THE IMPACT OF AGEING ON HEALTH CARE EXPENDITURES:
IMPENDING CRISIS, OR MISGUIDED CONCERN?

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About the author

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Statement of interests

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1.1 The Ageing of National Populations

The past few decades have seen an accelerating increase in the numbers and proportion of older people in the populations of many countries. In 14 countries with available data from the Organisation of Economic Cooperation and Development (OECD) (Table 1.1), the number of people aged 65 and over increased at an annual rate of 3% from 1970 to 1998, eclipsing the much slower growth rate for the total population, of 1.1%. As a result, the proportion of population aged 65 and over in the 14 countries with available data increased from 10% in 1970 to 14% in 1998.

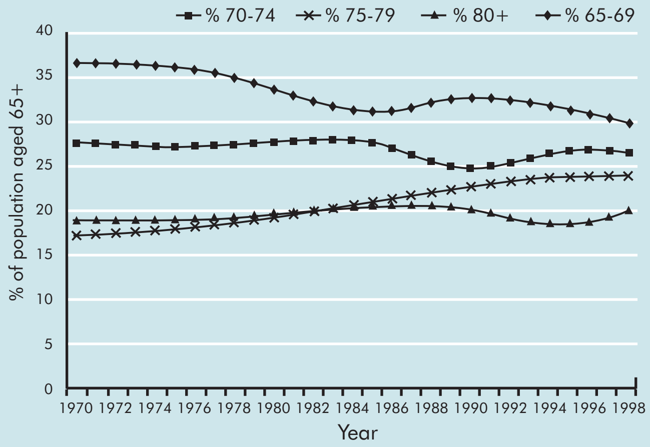
Table 1.1: **Statistics for OECD countries with available data, 1970 and 1998**

Country	Total Population (m)		% Aged 65+		Total HCE as % GDP	
	1970	1998	1970	1998	1970	1998
Australia	12.5	18.7	8.4	12.2	5.7	8.6
Austria	7.5	8.1	14.1	15.4	5.3	8.0
Belgium	9.7	10.2	13.4	16.5	4.0	8.6
Canada	21.3	30.5	8.0	12.3	7.0	9.3
Finland	4.6	5.2	9.1	14.7	5.6	6.9
France	50.8	58.4	12.9	15.8	5.7	9.4
Germany*	60.7	82.0	13.2	16.6	6.3	10.3
Italy*	53.8	57.6	13.6	17.6	5.1	8.2
Japan	104.7	126.5	7.1	16.2	4.6	7.4
Netherlands	13.0	15.7	10.2	13.5	7.2	8.7
New Zealand	2.8	3.8	8.4	11.6	5.2	8.1
Norway	3.9	4.3	12.9	15.6	4.4	9.4
Spain	33.9	39.4	9.4	16.3	3.6	7.0
Sweden	8.0	8.9	13.7	17.4	6.9	7.9
United Kingdom	55.6	59.2	13.0	15.7	4.5	6.8
United States	204.0	270.2	9.8	12.4	6.9	12.9

* Age-specific population numbers not available for the full time period 1970-1998

Source: OECD Health Data 2001.

Figure 1.1: **Population ageing within the older age groups in 14 OECD countries, 1970 to 1998**



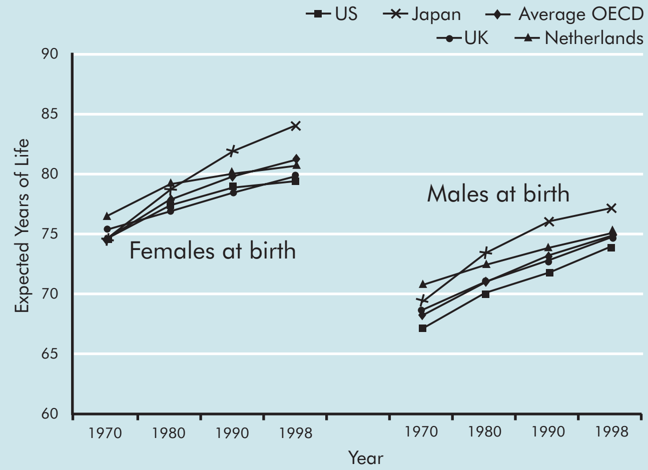
Source: OECD Health Data 2001.

Within the older age groups, there has been a shift towards the oldest old. The proportion of those aged 65 to 69 decreased from 36.5% to 29.9%, while the proportion aged 80 and over increased substantially from 17.1% to 23.9%. The percentage of the middle-old (70-79) remained relatively constant (Figure 1.1).

At least two main factors underlie this ageing of the population. First, there has been a decrease in fertility over the past few decades, thereby lowering the population numbers in the younger age groups. Using the number of children per woman aged 15 to 49 as an indicator, fertility rates decreased across developed countries from a population-weighted average of 2.4 children in 1970 to 1.7 children in 1998.

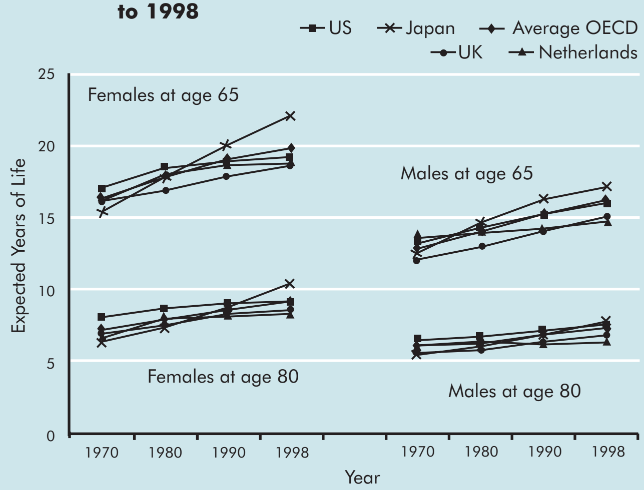
Second, age-specific mortality rates have decreased over time, leading to a noticeable increase in life expectancy. From 1970 to 1998, the population-weighted mean life expectancy for a male at birth rose from 68.2 to 75.0 years, and for a female from 74.9 to 81.0 years, with Japan at the high end and the US at the low end (Figure 1.2). Life

Figure 1.2: **Changes in life expectancy at birth, 1970 to 1998**



Source: OECD Health Data 2001.

Figure 1.3: **Changes in life expectancy at older ages, 1970 to 1998**



Source: OECD Health Data 2001.

expectancy at the older ages also increased dramatically (Figure 1.3). Japan still had the longest life expectancy at the older ages, and the Netherlands had the lowest, among the OECD countries.

Demographic projections indicate that the decades to come will see a continuation of this ageing process. In fact, the United Nations projects that concomitant declines in world fertility and rises in life expectancy will cause the world to age faster in the next 50 years than it did during the past half century. While the proportion of people aged 60 and over in the populations of developed regions rose from 12% in 1950 to 19% in 2000, it is expected to rise to 33% in the year 2050 (United Nations, 2001). In England, data from the Government Actuary's Department projects the proportion of people aged 60 and older to rise from 20.4% in 2000 to 29.7% in 2040.

1.2 The Economic Impact of Ageing

Population ageing will have a profound impact on the societies, politics, and economies of countries. In particular, ageing is associated with alterations in private and public expenditure patterns, due to differing needs and preferences of older versus younger consumers. It has been argued that the compensating effects of simultaneous increases in numbers of the older population and decreases in the young would lead to little overall change in macro-level private consumption (Richter, 1992). Social expenditures, however, can be expected to change dramatically; it has been estimated that public spending components sensitive to age structure – including old-age pension programmes, health and long-term care, family/child benefits, and education – comprise 40% to 60% of total public spending (Dang et al., 2001), with total social outlays per capita being higher for older than younger populations (Richter, 1992). Indeed, the OECD projects ageing to cause rises in age-related social expenditures, in 13 countries with available information, from an average of 18.7% of GDP in 2000 to 25.6% of GDP in 2050 (Dang et al., 2001).

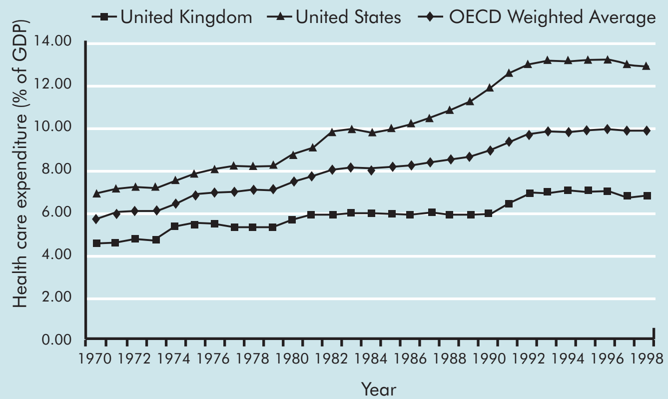
1.3 The Pressures of Rising Health Expenditures

Health policy makers have expressed concern over the pressures that ageing populations will have on rising health care expenditures. Over the past few decades, there have been substantial increases in the percentage of GDP spent on health care across nations (Figure 1.4). In 1970, the population-weighted average across the OECD countries was 5.7%. By 1998, this figure had risen to 9.9%, with the UK at 6.9% and the US at the high end with 12.9%.

Older populations are traditionally high users of health care relative to the rest of the population. OECD data for 12 countries show that per capita expenditure for those aged 65 and over was on average 3.7 times greater than for those aged under 65 in 1993. If this is the case, then it can be expected that an increase in the proportion and absolute size of the older population will lead to a substantial rise \in health care expenditures.

Interestingly, of cross-national studies that have examined various factors associated with health care expenditures in developed

Figure 1.4: **HCE as % of GDP for OECD countries, 1970 to 1998**



Source: OECD Health Data 2001.

countries, only one (Hitiris and Posnett, 1992) found the age structure of the population (usually measured by the percentage of population over age 65) to have a consistently significant association when accounting also for the effects of income, lifestyle factors, and environmental factors (Gerdtham et al., 1992a; Gerdtham et al., 1992b; Gerdtham et al., 1998; OECD, 1987; Getzen, 1992; Hitiris and Posnett, 1992; Leu, 1986; O'Connell, 1996). Indeed, the correlation between the population share of older age groups and the percentage of GDP spent on health care was insignificant for eight OECD countries in 1997 (Anderson and Hussy, 2000).

1.4 How do Demographic Shifts Impact on Health Expenditures?

In order to examine more closely the influence of population demographics on health expenditures within a particular country, researchers have mapped utilisation patterns as age-use and age-expenditure curves. By plotting use and/or expenditure against age, they are able to quantify a relationship between the two that can be used to assess the impact of changing demographics on health care utilisation and expenditure (Currie et al., 1996; Dang et al., 2001; Denton and Spencer, 1995; Denton and Spencer, 2000; Hills, 1995; Mayhew, 2000; Rice and Feldman, 1983; Schneider and Guralnik, 1990; Smith et al., 1999;). By applying this approach retrospectively, studies can examine the changes in health care expenditure that are associated with changes in demographic structure. Most of the studies employing this approach, however, have found the effects of ageing on health care expenditures to be small, accounting for approximately 0.3% to 0.8% annual expenditure growth over periods when the total increase in real health expenditure averaged 4% to 6% per annum (Barer et al., 1989; Denton, 1975; Fuchs, 1998; Gerdtham, 1993).

Beginning in the early 1970s, UK programme budget analysis also considered the impact of ageing on health spending, with an emphasis on inescapable commitments that had higher priority than desirable increases such as service improvement. Using a constant age-specific expenditure to estimate the allowance for demographic

change was an initial working assumption on available evidence (Hulme, 2003). A closer examination of the relationship between age and health care expenditures could help to better determine the impact that demographic changes will have on health care expenditures. This monograph therefore builds upon the existing literature to analyse whether there is indeed a link between ageing and health care expenditures and, if so, what form that link takes.

1.5 Overview of the Monograph

1.5.1 The dynamic age-expenditure relationship

Chapter 2 presents a study of age-specific expenditures for Hospital and Community Health Services (HCHS) and Family Health Services (FHS) in the National Health Service (NHS) England and Wales, which finds that the age-expenditure relationship has not stayed constant over time. The low-expenditure middle age groups had a faster proportional increase in their per capita health expenditures than the older age groups, influenced mainly by the trends of non-acute HCHS care. In contrast, three other countries with available data – Canada, Japan, and Australia – had disproportionate rises in per capita expenditures for the older age groups over time. A retrospective analysis of the relationship of health spending to 1) demographic changes, and 2) changes in per capita expenditure, finds that most of the spending changes from the mid-1980s to mid-1990s were accounted for by changes in per capita expenditures. Further examination was therefore pursued into possible influences on this age-specific per capita expenditure.

1.5.2 The effect of proximity to death on health care expenditures

Chapter 3 surveys the current epidemiologic and economic literature on ageing to propose an alternative influence for health care expenditures. The chapter examines epidemiological evidence of the "compression of morbidity" hypothesis, proposed initially by Fries (1980), to conclude that the additional years of life lived with increased life expectancy are more likely to be in health than in disability, and hence morbidity is likely to be concentrated at the end of life. Numerous economic studies have found that health care expenditures tend to be concentrated in the last year of life, and a longitudinal 5-year Swiss study found that once time to death was taken into account, age was no longer a significant factor in determining health care expenditures (Zweifel et al., 1999).

Chapter 4 examines the effects of proximity to death and age on hospital expenditures in the Oxfordshire region of England using a longitudinal, 29-year dataset. Proximity to death exerted a significant effect on hospital expenditures up to 15 years prior to death, including a more than fourfold jump in expenditures from the second to last year of life. Once proximity to death was accounted for, age had a much smaller expenditure effect. Expenditures in the last year of life were 30% higher for an 80 year old woman compared to a 65 year old woman, and 37% higher for an 80 year old man than a 65 year old man. In contrast, expenditures in the last year of life were 20% lower for a 95 year old than an 80 year old (man or woman). Ten years out from death, age did not have a significant trend in its effect on expenditures.

1.5.3 Projection analyses

Chapter 5 integrates the analyses of the proximity to death model to devise alternative projection methods of the impact of demographic change on health expenditures. Incorporating the effects of proximity to death in the expenditure model halved estimated increases in real national hospital expenditure over time, from an annual growth rate of 0.85% to 0.42%. The actual expenditure effect of increases in longevity after age 65 was small once the postponement of death-related expenditures was taken into account. Instead, the majority of the burden of ageing will occur in the form of increased birth cohort sizes – the post-WWII ‘baby boomers’.

CHAPTER 2 – IS THE ASSUMPTION OF CONSTANT AGE-SPECIFIC EXPENDITURES TENABLE?

2.1 Introduction

A major assumption embedded in the aforementioned literature of the impact of age on health care expenditures is the constant age-expenditure relationship over time. In determining the effect of demographics on health care expenditure, it is important to consider how age-specific utilisation patterns change among the age groups over time (White, 1999). Several studies looking at the age-expenditure relationship in time series have shown that expenditures have increased disproportionately among the very young and very old in comparison to those in the middle age groups. One study using data from the US Health Care Financing Administration showed that from 1977 to 1987 the percentage change in expenditures was higher for the under 19s (10.55%) and the 65 and over age group (12.44%) than for the 19-64 age range (9.24%) (Mendelson and Schwartz, 1993). Another US study found that per capita health care expenditure increased dramatically among the population aged 65 and over, from being less than that that of the under 65s in 1963 to being four times the per capita expenditure of the under 65s in 1987 (Cutler and Meara, 1998). Even within the older age groups, expenditures grew faster in the oldest old compared with the younger old. While spending grew 2.0% annually in the 65 to 69 age group, it rose by 4.3% annually in the 85 and over age group (Cutler and Meara, 1999).

A study of health care use in British Columbia found that per capita hospital use decreased from 1971 to 1983, but decreased at a slower rate for the older populations: a 10% decrease over the time period for males over 80 versus a 30% average decrease for all males. Medical service expenditures increased across all age groups from 1981 to 1984, but at a higher rate for the older populations (the growth rate for females over age 75 was 10% faster than that of the general population) (Barer et al., 1987).

In Sweden, from 1976 to 1985, per capita expenditure increased fastest for the 75 and over population, at 54.3%, versus a relatively stable per capita expenditure for the 15-64 age group (Gerdtham, 1993).

Thus, the "crisis" of an ageing population could expand beyond increased numbers of elderly, to include increased intensity of service use by them (Culyer, 1988; Evans, 1983).

Indeed, studies that have included the variable of intensity of services when evaluating the contribution of population growth and demographic changes to rising health care expenditures have found that the change in age-specific utilisation is a more important influence on expenditure growth than changing age structure per se. For instance, a study of physician service expenditures in British Columbia from 1974-75 to 1985-86 found that utilisation changes spurred annual expenditure growth by 3%, in contrast to demographic changes, which created a growth rate of 0.4% (Barer et al., 1989). A study examining personal health consumption of older Americans (including Medicare and non-Medicare expenses) found changes in age-specific per capita expenditure to create an annual growth rate of 3.9% from 1985 to 1995, more than 13 times the 0.3% annual growth rate caused by changes in age structure (Fuchs, 1998). Along the same lines, a study in Quebec found age structure changes to account for only 0.5% of health care expenditure growth from 1982 to 1992, while utilisation changes accounted for 47% of observed expenditure growth (Demers, 1996). A study of the number of ambulatory visits in Manitoba found age structure to account for 2.4% of the increase in visits from 1971 to 1983, compared with 43.4% for service intensity (Black et al., 1995).

Clearly, more detailed information on changes in age-specific expenditures over time could provide for more accurate modelling of the effect of age on health care expenditures. Additionally, an international comparison could provide a framework to examine if the pressures of ageing vary between countries, though longitudinal international comparisons to date have been hindered by the lack of comparable, long-term data series. In this study, the age-specific expenditure trends for the NHS in England and Wales are examined and compared with three other countries with available longitudinal data.

2.2 Data and Methods

Expenditures in the NHS in England and Wales were examined for the time periods 1985 to 1987 and 1996 to 1999. There are two main components of NHS care: Hospital and Community Health Services (HCHS), which comprised 73% of NHS expenditures in the two time periods; and Family Health Services (FHS), which comprised the remaining 27%. HCHS expenditure figures were compiled from data collected from NHS Trusts and Health Authorities in England and Wales, and then divided by age group using age-specific activity figures. Breakdowns of age-specific expenditures by individual HCHS sector were available for the years 1986-87 and 1996-99 into acute care (inpatient and outpatient) and non-acute care (including community health services, geriatric and obstetric care).

The FHS programme budget was not broken down by age group, and so data from the General Household Survey (GHS) were used to estimate the distribution of FHS expenditures across age groups, based on the distribution of the number of GP consultations in the two weeks prior to GHS interview.[1]

All expenditure figures were brought to 1998-99 prices using HCHS deflators provided by the Department of Health. Averaged period expenditures for 1985-87 and 1996-99 were used to smooth out any sudden changes in the expenditure data. Mid-year census population figures were similarly averaged for the corresponding years.

For the international comparison, long-term expenditure data were available for three countries: Japan, Canada, and Australia, for the age groups 0 to 14, 15 to 44, 45 to 64, and 65 and over. Three-year rolling average expenditures were calculated for the beginning and end of a comparable 12-year time period for each country, and all prices were brought to 1997 levels using price indices for total health expenditure from OECD data.

The health expenditure data of the four countries are reasonably comparable for the services they include, and more comparable than

[1] It was assumed that the age-specific distribution of GP consultations – which comprise 86% of total FHS expenditures when including related prescription expenditures – approximates that of all FHS services.

Table 2.1: **Sectors covered in health expenditure data**

	Inpatient Services	Outpatient Services	Hospital Room & Board	Physician Fees	Drug Expenditures	Long-term Care
Japan	✓	✓	✓	✓	✓	✘
Canada	✓	✓	✓	✓	✓	✘
Australia	✓	✓	✘	✓	✘	✘
England & Wales	✓	✓	✓	✓	✓	✘

Source: Seshamani and Gray, 2003.

any previously published or routinely available data (Table 2.1). However, it is important to note that, unlike the other countries, Australia does not include drug expenditures or the accommodation expenditures for inpatient stays. Thus, the included expenditures will not be quite as comprehensive for Australia as those of the other countries. Also, none of the countries had data on relevant social care expenditures such as long-term care. As will be discussed below, consideration of shifts of care from the health care to social care sectors could partly explain any trends in health care expenditures in the different age groups over time.

2.3 Results

2.3.1 Population health expenditures, population growth and ageing

At 1998-99 prices, total HCHS and FHS expenditures for England and Wales increased by 28%, from £25.5 billion in 1985-1987 to £32.7 billion in 1996-99 (Table 2.2). Age-specific expenditure increased most noticeably among the 0 to 4 age group. The changes in population expenditure are partially explained by a 4.3% increase in total population. There was not a marked ageing of the population, with the portion of the population in the older age groups staying relatively constant, at 15.5% in 1985-1987 and 15.7% in 1996-1999. However, within the older age groups there were shifts towards the

Table 2.2: **Population Figures, Total NHS Expenditures and Per Capita NHS Expenditures over Time, England and Wales**

	0 to 4	5 to 15	16 to 44	45 to 64	65 to 74	75 to 84	85+	All Ages
Combined NHS Expenditure								
1985-87								
£ million	1,642	1,888	6,655	5,022	4,085	4,469	1,698	25,459
£ per capita	543	288	328	493	969	1,762	2,711	537
1996-99								
£ million	2,579	1,980	9,342	7,156	4,491	4,746	2,399	32,693
£ per capita	839	283	463	627	1,088	1,769	2,517	661
% change								
Total	57.0	4.9	40.4	42.5	9.9	6.2	41.3	28.4
£ per capita	54.5	-1.9	40.9	27.3	12.3	0.4	-7.1	23.1
HCHS Expenditure								
1985-87								
£ million	942	1,165	4,152	3,562	3,327	3,958	1,576	18,683
£ per capita	312	178	205	350	790	1,561	2,516	394
1996-99								
£ million	1,747	1,220	6,136	4,855	3,489	4,029	2,260	23,735
£ per capita	569	174	304	427	845	1,502	2,372	480
% change								
Total	85.4	4.7	47.8	36.3	4.9	1.8	43.4	27.0
£ per capita	82.5	-2.1	48.4	21.7	7.1	-3.8	-5.7	21.8
FHS Expenditure								
1985-87								
£ million	700	723	2,503	1,459	758	511	122	6,776
£ per capita	231	110	123	143	180	201	195	143
1996-99								
£ million	831	761	3,206	2,301	1,002	717	139	8,957
£ per capita	270	109	159	202	243	267	146	181
% change								
Total	18.8	5.2	28.1	57.7	32.3	40.4	14.0	32.2
£ per capita	16.9	-1.7	28.6	40.8	35.1	32.7	-25.3	26.8
Population Figures								
1985-87 (m)	3.0	6.5	20.3	10.2	4.2	2.5	0.6	47.4
1996-99 (m)	3.1	7.0	20.2	11.4	4.1	2.7	1.0	49.4
% change	1.7	7.0	-0.4	11.9	-2.1	5.8	52.0	4.3

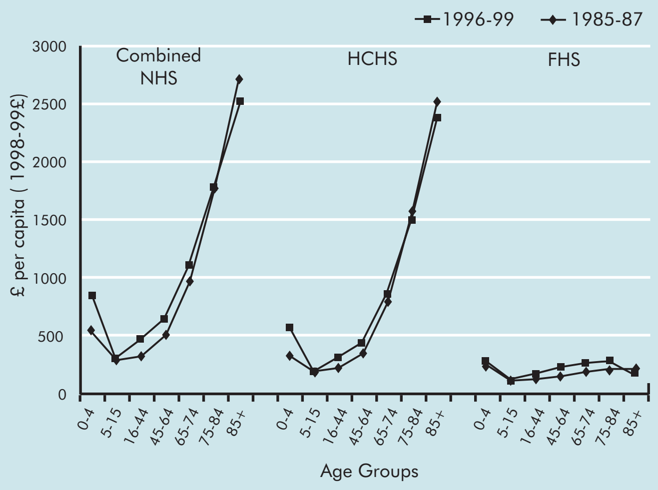
Source: Seshamani and Gray, 2002.

oldest old, with the population aged 85 and over rising from 8.4% of the older population in 1985-87 to 12.3% in 1996-99 (Seshamani and Gray, 2002).

2.3.2 Expenditures by age group

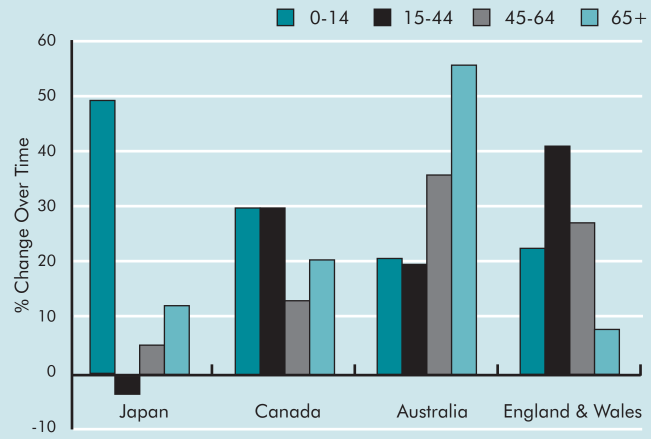
The age-expenditure curves in Figure 2.1 clearly demonstrate that the old and the young were higher expenditure patients than the middle age groups. Furthermore, the composition of expenditures in the age groups was slightly different; while HCHS expenditures comprised 84% of overall expenditure for the population aged 65 and over, for those aged 5 to 64 it comprised 66% of overall expenditures. Within the older age groups, per capita expenditures were more concentrated in HCHS with increasing age, at 94% of overall expenditures for the age group 85 and over, compared with 77% of per capita expenditures for age group 65 to 74.

Figure 2.1: **Age-expenditure curves for NHS expenditures**



Source: Seshamani and Gray, 2002.

Figure 2.2: **Percentage change in per capita expenditures by age group, 1980s to 1990s**



Source: Seshamani and Gray, 2003.

The age-expenditure curves of Figure 2.1 do not follow the assumption of constant age-specific expenditures over time, yet interestingly, they do not exhibit larger expenditure increases in the higher expenditure age groups (the very young and the old.) The traditional U-shape of the age-expenditure curve, with the very young and very old having the highest per capita expenditures, became slightly shallower over time, as the real per capita expenditures of the older populations decreased while the expenditures of the middle age groups rose (Figure 2.1). Only acute inpatient services demonstrated a disproportionate increase among the high-expenditure young and old.

The concentration of health care expenditures towards the older age groups was quite noticeable in 1985-87, with the population aged 65+ making up 15.5% of the population, and yet consuming 40.2% of total health services. Over time, however, national expenditures shifted towards the middle age groups. While the 65 and older population held a steady percentage of the population, by 1996-99 their proportion of health expenditures had fallen to 35.6%.

2.3.3 International Comparison

In contrast to England and Wales, Japan, Canada and Australia all had rapid per capita expenditure rises in the oldest age group between the mid-1980s and mid-1990s (Figure 2.2). Coupled with this difference in per capita expenditure pattern was a difference in demographic patterns – Japan, Canada, and Australia all experienced an ageing of their populations, while the demographic structure of England and Wales stayed relatively constant. As a result, while England and Wales had the highest population-level expenditure rises in the 45 to 64 age groups, overall population-level health expenditure increased fastest among the oldest age group for Japan, Canada and Australia. While England and Wales experienced a decreased proportion of expenditure being on the oldest age group over time, Japan, Canada and Australia all had increases in the proportion of national health expenditures going on the older population (Table 2.4) (Seshamani and Gray, 2003).

Notably, all three countries with expenditure information by health sector (Japan, Canada, and England and Wales) had larger differences in per capita expenditures by age group for their inpatient care compared with their outpatient and physician care, leading to the older age group's use of a larger share of national hospital expenditure than national physician expenditures. Additionally, inpatient expenditures were more likely to show a disproportionate increase in expenditure for the older age groups over time than were other sector expenditures.

2.4 Discussion

The analysis of age-expenditure curves of England and Wales counters the assumption of constant age-specific per capita expenditure. Contrary to the other countries of this study, the high expenditure older age groups did not have larger increases in their medical expenditures than the lower expenditure age groups. In fact, for non-acute HCHS care and for acute outpatient care, the middle age groups had the fastest rate of growth. Acute inpatient care alone

Table 2.3: **Proportion of population and expenditures accounted for by each age group**

	0 to 14	15 to 44	45 to 64	65+
Japan				
% of Population				
1983-85	22.0	44.7	23.3	10.0
1995-97	15.7	41.2	28.1	15.1
% of Overall Expenditure				
1983-85	8.0	24.2	31.9	35.9
1995-97	6.4	16.4	30.9	46.3
% of Inpatient Expenditure				
1983-85	5.1	23.1	30.1	41.8
1995-97	4.2	14.7	29.1	52.0
% of Other Expenditure				
1983-85	10.8	25.4	33.8	30.1
1995-97	8.3	17.8	32.4	41.5
Canada				
% of Population				
1980-82	22.3	49.3	18.9	9.6
1992-94	20.5	47.7	20.1	11.7
% of Overall Expenditure				
1980-82	10.5	33.1	22.0	34.4
1992-94	9.5	31.7	20.1	38.7
% of Hospital Expenditure				
1980-82	6.3	23.3	21.7	48.7
1992-94	4.4	19.9	18.6	57.1
% of Physician Expenditure				
1980-82	14.1	43.7	23.1	19.1
1992-94	12.0	39.3	24.4	24.4
% of Drug Expenditure				
1980-82	2.2	11.6	13.4	72.9
1992-94	2.0	11.0	13.0	74.0
Australia				
% of Population				
1984-86	23.4	47.2	19.1	10.4
1996-98	21.0	45.2	21.6	12.2
% of Overall Expenditure				
1984-86	13.0	43.2	24.9	18.9
1996-98	10.4	36.3	28.0	25.3
England and Wales				
% of Population				
1985-87	20.2	42.8	21.5	15.6
1996-99	20.4	40.9	23.1	15.7
% of Overall Expenditure				
1985-87	13.9	26.1	19.7	40.3
1996-99	14.0	28.6	21.9	35.6
% of HCHS Expenditure				
1985-87	11.3	22.2	19.1	47.4
1996-99	12.5	25.8	20.4	41.2

Source: Seshamani and Gray, 2003.

demonstrated a steepening of the age-expenditure curve, such that the older groups had larger increases in expenditures than the lower expenditure middle-age groups.

The different patterns of age-specific health care expenditures among the health care sectors likely reflect differing health service needs of the age groups. For instance, the continued disproportionate increase in older people's expenditures for services such as acute inpatient care could reflect an increased need among those age groups for hospital treatment, while acute outpatient services may not demonstrate as consistent a relationship between need for care and patient age. It is also possible that the different health care sectors have employed different patient management schemes, whereby expenditure-controlling measures have kept down expenditures for non-acute care of older populations, but have not yet impacted acute inpatient.

Of concern is the possibility that older people have decreased ability to get medical care. Within the acute setting, studies have shown differences in treatment between patient age groups, independent of clinical need. One study demonstrated significantly decreased rates of exercise tolerance tests and coronary angiographies for older patients compared with younger patients with similar clinical need (Bowling et al., 2001). A survey of coronary care units in the UK in 1991 found that nearly half employed upper age limits in their treatment policies, even though treatment restriction by age alone could not be sustained on clinical grounds (Dudley and Burns, 1992).

There may also be increased shifting of older patients from non-acute HCHS care into other social care settings, including residential and nursing home accommodation. Data from Laing and Buisson (1999) document that from 1988 to 1998 the market value of the UK nursing and residential care sector for older populations increased by 43%, from £5.1 billion to £7.3 billion, while the value of long stay hospital care in the NHS decreased by 52%, from £2.2 billion to £1.1 billion (holding prices constant at £1998-99). An increase in social care likely accounts in part for the differences in trends in health care expenditure observed between England and Wales and the other countries. Unfortunately, national expenditure data on long term care are not readily available to examine any service sector shifts.

There are several notable issues when interpreting the findings presented above. First, as with all international studies, there is not full comparability of the data sources.

Second, we looked at "expenditures" in this study not as opportunity expenditures but as the actual expenditure associated with the use of health services. For this reason, we used the health deflator to bring all expenditure figures to constant prices, to standardise the package of expenditures. Alternatively, one could use the GDP deflator, to represent more the opportunity expenditure of devoting increased resources to health care. However, using the GDP deflator would not substantially alter the results reported here.

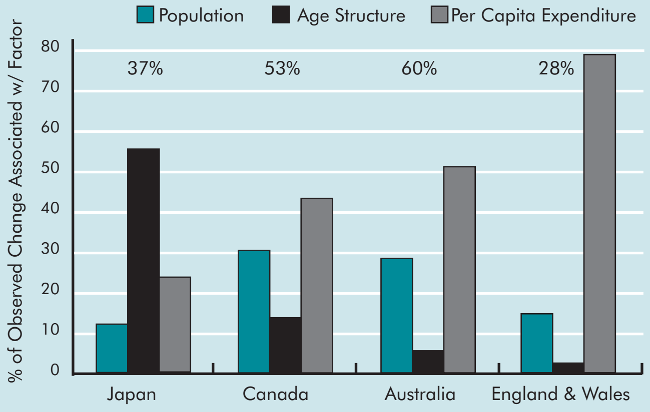
Third, all analyses were framed from the perspective of how individual patient characteristics ultimately determine national expenditure levels. The study does not detail the impact of more aggregate supply-side influences such as rationing schemes, policy objectives and resource limitations on national health expenditures.

2.5 Can Ageing Alone Explain Health Expenditure Increases?

2.5.1 A retrospective analysis

The relationship of national health expenditure changes with demographic changes (in terms of population size and age structure) and changes in age-specific per capita expenditure was determined next. Following the methodology of pervious work (Barer et al., 1989; Black et al., 1995; Demers, 1996; Mendelson and Schwartz, 1993), two of the three factors were held constant at levels from the first time period, the third factor was changed to the level at the second time period, and total expenditure was recalculated. Doing so enabled calculation of the change in expenditure associated with changes in one factor. It is important to note, however, that while such analyses demonstrate associations between health expenditure time trends and respectively demographic changes and age-specific per capita expenditure changes, they do not prove a causal link, nor do they account for inter-factor interactions. They simply serve to illustrate the importance of including the effect of a given factor in expenditure projections.

Figure 2.3: **Association of changes in individual factors to the rise in health care expenditures over time**



Source: Seshamani and Gray, 2003.

With its relatively stable demographic structure, changes in demographic composition or population size explain very little of the actual observed expenditure increase in England and Wales over the 12-year time period (Figure 2.3). Trends in age-specific per capita changes, however, predicted 78% of the rise in health care expenditures in the time period. While changes in age structure and population size were associated with a larger portion of the expenditure changes in Canada and Australia, changes in age-specific per capita expenditure still predicted a much larger portion of the observed increase. Only for Japan, with its rapidly ageing population, did demographic shifts alone predict a majority of the change in expenditures over time (Seshamani and Gray, 2003).

2.5.2 What Influences Age-Specific Health Expenditures?

The different patterns of health care expenditures in the older age groups across the four countries of study, and the dominance of changes in age-specific per capita expenditure as a predictor of changes in national health expenditure in three of them, indicate that there may not be a consistent causal relationship between age and health expenditures. Further examination of the influences on health care expenditures could improve calculations of the impact of ageing on health care expenditures. For instance, there could be differential diffusion of technology across the age groups. When a technology is initially developed, it may be used mostly among younger people, because of lack of sufficient knowledge of the effects on older patients, and lack of technical expertise to prevent mistakes from which older people may be less likely to recover. Over time, with increased technological expertise, more evidence from clinical trials, and also increased political and economic influence from the larger older population, the rate of technology use may rise at a faster rate in the older age groups than the younger age groups, leading to a disproportionate rise in their expenditures.

One study in Sweden found that utilisation rates for coronary artery bypass grafting (CABG) were constant from 1987 to 1994 for ages 60 and younger, but increased nearly fivefold for age group 80 to 84. Similarly, the rate of percutaneous transluminal coronary angioplasty (PTCA) increased fastest among the oldest old over a five-year period, and for dialysis over a three-year period (Dozet et al., 2002). A study of patients aged 65 and older in the US found increases in the rates of utilisation of seven frequently used procedures[2] to be highest among those aged 85 and older (Fuchs, 1999).

Additionally, recent epidemiologic literature has underlined the centrality of morbidity in understanding the relationship between age and health care utilisation – in particular, the hypothesis that as people live longer, they will live longer in health, with their illness (and subsequent health care use) getting "compressed" to the very end of life. An in-depth look into these compounding effects of age and time to death on health expenditures, and the ramifications that such relationships could have on future health expenditure projections, is the focus of the remaining chapters.

[2] The procedures examined were: angioplasty, CABG, cardiac catheterisation, carotid endarterectomy, hip replacement, knee replacement, and laminectomy.

CHAPTER 3 – ANOTHER PERSPECTIVE: HEALTHY AGEING AND THE COMPRESSION OF MORBIDITY HYPOTHESIS

3.1 Introduction

The findings of Chapter 2 on the changing age-expenditure relationship indicate that projections based on a constant age-expenditure relationship will not be very accurate. In order to model better how ageing affects health care expenditures, it is important to consider the epidemiology of trends in ageing. One must examine how morbidity is associated with an increase in life expectancy; namely, are the additional years of life lived in illness, thereby generating more health care expenditures, or are they lived in good health, thereby not increasing health care expenditures?

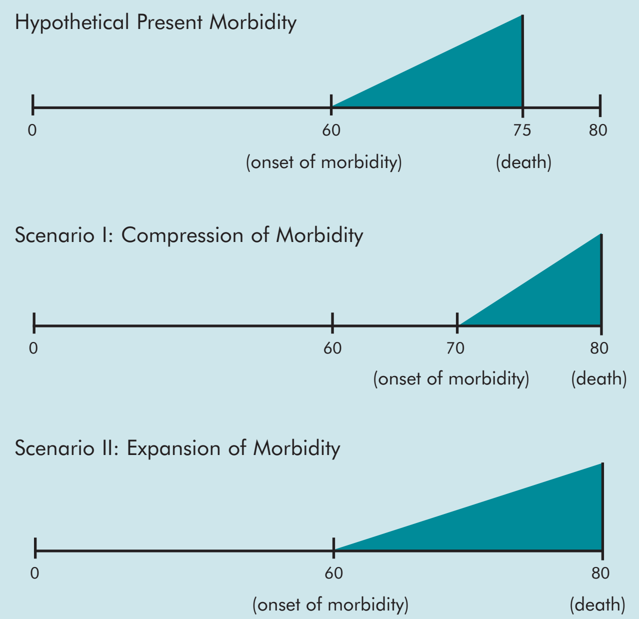
3.2 The Relationship between Life Expectancy and Morbidity

3.2.1 Existing Theories

There is much controversy over the relationship between increased life expectancy and morbidity. The "compression of morbidity" hypothesis, first proposed by Fries (1980, 1983), proposes that medical advances and lifestyle changes can postpone the onset of disability due to chronic diseases, which are the major source of deaths and disability in developed countries (see also: Fries, 1988, 1989, 2000; Fries et al., 1989; Manton and Soldo, 1985). The increase in age of onset of disability is predicted to be larger than the increase in life expectancy, perhaps due to the approach of the maximum biological life span in the population. The delay in onset of disability therefore pushes out morbidity towards the end of life (Figure 3.1). If the compression of morbidity hypothesis holds, then it can be expected that the number of years lived with disability will decrease, even though total years of life will increase.

However, other researchers have proposed an opposite, "expansion" of morbidity, hypothesis. Gruenberg (1977) and Kramer (1980) propose that the prevention of fatal sequelae of chronic diseases such as hypertension and diabetes will prolong the period lived with these

Figure 3.1: **Theories concerning the relationship between life expectancy and morbidity**



Source: Adapted from Fries, 1989.

morbidities. Along the same lines, Olshansky (1991) proposes that as medical advances postpone morbidity and mortality from fatal diseases and fatal complications of chronic diseases, people will live to older ages where non-fatal chronic diseases are immutable. Therefore, as life expectancy increases, so will the years lived with disability.

A final theory of the relationship between changes in total life expectancy and changes in healthy life expectancy falls between expansion and compression. This theory proposes that increased life expectancy will lead to increased prevalence of chronic disease. However, medical and lifestyle changes will slow the progression of chronic disease, thereby decreasing the number of years lived in severely disabled states. As a result, the population will have an increased prevalence of mild disability, but decreased prevalence of severe disability (Manton, 1982).

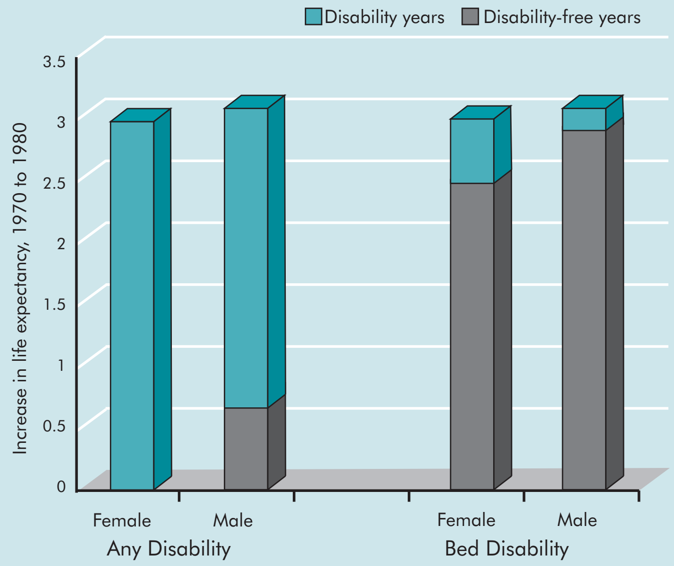
3.2.2 Studies on The Epidemiology of ageing

Numerous epidemiological studies have sought to determine which pattern of morbidity changes holds. When looking at trends of morbidity and disability over time, especially among older age groups, one would expect a decrease in disability if the compression of morbidity hypothesis holds. Studies from the US, UK and Canada from the 1960s to early 1980s, however, did not demonstrate a decrease in self-reported disability indicative of a compression of morbidity. Instead they often demonstrated an increase in total disability for older age groups, generally 45 and older (e.g. Bebbington, 1991; Colvez and Blanchet, 1981; Crimmins et al., 1989; Kaplan, 1991; Roos et al., 1993; Verbrugge, 1984).

However, the severity of disability measured greatly affected the findings. For instance, one national study of both institutionalised and non-institutionalised populations, using the US National Health Interview Survey and census data, found that the majority of the increase in life expectancy from 1970 to 1980 was of years with any disability. When defining disability instead only as severe disability (i.e. days in bed, hospital or institution), the majority of the increase in life expectancy was found to be in years without disability (Crimmins et al., 1989) (Figure 3.2).

Another US study, using the National Health Interview Survey for the non-institutionalised population, found an increase in reported days of reduced activity per year, from 1959 to 1980, but this was mostly due to an increase in non-bed days (days with reduced activity but not to the extent of staying in bed). Bed-disability days per year exhibited no trend in people aged 65 and over, and only a small upward trend in people aged 45 to 64 (Verbrugge, 1984). Such findings support the theory of mixed morbidity change proposed by Manton (1982), in which severe disability decreases but minor disability increases.

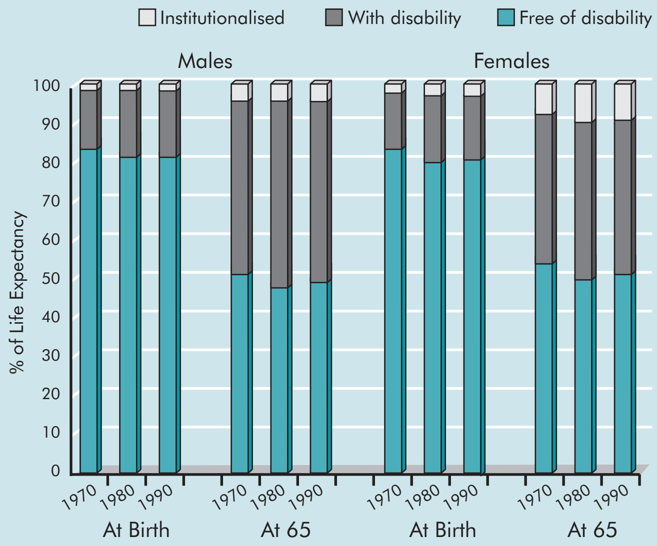
Figure 3.2: **Impact of the definition of disability on time trends**



Source: Adapted from Crimmins et al, 1989.

Studies from the US and France in more recent years have shown that even when looking at any disability, the prevalence may be decreasing over time (Crimmins et al., 1997; Freedman, 1998; Freedman and Martin, 2000; Fries, 2000; Manton, 1982; Manton and Gu, 2001; Manton et al., 1998; Robine et al., 1998; Waidmann and Liu, 2000; Waidmann et al., 1995). Figure 3.3 demonstrates the changing disability pattern for the US. From 1970 to 1980, both at birth and at age 65, the proportion of expected life lived without disability decreased. Between 1980 and 1990, the proportion of expected life at birth lived without disability was unchanged but at age 65 the proportion of expected life lived without disability increased (Crimmins et al., 1997).

Figure 3.3: **Proportions of expected life with and without disability in the US**



Source: Adapted from Crimmins et al., 1997.

More recent studies from the UK still found disability to increase, up to the mid-1990s (Bebbington and Darton, 1996; Dunnell and Dix, 2000; Kelly et al., 2000). However, the findings that demonstrated an increase in years of expected life lived with disability mostly referred to an increase in years with long-standing illness that limited activity in *any* way without specifying how minor or major this limitation was. When focussing on more severe activities of daily living (ADL) limitations, such as the inability to feed or bathe oneself, the increase in years of life expectancy was more evenly split between years with disability and years without disability, leading to a stable proportion of expected years spent with and without disability over time (Bebbington and Darton, 1996).

An international study by the OECD highlighted the potential differences in disability trends across countries from the mid-1980s to

the mid-1990s. Looking at the prevalence of ADL disability in the older populations, they found the UK, Australia, and the Netherlands to have very moderate improvements over time, while Germany, France, Japan, and the US had significant improvements (Jacobzone et al., 1999). Therefore, the international generalisability of disability trends is limited.

3.3 An Economic Viewpoint: The Expenditure Associated with Dying

Alongside these studies of epidemiological trends, have been assessments of the economic impact that increased life expectancy and associated patterns of morbidity can have on health care utilisation and expenditure. If increased life expectancy causes a delay in morbidity onset, and medical care is linked with levels of morbidity, then most of the medical care may actually be concentrated towards the end of life.

3.3.1 Studies of the expenditure on dying patients

Numerous studies have examined the expenditure associated with dying patients, and have found a concentration of medical expenditures towards the end of life. One study of US Medicare expenditures found that the 5.9% of Medicare recipients who died in 1978 accounted for 28% of Medicare expenditures in that year, and subsequent studies found that the percentage of Medicare payments devoted to patients in their last year of life remained constant to the mid-1990s (Hogan et al., 2001; Lubitz and Prihoda, 1984; Lubitz and Riley, 1993; Riley et al., 1987). One longitudinal study of people in the Oxfordshire area of England tracked hospital use for the 15 years prior to death to find that hospital days were concentrated towards the last few years of life (Himsworth and Goldacre, 1999). Expanding analysis to include expenditures on long-term care, a study in the Netherlands found that annual acute hospital and physician expenditures increased 170% when moving from the second to last to the last calendar year of life, and long-term care expenditures increased by 130% (Stooker et al., 2001). Among patients in their last year of life, health care expenditures were further concentrated in the months just before death. A study from 1976 to 1988 estimated that about half of US Medicare expenditures in the last year of life were incurred in the final 60 days (Lubitz and Riley, 1993). Another Medicare study, from 1986 to 1990, found that over half of the expenditures from the last year of life occurred in the final 90 days (Garber et al., 1998).

Comparisons of the average per capita expenditure on a patient in his/her last year of life with a patient who was not dying consistently show a higher expenditure for the dying patient, regardless of the health sectors included in the analysis. The ratio of expenditure between decedents and survivors ranges greatly among studies, from 1.9 to up to 6.2 times as high (Hogan et al., 2001; Latimer et al., 1999; Lubitz and Prihoda, 1984; Lubitz and Riley, 1993; McGrail et al., 2000; Roos et al., 1987; Temkin-Greener et al., 1992).

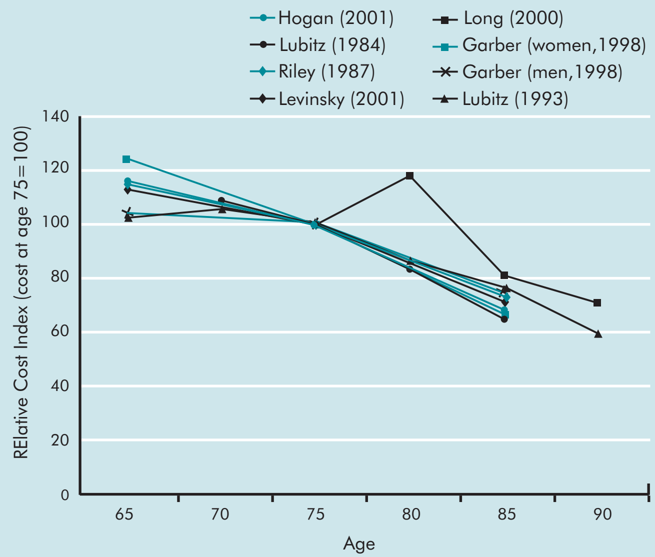
The high end-of-life expenditure may reflect increased disease burden towards death. A recent US Medicare study found decedents to have on average almost four significant diseases in the last year of life, while survivors on average had slightly more than one per calendar year (Hogan et al., 2001).

Thus, the key event driving health care expenditures may be proximity to death rather than age per se. The higher health care expenditures seen in the older age groups may actually be a function of the older age groups being closer to their death. Hence, modelling the effects of proximity to death on expenditure may provide more accurate estimates of future health care expenditures.

3.3.2 The influences of age and promixity to death on health care expenditures: descriptive studies

Several studies have begun to unravel the compounded influences of age and proximity to death on health care expenditures by examining the cost of dying among the older age groups. Studies of US Medicare claims data have found that as age at death increases, expenditures decrease for patients in their last year of life (Figure 3.4) (Garber et al., 1998; Hogan et al., 2001; Levinsky et al., 2001; Long and Marshall,

Figure 3.4: **US Medicare expenditures in the last year of life by age**



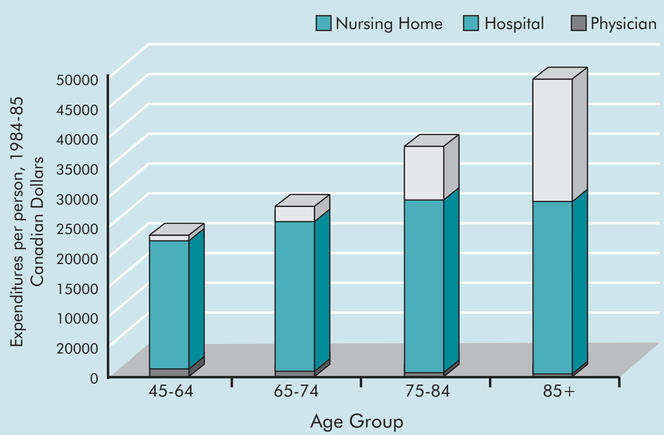
2000; Lubitz and Prihoda, 1984; Lubitz and Riley, 1993; Riley et al., 1987). The latest national study estimated that mean expenditures in the last year of life dropped from $31,800 at ages 65 to 74 to less than $20,000 at ages 85 and over (Hogan et al., 2001).

It is possible that this decrease in expenditures stems from a decrease in the aggressiveness of medical care for older patients in the last year of life. One study of Medicare beneficiaries in Massachusetts and California found that the percentage of hospital admissions that included some care in an intensive care unit decreased from the 65 to 74 age group to the 85 and older group by 40% in Massachusetts and 25% in California. The use of ventilators, pulmonary monitors, cardiac catheterisation, and dialysis was also much less frequent in the oldest old: just 70% to 80% of the frequency of use for age group 65 to 74 (Levinsky et al., 2001).

Analyses of hospital use in Australia and England by people aged 65 and older found that the likelihood of admission in the last year of life decreased with age of death but, once admitted, the oldest old had longer average hospital stays (Brameld et al., 1998; Henderson et al., 1990). For Australia, these effects cancelled each other out to give similar average days in hospital across age groups, but in Oxfordshire and surrounding regions of England, mean hospital days in the last year of life increased with age, from 21 days for ages 65 to 74 to 37 days for ages 85 and over.

However, these studies only consider a limited portion of health care expenditures in their analyses. Some of the decrease in expenditures in the last years of life at older ages may be explained by service substitution, with care for the oldest old being transferred to service sectors not covered by Medicare, such as nursing homes and hospice care. Indeed, out-of-pocket expenditures for the Medicare population – of which nursing home spending is a major component – are highest for the oldest old (Hogan et al., 2001). Although one regional US study still found expenditures to decrease in the oldest decedents

Figure 3.5: **Health care expenditures in Canada in the last four years of life**

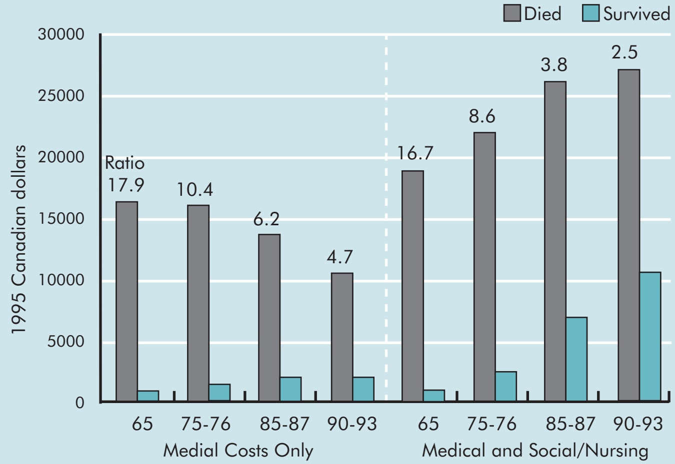


Source: Adapted from Roos et al., 1987.

even when including such health sectors as home health care and nursing home care (Scitovsky, 1988), there have been several studies to support the hypothesis of service substitution.

For example, a US study that did consider nursing home care in a nationally representative population found that total expenditures in the last two years of life increased with age; the $16,000 decrease in average per capita acute Medicare expenditures from age 75 to 95 was overshadowed by the $26,000 increase in nursing home expenditures (Spillman and Lubitz, 2000). Another study found total expenditures in the last year or two of life to decrease with age, but less sharply than when only considering more acute forms of care (Temkin-Greener et al., 1992). Two studies from Canada corroborate these findings; when looking at medical and nursing care expenditures, they found health care expenditures to increase with age of death, largely because of increased nursing home expenditures (Figure 3.5) (McGrail et al., 2000; Roos et al., 1987;).

Figure 3.6: **Comparison of per capita expenditures of survivors versus patients in their last six months of life, Canada**



Source: Adapted from McGrail et al., 2000.

Several studies in the US, Canada, and Germany have examined the combined effects of ageing and death on health care expenditures through trends in the ratio between average per capita expenditures for surviving and dying patients across the age groups. When considering medical expenditures such as hospital and physician services, the studies found that expenditures on treating a patient at the end of life tended to decrease in older patients, while expenditures on treating patients who were not at the end of life tended to increase in older versus younger patients (Busse et al., 2002; Lubitz and Prihoda, 1984; Lubitz and Riley, 1993; McGrail et al., 2000; Riley et al., 1987; Temkin-Greener et al., 1992). Thus, there was a large expenditure differential between dying and surviving patients at the younger ages, but this differential diminished into older ages as the expenditures of dying patients fell and the expenditures of surviving patients rose to meet each other. Including nursing home and social care expenditures did not change this pattern (Figure 3.6).

3.3.2 The influences of age and promixity to death on health care expenditures: longitudinal studies

The results of these descriptive studies indicate that there may be a compounding influence of both age and proximity to death on health care expenditures. One innovative and highly cited study examined this influence through inferential econometric analyses of longitudinal data. Zweifel et al. (1999) used health care expenditure data from two sickness funds in Switzerland to follow expenditures of people who died after age 65 for the last two years of their lives. Zweifel and colleagues' model examined the relationship between real quarterly health care expenditures and age, sex, type of insurance, quarter before death and year of incurred expenditures. For patients who died at age 65 and over, age was irrelevant in determining health care expenditure in the last two years of life, while the quarter before death was highly significant, corroborating the theory that as death approaches, health care expenditures rise. The authors then repeated the model for health care expenditures of "short-term survivors," using observations in the last five years of life, to find similar results.

While the Zweifel et al. study provided a new paradigm for the relationship between ageing and health care expenditures, there are several limitations to the paper that have led researchers to question whether the study findings can be generalised (Dow and Norton, 2002). The next chapter briefly outlines these limitations and extends the analysis with a longer-term examination of the effects of age and proximity to death on hospital expenditures.

CHAPTER 4 – THE EFFECT OF AGE AND PROXIMITY TO DEATH ON HOSPITAL EXPENDITURES

4.1 Introduction

The major limitation of the studies on ageing and proximity to death that were described in the previous chapter is truncation of the time period of analysis. The impact of ageing may occur long before one or five years prior to death, which is the time period of these studies. In particular, the onset of age-related chronic disease will often occur much earlier. It cannot be determined from the studies above whether surviving patients (those not close to death) show the same age neutrality of health expenditures as dying patients. Indeed, in discussion of his study, Zweifel noted, "A conclusive test of the two competing hypotheses [whether health care expenditure in older age increases as a function of closeness to the time of death or as a function of age] must rest on longitudinal data, which have not been available to this day." (Zweifel, 2000)

The Zweifel et al. analysis was performed on quarterly data. While providing interesting findings, this timeframe has limited applicability in designing expenditure projection models, since health care projections are estimated in years and not quarters. Actual expenditure predictions based on different ages and different remaining life expectancies are also needed to examine the magnitude of the effects of age and proximity to death on health care expenditures. Finally, there are several econometric concerns (Dow and Norton, 2002; Puhani, 2000; Salas and Raftery, 2001). Using the Oxford Record Linkage Study, I have addressed these limitations in a more robust analysis of the impacts on expenditure of age and proximity to death.

4.2 Data

The Oxford Record Linkage Study (ORLS) was founded by E.D. Acheson in 1963, collecting statistical abstracts longitudinally for each patient's hospital inpatient and day case care, birth certificates and death certificates in a defined geographical area around Oxfordshire,

Table 4.1: **Demographic representativeness of ORLS populations by age group and sex, compared with national statistics**

	% aged <45	% aged 45-64	% aged 65-74	% aged 75-84	% aged 85+	% of each sex in total population
1973						
ORLS	68.3	20.5	7.1	3.2	0.8	50.4%M, 49.6%F
England & Wales	62.5	23.7	8.9	4.0	0.9	48.6%M, 51.4%F
1983						
ORLS	66.2	21.2	7.4	4.2	1.0	49.7%M, 50.3%F
England	62.6	22.3	8.9	5.1	1.2	48.7%M, 51.3%F
1997-98						
ORLS	64.0	22.8	7.2	4.4	1.6	49.8%M, 50.2%F
England	61.2	23.0	8.3	5.4	1.9	49.3%M, 50.7%F

Source: Adapted from Lee and Goldacre, 2000.

England (Gill et al., 1993). ORLS populations are representative of England and Wales as a whole (Lee and Goldacre, 2000) (Table 4.1).

From this dataset, people who were aged 65 and over as of the end of 1970 were identified and their general and psychiatric hospital and death records were tracked to 1999, the end of the dataset. Choosing only those patients in the older ages ensured that most would have died by the end of the dataset, enabling accurate categorisation by time

Table 4.2: **Descriptive statistics of patients in the extracted ORLS dataset**

Mean (± SD)	Males	Females	Total
Number of patients	36,172	54,757	90,929
Age at death	76.2 ± 5.8	78.8 ± 6.0	77.8 ± 6.1
Average hospital days from 1970 until death	33.3 ± 56.9	43.3 ± 70.4	39.3 ± 65.6
Average hospital cost from 1970 until death	£8,901 ± £16,090	£11,730 ± £21,329	£10,605 ± £19,465

Source: Seshamani and Gray, 2004a.

Table 4.3: **Description of dataset variables**

Diagnostic Category	Marital Status	Social Class	Place of Death	Source of Admission	Place of Discharge
Heart Disease	Single	Social Class 1 & 2	Private address	Waiting list	Home
Stroke	Married	Social Class 3	Hospital	Accident and Emergency	Self-discharge
Cancer	Widowed	Social Class 4	Nursing home	Booked admission	Death
Respiratory	Divorced or separated	Other (Housewife, other, unknown)	Brought to hospital dead	Transfer	Transfer
Other	Unknown	–	Other	Long term care Other Unknown	Long term care Other Unknown

Source: Seshamani and Gray, 2004a.

to death for analyses. Data on hospital use in the ORLS are provided as patient days, counting day cases as one patient day. Expenditure data for 1997-99 collected by the Department of Health provided a weighted average expenditure per inpatient day specific to each specialty, which was matched to the specialty coding of the hospital episodes to estimate expenditures for each hospital stay in the dataset.

The initial data extraction provided hospital and/or death records for 108,056 patients. Removing patients with data errors (6%) and patients with no death records (who likely migrated from the Oxfordshire area, 10%) left a dataset of 90,929 patients (Table 4.2). The analytical variables are presented in Table 4.3.

4.3 Methods

The effects of age and proximity to death on health care expenditures were examined for up to 24 years from death. Hospital expenditures were aggregated into yearly expenditures, by each year from date of patient death, and the expenditure in a given year was examined in a regression analysis to determine the influence of proximity to death (number of years from death) and various patient characteristics including age, sex, marital status, social class and diagnosis. The model was then used to estimate the likelihood of being in hospital, expenditures once in hospital, and average yearly hospital expenditures at different ages and different times from death, with 95% confidence intervals.

4.3.1 Details of OF statistical Methods[3]

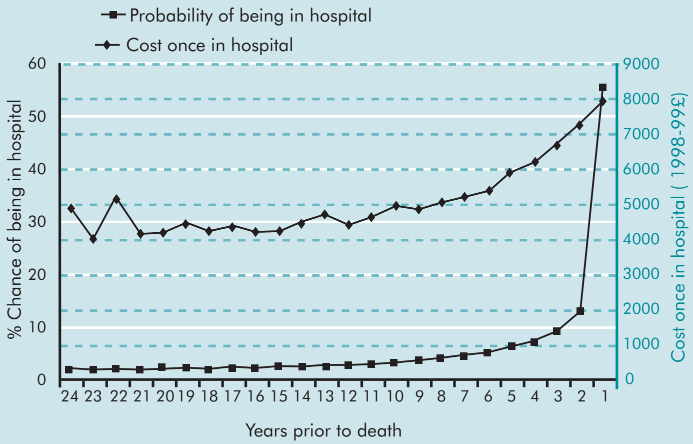
In the ORLS dataset, expenditures stemmed year after year from the same individual in a longitudinal manner. It was important to account for any idiosyncratic patient characteristics that could have longitudinally affected hospital expenditures, and so a random-effects panel data model was used.

Eighty-five percent of yearly expenditure observations in the dataset were zero. Therefore, a two-part analysis was employed (Jones, 2000; Puhani, 2000). The first part examined, using a probit model, the effects of age and year from death (as well as patient sex, cause of death, social class and calendar year) on the yearly likelihood that someone entered the hospital, with robust standard errors to correct for heteroscedasticity. The second part of the model examined the effect of age, number of years from death, sex, cause of death, social class, calendar year, diagnosis of hospital admission, marital status, source of admission and place of discharge on expenditures once in hospital. Due to skewness in the dependent variable, a linear regression model was run on the natural log of hospital expenditures, again with robust standard errors.

In order to illustrate more clearly the effects of age and proximity to death on health care expenditures, average expenditures were estimated at given ages and times from death, controlling for social class, cause of death and other covariates. The two-part model enables predictions of the probability of hospitalisation in a year (from the probit step), and then of the yearly expenditure among those patients that use hospital care in a year (from the second step). Multiplying the

[3] For further econometric details, see Seshamani and Gray, 2004a.

Figure 4.1: **Probability of being in hospital and expenditure once hospitalised, by year from death**



Source: Seshamani and Gray, 2004a.

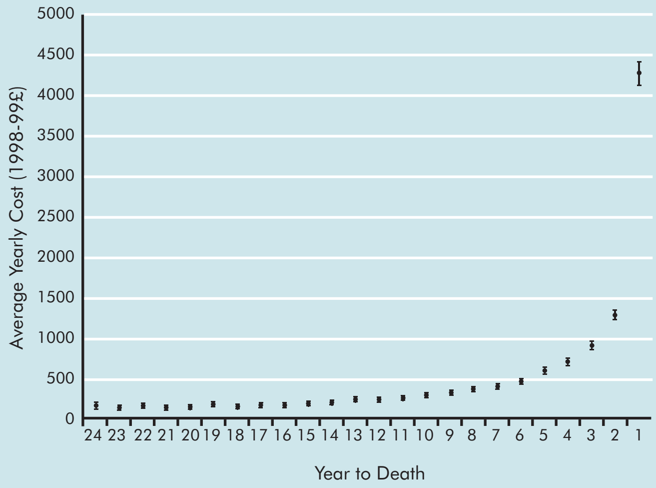
two predictions provides an estimation of the average yearly hospital expenditure across the whole population (Blough et al., 1999). Probabilities and expenditure values were calculated by time to death, holding all other covariates constant. 95% confidence intervals were derived using bootstrapping, clustered by individual patient.[4] Next, expenditure estimations were performed by patient age: for both males and females in the last year of life, and then for year 10 from death. Again, 95% confidence intervals were derived using clustered bootstrapping.

4.4 Results

The probability of being in hospital demonstrated a consistent and exponentially increasing trend with approaching death (Figure 4.1). From year 8 prior to death, there were significant jumps in the

[4] Bootstrapping was done on a cross-sectional model, rather than panel data model, to keep computations manageable. The point estimates between the two models were consistent.

Figure 4.2: **Predicted average yearly expenditure by time to death, with 95% confidence intervals**



Source: Seshamani and Gray, 2004a.

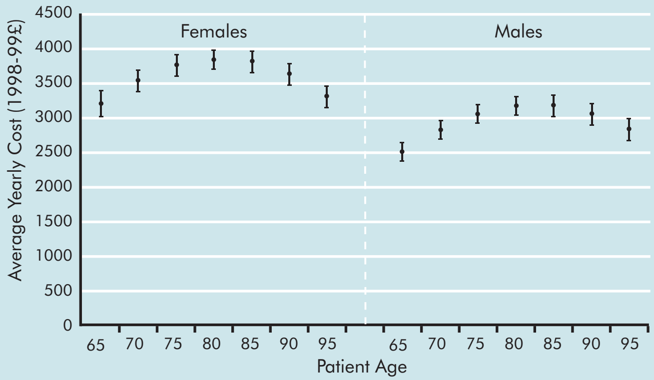
probability of being in hospital with each year approaching death, and the last year of life had a probability of being in hospital that was more than four times the probability when two years from death, at 55.2% versus 12.7%. Expenditures once hospitalised also showed an increasing trend with approaching death, but the confidence intervals overlapped more, with no significant expenditure difference between expenditure in year 2 prior to death (£7,225) and the last year of life (£7,931) (Seshamani and Gray, 2004a).

Average yearly expenditures were calculated by multiplying the probability of being in hospital by the expenditure once hospitalised. Figure 4.2 demonstrates that expenditures increased in an exponential manner, such that yearly expenditures nearly doubled over eight years from year 15 to year 8, nearly doubled four years later in year 5, then two years later in year 3, and then increased more than seven-fold from year 3 to the year prior to death.

In contrast to the effect of year from death on hospital expenditures, age per se had a somewhat weaker impact. Average yearly expenditures increased significantly by only 20% from age 65 to 80 for women and 26% from age 65 to 85 for men in the last year of life (Figure 4.3). After that point, expenditures declined significantly by 14% and 10% respectively to age 95. This parabolic age-expenditure pattern followed trends in the probability of being in hospital, with increasing probability to age 75, followed by a decrease in probability to age 95.

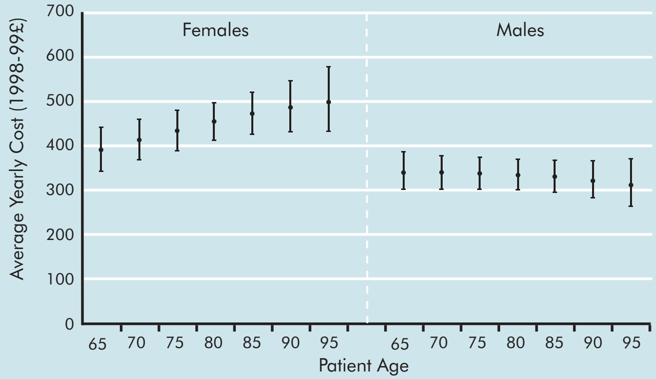
There was a change in the age-expenditure relationship when 10 years out from death (Figure 4.4). The average expenditure for women (though not for men) increased steadily through the age groups, with women aged 95 having a 27% higher expenditure than women aged 65. This increase stemmed from consistent rises both in the probability of being in hospital and in the expenditure once in hospital. However, all confidence intervals overlapped, meaning that 10 years from death, age did not significantly affect hospital expenditures.

Figure 4.3: **Predicted average hospital expenditure in the last year of life by patient age, with 95% confidence intervals**



Source: Seshamani and Gray, 2004a.

Figure 4.4: **Predicted average hospital expenditure 10 years from death by patient age, with 95% confidence intervals**



Source: Seshamani and Gray, 2004a.

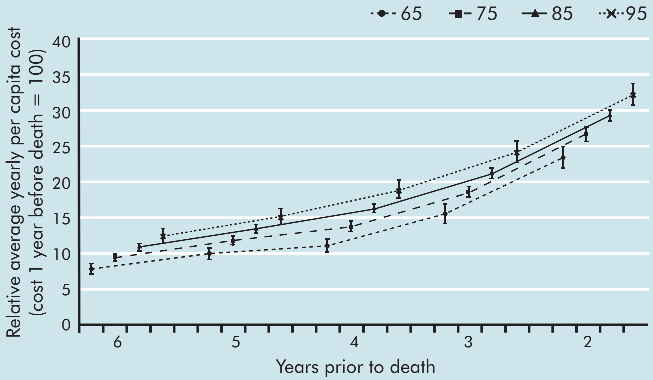
It is worth mentioning the effects of the other variables in the study. Heart disease was associated with lower likelihood of being hospitalised and lower expenditures once in hospital than cancer, stroke and respiratory illness. People from non-manual social classes had a higher likelihood of being in hospital than people from manual social classes, but had lower expenditures once in hospital. Married people tended to incur lower expenditures once in hospital. Admissions from a long term care facility were associated with the highest hospital expenditures compared with other sources of admission; the next most costly category involved patients transferred from another hospital. Hospital episodes that ended in transfer to another hospital were more expensive than hospital episodes that led to discharge anywhere else (home, death, long term care, or self-discharge). Later calendar years had a trend of lower expenditures among hospitalised patients after 1980.

4.5 Dynamic Aspects of the Effects of Age and Proximity to Death on Expenditures

4.5.1 Does the effect of proximity to death depend on patient age?

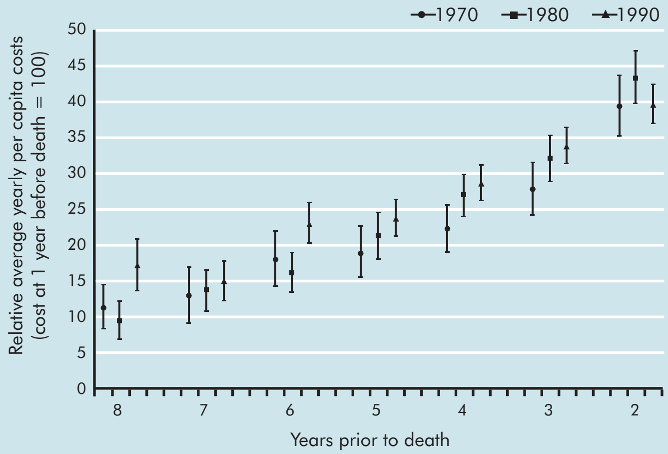
To see if the effect of approaching death varied by patient age, the model was rerun with an interaction term for age and proximity to death. Expenditures were estimated for the 10 years prior to death, at ages 65, 75, 85 and 95, using the methods described in the previous section. At each age, the expenditure for each year prior to death was expressed as a relative expenditure index, where expenditure had an indexed value of 100 when one year from death. As Figure 4.5 shows, from year 6 to year 2 prior to death, relative expenditures (as compared with expenditures in the last year of life) were higher with increasing age. Such a finding indicates that at the oldest ages, expenditures could be expected to rise a bit more gradually, with less of a surge at the very end of life. For example, the graph shows that for a 65 year old, expenditures would more than quadruple moving from the second to

Figure 4.5: **The effect of time to death on yearly hospital expenditures, variation by patient age, with 95% confidence intervals**



Source: Seshamani and Gray, 2004a.

Figure 4.6: **Changes in predicted expenditures relative to time to death, over three decades of analysis**



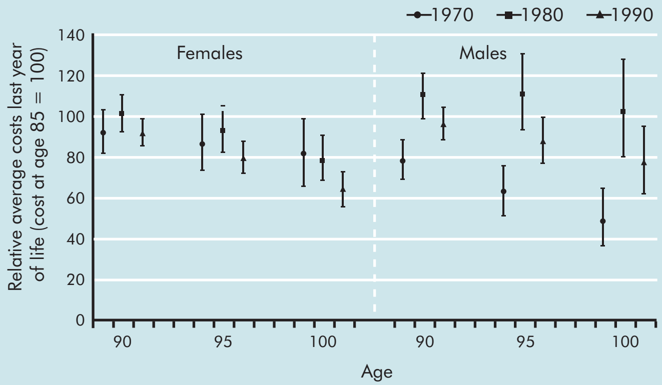
Source: Seshamani and Gray, 2004a.

last year of life, while for a 95 year old expenditures would triple. These differences between ages were all statistically significant.

4.5.2 Have the patterns of age, time to death, and health care expenditures changed over time?

A final consideration is whether the effects of age and proximity to death on hospital expenditures have changed over time. The answer to this question could provide additional information for modelling health care expenditure projections, since predictions are often carried through several decades. The ORLS dataset was subdivided into three calendar year cohorts: patients aged 85 and older in 1970 (n=6,215), patients aged 85 and older in 1980 (n=7,307), and patients aged 85 and older in 1990 (n=9,066). The effects of age and proximity to death (up to eight years prior to death) on annual hospital expenditures were then examined for each of these cohorts, from 1970 to 1978, 1980 to 1988, and 1990 to 1998 respectively.

Figure 4.7: **Changes in predicted expenditures in the last year of life relative to patient age, over three decades of analysis**



Source: Seshamani and Gray, 2004a.

As can be seen in Figure 4.6, later calendar years had less of a surge in expenditures at the very end of life, with higher relative expenditures for the years further from death. However, the expenditure differences across the cohorts were mostly insignificant, indicating that the effects of proximity to death on hospital expenditures stayed consistent through the years.

In contrast, the effect of age on expenditures in the last year of life was not stable over the decades. While there were no significant differences across the female cohorts, the effects of age on expenditures in the last year of life changed for the male cohorts (Figure 4.7). In 1970, expenditures decreased from age 85 to age 100, while in both 1980 and 1990, this expenditure decrease was significantly mitigated (and in the case of 1980, expenditures even increased to age 95).

4.6 Discussion

The effect of proximity to death has been well-established through this study. Significant year-by-year increases in average annual expenditures extended as far back as 12 years prior to death. The expenditure rises

were substantial, with a more than tenfold increase from year 5 prior to death to the last year of life. The increases in average expenditures were mainly fuelled by increases in the likelihood of being admitted to hospital. It is worth of note that the effect of proximity to death on expenditures stayed constant over the calendar years of analysis – which increases the utility of such a predictor for longer-term projection models.

In contrast, increasing age did not consistently generate higher hospital expenditures in the last year of life. Instead, average yearly expenditures significantly increased from age 65 to 80 or 85, but then significantly decreased to age 95, following the pattern of probability of being in hospital. The magnitude of average expenditure changes, between 20% and 30%, was also much smaller than the magnitude of expenditure changes from changing time to death. The decrease in the probability of being in hospital in the last year of life is consistent with previous studies of the ORLS (Henderson et al., 1990), and may be due to increased use of long term care facilities (Temkin-Greener et al., 1992), or more community and home care services in the older age groups. Also, there could be age-related rationing, in that physicians may be less likely to admit older patients who they feel are less likely to survive.

It is interesting to note that further out from death, at 10 years from death, average yearly expenditures increased with age for women, though the changes were not significant. The greater rate of hospitalisation among the oldest old when further from death could reflect the impact of age-related chronic disease. Also, there could be decreased use of nursing home care when further from death. Moreover, if the oldest old women are less frail when they are further from death, physicians may be more willing to try more intensive and invasive treatments.

The analysis comparing age-expenditure patterns over three decades found that the effect of age on expenditure may be changing over time, such that the decrease in expenditures observed in the oldest old in the last year of life is becoming less pronounced. As life expectancy increases, the oldest old may not be as frail – or perhaps more importantly, may not be perceived as frail – in future years. The better perceived health in the oldest age groups may make physicians more likely to use aggressive treatments, that were previously withheld for fear of inefficacy or harmful side effects (Cutler and Sheiner, 1998). Furthermore, an increase in health and decrease in disability in the oldest age groups could reduce the rate of admission to nursing homes. Keeping people in the community longer could increase the use of the hospital for their health care needs. As discussed in Chapter 2, there may also be changes over time in the diffusion of technology into the older age groups, due to improved techniques, more experience, and the increased political and economic clout of older populations. This technology diffusion could then lead to differential expenditure rises over the calendar years (Dozet et al., 2002; Fuchs, 1999). Regardless of the reason, an expenditure model that projects the impact of age on health expenditures in future decades must account for changes in the effect that age has on health care expenditures.

Expenditure models must also consider the interaction between patient age and time to death. The ORLS study found that at older ages, there was less of a concentration of expenditures at the very end of life. The narrowing of the expenditure gap between decedents and survivors in the older ages may result from an increased need for chronic medical care in the older ages, where longer-term diseases are more prevalent, or from a decreased use of life-saving techniques in older dying patients.

Also of note are the significant effects of other factors on patients' hospital expenditures, namely: cause of death, diagnosis, marital status, social class, source of admission and place of discharge. Heart disease led to a lower likelihood of being in hospital and lower expenditures once in hospital compared to patients in other major diagnostic groups. Patients with heart disease may be more prone to sudden death and other sequelae that do not generate much hospital usage (or even admission). Second, much of the management of cardiac care may be on an outpatient basis, particularly through medications. Married patients tended to have lower expenditures once in hospital, as did patients from non-manual social classes, possibly because of additional resources and carers to facilitate discharge home.

Hospital episodes with source of admission from long term care were more expensive than the other sources of admission. Given the low likelihood of transfer from long term care to acute hospital (at 0.2% of all hospital admissions), it is plausible that most medical needs are addressed in the long term setting itself, and that only patients who will need a substantial amount of care actually get transferred to hospital. Additionally, hospital episodes with place of discharge to another hospital were the most expensive, most likely due to a continuing or even escalating need for care.

4.7 A Lingering Issue

Thus far, the question of whether proximity to death affects health care expenditures has been examined. However, it is quite possible that health care expenditures in turn affect remaining time to death, by prolonging life with medical treatments (Salas and Raftery, 2001). The effect of health care expenditures on longevity has not been detected in literature that looks at regional or national aggregated data. Once factors such as sanitation and education are considered, health care expenditures are generally insignificant (Barlow and Vissandjee, 1999; Cochrane et al., 1978; Hitiris and Posnett, 1992; Leu, 1986; Levine et al., 1983; OECD, 1987; Poikolainen and Eskola, 1988; Zweifel et al., 2001).

However, a possibly better way to examine this issue would be a survival analysis with patient-level data, where the conditional probability of death in any given year could be modelled as a function of patient age, sex, social class and health care expenditures in that time period. Such a model was designed with the ORLS dataset, but consistently produced the paradoxical result that health care expenditures were associated with shortened survival. This is because the patients who entered hospital tended to be sicker (and therefore had worse prospects) than patients who did not enter the hospital. Without being able to control for patient health status, it looked as though hospital expenditures were associated with shortened survival. One would need reliable, time-varying indicators of health status to accurately discern the effect of health expenditures on survival.

CHAPTER 5 – THE POLICY IMPLICATIONS: ALTERNATIVE PROJECTIONS OF HOSPITAL EXPENDITURES FOR ENGLAND

5.1 Introduction

It has been established through previous chapters that projection methods employing constant age-specific per capita expenditures may not be accurate, due to changes over time in age-specific per capita expenditures. The analyses of the ORLS further demonstrate that proximity to death significantly affects hospital expenditures, to a larger extent than age. Thus, incorporation of the effects of time to death could prove critical for the more accurate calculation of hospital expenditure projections, and of the impact that future demographic changes will have on the health service budget.

The 2002 Wanless Report for HM Treasury included proximity to death in its inpatient long-term expenditure projections for the National Health Service (Wanless, 2002). The Wanless Report used data from Scotland which detailed hospital activity rates for people in their last year of life (decedents) and people not in their last year of life (survivors). Adjusting these relative activity estimates for England and incorporating them into age-sex activity rates provided by the Department of Health, the Wanless Report assigned people a baseline activity rate based on their age, sex, and decedent/survivor status. Multiplying this activity rate by projected numbers of people in each age/sex/decedent category in future years enabled projections that included the effects of impending death. Wanless then incorporated changes in health status, as well as practice pattern changes targeted in the NHS National Service Frameworks, to come up with final projections. Unfortunately, breakdown of the projections was not available to tease out the separate effects of demographics as compared with the effects of technology and practice patterns.

The Wanless Report projected a composite rise in NHS spending over 20 years, at a real annual growth rate of 4.2% to 5.1%, depending on the scenario adopted. This translated to an increasing portion of GDP invested in health care, from 6.5% of GDP in 2002-03, to a range from 9.4% to 11.3% of GDP in 2022-23.

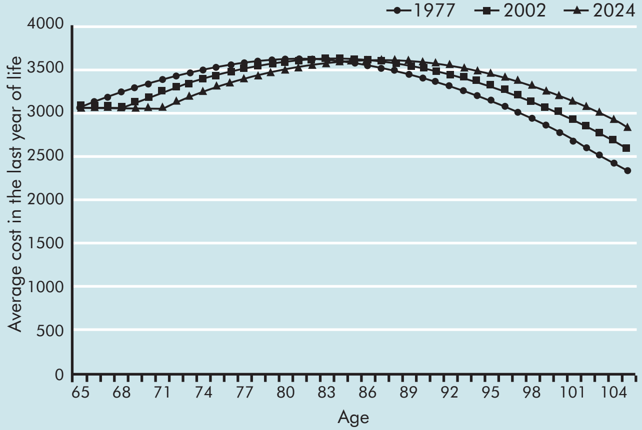
While groundbreaking in its projection methods, the Wanless Report's approach has several limitations. First, it was able to consider the effect of proximity to death on expenditures only in the last year of life. As our ORLS models have shown, the effects of approaching death on rising hospital expenditures can be seen as far back as 15 years from death. The report did model the changes in health status of survivors through other means, by assuming changes in disability prevalence and health seeking behaviour. However, as described in Chapter 3, methods of measuring disability are not yet standardised, and it is difficult to model expenditures accordingly. There is considerable uncertainty involved in forecasting disease prevalence and severity, especially with the dynamic evolution of new pathologies over time. A more rigorous incorporation of time to death in expenditure projections, which considers expenditures in years further from death as well as expenditures in the last year of life, could perhaps provide a more consistent proxy to the changes in health status of people not in their last year of life.

Another limitation of the Wanless Report approach was its use of a static relationship between age and expenditure. As discussed in the previous chapter, the effect of time to death on expenditure has remained stable across the decades, but the effect of age has changed, such that the decrease in expenditures generally seen in the oldest old has lessened over time. This change in pattern could be due to increased technology diffusion, less perceived frailty in the elderly, less age-based rationing and less use of nursing home care. Given the NHS's recent attention to trying to reduce problems of health care access and age discrimination in the older populations, it is vital to model the dynamics of the age-expenditure relationship better.

5.2 The Model

Analysis of the ORLS dataset in Chapter 4 provided a model with which to estimate expenditure changes, based not only on person age and sex, but also time to death and the interaction of age with time to death. The study presented in Chapter 4 found the effects of time to death to be stable over time, making for a straightforward long-term

Figure 5.1: **Modelled shifts in the age-expenditure curve to represent changes in age-based practice patterns over time**



model. However, the effects of age on hospital expenditures changed over time. It was hypothesised that the decline in expenditures seen in the oldest ages would occur at later and later ages as life expectancy improved, and that the onset of morbidity would be delayed as people live longer – an assumption that follows from trends examined in the epidemiological literature (see Chapter 3). These morbidity shifts would cause the age-expenditure curve to shift out over time (Figure 5.1).

This model was applied to single-year age population projections for England, to calculate predictions of the changes in hospital expenditures in England for the next 24 years. These results were compared with projections calculated using the more conventional approach, which employed constant age-specific per capita expenditure over time (Seshamani and Gray, 2004b).

5.3 Methods

Population projections by single-year ages for males and females were provided by the Government Actuary's Department for England

from 2002 to 2040. These projections incorporated predictions on changing mortality, fertility (birth cohort sizes) and migration rates over time, to provide population numbers for each age at each year. Using the age and sex-specific mortality rates for the different calendar years, the numbers of people in each age and sex group in each calendar year who were one year from death, two years from death, up to 15 years from death, were calculated.

Next, the ORLS model was used to estimate sex, age and time to death-specific per capita expenditures, scaled up to match the most recent price level of HCHS expenditures (provided by the Department of Health).[5] National hospital expenditure projections with these age, sex, and time to death-specific per capita expenditures were calculated by multiplying the number of males at each age one year from death by the per capita expenditure for males at each age at one year from death, the number of males at each age two years from death by the per capita expenditure for males at each age at two years from death, and so on. Summing the expenditures for each calendar year across age, sex, and time to death groups provided national expenditure projections that incorporated the changing profiles of time to death across the calendar years. As a point of comparison, national expenditures assuming constant age-specific per capita expenditures were also calculated. To focus on the effects of the "baby boom," expenditure projections for the 65 and older population were calculated, both with a proximity to death model and with a constant age-specific per capita expenditure model.

Of further interest is the effect that ageing – via changes in longevity after age 65 – will have on health expenditures. Population projections were altered to isolate this one factor by holding the number of people at age 65 for every year constant at the 2002 level and then recalculating future population numbers based solely on changing age and sex-specific mortality rates. The people in each age and sex group were then divided up by time to death using age and sex-specific

[5] To calculate time to death-specific per capita expenditures for the population aged less than 65, the relative expenditures by year from death for age 65 in the ORLS model were applied to Department of Health expenditures for the under 65 age groups.

mortality rates, and per capita expenditures for males and females at each age and time to death were estimated from the ORLS model as described above. Multiplying those per capita expenditures by the corresponding population numbers and summing for each year provided projected national-level expenditure for the 65 and older population, based solely on the demographic changes due to increased longevity after age 65.

5.4 Results

The total population in England is projected to increase at an annual rate of 0.38%, from 50.4 million in the year 2002 to 55.2 million in 2026. Concurrent with the overall population growth is an ageing of the population, with the age group 65 and over exhibiting a consistent increase in its share of the population, from 15.6% to 20.4%, while the younger age groups have decreases in their shares (Table 5.1). Due to very low age-specific mortality rates among those younger than 65, people aged less than 65 made up only 17% of people in the last year of life in 2002, compared to 31% from the age group 85+. Over time, as people live longer, higher percentages of people in the last year of

Table 5.1: **Share of population and expenditures by age group in England, 2002 to 2026**

	0-4	5-15	16-44	45-64	65-74	75-84	85+
% of Population							
2002	5.8	14.0	40.9	23.8	8.1	5.5	2.0
2026	5.4	11.9	36.0	26.2	10.4	7.3	2.7
%-point change	-0.4	-2.1	-4.9	+2.4	+2.3	+1.8	+0.7
% of Decedents							
2002	0.2	0.2	3.5	13.1	18.7	33.7	30.7
2026	0.1	0.1	2.5	12.0	17.1	32.9	35.2
%-point change	-0.1	-0.1	-1.0	-1.1	-1.8	-0.8	+4.5
% Expenditures							
2002	7.8	3.3	24.5	20.7	12.6	18.2	12.9
2026	7.2	2.8	21.2	21.7	13.2	18.8	15.1
%-point change	-0.6	-0.5	-3.3	+1.0	+0.4	+0.6	+2.2

Table 5.2: **Population and expenditure share of decedents in each age group, 2002 and 2026**

Age Group	2002		2026	
	% Population	% Expenditures	% Population	% Expenditures
0-4	0.03	1.54	0.02	1.02
5-15	0.01	0.65	0.01	0.44
16-44	0.09	3.83	0.07	3.10
45-64	0.56	18.97	0.47	16.48
65-74	2.35	43.32	1.68	36.98
75-84	6.24	56.69	4.63	52.76
85+	15.90	66.45	13.47	64.79

life would come from the older age groups, such that by 2026, 35% of the people in the last year of life would be aged 85 or older (Seshamani and Gray, 2004b).

With the decrease in age-specific mortality rates over time, all age groups have reduced percentages of the population who are in the last year of life, and among survivors there is an increase in the proportion

Figure 5.2: **Average time until death and predicted average real per capita expenditure for the population aged 65 and older**

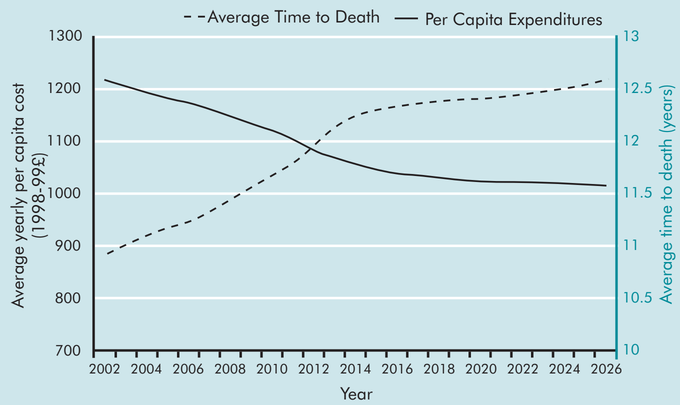
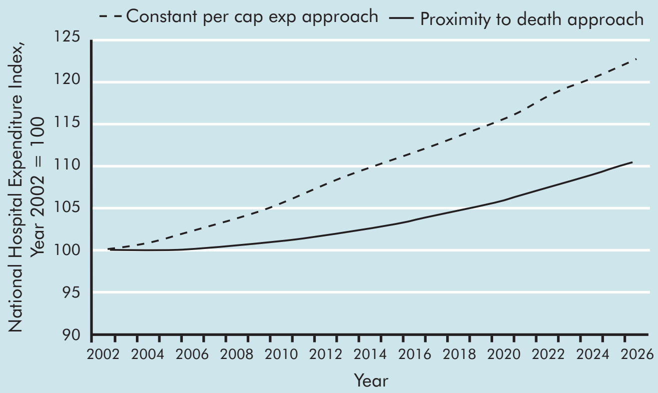


Figure 5.3: **Projections of aggregate hospital expenditures, constant per capita expenditure versus proximity to death models, England, 2002 to 2026**



of people further from death. The concentration of expenditures in dying patients is noticeable; while decedents comprised 1% of the population in the year 2002, they accounted for 29.3% of hospital expenditures. Over time, with the decline in age-specific mortality rates, decedents make up a smaller percentage of the population and expenditures of the different age groups (Table 5.2).

Due to the concentration of expenditures in the last year of life, as age-specific mortality rates decline over time and death is postponed, the real average per capita hospital expenditures of the older population decrease (Figure 5.2).

Calculating national hospital expenditures based on per capita expenditures that are specific to proximity to death gave an annual growth rate of 0.42%, from £21.9 billion in 2002 to £24.2 billion by 2026. This was approximately half of the 0.85% annual growth rate estimated when holding age-specific per capita expenditures constant, from £21.8 billion to £26.8 billion (Figure 5.3). As is evident in Figure 5.3, the discrepancies between the constant per capita expenditure forecasting method and proximity to death forecasting method were initially small, but quickly widened over the time period of projection.

The difference between the two methods is even more evident when focussing on the impact on hospital expenditures of increased longevity after age 65. Using the proximity to death projection method, there was very little expenditure impact from an increase in longevity in the older ages. In fact, the compound annual rate of growth for expenditures in the 65 and older population from the year 2002 to 2026 was only 0.08%. In contrast, using constant per capita expenditures would predict a growth rate ten times as high, at 0.87%.

Using constant per capita expenditures fails to take into account the postponement of death-related expenditures that coincides with an increase in longevity, and hence substantially increases the predicted expenditure growth rate needed for the health care system to "stand still" with population ageing. Considering the effect of the "baby boom" increased the growth rate of expenditures in the older populations to 0.75% when using the proximity to death projection model, but again this was half of the growth rate predicted by a projection method using constant age-specific per capita expenditures, namely 1.56%.

5.5 Discussion

Hospital expenditures in the NHS can be expected to be concentrated among dying patients. The 5% of patients in the last year of life generated approximately half the hospital expenditures for the population aged 65 and over in 2002. This concentration of expenditures was higher than that found in the US Medicare literature (Lubitz and Prihoda, 1984). However, this could be due to the fact that the model used here represents only hospital expenditures and not other sectors such as primary care or rehabilitative care.

Since imminent death is a main factor behind expenditures, lower mortality rates and rising life expectancy can be expected to push down average real per capita health expenditures in each population age group. This economic result is in line with those of previous US Medicare studies (Cutler and Sheiner, 1998; Miller, 2001) and follows from the epidemiological theory that with increased life expectancy morbidity is delayed at least slightly, such that persons of the same age will cost the health system less in future years, holding other factors constant (see Chapter 3). The traditional projection approach that keeps age-specific per capita expenditures constant would not pick up this dynamic aspect of ageing. Hence, applying constant age-specific per capita hospital expenditures to the predicted population figures led to an estimated growth rate twice that of a model that incorporates the effect of proximity to death. The further out one extends the projection, the larger the discrepancy in terms of predicted hospital expenditure.

Examining the isolated effects of increased longevity, ageing played almost no role in generating additional hospital expenditures over time – in fact, the compound annual growth rate for hospital expenditures in the 65+ population was only 0.08%. Most of the increase in hospital expenditures for the older populations came from the surge in birth cohort sizes due to the post-WWII "baby boom".

It should be stressed that the models described above focus specifically on the impact of demographic changes on hospital expenditures, and do not distinguish between inescapable expenditures to maintain health care at status quo and discretionary expenditures such as service improvements. Particularly, the models do not include factors such as technological change. It is widely believed that technological change and increasing treatment intensity are the major driving factors behind rises in health care expenditures (Fuchs, 1996). As described previously, these factors may interact with age, leading to increased technology diffusion in the older age groups and compounding demographic changes (Fuchs, 1999; Dozet et al., 2002). Moreover, differing governmental prioritization in a high-growth or low-growth economic scenario could alter the amount of resources devoted to service improvement and thus health expenditure growth (Hulme, 2003).

The models presented above considered the patterns of proximity to death only with respect to hospital expenditures. Trends in other sectors, such as long-term care, physician care and pharmaceuticals are as yet unknown, largely because longitudinal datasets are not available in these areas. Examination of the effects of age and proximity to death on expenditures in these sectors could further enable health policy makers to predict budgetary needs better in future years. It can be anticipated that pharmaceuticals will not demonstrate as pronounced a surge of expenditures at the end of life, since they instead play a central role in delaying the morbidity of age-related chronic diseases over long time periods prior to death. However, as shown in Chapter 2, HCHS expenditures comprise almost 75% of all NHS expenditures, and HCHS expenditures comprise even larger proportions of expenditures for the older age groups, at up to 94% for those aged 85 and older. Therefore, an analysis that examines the effects of age and proximity to death on hospital expenditures still provides an estimate for the majority of expenditures faced by the NHS.

Finally, the model reported here made several assumptions regarding changes in the effect of age on expenditure over time (see Figure 5.1). In a sensitivity analysis, two other scenarios of the relationship between age and expenditure were considered: first, that the relationship stays constant over time (with no shift of the age-expenditure curve), and second that the expenditure decline shifts out as in Figure 5.1, but that the expenditure increase does not shift out, leading to a plateau of expenditures around age 83. However, neither of these scenarios greatly altered expenditure calculations, or changed the striking differences observed between projections that account for proximity to death and those that do not. The small effect of sensitivity analyses around the age-expenditure pattern reflects the relatively low impact that age has on hospital expenditures, once proximity to death has been taken into account.

CHAPTER 5 – THE POLICY IMPLICATIONS: ALTERNATIVE PROJECTIONS
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CHAPTER 6 – CONCLUSION

6.1 Key Findings

The analyses described in this paper serve to highlight the necessity of including proximity to death (ie, changes in life expectancy) as well as age when determining the impact of demographic changes on future health expenditures. The often-used approach of multiplying constant age-specific per capita expenditures by differing population figures to assess the impact of changing demography on health expenditures is a rough estimate at best, as it assumes that morbidity stays the same when longevity increases. Epidemiological studies have shown, however, that there might be a compression of morbidity, whereby additional years of life are lived in health rather than illness, making a 65-year old 10 years from now healthier on average than a 65-year old now. Economically, this translates to a concentration of health care expenditures in the last years of life.

The model presented in this paper confirms that most hospital costs occur at the end of life, and that proximity to death is a much stronger predictor of hospital expenditures than age alone. Incorporating the effect of proximity to death on expenditures shows that increases in the numbers and proportions of the older populations will be partially countered by the postponement of death-related expenditures to later in life. The improved model derived from the ORLS study, which considers the interactive long-term effects of age and time to death on expenditures, may provide a next step towards more accurate expenditure projections for the NHS.

6.2 A Word of Caution

It is important to note, however, that the findings of a link between hospital expenditures and time to death should not be construed as implying that more expenditure-containing measures must be used with patients at the end of life. Retrospective studies have the advantage of knowing which patients are going to die and which are not. In reality, the time of death is usually unpredictable. In fact, one recent study found physicians to accurately estimate the remaining survival time of terminally ill patients upon hospice admission only 20% of the time (Christakis and Lamont, 2001). It is therefore hard to determine in advance when care should be "curative" or "palliative"

(Emanuel and Emanuel, 1994). Hence, use of the relationship between health care expenditures and time to death is intended more for population-level projections, to assess the impact of demographic changes on health service expenditures, rather than to guide decisions on individual patient care.

6.3 Future Research

The main question left unanswered from all of the studies presented above is: what is the impact of ageing on long-term care and medicines expenditures? As populations get older, the interface between health and social care and the use of outpatient drug treatments for chronic diseases will become increasingly important arenas for improved patient management. Budget systems and dataset coverage that are limited to only the inpatient health sector prevent a more comprehensive assessment of the health care expenditures of ageing populations. More study is needed in the other sectors of health and social care, to provide a more inclusive look at the impact that age will have on health and social expenditures in the future.

6.4 Final Thoughts

The demographic changes that are projected to occur over the next few decades will undoubtedly have an impact on the cultures, societies, politics, and economies of every country in the world. Well-founded research is crucial to understanding and meeting the challenges presented by rising numbers and proportions of older people in the world's population. Using more robust data and methods than have hitherto been employed, the analyses described in this monograph confirm that time to death is a predominant influence of health care expenditures and must be considered when determining the impact of demographic changes on future health care expenditures. The pressure of population increases and ageing demographic structure on health care expenditures will be partially countered by the postponement of death-related expenditures to later in life. In our enthusiastic pursuit of healthy ageing, this finding is consistent with emerging epidemiological evidence and is heartening for policy makers and physicians alike.

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