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RESEARCH ARTICLE

The Cost of an Additional Disability-Free Life Year for Older Americans: 1992–2005

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Objective. To estimate the cost of an additional disability-free life year for older Americans in 1992–2005.

Data Source. This study used 1992–2005 Medicare Current Beneficiary Survey, a longitudinal survey of Medicare beneficiaries with a rotating panel design.

Study Design. This analysis used multistate life table model to estimate probabilities of transition among a discrete set of health states (nondisabled, disabled, and dead) for two panels of older Americans in 1992 and 2002. Health spending incurred between annual health interviews was estimated by a generalized linear mixed model. Health status, including death, was simulated for each member of the panel using these transition probabilities; the associated health spending was cross-walked to the simulated health changes.

Principal Findings. Disability-free life expectancy (DFLE) increased significantly more than life expectancy during the study period. Assuming that 50 percent of the gains in DFLE between 1992 and 2005 were attributable to increases in spending, the average discounted cost per additional disability-free life year was \$71,000. There were small differences between gender and racial/ethnic groups.

Conclusions. The cost of an additional disability-free life year was substantially below previous estimates based on mortality trends alone.

Key Words. Value of spending, population aging, health care spending, multistate life table, microsimulation

Health spending on older Americans ages 65 and over has grown much faster than the size of its population since the inception of Medicare. Older Americans increased from 9.4 percent of the population in 1963 to 12.6 percent in 2000, but spending has nearly doubled from 19.7 to 39.2 percent of total medical spending (Meara, White, and Cutler 2004). As millions of baby boomers enter old age over the next two decades, the Medicare program is expected to face substantial fiscal challenges. This is particularly onerous

because it happens at a time when total health care spending already consumes nearly 18 percent of GDP in 2010 (Martin et al. 2012), the highest among all OECD countries (OECD Health Data 2011).

While the social and economic benefit of improved longevity is indisputable (Murphy and Topel 2006), many analysts believe that such rapid spending growth on older Americans is evidence of excessive spending given relatively poor performance in mortality trends (e.g., Muennig and Glied 2010). A recent study reported that the average cost for an additional year of life for 65-year olds was \$145,000 for 1990–2000 (Cutler, Rosen, and Vijan 2006). If both longevity and spending were discounted as recommended, the estimate would be even higher (Garber and Skinner 2008), implying excessive cost for longevity gains among older Americans.

Although improvement in mortality is an important health outcome, it is often more useful to know whether the added life years are concentrated in good or poor health. If the drop in old-age mortality is mostly achieved by merely extending the life of those suffering from chronic and debilitating diseases, rather than by avoiding their onset and/or reducing their severity, then it may be difficult to argue that growth in health care spending is associated with improved health quality of life. To properly assess the effectiveness of health spending on older Americans, it is therefore necessary to use an outcome measure that takes into account trends in both the quantity and the quality of life.

Health is multidimensional concept and health quality of life can be measured in many different ways (Cutler and Landrum 2011). But in considering their relation to growth in health care spending, two trends among older Americans stand out. One is that the rise in the treated prevalence of chronic conditions and the growth of elderly with multiple conditions explained a substantial part of spending growth in recent decades (Thorpe 2006; Thorpe et al. 2010). Another is that old-age disability has been declining steadily since 1980s to late 1990s (Freedman et al. 2004), thanks largely to earlier diagnosis and improved care of chronic conditions (Schoeni, Freedman, and Martin 2008). A recent study reported that spending among the least disabled elderly has grown more quickly than among the most disabled in 1992–2000, even though the former experienced more growth in chronic conditions (Chernew et al. 2005). Taken together, it is reasonable to believe that the rise in health

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spending on the elderly has contributed to the declines in old-age disability, which is commonly regarded as the consequence of debilitating chronic diseases (Guralnik, Fried, and Salive 1996). For this reason, trends in disability-free life expectancy (DFLE)—the expected number of remaining life years spent without disability (Robine et al. 1996)—is a more appropriate measure than life expectancy (LE) for evaluating the effectiveness of health spending in the United States.

In this analysis, I used a multistate life table (MSLT) model to estimate changes in DFLE and LE between two representative panels of older Americans—one in 1992 and the other in 2002, as well as changes in their cumulative (i.e., from current age to death) health spending. The results indicated that the gains in DFLE were larger than gains in LE during the study period 1992–2005. As a result, the cost of gaining an additional disability-free life year was substantially less than the cost of gaining an additional life year.

METHODS

Analytic Sample

The sample of Medicare beneficiaries was drawn from the longitudinal records of two representative samples of Medicare beneficiaries ages 65 and older in 1992 and 2002 from the Access to Care files of the Medicare Current Beneficiary Survey (MCBS). The MCBS survey follows a rotating panel design; each year the Access to Care sample interviews about four panels of 16,000 Medicare beneficiaries. The respondents' dates of death are obtained from the administrative records and added to the survey. Each panel in the survey received multiple extensive interviews over a 4-year period; the sampling period for the 2002 panel thus extended to 2005.

Personal health care spending in MCBS represents direct spending on all major service categories, including both Medicare covered and noncovered services (e.g., nursing home care and prescription drugs as of 2005), and was adjusted to 2006 dollars using the personal health care expenditure (PHCE) index developed by the Centers for Medicare and Medicaid Services (2007). Total spending was decomposed by types of service into acute care, long-term care, and other services. The acute care category included spending on inpatient, outpatient, and physician services. The long-term care category included spending on nursing home, hospice, and home health. The other services category included prescription drug and dental services.

Estimation of DFLE and Cumulative Spending

In this analysis, disability was defined as having difficulty or inability to perform the daily tasks because of a health problem. The tasks included IADLs (Instrumental Activities of Daily Living, such as doing light and heavy housework, managing money, etc.) and ADLs (Activities of Daily Living, such as bathing, eating, using the toilet, etc.). Both IADLs and ADLs are complex activity limitations that challenge a person's ability to live independently and provide self-care. ADL limitation is often one of the health measures to assess long-term care needs.

DFLE is a measure of expected value that, by definition, can only be estimated using a life table model. In demography there are two types of life table models for this purpose: the prevalence-based Sullivan method (Sullivan 1971) and the incidence-based MSLT model (Schoen and Land 1979). Sullivan method combines prevalence of disability with incidence of mortality to estimate DFLE. It is a useful method when longitudinal data are not available. But in situations where longitudinal data are available, the incidence-based MSLT is preferred because it most accurately reflects the impact of current conditions (i.e., disability onset, recovery, and mortality) on the evolution of the target population (Saito, Crimmins, and Hayward 1991; Laditka and Hayward 2003). The MSLT model is an extension of the simple period life table that underlies standard LE estimates, and it is the preferred method in analysis of health changes over time (Schoen 1988).

The longitudinal nature of the MCBS survey supports the use of a MSLT model for this study. I used a recently developed, publicly available program for the MSLT model—the SPACE (Stochastic Population Analysis of Complex Events) program (http://www.cdc.gov/nchs/data_access/space.htm). The SPACE program is the most comprehensive program for the MSLT model that is publically available. It has a number of advantages over other programs, such as it can estimate the transition probabilities of either duration-dependent (i.e., semi-Markov process) or duration-independent (i.e., first-order Markov) MSLT models, compute a variety of life course summary statistics via microsimulation and their survey design-adjusted standard errors via the bootstrap method (Cai et al. 2010a).

Due to relatively small sample sizes, a duration-independent MSLT model is used in this analysis to estimate average $DFLE_t^i$ for older Americans at age t ($t = 65, \dots, 100$; age is top coded at 100) in panel i ($i = 1992, 2002$), by gender and race/ethnicity. Based on the age-specific transition probability estimates for each gender and racial/ethnic group, I

simulated the life course for every member of cohort age t ($t = 65, \dots, 100$) in panel i , by gender and race/ethnicity; each age cohort consists of 50,000 persons and is distributed according to the observed distribution of health states in 1992 or 2002. Average DFLE for panel i was calculated as the average number of life years free of disability over all age cohorts, weighted by the gender and race/ethnicity distribution in panel i .

Spending between single-year age interval for panel i was estimated using a generalized linear mixed model to account for the skewed distribution of observed expenditure data at individual person level and the autocorrelation within a person over time (Blough, Madden, and Hornbrook 1999). The dependent variable was the personal health care spending incurred during the 1-year interview cycle; the explanatory variables included gender (or race/ethnicity), age at the beginning of the cycle, and health statuses at the beginning and end of the cycle. Spending for the 1992 panel was estimated using the 1992–1995 records, whereas spending for the 2002 panel was estimated using the 2002–2005 records. In addition to the adjustment for medical price inflation that was mentioned earlier, these separate regressions took into account the differential pattern of spending on older Americans that is conditional on one's health status, including any differences in the volume and intensity of care.

Cumulative spending for an individual age t in panel i was calculated as the sum of annual spending over his or her simulated life course from current age t to death. For example, if a disabled 73-year-old man in the 1992 panel is simulated to remain disabled between age 73 and 74, then annual spending corresponding to this pair of health states between age 73 and 74, say \$7,485, is added to his cumulative spending. If he then recovers to nondisabled state between age 74 and 75, with an associated spending of \$26,470, then his cumulative spending is now \$33,955 (i.e., the sum of \$7,485 and \$26,470). This process of adding up spending associated with the simulated health trajectory continues until the simulated person dies. This approach is identical to the method developed in an earlier study (Lubitz et al. 2003).

Discounted Cost of an Additional DFLE

The discounted cost of an additional disability-free life year was calculated as the ratio of changes in discounted cumulative spending between the two panels in 1992 and 2002 to corresponding changes in discounted average DFLE, multiplied by a scaling factor (e.g., 25, 50, and 75 percent) that reflects the contribution of increased spending to gains in DFLE. Cutler, Rosen, and Vijan (2006)

assumed that increased spending contributed about 50 percent of the gains in LE; however, there is no similar estimate available to help quantify the effect of increased spending on DFLE. Trends in DFLE reflect the complex interaction over time among trends in disability incidence, recovery, and mortality. There was evidence that improved medical care helped avoid the incidence of disability or reduce its severity over time (Schoeni, Freedman, and Martin 2008), but the impact on recovery was less clear due to various data and analytical limitations. Without a better and more informed alternative, this study assumed the same range of possible values (25, 50, and 75 percent) as in Cutler, Rosen, and Vijan (2006) to facilitate the evaluation of results.

Discounting of both spending and life year was performed at the individual level during simulation. A single common discount rate of 3 percent was applied. Using equal discount rates is consistent with the argument that health is valued equally across cohorts of elderly (Keeler and Cretin 1983).

Sampling Variability

The SPACE program estimates survey design-adjusted variance using a modified bootstrap method (Rao and Wu 1988). Not correcting for survey design typically underestimates the sampling variability and thus overestimates the statistical significance of differences. For this analysis I drew 2,000 bootstrap samples for the analysis by gender and 3,350 samples for the analysis by racial/ethnic groups, and performed the above statistical analysis and computation for each of them. The standard deviations of these estimates were found to have stabilized at these numbers of bootstrap samples, and they were thus used as the standard error of the corresponding point estimate from the original full analytic sample. Group differences were tested using a two-sample *t*-test with a significance level of 5 percent.

RESULTS

Table 1 shows that the majority of the sampled persons included in this analysis are women and white non-Hispanic. The average age was about 75 years for both panels. In 1992, 55 percent of older Americans had no IADL or ADL limitations; in 2002, this figure increased to 59.6 percent. Age-specific spending in nominal dollars increased substantially between 1992 and 2002; the growth was faster for younger age groups (93.5 percent for ages 65–74 vs. 41.4 percent for ages 85+).

Table 1: Characteristics of Sampled Persons at Baseline in the 1992 and 2002 Panels

	1992	2002
Sample size	8,546	3,142
	Weighted	
Age (in years)	74.9	74.4
Gender		
Male	39.3	41.5
Female	60.7	58.5
Race/ethnicity		
White non-Hispanic	86.2	82.3
Black non-Hispanic	7.4	6.7
Hispanic	4.7	6.8
Others	1.7	4.3
Functional limitation		
No IADL or ADL limitation	55.4	59.6
1 + IADL limitations only, no ADL limitations	13.6	13.2
1 + ADL limitations	31.0	27.2
Per capita spending (in current dollar)		
Age 65–74	4,925	9,531
75–84	7,274	13,204
85+	13,902	19,663

ADL, activity of daily living ;IADL, instrumental activity of daily living.

Source: The 1992 and 2002 panels of the Medicare Current Beneficiary Survey.

For all older Americans age 65 and over, the average LE increased 0.7 years from 11.9 years in 1992 to 12.6 years in 2002, whereas average DFLE increased significantly by 1.3 years from 5.2 years to 6.5 years (Table 2). This pattern holds for all gender and racial/ethnic groups. However, there are small differences within gender and racial/ethnic groups. Gains in DFLE were larger for men than for women (1.4 years vs. 1.1 years), and for blacks and Hispanics than for whites (1.7 and 1.9 years vs. 1.2 years).

Corresponding to the patterns of changes in LE and DFLE, Table 2 shows that the average spending rose significantly by \$38,000 from \$165,000 for the 1992 panel to \$203,000 for the 2002 panel. Average spending across all subgroups showed significant increases. Within gender and racial/ethnic groups, growth in spending was larger for women than for men (\$44,000 vs. \$31,000), and larger for blacks and Hispanics than for whites (\$68,000 and \$75,000 vs. \$37,000).

Table 3 presents changes in discounted average spending for the 1992 and 2002 panels by types of service. For all older Americans, changes in total

Table 2: Average Health Expectancy and Per Capita Cumulative Spending (in 2006 dollars) for Medicare Beneficiaries of Age 65 and Older in the 1992 and 2002 Panels

	<i>Health Expectancy (Undiscounted)</i>				<i>Average Per Capita Cumulative Spending (in 000s, Undiscounted)</i>			
	<i>1992</i>		<i>2002</i>		<i>1992</i>		<i>2002</i>	
	<i>Est.</i>	<i>SE</i>	<i>Est.</i>	<i>SE</i>	<i>Est.</i>	<i>SE</i>	<i>Est.</i>	<i>SE</i>
All								
TLE	11.9	0.2	12.6	0.3	\$164.7	\$4.7	\$203.1	\$7.0
DFLE	5.2	0.1	6.5	0.2				
Men								
TLE	11.3	0.3	11.9	0.4	\$162.0	\$7.8	\$192.9	\$11.5
DFLE	6.1	0.2	7.5	0.3				
Women								
TLE	12.3	0.2	13.1	0.4	\$166.4	\$5.6	\$210.7	\$8.5
DFLE	4.7	0.1	5.8	0.3				
Non-Hispanic white								
TLE	11.9	0.2	12.6	0.2	\$163.4	\$4.1	\$200.5	\$5.4
DFLE	5.3	0.1	6.5	0.2				
Non-Hispanic black								
TLE	11.4	0.8	12.3	1.1	\$153.9	\$17.4	\$221.8	\$20.8
DFLE	4.3	0.3	6.0	0.6				
Hispanic								
TLE	13.0	1.0	14.5	0.9	\$181.8	\$16.9	\$256.5	\$39.8
DFLE	5.1	0.5	7.1	0.5				

Note. Health expectancy refers to life expectancy and DFLE. DFLE is defined as expected years spent without having any difficulty or inability to perform at least one instrumental activity of daily living (IADL) or activity of daily living (ADL).

Source. Author's calculation from the 1992 and 2002 panels of Medicare beneficiaries in MCBS.

spending and spending on all three categories of service were statistically significant. Average discounted spending on other services (mostly prescription drugs) was expected to grow significantly by 66 percent from \$24,000 for the 1992 panel to \$39,000 for the 2002 panel. Cumulative spending on acute care would grow by 25.4 percent from \$67,700 for the 1992 panel to \$84,900 for the 2002 panel, whereas spending on long-term care was expected to decrease from \$23,400 for the 1992 panel to \$20,500 for the 2002 panel, reflecting the increase in DFLE for average elderly. This pattern generally holds for all gender and racial/ethnic subgroups, except that the elderly blacks in the 2002 panel would expect to incur 25 percent more in long-term care spending than the 1992 panel.

Table 3: Changes in Discounted Average Spending on Medicare Beneficiaries of Age 65 and Older in the 1992 and 2002 Panels (in 000s), by Types of Service (in 2006 dollars)

	1992						2002					
	Total		Acute		Long-Term		Others		Total		Acute	
	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE	Est.	SE
All	\$114.9	3.0	\$67.7	1.7	\$23.4	1.3	\$23.8	0.6	\$144.8	4.6	\$84.9	2.6
Men	\$112.1	5.1	\$71.2	3.2	\$18.5	1.6	\$22.5	1.0	\$137.7	7.6	\$86.5	4.5
Women	\$116.7	3.7	\$65.5	1.9	\$26.6	1.5	\$24.6	0.7	\$150.0	5.7	\$84.0	3.2
Non-Hispanic white	\$114.0	2.8	\$66.2	1.8	\$23.7	0.9	\$24.1	0.5	\$142.9	3.5	\$82.6	1.9
Non-Hispanic black	\$108.7	11.6	\$65.8	7.5	\$19.9	2.6	\$23.0	2.5	\$158.4	13.6	\$89.9	7.1
Hispanic	\$125.5	11.1	\$82.9	8.0	\$20.5	3.8	\$22.0	2.3	\$179.0	26.1	\$115.9	13.2

Note. Discounting calculates the present values of annual spending associated with each additional year of life. Discount rate is 3% for both life year and spending.

Source: Author's calculation from the 1992–2005 Medicare Current Beneficiary Survey.

Table 4: Discounted Cost of an Additional DFLE and LE for Medicare Beneficiaries of Age 65 and Older in 1992 and 2002 (in 000s)

	<i>Assumed Contribution of Increase Spending to Improvement in DFLE</i>					
	25%		50%		75%	
	<i>Est.</i>	<i>SE</i>	<i>Est.</i>	<i>SE</i>	<i>Est.</i>	<i>SE</i>
DFLE						
All	\$141.3	\$33.1	\$70.7	\$16.6	\$47.1	\$11.0
Men	\$93.1	\$46.2	\$46.5	\$23.1	\$31.0	\$15.4
Women	\$148.0	\$60.1	\$74.0	\$30.0	\$49.3	\$20.0
Non-Hispanic white	\$128.4	\$25.7	\$64.2	\$12.8	\$42.8	\$8.6
Non-Hispanic black	\$142.0	\$141.0	\$71.0	\$70.5	\$47.3	\$47.0
Hispanic	\$142.7	\$79.2	\$71.3	\$39.6	\$47.6	\$26.4
LE						
All	\$252.6	\$133.2	\$126.3	\$66.6	\$84.2	\$44.4
Men	\$243.1	\$154.2	\$121.5	\$77.1	\$81.0	\$51.4
Women	\$258.9	\$159.2	\$129.5	\$79.6	\$86.3	\$53.1
Non-Hispanic white	\$277.9	\$155.0	\$139.0	\$77.5	\$92.6	\$51.7
Non-Hispanic black	\$307.6	\$231.3	\$153.8	\$115.6	\$102.5	\$77.1
Hispanic	\$226.0	\$189.2	\$113.0	\$94.6	\$75.3	\$63.1

Note. The discounted cost is calculated by dividing changes in discounted real average spending (in 2006 dollars) on older Americans ages 65 and over between the 1992 panel and the 2002 panel by changes in discounted DFLE or LE between the two panels. DFLE is defined as the expected years spent without having any difficulty or inability to perform at least one instrumental activity of daily living (IADL) or activity of daily living (ADL). Discounting calculates the present value of each additional life year and associated health spending. Discount rate is 3% for both life year and spending.

Source. Author's calculation from the 1992 and 2002 panels of Medicare beneficiaries in MCBS.

Assuming that half of the gains in DFLE between the 1992 and 2002 panels of older Americans were attributable to increased spending, the discounted cost of an additional year of DFLE was \$70,700, whereas the discounted cost of an additional life year was \$126,300 (Table 4). If only 25 percent of the increases in DFLE were attributable to increased spending, then the discounted cost would be \$141,300 for DFLE and \$252,600 for LE; if the contribution was 75 percent, then the discounted cost would be only \$47,100 and \$84,200, respectively.

In all cases, the cost for an additional life year is substantially higher than the cost for an extra year free of disability. However, they are lower than what the other studies would suggest (Cutler, Rosen, and Vijan 2006; Garber and Skinner 2008). Among the many differences in analytic samples and methods, one notable difference is Cutler and colleagues only examined the trends for

65-year olds, whereas this study examined trends for all elderly ages 65 and older. Table 1 indicates that per capita spending for younger elderly (65–74) grew much faster between 1992 and 2002 than for the oldest old (85 and older). But the gains in DFLE relative to LE are greater in percentage terms for 85-year olds than for those 65-year olds (Cai and Lubitz 2007). This differential growth in per capita spending and DFLE (relative to LE) is likely a major source of the different results.

Under the assumption of 50 percent contribution, the discounted cost of an additional disability-free life year was less than \$75,000 for all gender and racial/ethnic groups, and the gender and racial/ethnic differences were relatively small. Even under the assumption that only 25 percent of the gains in DFLE were attributable to increases in health spending during this period, none of the discounted costs exceeded \$150,000, and the gender and racial/ethnic differences were moderate.

DISCUSSION

This study extended previous analyses of health care cost of an extra life year for older Americans by taking into account the trends in quality of life as well. Results comparing two nationally representative panels of older Americans in 1992 and 2002 indicated that the discounted cost of an extra disability-free life year was between \$47,000 and \$141,000, assuming that 25–75 percent of the gains in DFLE were attributable to increases in health spending. These estimates are substantially below previous estimates of costs based on trends in mortality alone (Cutler, Rosen, and Vijan 2006; Garber and Skinner 2008).

Many analysts consider high cost per extra life year as evidence that rapid spending growth in the United States has not “bought” commensurate gains in health. The results of this analysis suggest that we may have rushed to conclusion without examining all relevant evidence. The finding that older Americans gained more in DFLE than in LE implies that they did benefit greatly from advances in medical care, which is funded by both public and private sources. Advances in medical care have greatly improved survival for cancer patients (Preston and Ho 2009; Philipson et al. 2012) and reduced the fatal and debilitating consequence of cardiovascular diseases (Cutler 2001; Freedman et al. 2007). These advances have enabled millions of older Americans to regain or maintain an independent life style that they desire at a reasonable cost. If the recently passed Affordable Care Act can successfully reduce, or even eliminate, the substantial waste and inefficiency in the current

health care system (Berwick and Hackbarth 2012), and reverse the financial incentive in the third-party payment mechanism that encourages overutilization without paying close attention to quality of care, the cost of improving both quality and quantity of life for older Americans can be further reduced.

On the other hand, the results of this study should not be interpreted as support for the view that continued growth of health care spending at historical pace is desirable. If per capita Medicare spending continues to grow 2.4 percentage points faster than GDP as in 1975–2008, Medicare spending alone would be roughly 20 percent of GDP by 2082 (Chernew, Hirth, and Cutler 2009), more than the share for total national health care spending today. It is difficult to argue that the society as a whole will be willing to finance continued rapid growth of health spending on the elderly at the expense of other legitimate needs, including the medical spending on the younger population. The willingness to pay may be further reduced if future improvement in old-age mortality also becomes much more expensive than what we have experienced previously (Olshansky, Carnes, and Desesquelles 2001).

The encouraging results of this study were driven primarily by the favorable trends in old-age disability relative to mortality during the study period. The increase in DFLE was found concentrated in life years free of severe ADL disability due largely to its delayed onset (Cai and Lubitz 2007). The timing of such decline was attributed to advances in medical and pharmacologic treatment of chronic conditions, such as cardiovascular diseases, the development and adoption of specialized procedures, such as knee and joint replacement, and changes in socioeconomic status and reduction in poverty (Cutler 2001; Schoeni, Freedman, and Martin 2008).

However, it remains unclear whether these trends will continue in the future. Recent studies noted that the downward trend in the prevalence of old-age disability may have stalled (Fuller-Thomson et al. 2009; Seeman et al. 2010; Crimmins and Beltrán-Sánchez 2011). The rising prevalence of obesity among youths and children has exposed them to the possibility of hypertension and diabetes over a much larger portion of life than previous generations. As a result, the hypothesis of “compression of morbidity” may remain an unattainable dream as the debilitating consequences becomes more difficult to reverse (Crimmins and Beltrán-Sánchez 2011), and the medical cost for future elderly may rise sharply (Cai et al. 2010b; Reither, Olshansky, and Yang 2011).

This analysis provided only half the answer to the value-of-spending question by focusing on the cost side; the other half is the perceived benefit of an extra disability-free life year. Some have estimated the benefit of a quality-

adjusted life year (e.g., Ubel et al. 2003; Braithwaite et al. 2008) for the general population, which centers around \$200,000. But little is known about the benefit of a disability-free life year specific to the elderly population. Although one can make certain assumptions as in Garber and Phelps (1997), a separate and extensive analysis of the benefit side of the equation is needed before one can answer the value-of-spending question in a careful manner.

Although the results for average older Americans are favorable, it is clear that minority elderly remained at considerable disadvantage relative to non-Hispanic whites. Results in Exhibit 2 suggest that the racial/ethnic gap in cumulative spending grew larger over time relative to their differences in LE. This resulted in elderly blacks and Hispanics spending on average about 13.2 and 11.3 percent more than elderly whites per life year in 2002. Holding everything else constant and using the population projection for 2010–2050 from the Census Bureau, annual spending on all older Americans would be reduced by \$24.6 billion in 2025 and \$52.4 billion in 2050—a substantial saving of health care cost, if differences in spending between minority elderly and the whites were eliminated.

This study has a number of limitations. First, given how little we know about the exact impact of increased spending on improving DFLE, the conclusions of this study are derived under certain assumptions about the scaling factors, which are difficult, if not impossible, to estimate empirically. On one hand, while improved diagnosis and medical care of chronic conditions contributed to the decline of disability, nonhealth factors (e.g., modification of environment, changes in personal behavior, and general technology advances) may have also played a significant role (Ford et al. 2007). On the other hand, a large proportion of health spending may have contributed little to health improvement, as the extensive literature on regional variation in Medicare spending has suggested (Fisher et al. 2003a,b). Furthermore, the contribution of medical spending to mortality reduction and improvement in population health could vary over time as technology and the pattern of health service utilization evolve. With lack of a better alternative, this study used the same range of factors as in Cutler, Rosen, and Vijan (2006), but a separate and extensive analysis is needed to help derive more informed estimates.

Second, this study measured progress in population health in terms of trends in limitations in IADL and ADL only. Although results are similar if alternative measure of DFLE (e.g., based on only ADL limitations) were used (not reported here), it is important to note that functional limitations do not reflect the full burden of morbidity in old age. Other measures of health (e.g., mental health) are important as well, and health quality should preferably be

measured in continuum rather than as a binary variable. The development of a more refined and comprehensive measure of population health will likely improve the assessment of the health-adjusted value of spending.

Third, an important assumption that underlies the period life table approach is that the modeled population is stationary and follows a set of transition probability that does not change over time. In other words, the transition probabilities facing a current 65-year-old in 20 years is the same as those facing a current 85-year-old. This assumption implies that the projected health trajectory does not necessarily represent the real life experience of an elderly person as the cohort life table would. In situations where old-age mortality continues to fall, period life table will understate the true gains in LE; in situations where old-age mortality reduction is stalled or even reversed (e.g., Olshansky et al. 2005; Reither, Olshansky, and Yang 2011), period life table will overestimate. The impact on DFLE and changes in DFLE remain less clear, however, because they depend on future trends in disability incidence and recovery, which may or may not coincide with the trend in mortality (Crimmins, Saito, and Ingegneri 1997; Cai and Lubitz 2007).

Similarly, the potential impact on cumulative spending estimates remains unclear as well. If one assumes that per capita spending continues to grow unabated for all age groups, then cumulative spending will likely be underestimated, and probably more so for the 2002 panel, if holding everything else constant. But it is likely that everything will not be constant. Per capita spending growth may continue to vary by age, as they have in the past (Chernew et al. 2005). Longer life is not necessarily associated with higher cumulative spending (Lubitz et al. 2003). Other institutional changes in the US health care system may change the pattern of spending in such a way that shifts the financial risk away from the Medicare program. For example, if private employers are willing to invest in the obesity prevention program, as many of them do, future burden on Medicare may be greatly reduced (Finkelstein et al. 2008). These numerous factors may interact with and offset each other, making it difficult to evaluate the presence and the magnitude of potential bias in cumulative spending as a result of using the period life table approach.

CONCLUSION

This study contributes to the ongoing debate on the value of health spending in the United States by expanding the discussion to include trends in health

quality of life. Although spending on older Americans grew rapidly in recent decades, it helped enable millions of Medicare beneficiaries to regain or maintain an independent life style that they desire at a reasonable cost. This fact is important for policy makers who are looking for ways to reform the Medicare program to buy more value with its resources.

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