

## SPECIAL ARTICLE

## LONGEVITY AND MEDICARE EXPENDITURES

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**Abstract Background.** In the United States, the elderly account for over one third of health care spending. The total population over the age of 65 is projected to increase, as is life expectancy beyond the age of 65. We studied current patterns of Medicare expenses according to age at death and the possible effect of future demographic changes on Medicare spending.

**Methods.** We used data from the Medicare program to estimate lifetime Medicare expenses for a sample of 129,166 beneficiaries, 65 or older, who died in 1989 and 1990, according to age at death. Spending for nursing home care not covered by Medicare was excluded. (Nursing home costs represent about 20 percent of total health care spending for the elderly and increase with age.) Through simulation, we assessed the lifetime payments by Medicare for enrollees who turned 65 in 1990 and those who will do so in 2020.

**Results.** Estimated lifetime Medicare payments (in 1990 dollars) ranged from \$13,044 for persons who died at 65 years of age, to \$56,094 for those who died at 80, to \$65,633 for those who died at 101 or older. The pay-

ments associated with an additional year of life and the average annual payments over an enrollee's lifetime both decreased as the age at death increased. The estimated 7.9 percent increase in life expectancy beyond 65 years that will have taken place between 1990 and 2020 (19.1 years past the age of 65 in 2020, as compared with 17.7 years in 1990) was associated with an estimated increase of 2.0 percent in lifetime Medicare payments. Of the estimated \$98 billion increase in total lifetime payments (in 1990 dollars) from the 1990 group to the 2020 group, 74.3 percent was due to the larger size of the original birth cohort who will reach the age of 65 in 2020, 22.5 percent to an increase in the proportion of that birth cohort projected to survive to 65 years of age, and 3.2 percent to improved life expectancy beyond 65.

**Conclusions.** The effect on Medicare spending of increased longevity beyond the age of 65 may not be great. Total Medicare payments will be more substantially affected by the expected increase in the absolute number of elderly people. (N Engl J Med 1995;332:999-1003.)

**I**N the United States, the elderly account for over one third of health care spending. Almost two thirds of their health care is paid for by Medicare — the largest single source of health spending in the United States — and Medicaid,<sup>1</sup> and a considerable proportion of these costs is incurred in the last year of life.<sup>2</sup> The proportion of the population over the age of 65 is expected to increase into the next century, heightening concern about health care spending.<sup>3</sup> Life expectancy beyond the age of 65 is also expected to rise, although there is considerable debate over the size of the increase. Estimates of the upper limit of average human life expectancy range from 85 to 100 years.<sup>4-6</sup>

To quantify the cost of increased longevity, we used Medicare data to compare the payments made for people who died at advanced ages with those made for people who died younger. A previous study calculating lifetime Medicare payments according to age at death was limited to enrollees who died between the ages of 65 and 80 years.<sup>7</sup>

We estimated total lifetime Medicare expenditures according to the age at death for program enrollees who died at each age from 65 through 100, and made a single estimate for those who died at 101 or older. We also used simulation techniques to estimate the effect

of future demographic changes, including increased longevity, on Medicare payments. We used a longitudinal file on a sample of enrollees that began with data from 1974 and regularly updates information on enrollees' Medicare expenditures.

## METHODS

## Source of Data

The Continuous Medicare History Sample is a file containing longitudinal information on a 5 percent random sample of Medicare beneficiaries. The information in the file comes from Medicare administrative data — claims submitted by physicians, hospitals, and other providers and enrollment records. New beneficiaries are periodically added to the sample, and the records of beneficiaries who die are retained in the file. The data are limited to payments for services covered by Medicare: hospital inpatient services, skilled nursing services provided after hospitalization in a qualified facility, home health services, the services of physicians and other medical providers, outpatient services, and — since October 1983 — hospice care. Important costs not covered by Medicare are those for care in nursing homes that does not qualify as skilled nursing care and charges for medications provided outside the hospital. Spending on nursing home care accounts for about 20 percent of total health care spending for the elderly in the United States,<sup>1</sup> but in 1990 Medicare paid for only 4.5 percent of such care.<sup>8</sup> Thus, our results reflect payments made predominantly for acute medical care.

## Study Sample

The study sample consisted, with certain exceptions, of all persons in the Continuous Medicare History Sample who were 65 years of age or older and who died in 1989 or 1990. Any person who had ever been enrolled in a health maintenance organization under Medicare was excluded because Medicare does not receive complete data on the services provided to such people. Also excluded were persons not continuously covered from the age of 65 by both Medicare Part A (hospital insurance) and Part B (optional supplementary medical in-

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surance), persons with end-stage renal disease on their enrollment record, and disabled beneficiaries under 65 years of age. The sample was made up of 129,166 persons (Table 1).

### Estimating Lifetime Payments

Our goal was to analyze lifetime payments according to an enrollee's age at death. Because the Continuous Medicare History Sample was begun with 1974 data, complete data on yearly payments from the age of 65 until the time of death — for persons who died in 1989 or 1990 — were available only for those who had died between the ages of 65 and 81. For persons who died in 1990 at 82 or older, the sample contained data only on their final 17 years of life — the years since 1974; Medicare payments for those persons in earlier years, before 1974, had to be estimated. Thus, payments had to be estimated for the 18th year before death for those who died at 82 years of age, for the 18th and 19th years before death for those who died at the age of 83, and so on. This is illustrated in Figure 1, which shows lifetime payment patterns for persons who died at 75, 85, and 95 years of age.

An earlier study<sup>7</sup> as well as our own data shows that Medicare payments are heavily concentrated in the years just before death. About two thirds of all payments for beneficiaries who die at 80 years of age are made for care in the last five years of life. Since we had records of the actual Medicare payments made in up to the last 17 years of life, our data included the typically highest-cost years of a beneficiary's lifetime (Fig. 1). We needed to estimate payments only for the relatively low-cost years long before death. Our calculations of total lifetime payments therefore do not depend greatly on the particular estimation techniques we used.

To develop regression models predicting Medicare payments made before the 17th year preceding death, we used our data on the actual payments made in the final 17 years of life. The models were based on data from the subgroup of persons in our sample who died at 83 or older and for whom we thus had information on the last 17 years of life. This subgroup was divided into cohorts according to their age at death. There were a total of 19 cohorts — 1 for each year of age at death between 83 and 100, and 1 for those who died at 101 or older. Payments made in the last two years of life were excluded because, on average, they are very high and their inclusion would have made estimation of the model difficult. As an illustration of the method, the 15 years of data used in the models for the cohort of persons who died at 83 years of age would include the average annual payments made from the age of 67 to the age of 81. There were a total of 285 observations (15 years × 19 cohorts). The dependent variable in the models was the average payment for a particular cohort in a particular year before death. The independent variables were the age at which payments were incurred, the age at death, and the product of the first two variables. We developed three separate models, one for all persons in the study sample and one each for men and women. In the model for all persons, the equation was as follows:

$$100,000 \div \text{average annual payments} = 300.84 - (6.34 \times \text{age at which payments were incurred}) - (0.321 \times \text{age at death}) + (1.0391 \times \text{age at which payments were incurred} \times \text{age at death}).$$

The value of  $R^2$  for this model was 0.96. The equations for men and women are not presented here but are available from the authors.

Actual and estimated payments for each cohort were summed to produce estimates of total lifetime Medicare payments. We then fit-

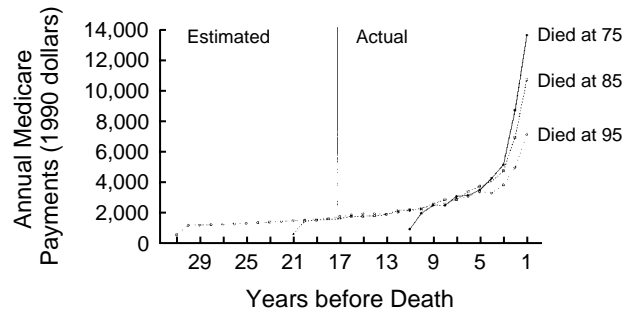


Figure 1. Annual Medicare Payments for Persons in the Study Sample Who Died at 75, 85, and 95 Years of Age.

Annual payments are shown for each of up to 31 years preceding death. These enrollees died in 1989 or 1990 at 65 years of age or older.

ted a curve to lifetime payments expressed as a function of the age at death. The equation for the curve used in the model for all persons was as follows:

$$\text{lifetime payments} = \$66,522 \times (1 - e^{-0.109(x+1.50)}),$$

where  $x$  = total years of coverage by Medicare before death and  $e = 2.718$ . The value of  $R^2$  was 0.99. The equations for men and women are available from the authors.

In our estimates of lifetime Medicare payments for persons who died at the age of 90 or older in 1990, we assumed that these persons would have been covered by Medicare since the age of 65. In fact, because the Medicare program began in July 1966, these people did not have Medicare coverage until some years after they became 65. We made this assumption in order to be able to compare the estimated lifetime payments of this group with those of younger persons who had been fully covered from 65 years of age. In the future, the proportion of the elderly who turned 65 before Medicare began will, of course, diminish.

### Adjustment for Inflation

We converted payments to 1990 dollars by using the rate at which per capita Medicare payments (both Part A and Part B) for all elderly beneficiaries changed from 1974 — the first year of the Continuous Medicare History Sample — to 1990. This approach adjusts both for price inflation and for changes in the volume and pattern of services covered by Medicare. Because Medicare payments have increased at a faster rate than prices alone, taking into account price inflation alone would have resulted in a large underadjustment.

### Simulations

In order to explore the effect of changes in longevity on Medicare payments, we used the mortality and population projections of the Office of the Actuary of the Social Security Administration to compute the lifetime payments for the cohort of people born in 1925, who became 65 years old in 1990, and the baby-boom birth cohort of 1955, who will turn 65 in 2020. These same projections were used in the 1993 Annual Report of the Social Security Administration's Board of Trustees.<sup>9</sup> We used Alternative II from this report, the middle mortality projection, for both cohorts. Average lifetime payments for the two cohorts were computed by multiplying, for each year of age from 65 on, our previous estimates of lifetime payments according to age at death and sex by the proportion of the elderly population projected to die at that age. For each cohort, the resulting products for each age were summed to calculate the projected average lifetime payments. All payments were expressed in 1990 dollars.

We also allocated the difference in total Medicare expenditures between the cohorts to three factors: the larger size of the 1955 birth cohort, the larger proportion of that cohort expected to survive to 65 years of age, and the greater projected longevity of that group beyond 65 years, using a method described by Peden and Lee.<sup>10</sup>

Our purpose in the simulations was to explore the effect of demo-

Table 1. Age at Death and Sex of Persons in the Study Sample.

CHARACTERISTIC	NO. OF PERSONS
Age at death (yr)	
65-74	38,126
75-84	49,427
85-94	35,211
≥95	6,402
Sex	
Male	59,508
Female	69,658
Total	129,166

graphic changes on Medicare expenditures, not to predict what Medicare expenditures will be in the next century. We selected the 1925 and 1955 birth cohorts to illustrate the effect of these demographic changes. We did not attempt to predict the effects on Medicare spending of future inflation, medical advances, program changes, and other factors.

## RESULTS

### Lifetime Payments

Estimated lifetime payments ranged from \$13,044 for persons who died at 65 years of age, after an average of half a year of Medicare coverage, to \$56,094 for enrollees who died at 80, to \$65,633 for those who died at 101 or older (Fig. 2). The increase in lifetime Medicare payments associated with an additional year of life decreased as the age at death rose. For example, persons who died at 70 incurred an average of \$3,571 more in payments over their lifetimes than people who died at 69. Persons who died at 80 had \$1,201 more in lifetime expenditures than those who died at 79, and those who died at 90 incurred only \$404 more in lifetime expenditures than those who died at 89. Thus, average annual Medicare payments were considerably lower for persons who died at an advanced age. For example, the average yearly payments for persons who died at 70 were \$6,457 (\$35,511 divided by 5.5 years of Medicare coverage) and the average for persons who died at 90 was \$2,471 (\$63,015 divided by 25.5 years).

Two factors help explain why the additional amount of lifetime payments associated with each additional year of life decreases with age. First, the costs of medical treatment near death decrease with increasing age at death, a pattern seen in earlier studies.<sup>2,7</sup> In our study, costs in the last two years of life for persons who died at 101 years of age or older (\$8,296) were 37 percent of those incurred by persons who died at 70 (\$22,590) (Fig. 3). Figure 4 shows payments made by Medicare in the last 10 years of life for persons who died at the age of 75 or older (the youngest age for which there would be at least 10 complete years of Medicare payment data is 75 years). Payments made in the 3rd to 10th year preceding death decrease only slightly with advancing age, as compared with the pronounced decline seen in the level of payments made during the final two years of life.

Second, the additional years covered by Medicare for longer-lived persons are the years farthest from death. For any one enrollee, whether he or she dies at 68 or 90 years of age, Medicare will pay the costs of final illness. The additional years covered for the longer-lived person are the relatively healthy and low-cost years substantially before the end of life. The farther a year is from the time of death, the less expensive it is for Medicare, on average.<sup>7</sup>

### Simulations

With our simulations, we were able to isolate the effect of individual demographic factors on Medicare payments (Table 2). The average life expectancy of Medicare beneficiaries who became 65 years old in 1990 is 17.7 years. Applying our estimates of lifetime

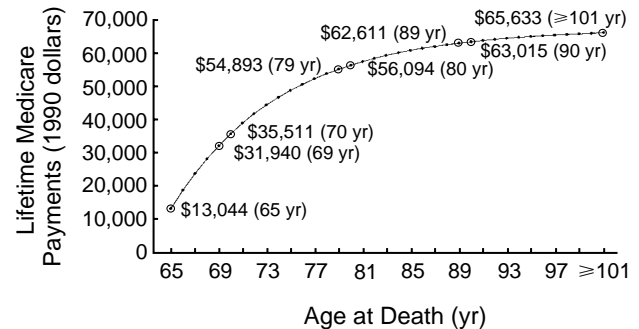


Figure 2. Estimated Lifetime Medicare Payments for Persons in the Study Sample, According to Age at Death.

These enrollees died in 1989 or 1990 at 65 years of age or older.

payments according to age at death to the projected mortality pattern of this cohort, we calculated that the average per capita lifetime payments for the group would be \$53,256, in 1990 dollars. The cohort turning 65 years old in 2020 is projected to live an average of 19.1 years past 65. We estimated this second group's average per capita lifetime payments to be \$54,326, in 1990 dollars. Thus, an average life expectancy beyond 65 years that was 7.9 percent longer resulted in an estimated increase of only 2.0 percent in average lifetime Medicare payments.

In addition to per capita payments, we calculated total lifetime payments for the cohorts. Total payments for the cohort enrolling in Medicare in 1990 were estimated at \$112 billion in 1990 dollars; total payments for the cohort enrolling in 2020 were estimated at \$210 billion. Of the \$98 billion difference in lifetime payments between the two cohorts, 74.3 percent was due to the difference in the absolute size of the original birth cohorts. The projected increase in the proportion of the birth cohort surviving to 65 years from the 1990 to the 2020 enrollment cohort accounted for 22.5 percent of the difference, and increased longevity beyond age 65 accounted for only 3.2 percent.

## DISCUSSION

The effect of increased longevity on Medicare expenditures is mitigated by two factors: the decrease

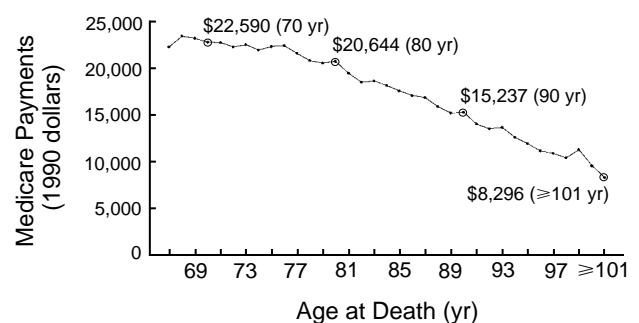


Figure 3. Medicare Payments in the Last Two Years of Life for Persons in the Study Sample, According to Age at Death.

These enrollees died in 1989 or 1990 at 65 years of age or older.

seen in payments in the years immediately before death as the age of the beneficiary increases, and the fact that the additional period of any one enrollee's life that is covered consists of relatively low-cost years before the terminal illness. Average Medicare payments per person for the third and earlier years preceding death show little relation to an enrollee's age at death, which suggests that any limitation of care related to age takes place mainly in the time near death, when severe illnesses often develop, rather than in earlier years. It may reflect a belief on the part of those who provide care that aggressive medical interventions are sometimes less appropriate for very old, frail persons. Our study, of course, was concerned with the costs of care. We did not address the issue of whether the care provided enrollees was appropriate or adequate. Changes in the attitudes and practices of health care providers could very well alter the level and pattern of Medicare payments.

The relatively moderate effect on Medicare expenditures of longevity beyond 65 years of age was demonstrated in our simulations of lifetime Medicare payments for two cohorts: persons who became 65 years old (and thus enrolled in Medicare) in 1990, and those who will turn 65 in 2020. Most of the additional lifetime payments for the 2020 enrollment cohort were the result of the greater number of projected beneficiaries in that group. This, in turn, was due mostly to the greater number of births that took place in 1955 — a baby-boom year — and, to a lesser extent, to that birth cohort's higher rate of survival to the age of 65. Very little of the additional payments for the later-born cohort resulted from the increased longevity beyond the age of 65 projected for that group.

Projections of the effect of an aging population on health care costs have often not been adjusted for the effects of increased longevity on health care spending.<sup>11,12</sup> A few studies, however, have found that increased longevity lowers the cost of health care provid-

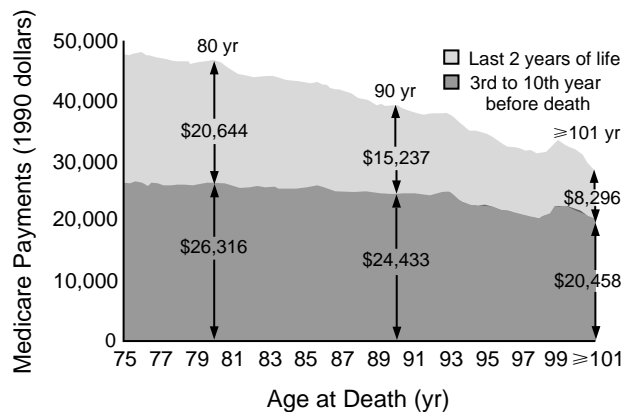


Figure 4. Medicare Payments in the Last 10 Years of Life for Persons in the Study Sample, According to Age at Death and Length of Time before Death.

These enrollees died in 1989 or 1990 at 65 years of age or older.

Table 2. Characteristics of the 1990 and 2020 Medicare Enrollment Cohorts Used in the Simulations.\*

MEASURE	1990	2020	INCREASE (%)
Size of birth cohort (millions)†	3.05	4.81	57.7
Percentage of birth cohort surviving to age 65†	69.2	80.3	16.0
No. of Medicare beneficiaries (millions)†	2.11	3.87	83.4
Life expectancy at age 65 (yr)†	17.7	19.1	7.9
Average lifetime Medicare payment per enrollee (1990 dollars)	53,256	54,326	2.0
Total lifetime Medicare payments for enrollment cohort (billions of 1990 dollars)	112	210	87.5

\*The 1990 cohort consists of all persons who became 65 years old in 1990, and the 2020 cohort those who will become 65 years old in 2020.

†Data are from the Office of the Actuary, Social Security Administration.

ed to the younger elderly, because a smaller proportion of that group incurs the high expenses characteristic of the years just before death.<sup>13,14</sup> These studies support our conclusion that the effect of increased longevity on Medicare expenditures may be moderate.

Improved survival from birth to 65 years of age obviously increases Medicare expenditures. But, if we imagine a situation in which the number of people turning 65 remains constant and in which, as suggested elsewhere,<sup>4,6,15,16</sup> the great majority of deaths occur after the age of 65, then the effect on the Medicare budget of additional longevity beyond 65 years of age should not be great. In our simulations, we assumed that the patterns of medical costs according to the age at death would not change. In particular, we assumed that increased longevity for the elderly is not the result of expensive medical interventions. This assumption is debatable, but some believe that it is possible to compress morbidity — to shorten the time an elderly patient must suffer chronic infirmity before death — through the use of relatively inexpensive preventive measures.<sup>4</sup> We also assumed in the simulations that any future changes in the patterns of disease and causes of death among the elderly will not affect the present distribution of Medicare costs in relation to the age at death.

An important limitation of our study is the exclusion of most nursing home costs from our data. Lifetime nursing home use increases according to the age at death — only 17 percent of those who died between the ages of 65 and 74 years had lived in a nursing home at some time in their lives, but 60 percent of those who died between the ages of 85 and 94 had done so, according to a 1991 study.<sup>17</sup> Therefore, the amount of total payments for health care added by each additional year of life may not decrease if all nursing home costs are considered. It is important to emphasize that our findings apply to payments made by Medicare for acute medical services, not to all costs of health care. Research ought to be done with data bases containing information on all medical expenses, regardless of the payment source, in order to examine the pattern of total costs. It is also important to keep in mind that our simulations are not projections of what actual

Medicare costs will be, but simply an analysis of what future changes in costs may be, if historical payment patterns and current demographic trends continue. Although we examined the effect of likely demographic changes on payments, we did not project the effects of inflation, technical changes, or other factors on Medicare spending.

In conclusion, our findings indicate that demographic changes in the population of Medicare enrollees should affect the program's expenditures principally through the increased number of elderly persons, not through increased longevity among the elderly. If the population of the United States were to reach a level of little or no growth, in which most people survived to 65 years of age, our findings suggest that further improvements in longevity beyond the age of 65 would have only a moderate effect on Medicare expenditures.

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