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THE MEDICAL COSTS OF THE YOUNG AND OLD: A FORTY YEAR PERSPECTIVE

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ABSTRACT

In this paper, we examine the growth in medical care spending by age over the past 40 years. We show that between 1953 and 1987, medical spending increased disproportionately for infants, those under 1 year, and the elderly, those 65 and older. Annual spending growth for infants was 9.8 percent and growth for the elderly was 8.0 percent compared to 4.7 percent for people aged 1-64. Within the infant and the elderly population, excess spending growth was largely driven by more rapid growth of spending at the top of the medical spending distribution. Aggregate changes in outcomes for infants and the elderly are consistent with these changes in spending growth, but we do not present any causal evidence on this point.

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It is widely known that medical costs have increased over time. In the United States, as in most of the developed world, medical spending growth has exceeded income growth by several percentage points per year for three decades or longer (Levit et.al., 1994). In country after country, the cost of medical care has become a major public sector issue.

But much less is known about what medical spending is buying us. Is medical spending valuable or wasteful? Should we want to limit total spending or increase it? The answer to this question is by no means clear. On the one hand is voluminous evidence that medical spending conveys great value. Randomized clinical trials, for example, routinely document the benefits of new pharmaceuticals and medical devices. And we would venture to guess that most people would prefer today's medical system to the medical system of 30 years ago, even given the much higher cost of medical care today. This suggests that people are on net better off because of the additional medical care spending than they would be without it.

On the other hand is a great sense that medical care often brings little in the way of health benefit. Nearly one-third of Medicare spending occurs in the last 6 months of life (Lubitz and Riley, 1993), which has been interpreted as evidence that a lot of medical care is wasted on those who would otherwise not survive.[1] Other studies such as the Rand Health Insurance Experiment (Newhouse et al., 1993) show that putting people in less generous insurance policies reduces their spending on medical services but does not affect their health. And direct estimates of the value of medical care typically find that at the margin, a substantial amount of medical care has

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[1] Of course, since people who are sick are more likely to die than people who are healthy, medical care spending will naturally be skewed to those near death. Still, the magnitude of the skewness is large.

little or no health benefit (Chassin et al., 1987; Greenspan et al., 1988; Winslow et al., 1988a, 1988b; Kahn et al., 1990; Newhouse et al., 1993; Cutler, 1995; Staiger and Gaumer, 1994; McClellan and Newhouse, 1995).[2]

Our goal is to understand why medical care has become so expensive over time and what has been its value to society. We focus particularly on medical spending by age. Many of the concerns about the medical care system are associated with changes in the age distribution of medical resources and an increase in the share of resources going towards the elderly (Lubitz et. al., 1993). And the most pressing cost problem in the medical care economy is the pending insolvency of Trust Funds to provide medical care for the elderly. Further, growth in spending by age is important in forecasting medical costs as society ages (Lubitz et. al., 1995). If patterns of medical spending by age are changing over time, projections of spending based solely on the number of people of different ages will be inaccurate.

Our analysis is based on periodic surveys of national health expenditures conducted in 1953, 1963, 1970, 1977, and 1987. The surveys have large numbers of people (from 8,000 to 40,000 people per survey) and aggregate all of acute care spending.

Our analysis of age-based spending documents two conclusions. First, there has been a dramatic change in the distribution of medical spending over time. While spending on medical care has increased for all people, it has increased disproportionately for the very young (those <1 year-old) and the old (those >=65 years old). Over the 24 year period from 1963 through 1987, per person spending on infants increased by 9.8 percent per year, and per person spending on the

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[2] Cutler and Staiger (1996) review the evidence on the marginal and average value of medical spending.

elderly increased by 8.0 percent per year, compared to only 4.7 percent per year for the "middle-aged" (ages 1-64). The share of medical care spending for infants and the elderly doubled from 17 to 36 percent.

We further show that essentially all of the disproportionate growth of spending for the very young and the old is accounted for by high cost users within those groups. For infants, 89 percent of the excess spending increase over the middle-aged is accounted for by the top 10 percent of the spending distribution. For the elderly, the equivalent share is 66 percent. Thus, in understanding the concentration of medical spending by age, we need to understand the concentration of spending among high cost users.

In the second part of the paper, we consider who are the high cost users of medical care. We show that a substantial amount of high cost medical use is associated with the increasing technological capability of medicine. Among infants, high cost users are premature babies with substantial respiratory or other acute conditions. For the elderly, high cost users are generally patients with severe cardiovascular problems or cancer. For both infants and the elderly, the capacity to devote many more resources to the most pressing cases has increased over time.

In the third part of the paper, we look at how health outcomes for premature infants and the sick elderly have changed over time. We find substantial health improvements in most of the categories of high cost medical care. Infant mortality among very low birth weight infants has fallen substantially at exactly the time when the cost of these infants rose most rapidly. And mortality improvements among the elderly have been especially prominent in cardiovascular care, where spending increases have been dramatic. Our analysis is not causal; we do not have any direct link between the technologies we discuss in the second part of the paper and the

outcomes we analyze in the third part of the paper. But our results suggest such a link is plausible.

We begin in the next section with some basic facts about the distribution of medical spending over time. In the second section, we look at the age distribution of medical care utilization. The third section focuses in more detail on high cost users of medical care. The fourth section looks at trends in medical outcomes over time. The last section concludes.

I. The Basics of Medical Spending

Much of our knowledge about individual spending on medical services is based on periodic surveys of national medical expenditures that have been conducted over time. In the post-World War II period, there have been 7 such surveys: the 1953 and 1958 National Surveys of Family Medical Costs and Voluntary Health Insurance in the United States; the 1963 and 1970 Surveys of Health Services Utilization and Expenditures; the 1977 and 1980 National Medical Care Utilization and Expenditure Surveys; and the 1987 National Medical Expenditure Survey. Beginning with the 1963 survey, all of the surveys are available in machine readable form; for data from the 1950s, we are forced to use published tabulations from the survey authors (Anderson, Collette, and Feldman, 1963 and Anderson and Feldman, 1956). In the absence of micro data, we omit consideration of the 1958 survey. We also omit the 1980 survey because we are interested in long term trends, so differences between 1977 and 1980 data are less important for this analysis. We would clearly like to have more recent data for our analysis; while there is a more recent survey being conducted (the 1996 National Medical Expenditure Survey), these

data are not yet available.

The surveys all gather information on the range of acute care medical expenditures in a one year period. Several features of the data are important to note. Newborn hospital admissions for delivery are counted as part the mother's admission unless the newborn is discharged on a later date than the mother, when the newborn is recorded as having a separate admission.[3] In all cases, the institutionalized population is not included in the survey, and any information on long term care is excluded. With the exception of the 1987 NMES long term care supplement, the surveys give no information about nursing home spending, including spending on nursing homes for those now living in the community.

Table 1 shows summary statistics about the data. The sample sizes are large: 8,846 in 1953; 7,803 in 1963, 11,619 in 1970; 38,815 in 1977; and 34,456 in 1987. Table 1 also shows basic statistics about medical care spending. In real ($1987) terms, medical spending rose from $278 per person in 1953 to $1,521 per person in 1987. Growth was 3.3 percent per year in the 1953 to 1963 period. Growth was most rapid in the 1963-1970 period (7.9 percent per year), when Medicare and Medicaid were created and insurance coverage for the privately insured population expanded as well. In the next seven years, growth slowed to 3.8 percent per year. In the 1980s, spending growth increased again, to 5.5 percent per year. The average change over the entire period is 5.0 percent per year.

The remaining columns of Table 1 document another frequently-noted fact about medical

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[3] In the 1987 data, attempts were made to assign costs separately to newborns and mothers in all cases, but there are cost variables which assign the newborn's costs to the mother for normal deliveries where the newborn's stay does not exceed that of the mother.

spending (Berk and Monheit, 1992): medical spending has become increasingly concentrated among high cost users over time. In 1953, the top 10 percent of the spending distribution accounted for less than 43 percent of total spending; by 1987, that share was 72 percent.[4] Most of the increase occurred in the 1950s and 1960s; since 1970, the distribution of overall medical spending has been relatively stable.

II. Medical Spending by Age

While the aggregate facts about medical spending are well known, much less is known about the distribution of medical spending by age or disease. Ideally, we would construct a set of "national disease accounts" -- accounts that measure spending on particular diseases over time.[5] But the surveys do not include detailed diagnosis codes for spending prior to 1977. Instead, we consider first medical spending by age.

We denote spending for age group a at time t as $C_t(a)$. We divide the population into 11 age groups: <1; 1-4; 5-14; 15-24; 25-34; 35-44; 45-54; 55-64; 65-74; 75-84; 85+.[6] Table A-1 in the appendix shows average spending for survey years between 1963 and 1987, as well as

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[4] According to Anderson and Feldman, (1956) the top 11 percent of the distribution of families spent 43 percent of the total dollars spent on health care in 1953. Without micro data it is impossible to know exactly what share of medical spending the top 10 percent consumed.

[5] The current national health accounts tabulate spending by payer and sector of medical care provision (hospitals, physicians, etc.). For a set of disease accounts for 1995, see Triplett (1997).

[6] The 1953 data are only available for more aggregated age groups: 0-5; 6-17; 18-24; 25-34; 35-54; 55-64; and 65+.

average annual growth rates within age groups. To examine the differential spending by age over time, we define relative age-specific spending as:

$$C_t^r(a) = \frac{C_t(a)}{C_t(35-44)} \qquad (1)$$

Figure 1a shows relative medical spending by age for each of the five surveys. The data show a clear pattern: relative to spending on 35-44 year-olds, spending for the very young (those less than age 1) and the old (those above 65) have increased dramatically over time. The trend for infants is startling. In 1953, per capita spending on those under 5 was less than half of per capita spending on middle-aged adults. In 1963, per capita spending on infants was 53 percent of per capita spending on middle aged adults. In 1970, this figure was 64 percent. By 1977, per capita spending on infants was 97 percent of spending on middle-aged adults. After 1977, spending on infants soared. By 1987, the average infant used 2.3 times the medical services of middle-aged adults. Figure 1b shows relative spending plus or minus one standard error for 1963 and 1987. Given that there are relatively few infants in each survey year (200-500), it is not surprising that relative spending for infants is measured imprecisely. Still, the dollar amounts are staggering; real average spending for high cost infants above the 90th percentile tripled in the 1977-1987 period, from $6,690 to $21,505.

Figure 2 shows the implied growth rates of spending. If we define the "middle-aged" as those aged 1-64, spending on the middle-aged rose 4.7 percentage points per year between 1963 and 1987, while spending on infants rose by 9.8 percentage points per year.

The change in relative spending for the elderly is equally dramatic, but less concentrated

in time. In 1953 and 1963, spending on the elderly was less than 30 percent higher than spending on the middle aged. In addition, among the elderly population, spending declined at increasingly older ages during our sample period. Where the 75-84 year-olds used $689 per person in 1963, those aged 85+ used only $447 per person. Over time, spending for the elderly has increased, particularly among the oldest old. By 1970, average spending on the elderly was twice the amount for 35-44 year-olds; by 1977 it was 2.6 times as high as for 35-44 year olds; and by 1987 it was 4 times average spending on 35-44 year olds. Further, within the elderly population, spending on the age 85+ population increased even more dramatically than spending among the younger old. In 1963 per capita spending on those 85+ equaled average spending on 35-44 year olds. By 1987, spending for the average person over 85 was 5.2 times average spending for 35-44 year olds. As Figure 2 shows, the growth of per person spending on the elderly averaged 8.0 percent annually between 1963 and 1987, including a rate of over 10 percent annually for the oldest old.

Recall that spending on the elderly excludes long-term care services, which have also increased over time; total medical spending has thus become even more skewed than these data suggest.[7]

Figure 1 also shows a temporary increase in spending on 15-24 year-olds in 1970 that is eliminated by 1977. In the 1970 sample, two young men aged 19 and 20 have unusually high charges, which causes average spending for this group to be skewed.

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[7] Real spending on nursing homes has increased from $3.9 billion in 1960 to $41.9 billion in 1985. Since 90 percent of nursing home residents are 65 years of age or older, this implies that spending has become even more skewed towards the elderly.

The disproportionate growth of medical care spending for the elderly and the very young is substantively quite large. In 1963, spending on infants and the elderly accounted for 17 percent of total spending (1.6 percent for infants and 15.1 percent for the elderly). By 1987, spending on these two groups accounted for 36 percent of total spending (2.7 percent for infants and 33.2 percent for the elderly). We are not the first to document such a trend. Anderson, Collette, and Feldman (1963) document a similar trend over the 1953-1958 period. In the 1953 and 1958 surveys, spending grew most rapidly for those under 6 and those over 65. Although the authors are unsure about the causes of this rapid growth, they note that insurance enrollment grew more rapidly for the aged than for others over this period. The trend of rapid spending growth for the young and the old has continued throughout our sample.

As an alternative metric, Figure 3 shows a simulation of medical spending if growth for the elderly and infants matched growth for the middle-aged. The upper line in the Figure is actual per capita medical spending. The lower line is spending under the alternative scenario. By 1987, the disproportionate growth of spending for infants and the elderly accounted for over $300 in spending per person, or over one-quarter of the total increase in medical spending since 1953.

Why has spending for infants and the elderly increased so rapidly? Has the increase been concentrated among high cost users or has it been more uniform throughout the distribution? The views about wasteful spending suggest that disproportionate spending growth ought to be concentrated in the very high cost users among these groups.

We address this question by considering broader parts of the distribution of spending than just the mean. Suppose we consider percentile q of the distribution of spending within each age

group. That is, $C^q_t(a)$ is spending at the q^{th} percentile of age group a at time t. We can define relative spending at the q^{th} percentile of the distribution as:

$$C_t^{r,q}(a) = \frac{C_t^q(a)}{C_t^q(35-44)}, \qquad (2)$$

Figures 4(a) and (b) show relative spending at the 50th and 90th percentiles of the spending distribution. For infants, neither the 50th percentile of spending nor the 90th percentile of spending increase much relative to middle-aged adults. Even in 1987, the 90th percentile of spending for infants is only just above spending for 35-44 year-olds, while the mean was over two times higher. The implication is that essentially all of the growth of spending is in the very high cost users — those above the 90th percentile. For the elderly, spending for the median person increases substantially less than spending for the mean person, and spending at the 90th percentile increases by only the amount of the mean. Thus, for the elderly as well there appears to be an increasing concentration of the distribution among high cost users.

We can be more precise about how much spending at different points in the distribution contributes to overall growth in spending. To do this, we first divide the sample into 3 age groups: <1, or infants; 1-64, or "middle-aged"; and 65 and older, or elderly. We then define "excess spending growth" as the increase in per capita spending resulting from more rapid growth of spending for infants (or elderly) than for the middle-aged population. In other words, we ask the question, "What would spending on infants (or elderly) be in 1987 if it grew at the same rate as spending on the middle-aged over the 1963-1987 period?" The difference between actual spending on infants (or elderly) in 1987 and this hypothetical spending at middle-aged growth

rates is total excess spending growth for an age group. Using infants as an example:

$$Excess\ Spending(<1) = Spend_{1987}(<1) - Spend_{1963}(<1)\cdot\left(\frac{Spend_{1987}(1-64)}{Spend_{1963}(1-64)}\right), \qquad (3)$$

where $Spend_t(a)$ is average spending in age group a in year t. We then divide each age group into four subgroups: those in the bottom 50 percent of the spending distribution; those in the 50th to 75th percentiles of the spending distribution; those in the 75th to 90th percentiles of the distribution; and those above the 90th percentile. For each age group, we calculate what share of excess spending is attributable to different parts of the spending distribution.

Consider spending on the bottom 50 percent of the distribution. For infants, this is:

$$Spend_t^{0-50}(<1) = \frac{\int_{q=0}^{50} C_t^q(<1)}{N_t(<1)}, \qquad (4)$$

where we have divided total spending in the bottom half of the distribution by the total number of infants $N_t(<1)$ so that this amount is the contribution of this set of infants to average spending. If spending for the bottom 50 percent of the distribution had increased at the rate of spending for the bottom 50 percent of the middle-aged population, in 1987 this group would have spent:

$$Spend_{1987,hypothetical}^{0-50}(<1) = Spend_{1963}^{0-50}(<1) * \frac{Spend_{1987}^{0-50}(1-64)}{Spend_{1963}^{0-50}(1-64)}, \qquad (5)$$

We subtract this figure from $Spend_{1987}^{0-50}$ and divide the result by total excess spending growth for infants to determine what share of excess spending growth for infants is attributable to infants

in the bottom half of the distribution.

Figure 5a shows the contribution of excess spending growth for infants and the elderly resulting from faster growth in different parts of the distribution. In both cases, the excess growth in medical care spending is particularly concentrated in high cost users. For infants, 89 percent of the excess spending growth is a result of excess spending increases in the top 10 percent of the population.[8] For the elderly, 66 percent of excess spending growth results from higher cost growth in the top 10 percent of the distribution.

The highly concentrated spending growth at the top of the distribution for infants and elderly reflects concentrated spending growth on the very ill in all age groups. Figure 5b shows the annual percentage change in spending from 1963-1987 for different age groups and at different points in the spending distribution within each age group. In all age groups, spending growth rises with the percentile in the spending distribution. For those aged 1-64, spending grew at an average rate of 4.7 percent per year, yet even at the 95th percentile, spending is growing more slowly at 4.6 percent per year. This implies that like infants and the elderly, spending growth for the middle aged is highly concentrated at the top of the distribution. However, spending growth is much slower for the middle aged than for infants and elderly, even above the 90th percentile of spending.

An alternative way to examine whether our trends reflect rapid spending growth for the ill of all ages, is to choose a constant dollar amount and to compare spending growth for all those

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[8] Indeed, 60 percent of spending growth is attributable to above average growth in the top 2 percent of the distribution. Because the number of infants is so small, however, the uncertainty about this estimate is high.

above this dollar amount. This allows us to look only at the most severely ill respondents in all age groups. Because the 1-64 year old population is a healthier group than infants and elderly, even those in the 95th percentile of the distribution are likely to be relatively healthy, and therefore spend little. We want to examine the tendency for spending on the very ill at all ages to grow much more rapidly than per capita spending in an age group. We looked at spending growth for those with real spending over $2,000. Measured in 1987 dollars, this is well above the 90th percentile of spending for all three groups in 1963 but below 90th percentile spending on all groups in 1987. Average spending for all infants spending over $2,000 grew 7.8 percent annually between 1963 and 1987. This figure was 4.9 percent for the elderly and 2.4 percent for those aged 1-64. The differences in growth rates among the very ill of different ages show that although the trend of highly concentrated spending growth at the top of the spending distribution may occur within all age groups, it is most striking for infants and the elderly.

It is thus clear that in understanding why medical care has become so concentrated by age, we need to understand why it has become so much more concentrated among high cost users within any age. We turn to this next.

III. Who Are the High Cost Users?

Understanding why high cost users spend more than they used to is hampered by data problems. The only surveys that contain detailed information about diagnoses are the 1977 and 1987 surveys. Thus, we cannot look at the distribution of high cost users over more than a 10 year period. Still, there was a substantial increase in concentration among high cost users

between 1977 and 1987, and we proceed with this analysis.

High-Cost Elderly

We begin with an analysis of high cost elderly. We divide acute care spending and spending on prescription medicines for the elderly into 15 groups and one category for other diagnoses based on the chapters of the *International Classification of Diseases, Ninth Revision* as adapted for use in the Health Interview Survey (National Center for Health Statistics, 1979). The categories include: parasites and infections; neoplasms; endocrine; blood; mental disorders; central nervous system; circulatory system; respiratory system; digestive system; genitourinary system; skin; musculoskeletal system; injuries and poisoning; impairments; and other. Because the surveys use impairment codes and often do not code congenital anomalies, we omit the congenital anomaly category, and use the NMES category for impairments. Because we are focusing on those over 65, conditions relating to pregnancy and the perinatal period are omitted. For each person, we sum all costs associated with each diagnosis group. We then assign each person a "primary diagnosis", or the diagnosis group that accounts for the largest amount of spending. In most cases (particularly for high cost users), this is a fairly clear delineation.

Figure 6 shows the distribution of primary diagnosis for the top 10 percent of the elderly spenders in 1987. The most common diagnosis in this group is circulatory system disorders, accounting for 28.0 percent of the top spenders. Second in importance is neoplasms (which includes benign and cancerous growths), with 14.4 percent of the people. The other diagnoses generally have 5 to 10 percent of the top spenders.

The primary diagnosis of top spenders did not change substantially over the 1977 to 1987 period. In 1977, the most common diagnosis was circulatory system disorders (25.7 percent of high cost users), followed by other (11.4 percent) and neoplasms (11.3 percent). We suspect, however, that if we were able to look at spending in the 1950s or 1960s, we would observe more of a change in primary diagnoses.

We examined the growth of spending on circulatory disorders and cancers to see how they contribute to spending growth. We wanted to know whether costs grew more rapidly for these conditions than for overall spending. In addition, we examined whether cost growth differed at different points in the spending distributions for these conditions. The top rows in Table 2 show the growth of spending for individuals with a primary diagnosis of a circulatory system disorder.[9] Costs for the average patient with a primary diagnosis of a circulatory system disorders grew 7.3 percent per year. This rapid growth occurred throughout the distribution of spending on circulatory disorders with growth in spending ranging from 7.0 percent to 7.6 percent at different parts of the distribution. The lower half of Table 2 shows a similar trend for patients with a primary diagnosis of neoplasms. Overall spending for those with a primary diagnosis of neoplasms grew at an average annual rate of 4.0 percent. Growth was highest in the top 10 percent of spenders with a primary diagnosis of neoplasms, where real growth averaged 5.2 percent per year.

Since circulatory disorders were by far the most common primary diagnosis among high cost elderly, we examined them more closely by dividing the circulatory disorder diagnoses into

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[9] The trends shown in Table 2 do not change when one looks at all respondents with a circulatory disorder instead of limiting the sample to those with a primary diagnosis of circulatory disorder.

16 detailed groups using the Clinical Classifications for Health Policy Research (CCHP). We were forced to collapse categories relating to ischemic heart disease into a single category and categories relating to cerebrovascular disease into a single category due to the coding procedures used for the NMES which did not distinguish between these groups. Table 3 shows the individual CCHP categories included under ischemic heart disease and cerebrovascular disease. The category for ischemic heart disease includes all acute myocardial infarctions (heart attacks) and coronary atherosclerosis (hardening of the arteries, angina) and other heart diseases. The category for cerebrovascular disease includes the sub-categories: acute cerebrovascular disease, occlusion or stenosis of precerebral arteries, other and ill-defined cerebrovascular disease, transient cerebral ischemia, and late effects of cerebrovascular disease. Figure 7 shows the distribution of detailed diagnoses for high cost elderly with a primary diagnosis of a circulatory disorder. Within this group, half had a diagnosis of ischemic heart disease in connection with their most expensive medical event. Cerebrovascular disease was diagnosed for 8.9 percent of high cost elderly during their most expensive medical event. In 1987, the average cost for an expensive medical event relating to ischemic heart disease was $17,419 among the high cost elderly. Cerebrovascular conditions were slightly less costly averaging $15,224 for expensive medical events among the high cost elderly.

To gain a clearer picture of why these diseases are so costly, we looked at procedure codes in 1987. Unfortunately most expensive medical events have no procedure code. For the 30 percent of expensive events with procedure codes, the most common procedures are unspecified "Other operations on vessels" occurring during 38.7 percent of these expensive medical events. "Other operations on heart and pericardium" and "Operations on vessels of

heart" are also common occurring during 21.1 percent and 20.2 percent of coded expensive medical events respectively. These procedure categories are broad, but they include bypass surgery, peripheral bypass surgery and other operations performed to treat ischemic heart disease. Not surprisingly, the procedures that make circulatory disorders expensive are operations to treat circulatory diseases, particularly ischemic heart disease and other vascular diseases.

Using high technology care to treat even common diagnoses contributes to the growth in relative spending for the elderly. For example, during the period from 1984-1991, the share of Medicare patients with acute myocardial infarctions receiving catheterization, angioplasty, bypass surgery, or some combination of these, grew from 11 percent to 41 percent (Cutler et. al. 1996). The proliferation of technology to treat cardiovascular disease probably drives much of the spending growth for high cost elderly with circulatory disorders.

High-Cost Infants

Understanding the reasons for increased spending among high cost infants is more difficult than it was for high cost elderly. Generally, the surveys omit diagnosis codes for infants, and procedure codes are rarely used. This makes it impossible for us to use the "primary diagnosis" approach to understand high cost users. Nor does the survey contain information such as birth weight of the infant or subsequent infant death.

However, the survey does provide some clues about what makes the high cost infants different from other infants. Sixty percent of the high cost infants experienced their most expensive medical event at the time of birth. It is much rarer for post-birth medical problems to

lead to high spending. Two thirds of the high cost infants did not undergo any surgery during their most expensive medical event.

Perhaps most striking is how long the high cost infants were in the hospital. The average length of stay for high-cost infants during their most expensive medical event was 23 nights in 1987. That was a dramatic increase over 1977, where the high cost infants stayed in the hospital only 13 nights during their most expensive stay.

Indeed, Figure 8 shows the distribution of length of stay for all infants at the time of birth. Although there is an increase in the share of births requiring 1 night or 0 night stays in 1987 compared with 1977, the upper tail of the distribution increases in 1987 compared to 1977. For example, only 1 percent of births in 1977 were in the hospital over 30 days, compared to 6 percent in 1987.

The reason for a long stay at birth is generally complications related to premature delivery. Infants born very prematurely tend to have respiratory or other developmental problems that either result in immediate death or require long hospital stays. Over time, as the technology available to treat these infants has increased, more of them may be surviving the premature birth but requiring longer hospital stays.

This is consistent with the sketchy evidence that is available on the diagnosis of high cost infants. Fifty-seven percent of the high cost episodes had a diagnosis code. Of these events, 24 percent had a condition code indicating that the baby was born prematurely--between 1,000 and 2,400 grams at birth. Among babies who were not high cost, less than one percent have a diagnosis code indicating that they were born prematurely.

The most common conditions among high cost infants were disorders involving the

respiratory system. Thirty-five percent of the high cost sample had a respiratory condition in connection with their most expensive medical event. These ranged from post-birth respiratory disease, to congenital respiratory anomalies and a variety of lower respiratory diseases. Respiratory conditions (pneumonia excepted) is a frequent complication of premature birth; many congenital anomalies, heart, and respiratory conditions, for example, originate because infants are born before fully developing.

The evidence seems consistent with a story of increasing costs related to low birth weight. As technology to treat premature babies has improved, the costs of low birth weight children — and thus the overall costs of infants — has increased.

Historical trends in the proliferation of neonatal care support this contention. In particular, the increasing cost of infants after the mid-1970s is consistent with the major technological innovation of this period — the diffusion of neonatal intensive care units [NICUs]. NICUs are intensive care facilities specially designed for complications arising shortly after birth, such as respiratory failure or incomplete physical development. In 1976, the first year that the American Hospital Association kept data on this technology, 8 percent of hospitals had a NICU, and there were 5,630 NICU beds in total. By 1990, 19 percent of hospitals had a NICU, and the number of NICU beds had nearly doubled.[10] Among the largest hospitals (those with 400 or more beds), two-thirds had a NICU in 1990.

Although we cannot be certain with our data, we suspect that the diffusion of neonatal intensive care units and their associated technologies explains much of the cost explosion for

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[10] In both of these years, the number of NICUs is slightly understated because hospitals that had neonatal intensive care services as part of their medical/surgical ICU were not counted. The understatement is not likely to be large, however.

infants. Medical technology is buying us, in the crudest sense, care for infants who previously died at birth.

IV. The Value of Medical Spending

Understanding the sources of cost growth is only one concern; determining the value of this spending is a second. In this section, we look at crude measures of outcomes to see if there is some contemporaneous relation between spending increases and health. We do not interpret these data as causal. Instead, we are interested in examining whether the basic facts about health outcomes are consistent with the cost trends. If increased spending on cardiovascular disease and neoplasms in the elderly is not associated with better outcomes for patients with these diseases in aggregate, it will be hard to argue that the medical spending is buying much in the way of improved health. In future work, we intend to examine the causality issue in more detail.

The Health of the Elderly

Given that over 40 percent of the high cost elderly have primary diagnoses relating to circulatory disorders or malignant neoplasms, one can look to mortality rates for these diseases to provide evidence on how outcomes for patients with these diseases changed over time.

Figure 9 shows death rates for 4 groups of diagnoses: diseases of the heart, cerebrovascular disease, malignant neoplasms, and all other diagnoses. Over the 3 decades between 1960 and 1990, death rates for heart disease and cerebrovascular disease have

plummeted. In 1960, the age-adjusted death rate due to heart disease was 287 per 100,000. This figure fell nearly in half, to 152 per 100,000 by 1990. Similarly, deaths due to cerebrovascular disease fell by 60 percent, from 80 per 100,000 in 1960 to 28 per 100,000 in 1990. This is certainly consistent with improved, but high cost, medical care.

In contrast to the improvements in outcomes for major circulatory diseases, deaths attributable to malignant neoplasms witnessed a slow but steady rising trend during this time period, with deaths per 100,000 rising from 125 to 135. While mortality due to neoplasms has declined for younger ages, mortality rates have increased for those over age 50 (Cohen et. al. 1995). Similar trends in cancer mortality have been documented in Canada (Berkel, 1995). Clearly we have made little progress preventing death from cancer over this time period.

Of course, the technologies that have increased costs may not have been the ones that extended life. The source of reduced mortality for cardiovascular disease is a subject of great debate. The general consensus in the literature (Hunink et. al. 1997), is that high-tech medicine has been less important in improved health than have been lifestyle modifications and pharmaceuticals that provide better primary prevention (reduced incidence of disease at all) and secondary prevention (reduced incidence of disease reoccurrence). But the contributions of these different factors is likely to change over time, and there has been much less analysis of the reasons for improved health over the past decade than in previous time period.

The Health of Infants

The most readily available measure of health outcomes for infants is infant mortality; as

spending has increased, we consider what has happened to mortality in the first year of life.

Rather than look at overall infant mortality, we examine infant mortality by birth weight. There are two reasons for this. First, to the extent that the technological changes are concentrated among premature infants, mortality reductions should be concentrated in this group as well. In addition, exogenous changes in birth weights for infants will naturally affect infant mortality, and we want to purge these from our estimates.

Figure 10 shows infant mortality rates (deaths per 1,000 live births) in years 1960, 1983, and 1991. Over the period from 1960-1991, dramatic gains were made in mortality outcomes for low birth weight babies, particularly those under 2,000 grams. Among babies born between 1,500-1,999 grams, deaths per 1,000 dropped 75 percent, from 207 to 40. Among the 1,000-1,499 gram babies, deaths dropped by 80 percent, from 549 per 1,000 to 91 per 1,000 over these three decades. Among those under 1000 grams, deaths per 1,000 fell in half, from 919 to 521.

In Figure 11 we show the annual percentage decline in infant mortality by birth weight from 1960 to 1983 and from 1983 to 1991. The most prominent feature in this graph is the way the decline in infant deaths occurs most rapidly in the low birth weight ranges, particularly in the 1,000 to 1,999 gram range. This is particularly true in the 1983 to 1991 period. From 1960 to 1983, infant mortality reductions were greater among lighter infants but not by a large amount. The decline was about 5.5 percent per year for the lighter infants and perhaps 4 percent per year for the normal birth weight infants. After 1983, however, infant mortality reductions were particularly concentrated among the lightest infants. Mortality for infants born between 1,000 and 1,499 grams, for example, declined by 7 percent per year, compared to 3 percent per year for normal birth weight infants.

The increasing emphasis on mortality reductions for the lightest infants over the 1980s is consistent with the diffusion of medical care designed for very low birth weight infants. Recall that the costs of very expensive infant care increased most rapidly from the late 1970s to the late 1980s, and that neonatal intensive care units expanded most rapidly in this period. Thus, the evidence is certainly consistent with a fair return to medical spending.

The one exception to this story is the very lightest infants — those born under 1,000 grams. For these infants, reductions in infant mortality have been low in all periods. We suspect that one reason that we do not observe such rapid improvements in infant mortality for babies born less than 1,000 grams may be the way live births are counted. Although nothing has changed in the official definition of live births over the 1960-1991 period, it is plausible that very premature infants who died minutes after birth were not counted as a live birth when there was no technology available to treat them. Now that technology offers more possibilities for saving very low birth weight babies, these babies are more likely to be counted as live births so that the number of live births has increased in the low birth weight ranges.[11]

Some evidence for this is provided by the increasing number of very low birth weight live births over time. The ratio of births below 1,000 grams to births between 1,000 and 1,499 grams has been increasing over time, even as the ratio of births between 1,000 and 1,499 grams and 1,500 and 1,999 grams has been relatively constant. It may be that we are understating the gains made in reducing infant mortality among babies born weighing less than 1,000 grams because we are counting more of the subsequent deaths as live births than we used to.

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[11] Across types of medical care, diagnosis of disease is quite strongly associated with the ability to treat disease. See Cutler and Richardson (1997).

One drawback of using infant mortality to measure gains in infant health is that it provides no evidence about long-term outcomes for low birth weight babies. There is considerable evidence that low birth weight babies who survive the neonatal period are much more likely than heavier infants to have problems that continue throughout childhood and later in life (Institute of Medicine, 1985; Saigal et. al., 1996). The evidence presented here does not capture this component, which should be included in any evaluation of the costs and benefits of increased medical spending on infants.

V. Conclusions

Although the growth in health care spending and the concentration of health care spending have been well-documented, until now we have known little about the nature of this growth and the high cost spenders that drive it. Our analysis shows a striking trend in the growth of health care spending. Not only is spending at a point in time highly concentrated at the top of the spending distribution, but the growth in health care spending is highly concentrated as well. We find that growth is most rapid among the young, those less than 1 year-old, and the old, those 65 or older. Within these rapid growth groups, the growth in spending is largely driven by those at the top of the spending distribution. We find that 89 percent of excess spending growth for infants originates from tremendous growth in health care spending for the top 10 percent of the spending distribution of infants. For the elderly, 66 percent of excess spending growth originates from high cost users. Among the young, this spending often is associated with the birth, and it seems likely this is in connection with premature birth. Among the old, circulatory disorders and

neoplasms are the most common primary, or high cost, diagnoses.

In our initial attempts to see whether gains in health outcomes are consistent with increased spending, we find that high spending growth on a particular population or condition is accompanied by gains in health outcomes for these conditions over time. While infant mortality has plummeted since 1960, the reductions are largest among low birth weight babies. In our analysis of diseases driving the high cost elderly spending, we find that deaths due to circulatory disorders have decreased dramatically over time, even during periods where mortality due to other causes is relatively constant. The trend in mortality for malignant neoplasms is an exception to the broad finding that where spending is most concentrated, the gains in health outcomes are great. Future research should try to address whether the correlation between high spending and health gains is causal. Regardless of whether this relationship is causal, our findings suggest that one can understand more about the growth in health care spending by learning more about technologies aimed at helping very ill infants and elderly.

Our results also have implications for forecasting medical spending growth over time. Common forecasts of medical spending do not account for changes in relative spending by age over time. Our results suggest this understates the future growth of costs, since the fastest growing age group, the 85+ population, is also the group whose costs are growing most rapidly.

Finally, determining what caused the shift in resources toward infants and elderly is important. Clearly, the advent of Medicare, Medicaid, and the increased generosity of private health insurance coverage have played a role in raising the share of medical spending on infants and the elderly. However, little is known about the mechanism that transforms increased insurance coverage into technological improvements, and ultimately gains in health. Answering

these questions should be part of any agenda to contribute to debates on medical spending.

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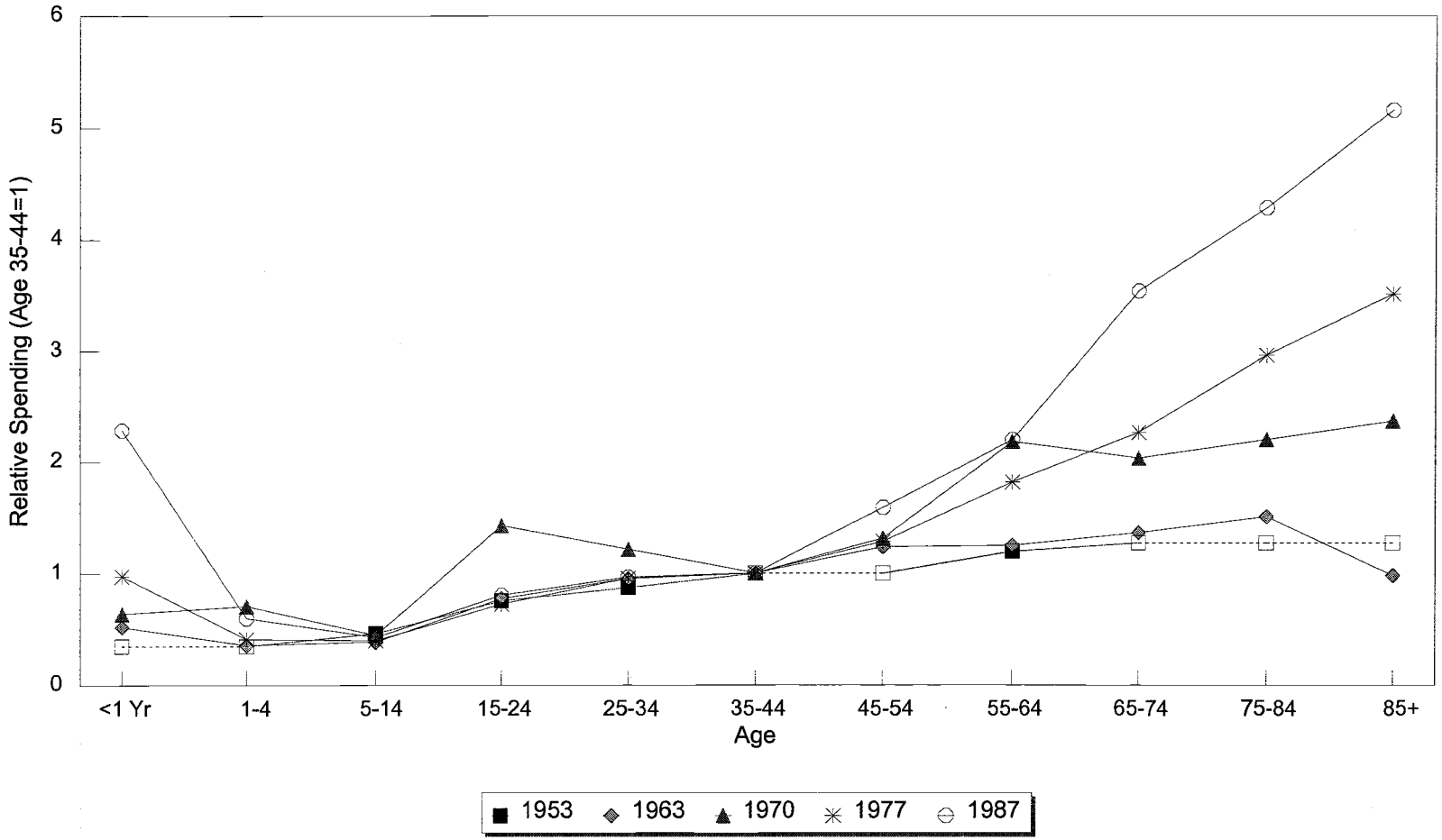
Figure 1a: The Age Distribution of Medical Spending 1953-1987



1953 age groups include: 0-5,6-17,18-24,25-34,35-54,55-64, & 65+. Relative spending for 5-24 year olds was constructed assuming a uniform age distribution. Dashed lines in 1953 connect all age groups which were combined when calculating relative spending.

Figure 1b: The Age Distribution of Medical Spending
1963-1987

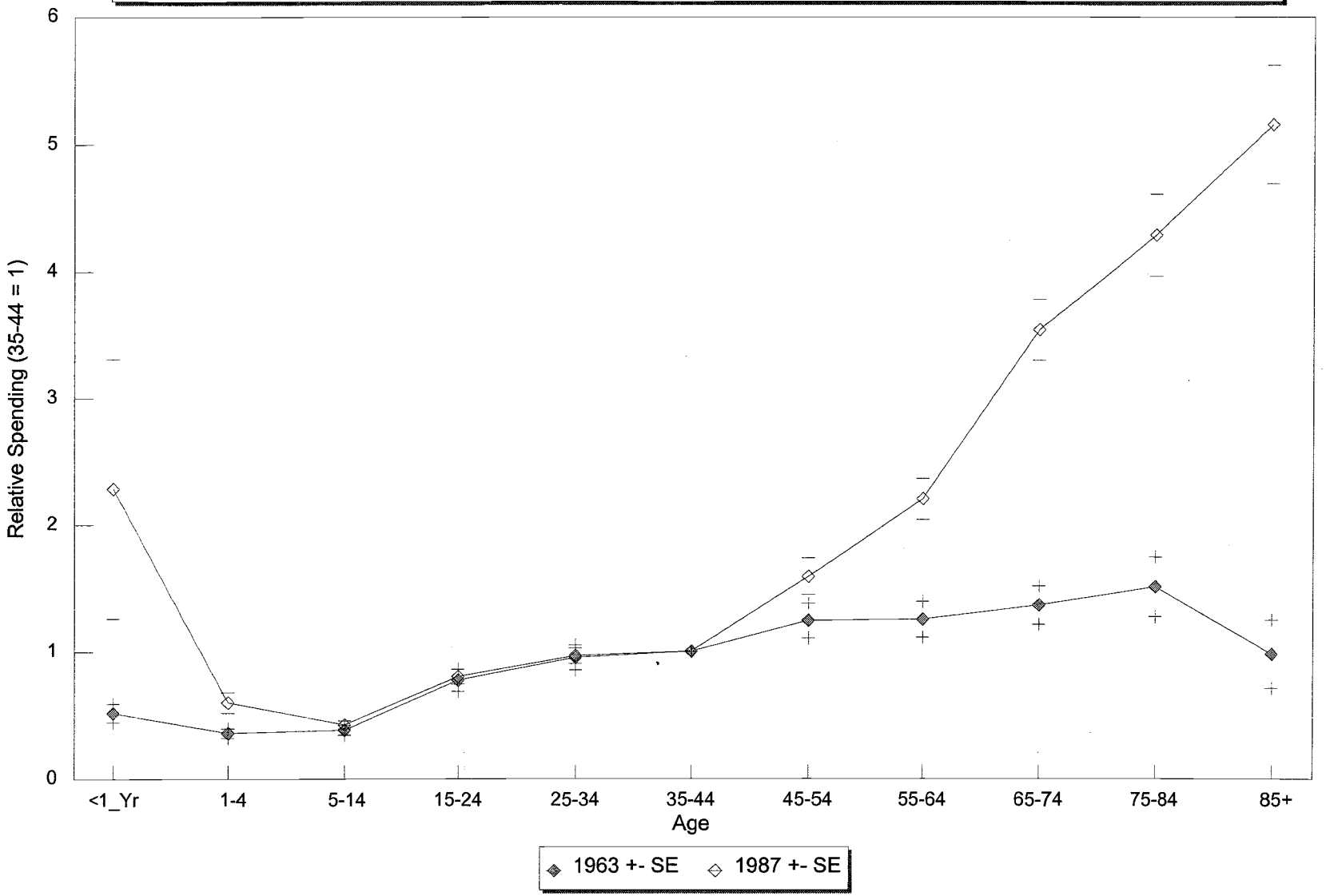


Figure 2: Growth of Medical Spending, 1963-1987

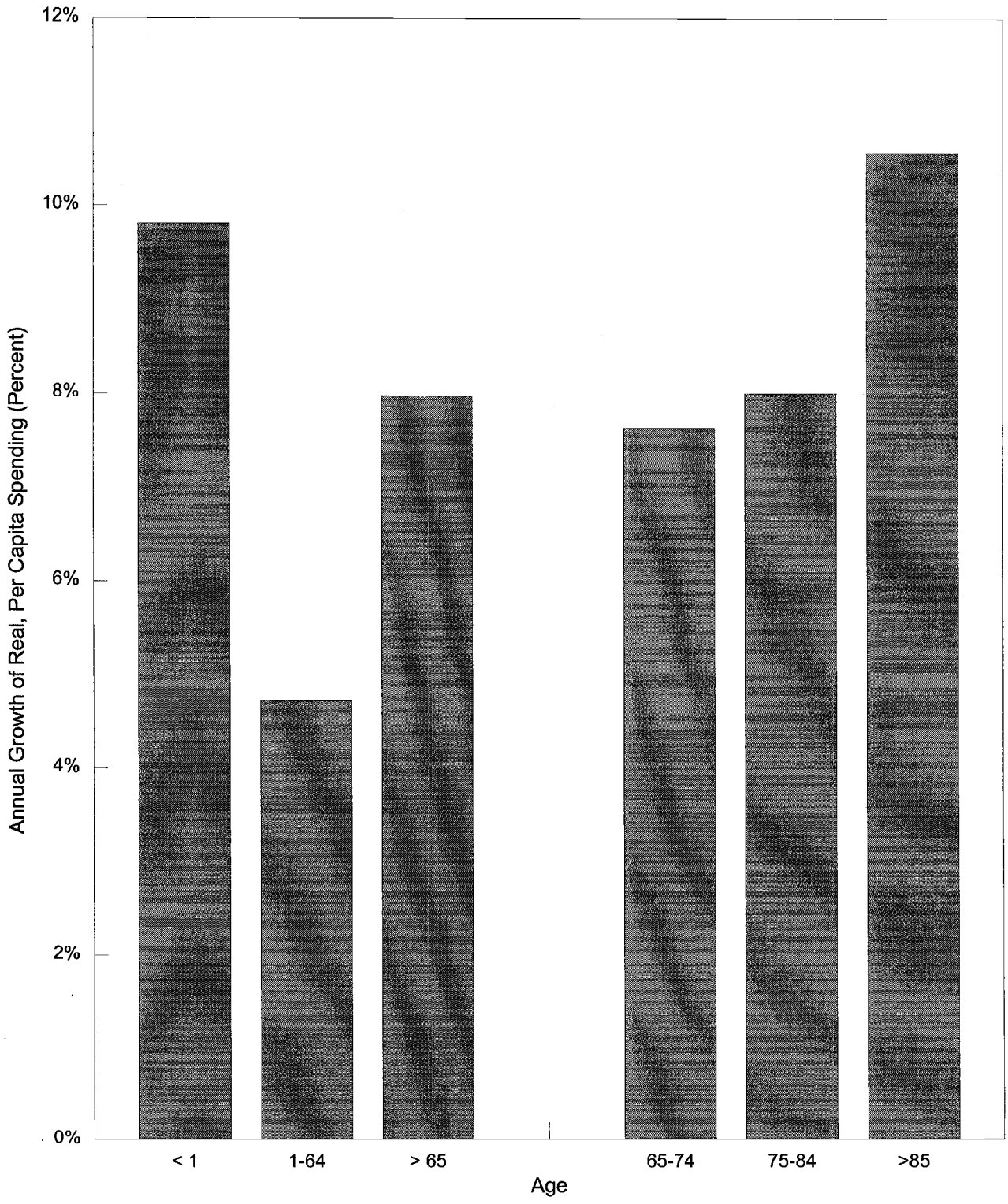
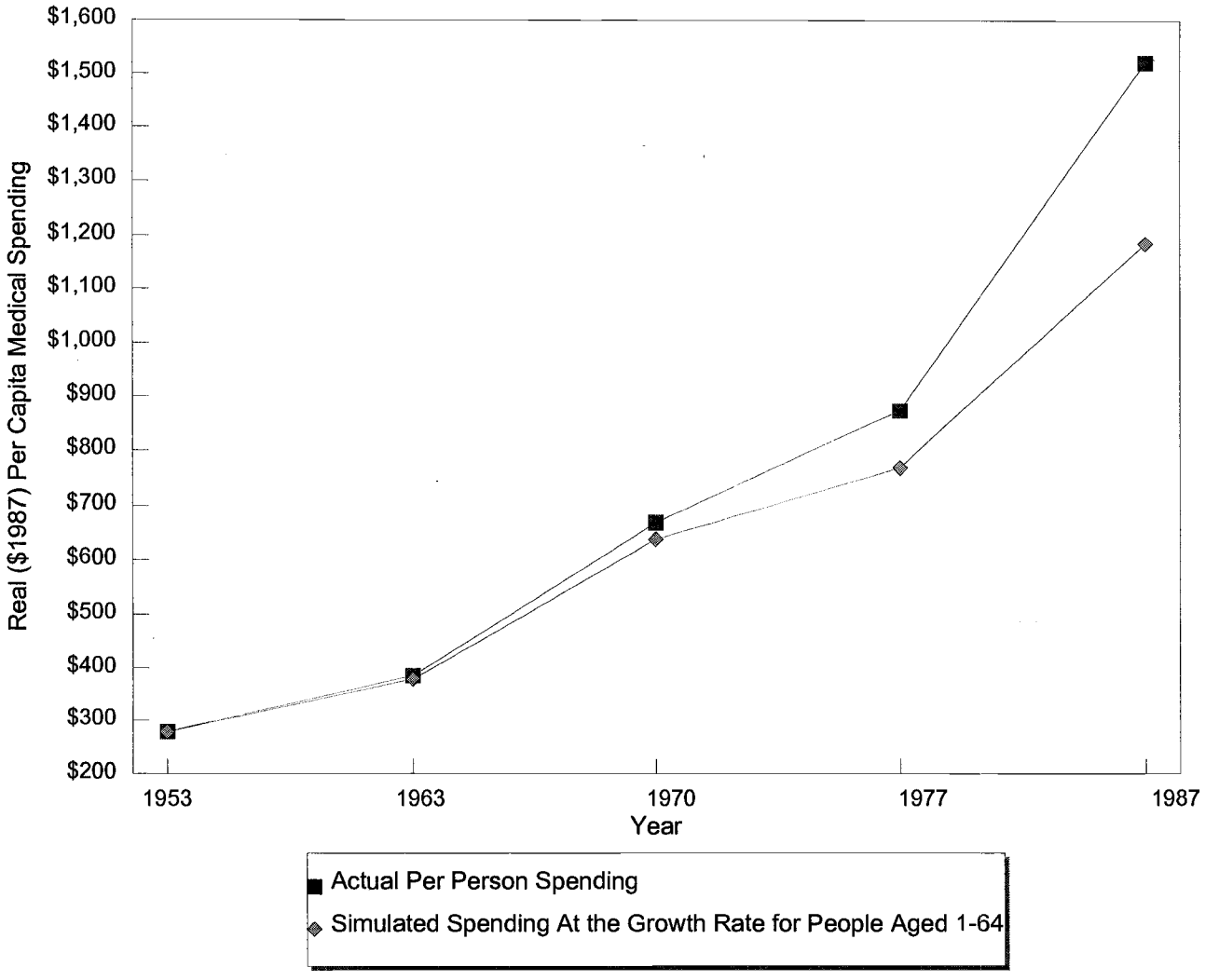


Figure 3: Medical Spending With Less Rapid Cost Growth For Infants and the Elderly



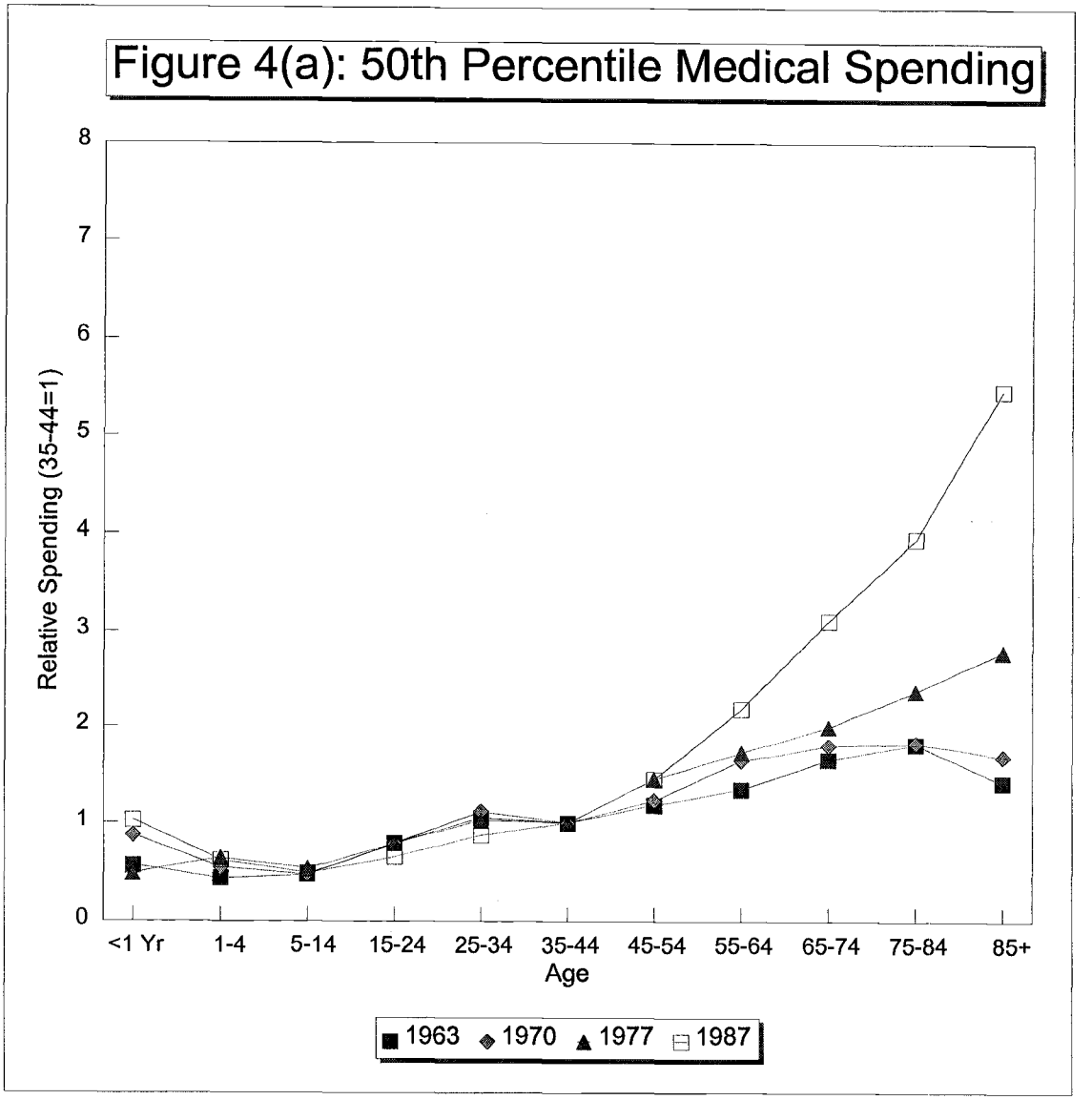


Figure 4(a): 50th Percentile Medical Spending
Relative Spending (35-44=1)
0
1
2
3
4
5
6
7
8
<1 Yr
1-4
5-14
15-24
25-34
35-44
45-54
55-64
65-74
75-84
85+
Age
1963
1970
1977
1987

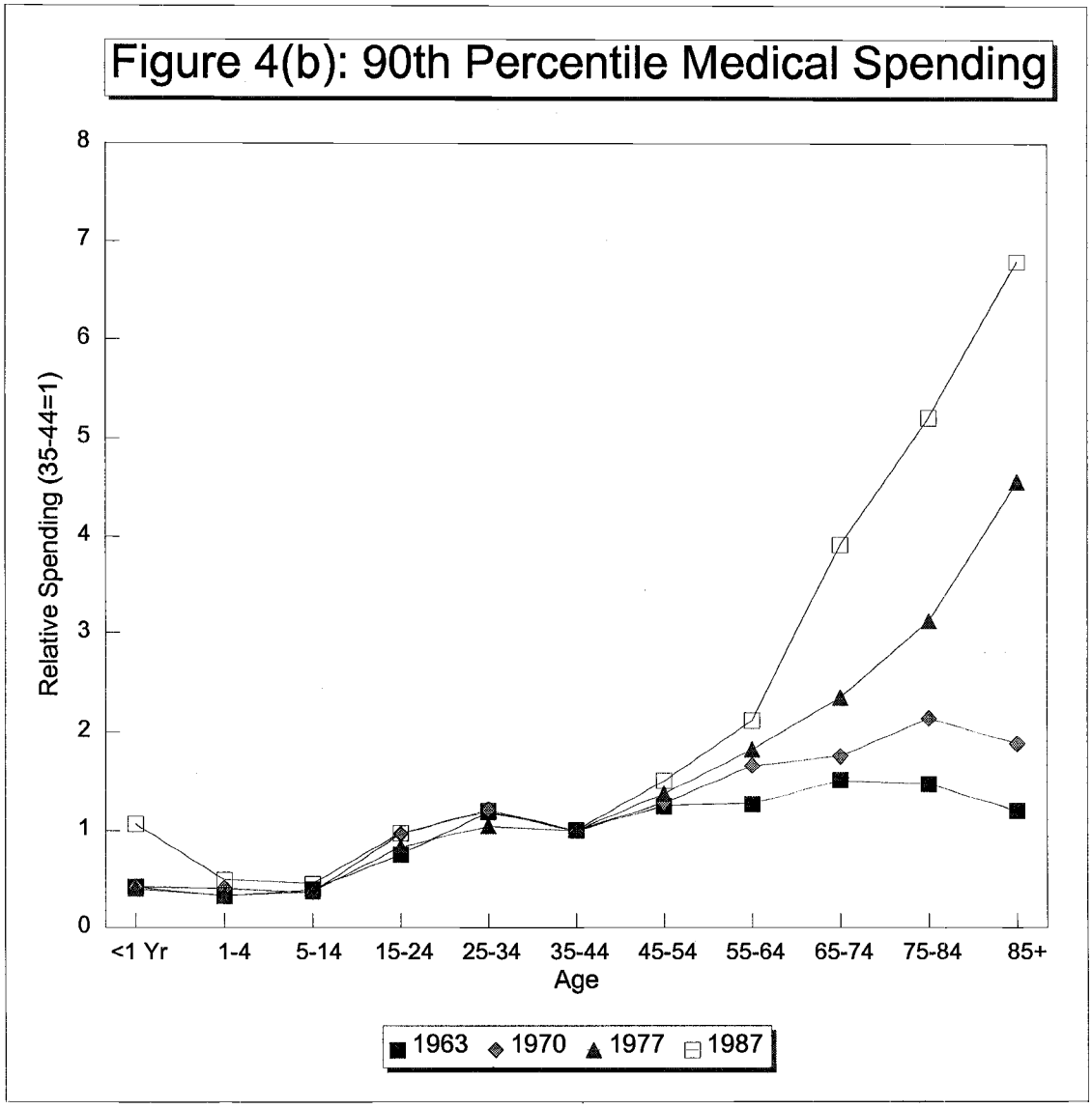


Figure 4(b): 90th Percentile Medical Spending
Relative Spending (35-44=1)
0
1
2
3
4
5
6
7
8
<1 Yr
1-4
5-14
15-24
25-34
35-44
45-54
55-64
65-74
75-84
85+
Age
1963
1970
1977
1987

Figure 5a: Accounting for Excess Medical Spending Growth of Infants and the Elderly

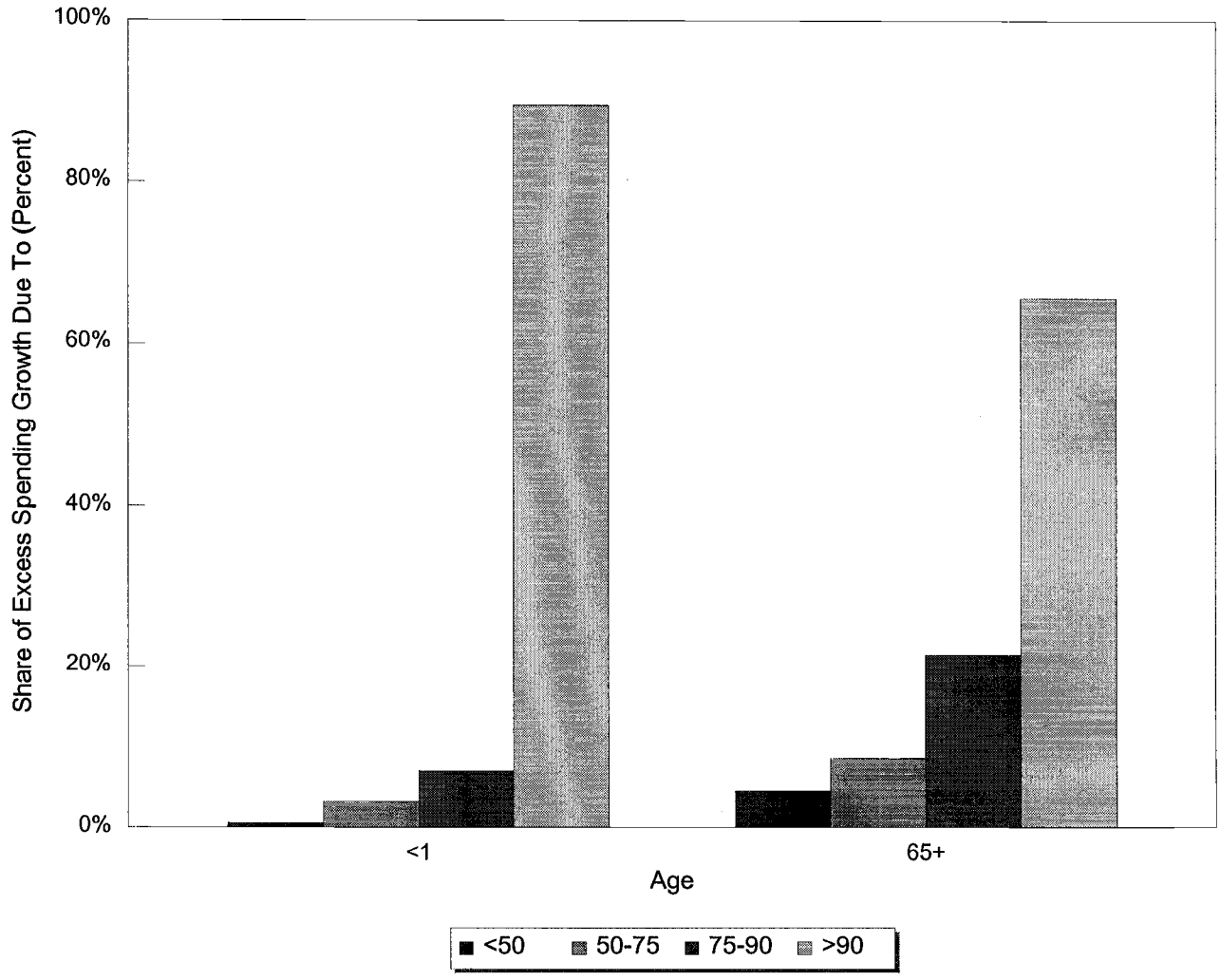


Figure 5b: Annual Percentage Change in Spending 1963-1987
By Age Group and Percentile of Spending

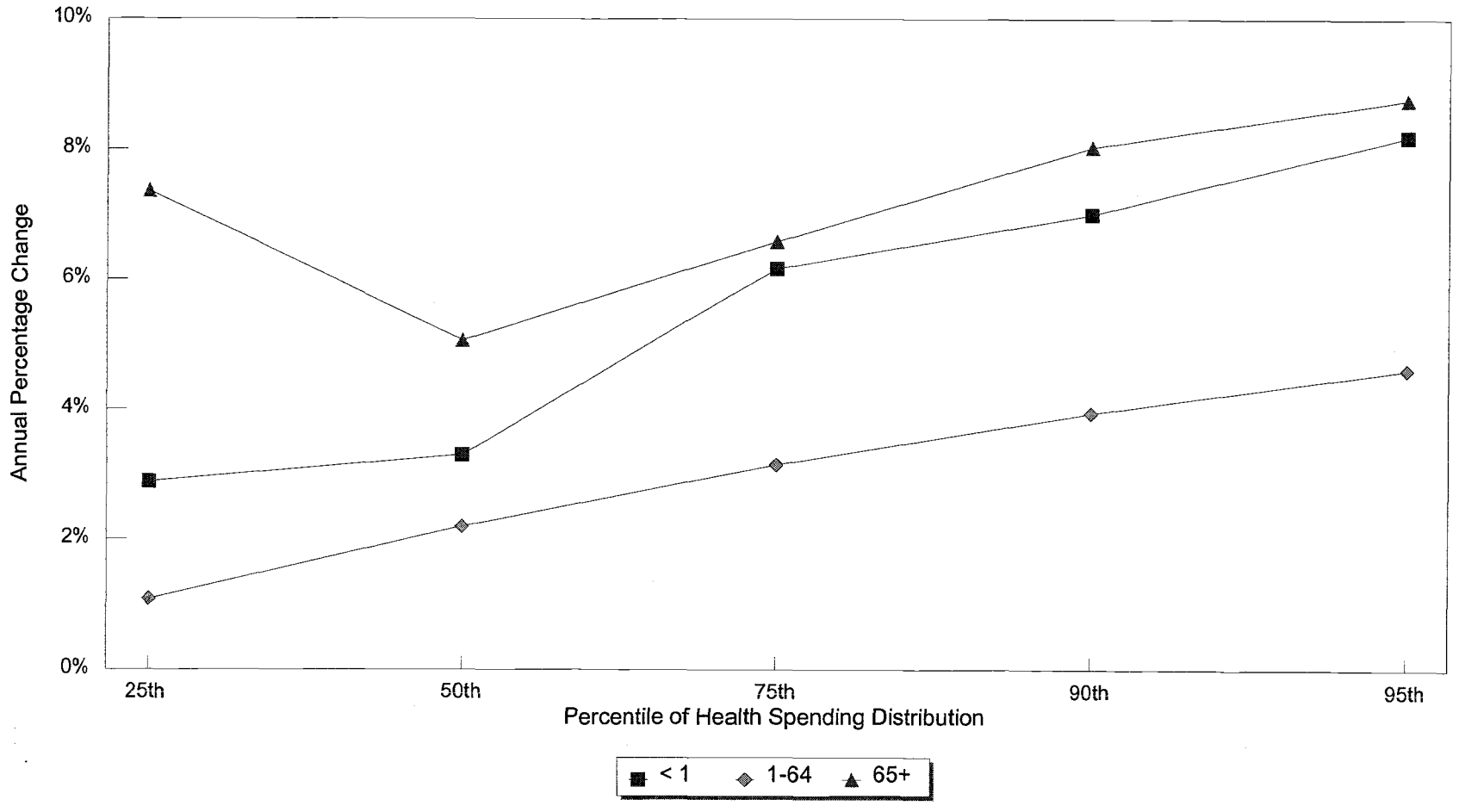


Figure 6: High Cost Elderly by Primary Diagnosis

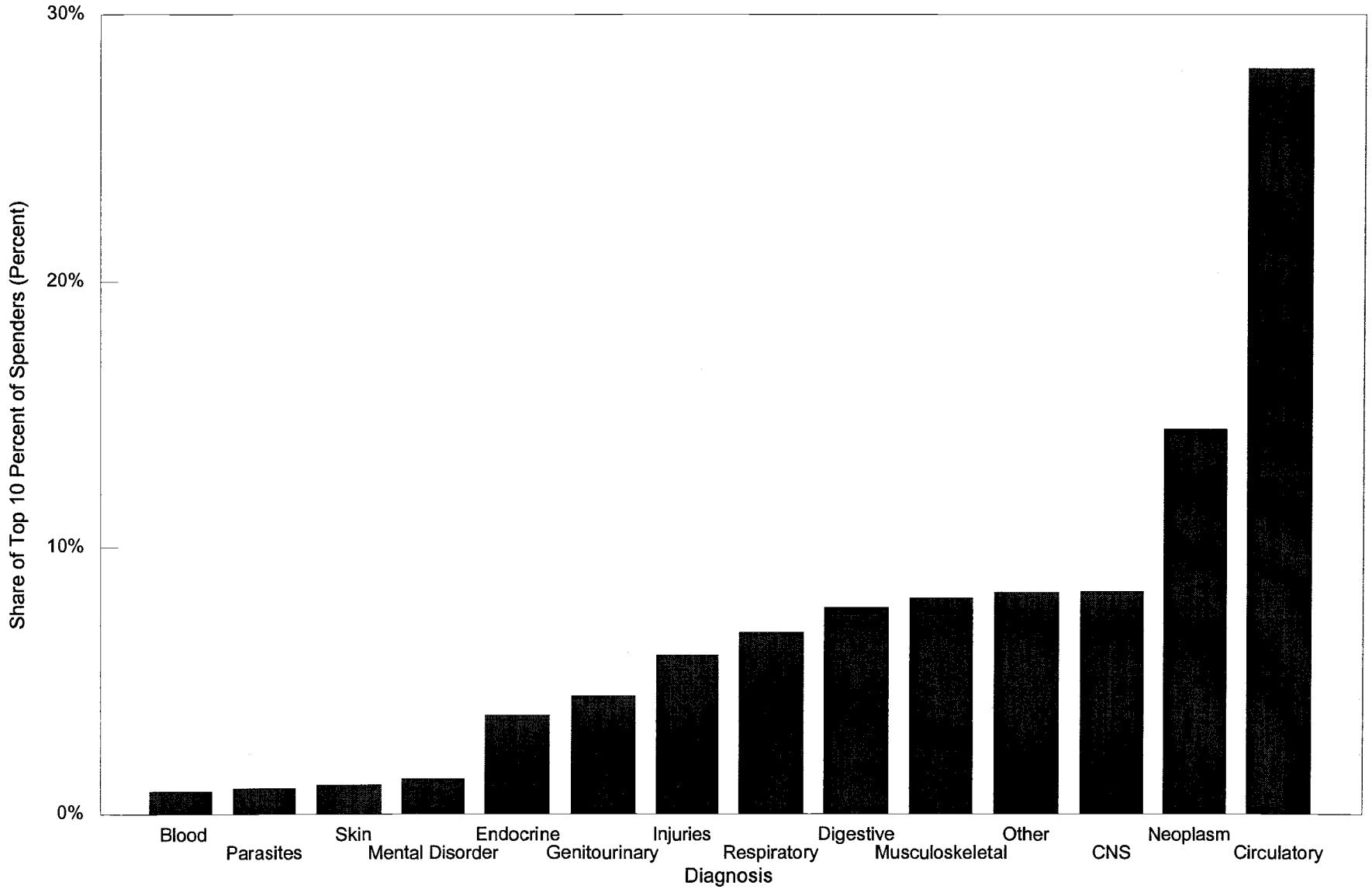


Figure 7: Detailed Diagnoses for High Cost Elderly With Primary Diagnosis of Circulatory Disorder

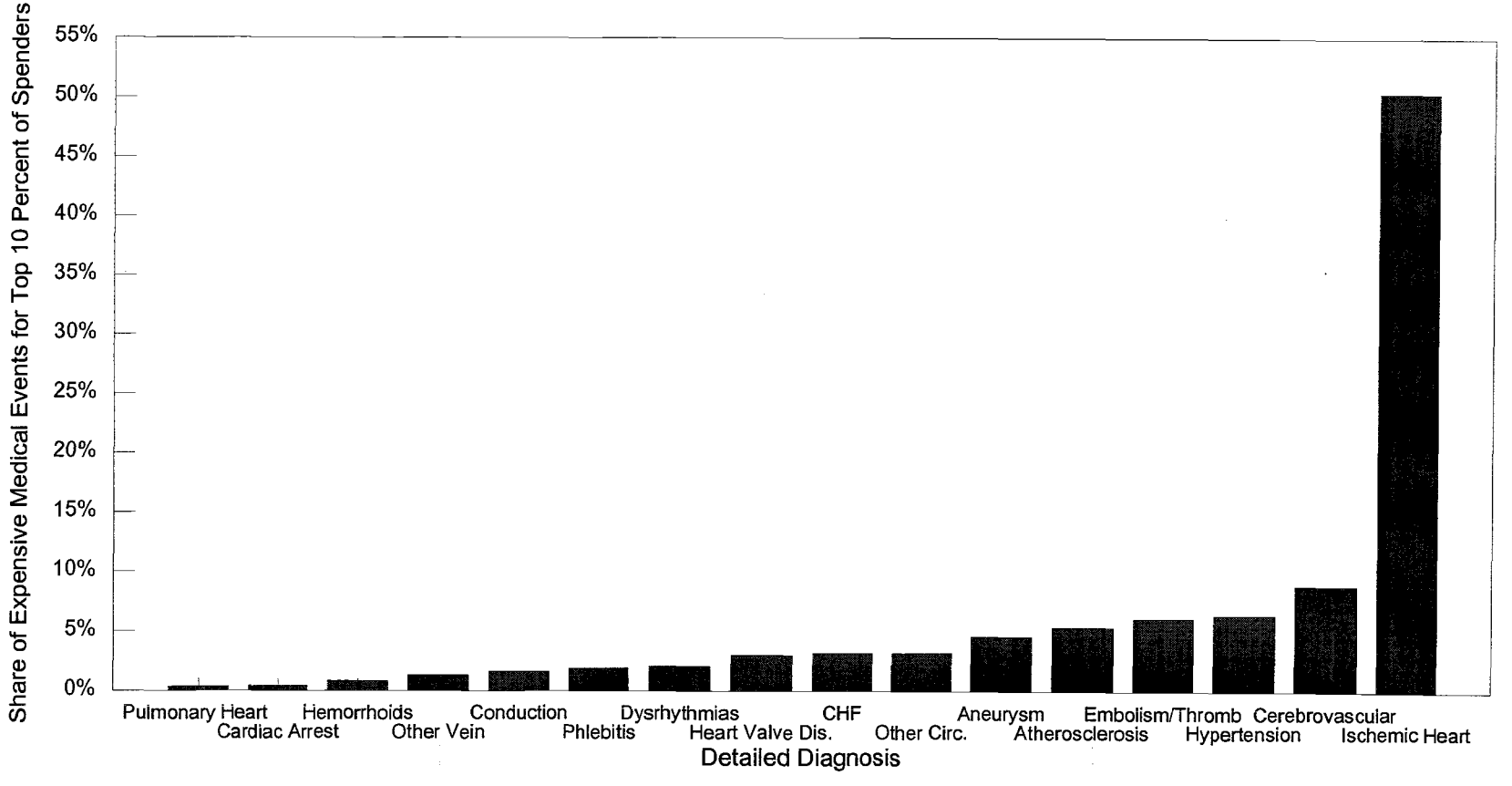


Figure 8: Length of Stay at Time of Birth

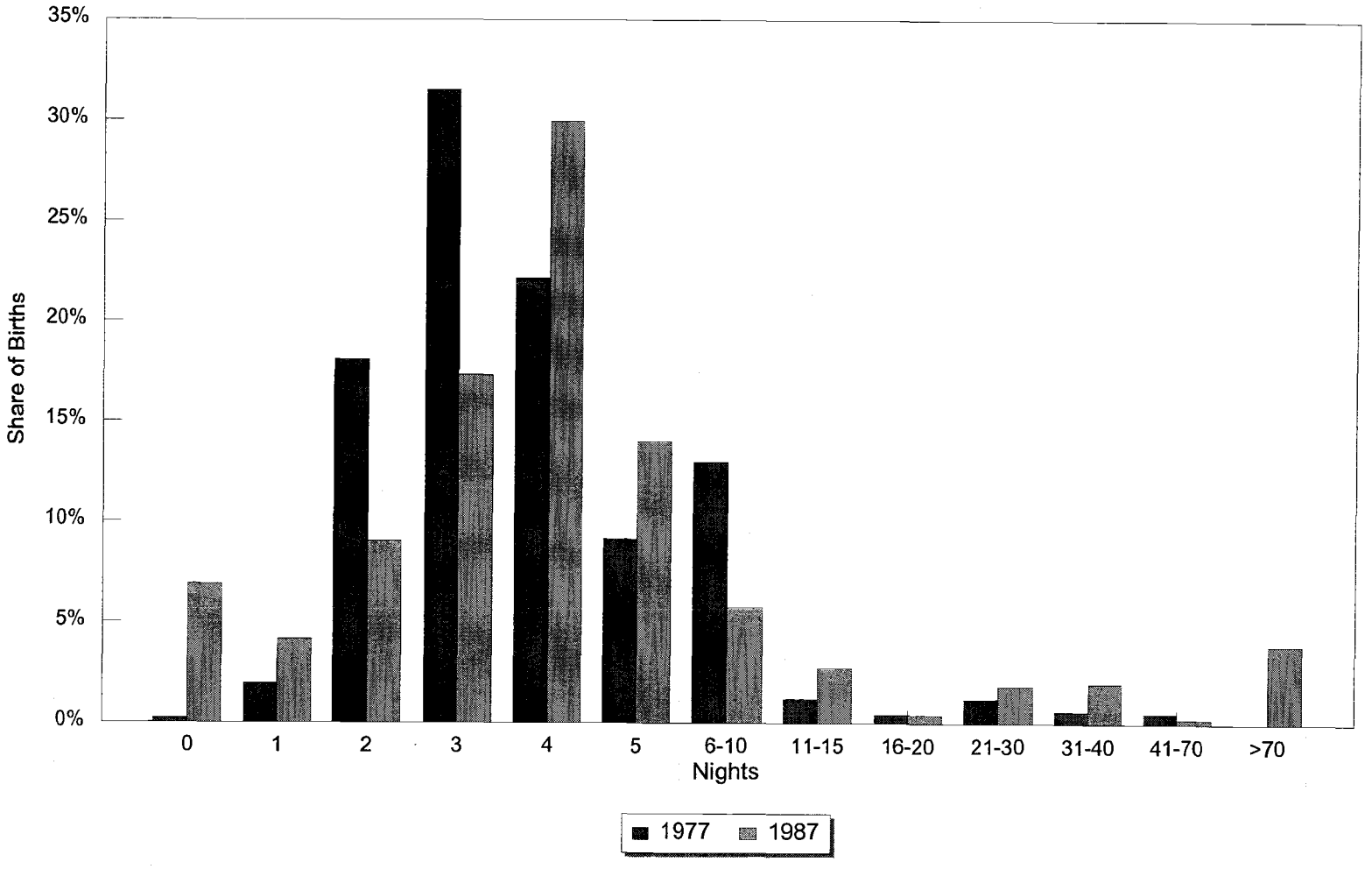
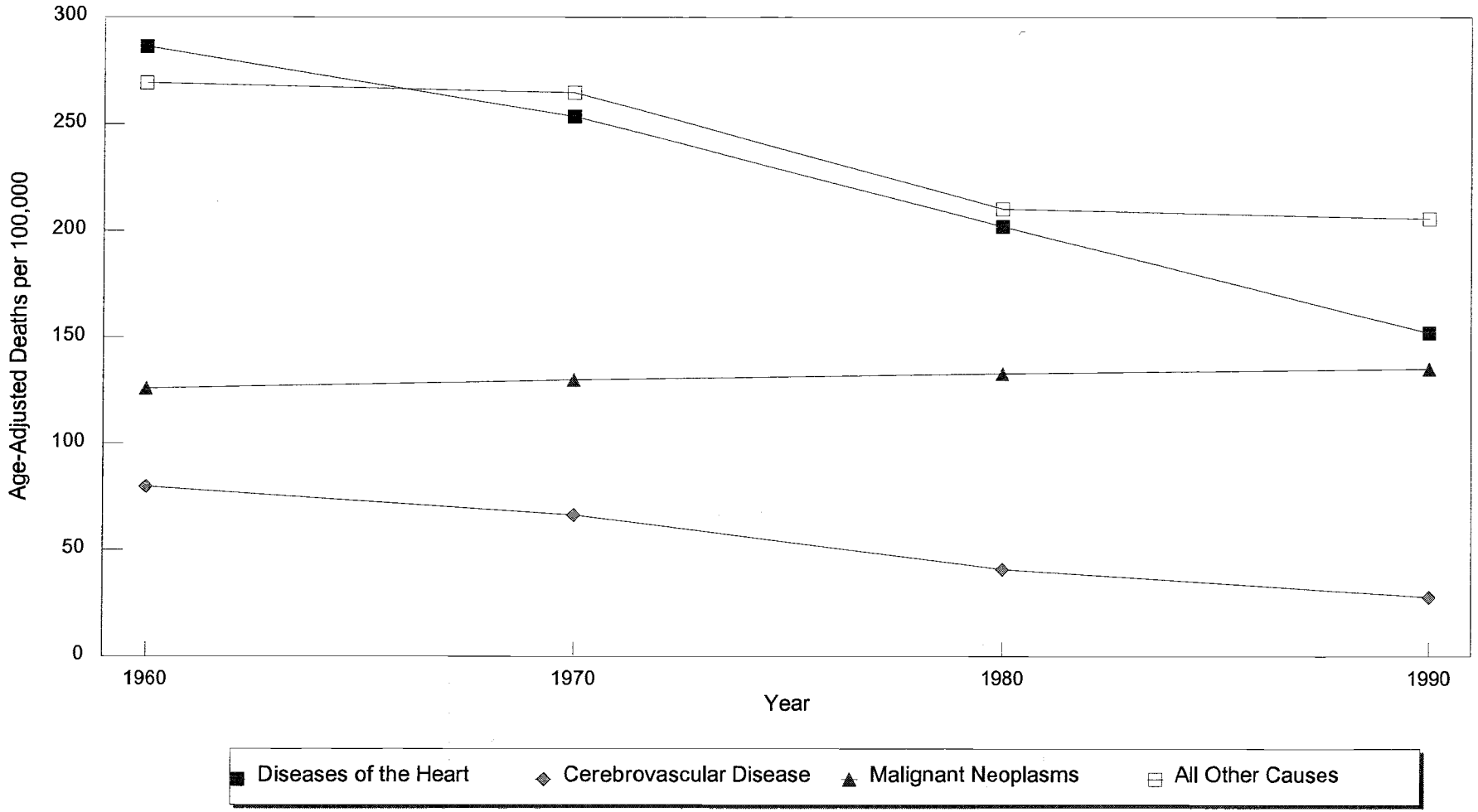
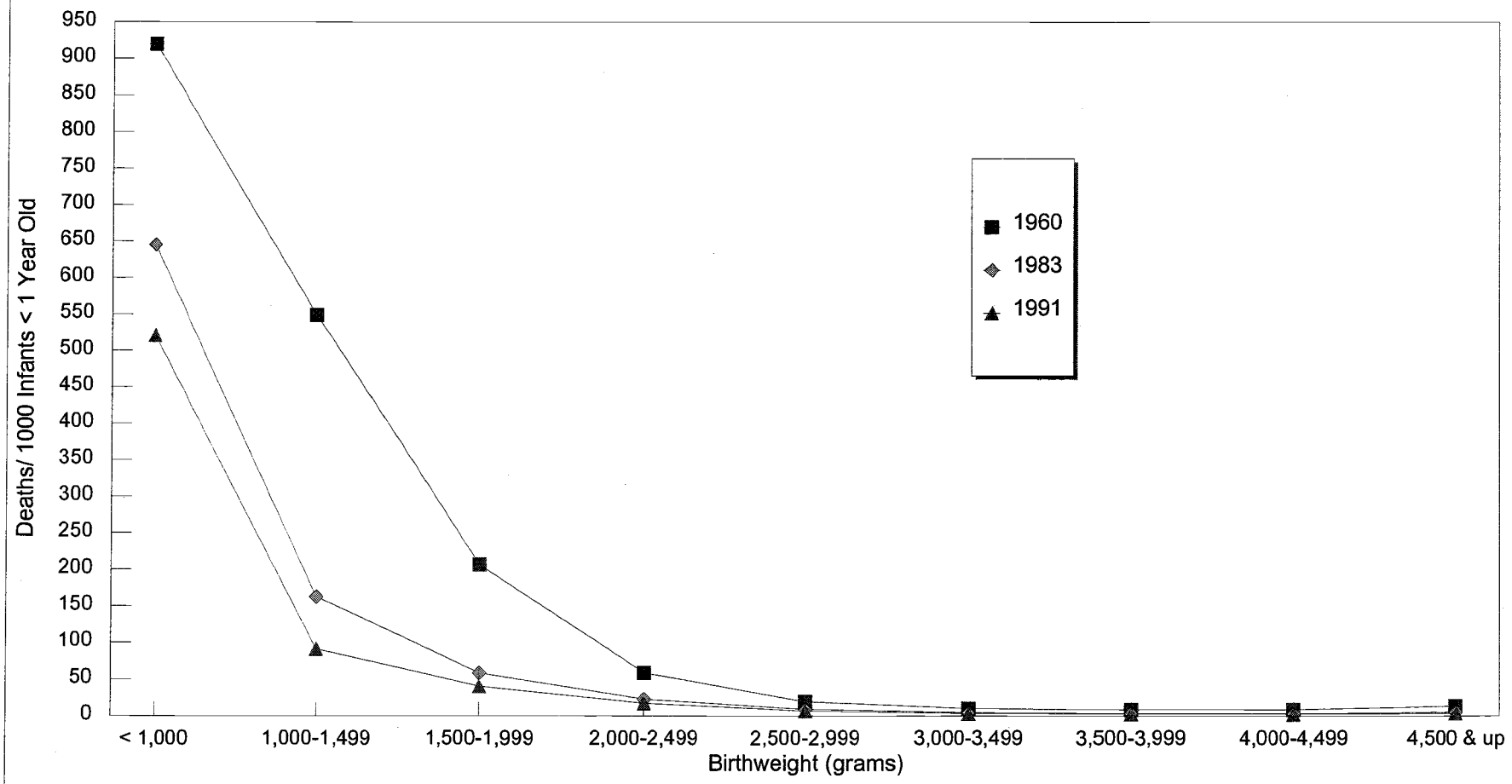


Figure 9: Changes in Death Rates for High Cost Diagnoses 1960-1990



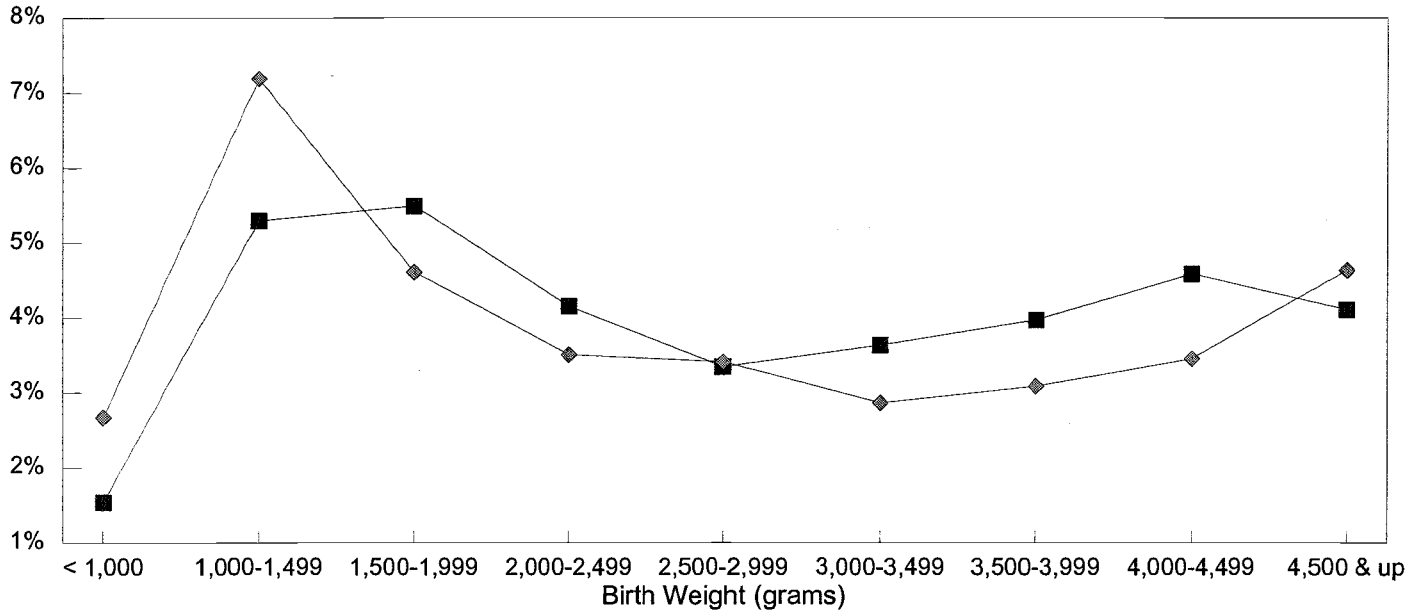
Source: Trends in the Health of Older Americans: United States 1994, National Center for Health Statistics.

Figure10: Infant Mortality by Birth Weight 1960-1991



Source: National Center for Health Statistics, Vital and Health Statistics

Figure 11: Decline in Infant Mortality by Birth Weight 1960-1991



Source: Based on Calculations using Vital and Health Statistics published by the National Center for Health Statistics

Table 1: Characteristics of Medical Spending

Year	Number of Observations	Average Spending	Average Spending Change	Share of Spending by Percentile: <50	50-90	90+
1953	8,846	$278	---	---	---	<43%[a]
1963	7,803	$385 (17)	3.3%	5%	36%	59%
1970	11,619	$668 (43)	7.9% (0.7)	4%	30%	66%
1977	38,815	$874 (16)	3.8% (0.9)	3%	27%	70%
1987	34,456	$1,521 (40)	5.5% (0.4)	3%	25%	72%

Note: Average spending is in real (1987) dollars adjusted using the GDP deflator. Standard Errors are in parentheses.

a- According to Anderson and Feldman (1956) , the top 11 percent of the health spending distribution consumed 43 percent of all health care dollars in 1953.

Table 2: Growth Rate of Costs for Primary Diagnosis of Circulatory Disorders or Neoplasms

	Average Spending 1977	Average Spending 1987	Annual Growth Rate of Real Average Spending
Circulatory Disorders			
All	$2,001	$4,140	7.3%
	(259)	(346)	(1.5)
<50th Percentile	$126	$254	7.0%
	(3)	(5)	(0.3)
50th - 75th Percentile	$449	$950	7.5%
	(11)	(21)	(0.3)
75th - 90th Percentile	$2,443	$5,229	7.6%
	(103)	(165)	(0.5)
>90th Percentile	$14,546	$29,743	7.2%
	(2,045)	(2,002)	(1.6)
Neoplasms			
All	$5,552	$8,304	4.0%
	(611)	(869)	(1.5)
<50th Percentile	$492	$726	3.9%
	(56)	(48)	(1.3)
50th - 75th Percentile	$4,232	$5,296	2.2%
	(401)	(290)	(1.1)
75th - 90th Percentile	$10.689	$15,011	3.4%
	(438)	(557)	(0.6)
>90th Percentile	$25,079	$42,392	5.2%
	(2,281)	(3,894)	(1.3)

Note: Spending is in real (1987) dollars adjusted using the GDP deflator. Standard Errors are in parentheses

Table 3: Individual Diagnoses Included in Ischemic Heart & Cerebrovascular Diseases

Diagnosis Group	Clinical Classifications for Health Policy Research (CCHPR) Recode	Examples include:
Ischemic Heart Disease	Acute Myocardial Infarction (Heart Attack)	
	Coronary Atherosclerosis (Hardening of Arteries)	Postmyocardial infarction Syndrome Intermediate coronary syndrome Old myocardial infarction Angina pectoris Other specified forms of chronic ischemic heart disease
	Other and Ill-defined Heart Disease	Aneurysm of heart Myocardial degeneration Cardiovascular disease, unspecified Cardiomegaly Rupture of chordae tendinae Rupture of papillary muscle Aquired Cardiac septal defect
Cerebrovascular Disease	Acute Cerebrovascular Disease	Subarachnoid hemorrhage Intracerebral hemorrhage Other and unspecified intracranial hemorrhage
	Occlusion or Stenosis of Precerebral Arteries	
	Other and Ill-Defined Cerebrovascular Disease	Cerebral atherosclerosis Other generalized ischemic cerebrovascular disease Hypertensive encephalopathy Cerebral aneurysm, nonruptured Cerebral arteritis Moyamoya disease Nonpyogenic thrombosis of intracranial venous sinus Transient global amnesia
	Transient Cerebral Ischemia	
	Late Effects of Cerebrovascular Disease	

Note: Diagnosis groups are those used in the National Medical Expenditure Survey, 1987. Recode groups are based on CCHPR recodes from the Agency for Health Care Policy and Research.

Appendix

Table A-1: Average Spending by Age Group 1963-1987

Age Group	1953[a]	1963	1970	1977	1987	Average Annual %Δ 1953-1987	Average Annual %Δ 1963-1987
<1	$119.32	$236.12	$353.45	$789.71	$2,502.64	9.0	9.8
		(28.06)	(56.37)	(273.84)	(1,117.01)		(1.9)
1-4	$119.32	163.53	391.09	333.80	654.75	5.0	5.8
		(11.41)	(137.23)	(20.63)	(82.33)		(0.5)
5-14	$157.68	175.17	246.91	322.56	465.51	3.2	4.1
		(11.94)	(21.93)	(17.67)	(27.80)		(0.3)
15-24	$257.40	353.48	791.35	588.03	880.55	3.6	3.8
		(28.77)	(218.94)	(19.25)	(49.74)		(0.4)
25-34	$298.31	434.84	672.93	773.44	1057.75	3.7	3.7
		(28.87)	(51.63)	(30.21)	(45.22)		(0.3)
35-44	$340.92	456.33	553.70	810.53	1095.19	3.4	3.6
		(35.56)	(48.46)	(37.84)	(51.33)		(0.4)
45-54	$340.92	566.35	728.57	1043.4	1742.03	4.8	4.7
		(44.70)	(62.80)	(46.44)	(135.66)		(0.5)
55-64	$409.11	570.96	1207.54	1476.35	2410.35	5.2	6.0
		(56.29)	(209.88)	(86.06)	(137.86)		(0.4)
65-74	$434.68	622.08	1124.76	1835.15	3874.34	6.4	7.6
		(49.62)	(82.19)	(96.26)	(191.32)		(0.4)
75-84	$434.68	688.66	1217.90	2400.05	4694.39	7.0	8.0
		(92.64)	(147.28)	(207.79)	(280.08)		(0.6)
85+	$434.68	447.46	1310.52	2845.54	5650.04	7.5	10.6
		(117.04)	(508.05)	(357.94)	(433.79)		(1.1)

[a] The 1953 age groups include: 0-5, 6-17, 18-24, 25-34, 35-54, 55-64, & 65+. Average Spending for 5-24 year olds was constructed assuming a uniform age distribution.

Note: Average spending is in real (1987) dollars using the GDP deflator. Standard Errors are in parentheses.