden of Disease Study provide detailed information on diseases starting in 1990 (see online appendix exhibit A1).[10] These data include age-standardized death rates, disability-adjusted life-years (DALYs), and associated historical ranks for each condition for the period 1995–2015.

The World Health Organization provides US-specific estimates of condition-specific DALYs beginning in 2000 (appendix exhibit A2).[10] Using the US-level statistics for the period 1995–2015, we compiled relative rankings from each data source. Based on the relative rankings, we identified conditions that caused some of the highest levels of morbidity and mortality in the US since 1996.[11] Based on the relative rankings of morbidity and mortality as defined by these US-level data, the seven conditions we chose to analyze were ischemic heart disease; cancer of the trachea, bronchus, or lung (hereafter, lung cancer); breast cancer; HIV/AIDS; cerebrovascular disease; chronic obstructive pulmonary disease (COPD); and diabetes.

We analyzed costs and burden of disease at the patient level rather than across conditions or at the aggregate level. This approach was used to remove the impact of nonmedical interventions on disease incidence and prevalence, because the primary focus of this study was to assess the impact of medical interventions after diagnosis. However, the patient-level approach does not remove the impact of nonmedical interventions on disease severity. This is discussed further in the Limitations section.

IDENTIFYING COSTS PER CONDITION Data from MEPS were used to estimate annual costs for patients with the seven conditions identified from the US morbidity and mortality data and listed above. Clinical Classifications Software (CCS) codes were used to identify conditions in the MEPS data.

MEPS was initiated in 1996 and provides nationally representative estimates of health care use and spending for the US civilian noninstitutionalized population.[12] At the time of this study, the most recent data available were for 2015. Because of MEPS data availability, we selected 1996 as the index year for the study period. Following the index year, in each subsequent year a new panel of households was selected, drawn from participants in the previous year's National Health Interview Survey,[12] with a sample size of approximately 15,000 households per year. MEPS contains sections on access to care, medical conditions, charges, medical events, health status, home health, hospital stays, income, employment, and prescribed medications. The questions in every section are not asked during each round, but the recall period for each round (on average, four to five months) is defined so that the data for each respondent cover two full calendar years.

Within the MEPS data, all health care use and spending are associated with up to four medical conditions using CCS codes, based on participants' self-reports. We assigned costs to one of our selected diseases if the respondent had a CCS code for the disease and had the same CCS code assigned as a reason for the expense. For example, lung cancer costs were assigned to patients with lung cancer if the respondent reported utilization that was associated with a lung cancer CCS code. Total per person costs for each disease were defined as the sum of payments for care for the patient associated with the disease. We included visits to medical provider offices, emergency departments, and outpatient departments; hospital inpatient stays; and prescribed medicine purchases. This value included out-of-pocket payments and payments made by insurance. Thus, the cost incorporated insurance discounts but did not include any manufacturer or other rebates that may have been applied to prescription drugs. To account for the difference between the paid amount recorded in MEPS and what is reported to have been received by providers, the insurance-paid portion of prescription drug spending was discounted by 27 percent for the 2015 data.[13] Because rebates were not commonly used in the mid-1990s, discounts were not applied to prescription drug spending in 1996. Of note, the response rate in MEPS for collecting prescription information was 72.2 percent in 1996 and 83.2 percent in 2015.

Chemotherapy costs are not directly recorded in MEPS. Before 2013 the outpatient and office visit encounter files included an indicator to flag visits that included chemotherapy administration. We counted the payments for these visits toward the cost of prescription drugs in 1996. For 2015 we calculated the proportion of total spending in 2012 associated with chemotherapy administration visits. We applied that proportion to total spending in 2015 to obtain the payment for chemotherapy in 2015. Similar ratios of chemotherapy costs to total costs of treatment for breast cancer and lung cancer were reported by Joan Warren and colleagues[14] and Helen Blumen and colleagues.[15]

We estimated the mean per person spending and standard errors for 1996 and 2015 for each condition after adjusting all cost data for inflation to 2016 US dollars using the US Consumer Price Index for All Urban Consumers (CPI-U). Standard error estimates were produced for mean spending in each year for the conditions, to demonstrate the level of variability within the data. It is well known that health care spending has grown more quickly than general inflation, and thus this approach may have understated the 1996 cost of the analyzed diseases. Therefore, we performed sensitivity analyses using both the medical care component of the CPI and the Personal Consumption Expenditures (PCE) price index. The PCE price index is more sensitive to changes in medical spending than the CPI is.[16]

IDENTIFYING BURDEN PER CONDITION We assessed the burden of disease from mortality and morbidity in the form of mean annual DALYs per person with each of the selected conditions using data from the 2015 Global Burden of Disease Study for the years 1996 and 2015.[17,18] DALYs are calculated by summing years of life lost and years of life lived with disability. Years of life lost is a measure of premature death; it is calculated by starting with the highest achievable life expectancy in a given year for a given age group, then subtracting the age at which a person in that age group dies. Years of life lived with disability is a measure of the time lost to diseases and injuries that degrade health but do not cause death; itis calculated by multiplying a disability's severity by the time that the disability lasts. DALYs are measured on a scale of 0 to 1, where 0 represents perfect health and 1 represents death. Lower scores correspond to more desirable states, and one DALY equals one lost year of healthy life. We report per person DALYs for each condition in both 1995 and 2015 by dividing the aggregate DALY number from the Global Burden of Disease Study by the number of people with the disease in that year.

The Global Burden of Disease Study presents the mean DALY for each condition as well as lower and upper bounds. We conducted sensitivity analyses using the lower and upper bounds for each condition to generate a range of potential benefit values.

Using data on spending and outcomes as described, we calculated condition-specific incremental cost-effectiveness ratios (ICERs). The ICERs were calculated by dividing the per person difference between 2015 and 1996 in costs by the per person differences between 2015 and 1996 in DALYs. The ICER for cost per DALY averted in 2015 compared to 1996 was calculated by dividing the difference between PPTC in 2015 and 1996 by the difference in PPD in 2015 and 1995, where PPTC is the per person total cost and PPD is the per person DALY.

LIMITATIONS This study had several limitations, and the results should be regarded as preliminary evidence on which further research can expand.

First, in our base case we assumed that all of the changes in health outcomes after diagnosis were attributable to medical care interventions. However, because public health interventions and lifestyle changes after diagnosis are likely to have contributed to the improved health outcomes, we also describe the impact on our estimates of alternative assumptions about the percentage of outcome gains after diagnosis that are attributable to medical care using values estimated with the IMPACT model for cardiovascular disease.[19] Additionally, sensitivity analyses that varied the proportion of the outcomes attributable to medical care by up to 75 percent did not change our findings.

Second, although unipolar depression was identified as one of the conditions with the highest levels of morbidity and mortality in the US data, it was not included in the analyses because, before 2004, MEPS did not include a CCS code uniquely related to depression. Instead, depression was in the category of "other mental conditions," alongside conditions such as neurotic disorders, sexual disorders, and psychophysiologic disturbance.

Third, the MEPS data share the general limitations of all self-reported survey data, such as sample size and recall of accurate information.

Fourth, for several of the conditions included in this analysis, the number of participants reporting the condition was small and thus associated with large variability in cost data. To understand the impact of this limitation, we calculated the standard errors for MEPS[20,21] cost estimates for each condition. The standard errors for the cost data were combined with the upper and lower estimates of the DALYs to generate ranges for the disease-level ICERs. These results, which are presented in appendix exhibits A6 and A7,[10] do not alter the primary conclusions of this study. However, caution should be taken when interpreting the findings in diseases with small sample sizes in MEPS, particularly lung cancer, breast cancer, and HIV/AIDS.

Fifth, the MEPS data have several additional limitations, including the following: There is an estimated expenditure gap of 14–19 percent when compared with data from the National Health Expenditure Accounts;[20,21] third-party payments are also suspected to be underreported; and it cannot be assumed that cost data from MEPS are representative of such data for the US population, as they do not contain information on all states or on institutionalized populations (including nursing home residents)—which is a particular limitation for studying cerebrovascular disease. Nonetheless, the MEPS data are consistently used in studies related to US health care spending and are currently the only viable option for analyzing total health care spending by disease.[22–24] Additionally, these limitations are stable across each year of the MEPS data, and thus assessing changes in health care costs is unaffected by variation in the expenditure gap and the omission of patients in nursing facilities. That is, although the per person monetary cost may be underestimated, the direction of the change in cost is unlikely to be affected by these limitations.

Finally, this analysis focused on the diseases with significant impacts on morbidity and mortality at the population level. Other diseases with lower disease burden, smaller patient populations, or both will likely differ in terms of the value of each additional dollar spent, with many conditions having higher costs associated with reduced disease burden. This limits the generalizability of our findings to all diseases. However, it reinforces the study's main point that health care cost management strategies need to be disease specific.

Results

For all seven conditions, the estimated number of patients living with each condition increased from 1996 to 2015 (exhibit 1), as a result of decreases in mortality rates, increases in incidence, or both. Estimated total spending increased substantially from 1996 to 2015 for all conditions.

After changes in the prevalence of each disease were accounted for and inflation was controlled for, reductions in per person total costs (adjusted to 2016 dollars) from 1996 to 2015 were observed for four of the seven conditions: lung cancer ($10,938.37), ischemic heart disease ($5,036.89), cerebrovascular disease ($1,218.75), and HIV/AIDS ($587.34) (exhibit 2). Moderate increases in per person costs were observed for breast cancer ($402.01), COPD ($560.24), and diabetes ($799.98). The change in per person DALYs was variable across conditions, with considerable improvements observed in HIV/AIDS, lung cancer, ischemic heart disease, and breast cancer. Cerebrovascular disease and diabetes showed modest improvements, and COPD experienced a slight decline in per person DALYs.

The per person assessment of the condition-level cost-effectiveness ratio identified both cost savings and improved health among patients with lung cancer, ischemic heart disease, cerebrovascular disease, and HIV/AIDS (exhibit 3). The condition-level assessment for breast cancer and diabetes identified slight cost increases but improved health. Finally, the condition-level assessment for COPD identified cost increases and a slight worsening of health.

Sensitivity analyses using the upper- and lower-bound estimates of the DALYs showed that the results were robust to deviations around the estimated DALYs (appendix exhibit A3).[10] However, sensitivity analyses using different inflation adjustments altered the results. When we used the medical care component of the CPI (appendix exhibit A4),[10] cost reductions were greatly amplified for some conditions (lung cancer,

EXHIBIT 1

Aggregate disability-adjusted life-years (DALYs), prevalence, and total spending for seven chronic conditions, 1995 or 1996 and 2015

	Breast cancer	Lung cancer	Cerebrovascular disease	COPD	Diabetes	HIV/AIDS	Ischemic heart disease
AGGREGATE DISABILITY-ADJUSTED LIFE-YEARS							
1995	1,180,463	3,297,932	2,344,796	2,243,078	2,597,478	2,211,626	8,892,882
2015	1,298,260	3,531,531	2,241,775	3,031,070	3,939,331	360,805	7,785,449
PREVALENCE (NUMBER OF PEOPLE WITH CONDITION)							
1996							
Weighted	679,522	323,556	2,381,383	15,403,441	9,704,312	227,358	3,626,991
Unweighted	48	22	173	1,188	830	19	271
2015							
Weighted	2,680,767	455,305	4,354,596	15,615,194	27,700,589	498,849	13,847,877
Unweighted	217	46	436	1,362	2,982	63	1,262
SPENDING ($)							
1996							
Amount	1,929,028,289	5,566,669,624	9,549,958,748	7,719,128,556	10,334,262,751	2,484,559,097	20,973,208,853
SE	587,787,628	2,261,066,044	2,449,175,061	1,932,053,969	1,173,819,128	1,556,854,216	5,648,390,682
2015							
Amount	12,560,369,237	6,915,023,306	21,139,085,080	20,460,216,609	66,445,268,471	7,945,679,568	52,083,309,570
SE	2,631,500,32	4,722,737,848	4,722,737,848	3,272,822,426	4,003,400,639	1,708,043,720	6,910,118,721

SOURCE Authors' analysis of data from the Global Health Data Exchange (2017) and the Agency for Healthcare Research and Quality (2018). **NOTES** Appendix exhibit A3 shows lower and upper bounds (see note 10 in text). COPD is chronic obstructive pulmonary disease. SE is standard error.

cerebrovascular disease, and ischemic heart disease), and cost increases either were reduced (for COPD and diabetes) or became cost reductions (for HIV/AIDS and breast cancer). When we used the PCE price index (appendix exhibit A5),[10] the magnitude of cost reductions also increased for some conditions (lung cancer, ischemic heart disease, HIV/AIDS, and cerebrovascular disease), and the magnitude of cost increases was somewhat reduced (for breast cancer, diabetes, and COPD). This did not change the direction of the ICERs for any of the diseases.

Discussion

Our goals for this study were to identify whether increases in health care spending on prevalent chronic conditions in the US over time might have been a positive investment. We estimated changes in self-reported health care costs and

EXHIBIT 2

Per person total costs and disability-adjusted life-years (DALYs) for seven chronic conditions, 1995 or 1996 and 2015

	Breast cancer[a]	Lung cancer[b]	Cerebrovascular disease[b]	COPD[c]	Diabetes[a]	HIV/AIDS[b]	Ischemic heart disease[b]
COSTS PER PERSON ($)							
Unadjusted							
1996	2,838.80	17,204.66	4,010.26	501.13	1,064.91	10,927.96	5,782.54
2015	4,685.36	15,187.67	4,854.43	1,310.28	2,398.70	15,928.03	3,761.10
Adjusted							
1996	4,342.46	26,317.64	6,134.42	766.57	1,628.98	16,716.30	8,845.44
2015	4,744.47	15,379.27	4,915.67	1,326.81	2,428.95	16,128.96	3,808.55
DISABILITY-ADJUSTED LIFE-YEARS							
1995	1.74	10.19	0.98	0.15	0.27	9.73	2.45
2015	0.48	7.76	0.51	0.19	0.14	0.72	0.56
PER PERSON CHANGE IN:							
Costs (adjusted)	$402.01	−$10,938.37	−$1,218.75	$560.24	$799.98	−$587.34	−$5,036.89
DALYs	1.25	2.44	0.47	−0.05	0.13	9.00	1.89

SOURCE Authors' analysis of data from the Global Health Data Exchange (2017) and the Agency for Healthcare Research and Quality (2018). **NOTES** DALYs are reverse coded, so that higher numbers represent a smaller disease burden. Total costs were inflated using the Consumer Price Index for All Urban Consumers (CPI-U). COPD is chronic obstructive pulmonary disease. [a]Improved DALYs and higher costs. [b]Improved DALYs and lower costs. [c]Worsening DALYs and higher costs.

changes in global estimates of burden of disease from mortality and morbidity over a twenty-year period for seven conditions responsible for the most mortality and morbidity within the US. We observed reductions in the burden of disease from morbidity and mortality from 1995 to 2015 among six of the seven conditions. Moreover, we observed inflation-adjusted reductions in treatment costs for four of the seven conditions.

In an aging country where chronic conditions are becoming more prevalent because of longer life expectancies and poor health behaviors, the costs associated with treating chronic conditions are increasing. This situation has caused concern across the US, with calls for caps on health care spending. However, our study provides preliminary evidence to show that increases in inflation-adjusted spending per person, when prevalence is accounted for, may be small or nonexistent for some conditions. In addition, reductions in per person disease burden were observed, which indicates that spending for care for these conditions has value. Policies that focus only on rising health care spending and on spending designed solely to prevent health care cost increases may hinder health care innovation.

The observed reductions in per person disease burden result from a variety of factors, including lifestyle modifications, improvements in clinical knowledge of diseases, the availability of a wider range of diagnostic tools that allow earlier diagnosis, and the existence of more effective interventions after diagnosis. However, in this study we were not able to estimate the costs associated with nonmedical interventions or to assess the extent to which observed improvements in disease outcomes after diagnosis were attributable to nonmedical interventions after diagnosis or to nonmedical or medical interventions before diagnosis.

It is notable that the disease-specific ICERs identified in this study were much lower than ICERs typically presented in cost-effectiveness analyses of a single innovative medical intervention, which often range from $50,000 to $150,000 per quality-adjusted life-year.[25–27] For example, results from two cost-effectiveness analyses of combination therapy in the treatment of HIV/AIDS during our study period reported ICERs of approximately $26,000[28] and −$56,000.[29] Additionally, results from a cost-effectiveness analysis of alternative interventions in cardiovascular disease demonstrated lifetime ICERs of approximately $16,500[30] and $30,000.[31]

Our analysis, which focused on the causes of high mortality and morbidity in 1996, used a longer time horizon, during which many innovative treatments were introduced. In addition, in our base-case analysis we captured both improvements in average patient health resulting from lifestyle modifications and advancements in treatment and diagnostic capabilities. Since healthier patients require less-intensive care, they may be treated in a less costly setting of care with lower-cost treatments. The broad impact of these diseases made the categories a natural target for innovation early in the study period. However, in our sensitivity analysis, when we reduced the proportion of the outcomes attributable to medical care by 50 percent, four of the seven conditions continued to show improved outcomes and lower costs, while the remaining three conditions continued to show significant value in spending as a result of improved outcomes. Such results are expected, given that many of the included diseases are treated with drugs. This analysis captured the lower costs of generic versions of brand-name drugs that had lost their patent protection. For instance, we found that prescription drug spending per person dropped for three of the seven conditions—breast cancer, cerebrovascular disease, and ischemic heart disease (data not shown). In short, the longer time horizon may have contributed to the disease-specific ICERs being much lower than the values typically seen in cost-effectiveness studies of a single innovative intervention.

Annual changes in health care spending per treated person did not occur uniformly across diseases. Rather, there was significant variation across diseases, with inflation-adjusted spending per treated person decreasing in four of the seven conditions included in this study. Similar to changes in health care spending, the value of health care dollars spent across diseases as

EXHIBIT 3

Cost per disability-adjusted life-year (DALY) gained from 1995 to 2015 for seven chronic conditions

Condition	Inflation-adjusted change in cost per person ($)	Per person change in DALYs	ICER
Lung cancer	−10,938.00	2.44	Dominant
Ischemic heart disease	−5,037.00	1.89	Dominant
Cerebrovascular disease	−1,219.00	0.47	Dominant
HIV/AIDS	−587.00	9.00	Dominant
Breast cancer	402.00	1.25	$321
Diabetes mellitus	800.00	0.13	$6,377
COPD	560.00	−0.05	Dominated

SOURCE Authors' analysis of data from the Global Health Data Exchange (2017) and the Agency for Healthcare Research and Quality (2018). **NOTES** DALYs are reverse coded, so that higher numbers represent a smaller disease burden. "Dominant" means that DALYs and costs decreased for the condition over the study period. "Dominated" means that DALYs and costs increased for the condition over the study period. For conditions in which costs increased and DALYs decreased, the incremental cost-effectiveness ratio (ICER) result is presented. COPD is chronic obstructive pulmonary disease.

part of this increased spending can be highly variable.

Policy Implications

Findings from this study highlight several important policy implications relevant to the debate on rising health care costs. First, focusing solely on total rising costs for the system may lead to the creation of harmful policies. It is important that assessments of costs adjust for changes in both disease prevalence and inflation. These adjustments may lead to different conclusions on changes in health spending, as observed in this study.

Second, our analysis suggests that for some diseases, additional spending is both cost-effective and a source of high value creation. Public dialogue regarding health care spending in general requires appropriate consideration of the trade-offs between decreased spending and health improvements driven by medical care, to avoid the implementation of misinformed policies and barriers to advancement.

Third, the study results demonstrate a high level of variability across conditions in both changes in cost of treatment per person and the extent of benefit from changes in medical care. This underlying variability means that efforts to constrain medical spending should be careful not to stifle investments that could produce high-value results. Therefore, cost management strategies and policies should incorporate a disease-specific approach, targeting areas where increased spending is associated with fewer health benefits.

Conclusion

This study provides preliminary evidence demonstrating that within six of the top seven conditions associated with the greatest mortality or morbidity in the US, the change in inflation-adjusted dollars spent on treatment from 1995 to 2015 was both cost-effective and a source of high value creation. The study had two key findings: First, for some conditions, dollars spent on medical care can be a source of high value creation, and such investment should continue. Second, there is significant variability in value across diseases, which highlights the need for disease-specific spending approaches. ■

This study was funded by the National Pharmaceutical Council.

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10 To access the appendix, click on the Details tab of the article online.

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