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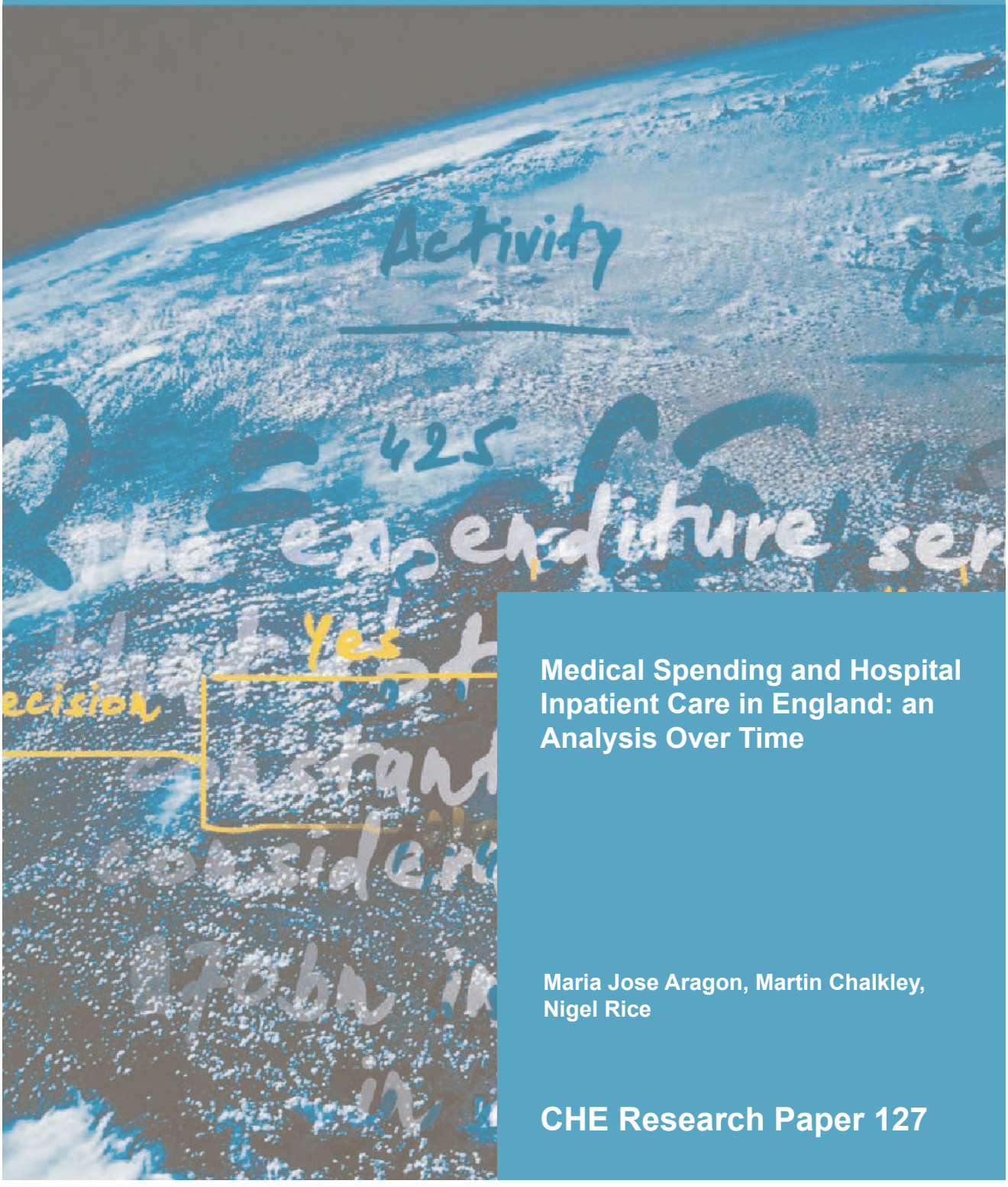

Medical Spending and Hospital Inpatient Care in England: an Analysis Over Time

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CHE Research Paper 127

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Abstract

Health care in England is predominantly provided free at the point of service through the publicly funded National Health Service (NHS). Total NHS expenditure, which has risen in real terms by an average of 3.7% per annum since the inception of the NHS in 1948, constituted 7.9% of GDP in 2012. This paper presents a summary of the trends in medical expenditure in England and then using detailed administrative data presents analysis of the growth over 15 years of expenditure and activity in hospital inpatient health care, which represents around 20-25% of all NHS expenditure. We document the coincidence of observed trends in expenditure with reported activity, morbidity and the proximity of individuals to death. We find that; (i) expenditure for both elective and emergency inpatient care broadly follows activity so expenditure is mostly driven by activity rather than unit costs; (ii) expenditure is concentrated in individuals with multiple diseases so that the prevalence and identification of complex medical conditions are important drivers of expenditure and (iii) health care activity rises substantially for individuals in the period before death so that expenditure is driven substantially by mortality in the population. Taken together these findings indicate that this element of health care expenditure in England has been substantially driven by the underlying morbidity and age of the population in conjunction with improving health care technology.

JEL: H51; J11; I19.
Keywords: English National Health Service, health care expenditure, health care activity, end of life expenditures.

1. Introduction

Health care in England is predominantly provided publicly through the National Health Service (NHS). The system, largely free at the point of use, is funded through conventional income and expenditure taxes and employment-related National Insurance contributions. Direct patient contributions are small with minimal copayments. From its inception in 1948 through to 2014 UK public spending on the NHS has risen in real terms by an average of 3.7% per annum to approximately 7.9% of GDP in 2012. NHS expenditure in England amounted to £108.8b in financial year 2010/11, equivalent to approximately £4,618 per household (Harker 2012).

This article documents the trend in aggregate health care expenditure in England over the past twenty years and provides a detailed analysis of one component of this expenditure over 15 years. Overall expenditure responds to changes in the real costs of delivering healthcare, the volume of activity that is undertaken and the composition of that activity and these in turn can be expected to reflect the underlying health of the population. In order to examine the potential contributions of these diverse factors it is necessary to disaggregate expenditure both in terms of the kinds of services delivered and the characteristics of the individuals who receive it. Our focus is expenditure on Hospital and Community Health Services (HCHS), which represents around 65% of NHS expenditure. More specifically, we consider admitted patient care which includes inpatient and day cases. Together these represent approximately one third of total HCHS expenditure. Besides being a large part of overall expenditure, inpatient is appropriate to study because there are administrative data on NHS hospitals' activity providing details of individual patients, including dates of admission and discharge, whether the admission was planned, and clinical information on diagnoses and procedures, amongst others. We combine these data with records that provide the cost of each admission.

The data we examine concern all inpatient activity and provide approximately 15 million (varying from 12m in 1998/99 to 19m in 2012/13) records per annum enabling detailed analysis generalisable to the population of health care users as a whole. By matching admissions to their costs we are able to establish the pattern of this area of health care activity in England over a 15 year period to 2012/13. We investigate how expenditure translates to trends in activity and changes in morbidity and the age and gender characteristics of the population over the same period. We then focus further on expenditure at the end of life since it is well documented that expenditure at the end of life is greater than at other points in the life cycle.

We find that expenditure for both elective and emergency inpatient care broadly follows activity. There is thus no obvious evidence either that increasing unit costs are a substantial driver of expenditure or that hospital expenditure is driven by demand for discretionary treatments. We find evidence that expenditure is concentrated in individuals with multiple diseases so that the prevalence and identification of complex medical conditions is a potentially important driver of expenditure. And we confirm previous findings that health care activity and associated expenditure rises substantially for individuals in the period before death so that expenditure is driven substantially by mortality in the population. Taken together these findings indicate that expenditure on inpatient health care in England has been substantially driven by the underlying morbidity and age of the population in conjunction with improving health care technology.

A novel element of our study is the construction and analysis of a consistent time series of 15 years of detailed administrative records in order to disaggregate and understand the potential drivers of a substantial element of publicly funded healthcare expenditure in England.

2. Institutional Framework

Health care delivery in the United Kingdom (UK) is synonymous with the publicly funded NHS which accounts for by far the greater proportion of health care provision with the (growing) exception of dental health care. Although it is often described as a single entity, the NHS is comprised of four separate publicly funded systems for each of England, Scotland, Wales and Northern Ireland. Each traces its origins back to 1948, although a precursor publicly funded system in Scotland existed for some 35 years prior to that. Block grants via the Barnett formula are used to determine public funding to each of the devolved administrations within which each is free to decide how much to spend on the NHS. The broad functional split of expenditure in all cases is between secondary care termed *Hospital and Community Health Services* and primary care usually termed *Family Health Services*. The former accounts for around 65% of total expenditure, details for which are provided in Section 3 below.

Although the UK tax system contains an element called National Insurance the term is not really useful.[1] Conventional income and expenditure taxes and so-called 'insurance' contributions are pooled and provide almost all of the financing for the NHS. Patient contributions are limited to a few items; dental care, prescription medicines and eye tests although there are some differences in these across jurisdictions. For example, prescription charges for eligible patients are currently £8.20 per item dispensed in England. This raised £450m in 2010/11 or around 0.5% of the NHS resource budget (Department of Health 2011). Wales, Scotland and Northern Ireland have abolished prescription charges. Charges for dental treatment vary across jurisdictions with England paying between £17.50 and £209 depending on the service provided (UK Statutory Instrument 2009/407 2009). Dental charges provided £614.3m in funding in England in 2009/10 (Health and Social Care Information Centre 2011).

Health care professionals can be either directly employed by the NHS (usually true for hospital physicians and nurses) or self-employed contractors of the service (usually the case for general medical practitioners and dentists) and such individuals are then free to engage in private practise. Traditionally hospital services were (and still mostly are) supplied by NHS organisations but there has recently been a move towards contracting with non-NHS suppliers.

Rationing of health care has always been a politically charged issue. With effectively zero copayment the NHS has traditionally relied on a gatekeeping role of primary physicians and waiting lists to limit hospital-based treatments. For other treatments there are various forms of waiting or queueing that regulate demand.

There has been a substantial recent process of system reform, especially of hospital provided health care, commencing in 2004 and mostly affecting only England. This has seen the adoption of fixed prices for hospital treatments, greater discretion over the use of funds by NHS hospitals, and empowerment of patients through encouraging choice and 'shopping around'. These changes have been evidenced to increase hospital activity. There has also been greater direct setting of targets for waiting times and other performance measures, which have applied to a greater or lesser extent across the four jursidictions.

[1] National Insurance contributions (NI) are employment (including self-employed) based contributions that qualify individuals for certain benefits under the National Insurance Fund. These include state pensions, incapacity benefits, sick pay, jobseeker's allowance bereavement benefits and maternity pay. NI is also used to fund the NHS. In Great Britain in 2012-2013, approximately 20% (£20b) of total NI was used for this purpose; the remainder allocated to the National Insurance Fund (circa £84b) (Government Actuary's Department 2013).

3. Basic Trends in Health Care Expenditure

Total (public plus private) health expenditure in the UK, as a percentage of GDP, has more than doubled over the past 50 years from almost 4% in 1960 to 9.4% in 2012 (public spending was approximately 7.9% of GDP). Figure 1 shows that the percentage of GDP spent on health has consistently increased since the 1960s with the exception of plateaux during the mid to late 1970s, the early to late 1980s and the mid 1990s. There are notable increases in expenditure as a proportion of GDP across the time series. Those occurring in the mid 1970s, early 1980s and early 1990s coincide with recessions; the large and sustained increase in the late 1990s onwards occurred under a government policy of year-on-year real term increases in funding of the NHS with the steep rise in the final two years to the end of 2009 coinciding with the most recent recession. The drop in funding as a share of GDP at the end of the series occurs during a period where health funding was maintained in real terms whilst GDP increased. Over the period from financial years 1949/50 to 2013/14 public spending on health in the UK has risen by an average of 3.7% per annum in real terms (Lloyd 2015).

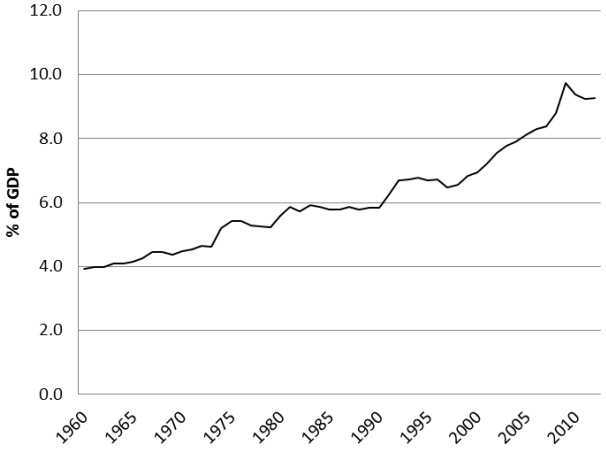

Figure 1: Total Expenditure on Health as Percentage of GDP

Figure 2 shows the breakdown in total health expenditures between public, or general government health expenditure (GGHE), and private expenditure. The split in sources of funding has remained reasonably constant over time with the majority, around 80%, financed through public funds. Since privately funded health care is small relative to public funding and that the main provider of health services is the NHS, we will focus on NHS expenditure.

The main source of financing for the NHS is public funding raised via National Insurance Contributions (around 18%) and general taxation at around 80% (see Figure 3). Patient charges (e.g. co-payments for prescriptions) account for less than 2% of total expenditures. There was a notable change in the composition of funding in 2003 with the introduction of an extra 1% in National Insurance contributions used to finance increases in health expenditure in the UK.[2]

The main recipient of NHS funding is Hospital and Community Health Services (HCHS), which represents almost two thirds of total NHS expenditure and includes hospital inpatient, day case and outpatient activity. The other components, Family Health Services (FHS), GP prescribing and Non-NHS provision represent smaller shares, around 17%, 15% and 6% on average, respectively (see Figure 4).

[2] http://news.bbc.co.uk/1/hi/uk_politics/1934690.stm; http://webarchive.nationalarchives.gov.uk/+/http://www.hmrc.gov.uk/budget2002/hmt1.htm, both accessed on 24 July 2015

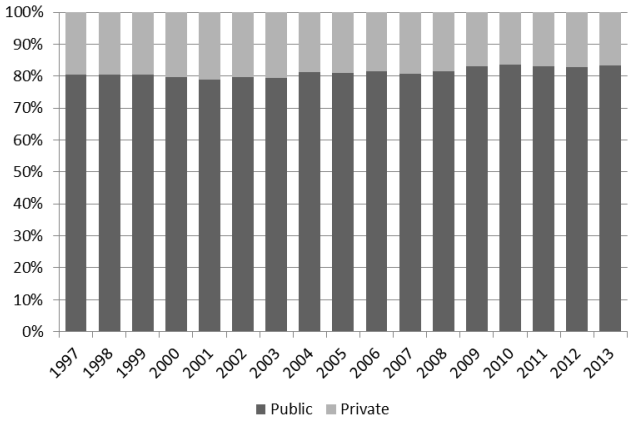

Figure 2: Government and Private Expenditure as Percentage of Total Expenditure on Health

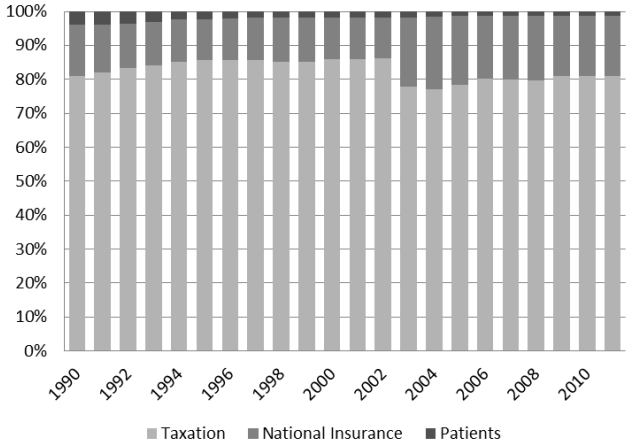

Figure 3: NHS Sources of Funding

Focusing on the last decade, where large and sustained increases in health expenditures as a percentage of GDP took place, we can see from Figure 5 that this translated into substantial increases in real NHS expenditure per capita over this period for all four countries of the UK. The largest increase occured in Northern Ireland, where per capita expenditure almost double in real terms, followed by England with an increase of over 70%; Scotland and Wales increased their expenditure by 56% and 52% respectively.

Given the substantial role of hospital services in the provision of health care in England, together with the availability of inpatient hospital administrative records over a number of years which can be costed in a reasonably consistent manner, we focus our attention on this particular aspect of the NHS. This allows us to investigate trends over a 15 year period to 2012/13 in expenditure and its relationship with trends in activity and changes in morbidity over the same period. The data further allow us to consider in detail expenditure in proximity to death and cumulative life-cycle expenditures at the end of life.

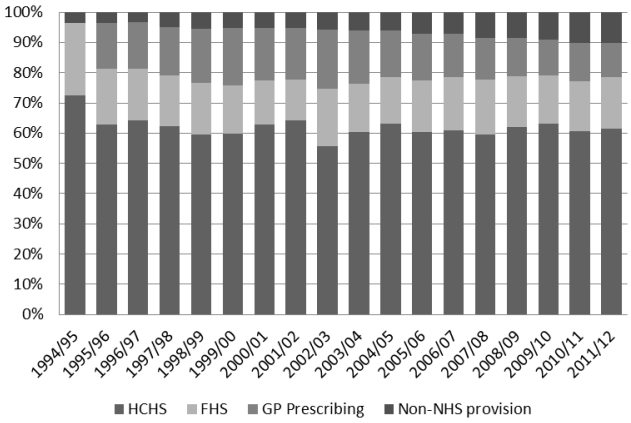

Figure 4: NHS Expenditure

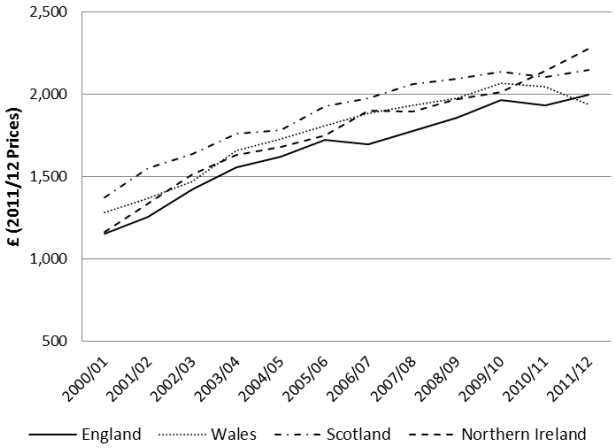

Figure 5: Health Care Expenditure per capita in the UK

4. Data

To determine the composition both of patients treated and the treatments they receive we use data from the Hospital Episode Statistics (HES), Admitted Patient Care. This reports all admissions to NHS hospitals in England and includes information about the patient, the dates of admission and discharge, whether the admission was planned or not, and clinical information (diagnoses and procedures) and sundry other details.

Each observation in HES corresponds to an episode, which collects the information during the period a patient is under the care of one consultant. If the patient is transferred to the care of another consultant, a new episode will be created, and these two episodes will form a *spell*, which corresponds to the whole period the patient was admitted into a particular hospital. Most spells (between 90% and 95% in the financial years 2010/11 to 2012/13) have only one episode, and only a small proportion (between 1% and 3% over the same period) have three or more.

In order to establish a breakdown of expenditure as between the volume of activity and its composition we match each episode to its cost. HES does not include information regarding these costs but they are recorded separately under a system known as Reference Costs. National average unit costs for each type of treatment are reported in Reference Costs for each financial year, and these costs are constructed using the information reported by NHS hospitals regarding their activity and costs for the financial year. To bring these two datasets together we need to match it using Healthcare Resource Groups (HRGs), each episode can be assigned to a HRG and HRGs are the unit used to defined costs.

Whilst simple in principle this process is complicated in practise by the changing nature of the classification system. Until 2002/03 HRGs were reported in HES using version 3.1, and from 2003/04 using a different version 3.5. Since 2006/07, another new and substantially different system was produced called HRG 4. That system in turn is subject to numerous revisions. We set out the steps that we were required to take and some of the unresolved issues that we encountered in this process in Appendix B.

5. Trends in hospital inpatient care

The analyses that follow present descriptive inference conditional on the population of inpatient users; that is, we only observe individuals' expenditure and activity data in periods when they have accessed services.

A key concern for health policy is to understand the underlying drivers of the observed growth in health care expenditure. Are trends in expenditure dominated by demand or supply side characteristics? For example, is expenditure simply responding to changing health care needs brought about through population growth and a changing demographic profile? Is the 'average' person sicker than before, in the sense that there exists a greater prevalence of morbidity at a particular point in time, or that prevalence has remained stable but the severity of morbidity has increased? Have expectations about the benefits of health care treatment increased thereby raising demand? Are patients treated more intensively using improved and more expensive technologies? Are there more and different kinds of sickness that we can now treat? Has the political dynamic of increased funding in itself had a role to play, for example, in encouraging supplier induced demand to justify calls for additional expenditure?

These are the questions that motivate our analysis. While unpicking causal relationships is beyond the analysis presented here, the data allow us to gain some insight into these issues by observing the coincidence of changing expenditure and changing activity and morbidity over time. We aim to provide a coherent analysis of the trends in hospital inpatient expenditure in England since 1998/99 and its links to activity and morbidity, with a particular focus on expenditure in proximity to death.

5.1. Health care expenditure profiles over time

With the exception of the years from 2006/07 to 2008/09, total inpatient expenditure rose over the 15 year period from 1998/99 to 2012/13 (Figure 6). Expenditure in 1998/99 was approximately £14.1b and by the end of the series amounted to £23.7b (in 2012 prices); an increase of £9.6b (or 68%). Over the seven year period to 2005/06, the increase was reasonably constant averaging approximately 7% annually. From 2010/11 onwards annual inpatient expenditure has remained relatively flat. There was a notable fall in expenditure growth in 2006/07 and a subsequent decrease in 2007/08. This appears to be due to the fact that the new classification system (HRG 4) had a higher number of HRGs with zero cost than its predecessor (HRG 3.5) and a different way of costing non-electives (see Appendix B). Throughout the period women received a greater share of expenditure with the difference over men increasing from £1.7b to £2.3b across the series.

The two main components of inpatient health care expenditure are elective and emergency care. These are defined by admission type on arrival to hospital and are potentially revealing of the underlying drivers of expenditure trends. Arguably, one might expect trends in emergency care to be less prone to increasing population demand, and particularly supply-induced demand, than elective care as it would appear reasonable to assume that people do not choose to be rushed into hospital as an emergency admission. Both, however, show similar trends of rising expenditure over time (see Figure 7) with elective care rising approximately 77% across the period and emergency care by around 72%. In all years emergency expenditure was greater than observed for elective care but accounted for a smaller proportion of total activity. A greater share of expenditure was provided to women for both elective and emergency care. It is clear that the dramatic fall in total expenditure to 2007/08 is due largely to changes in the costing of activity applicable to emergency care.

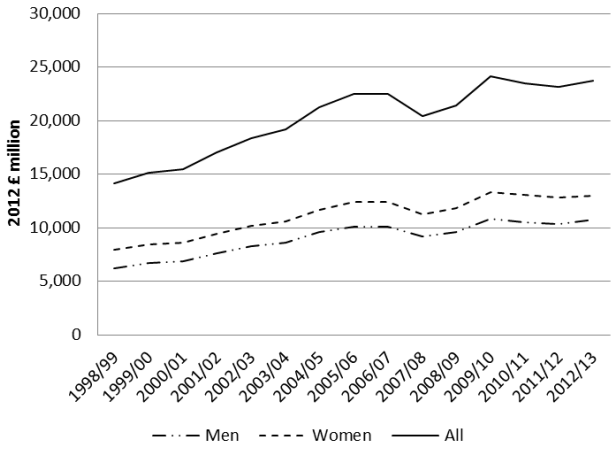

Figure 6: Total Inpatient Health Care Expenditure

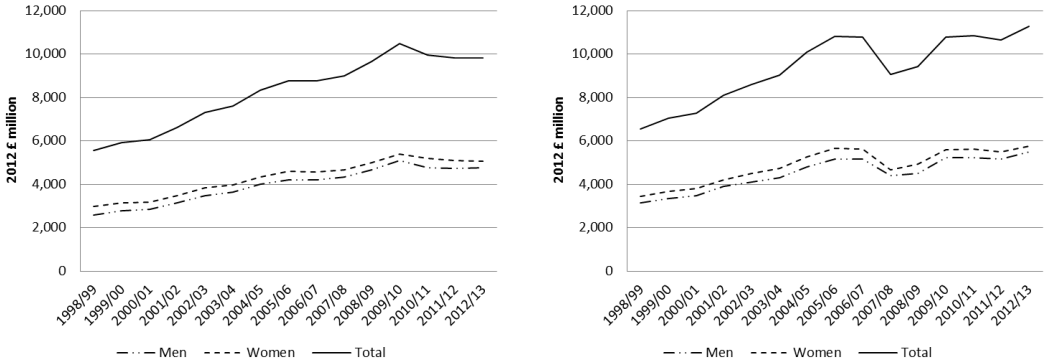

Figure 7: Elective (l.h.s.) and Emergency (r.h.s.) Expenditures

5.2. Health care activity profiles over time

To understand better the observed rise in inpatient expenditure we consider the change in activity over the same period. Increased activity might be observed through two channels. First, increased activity brought about by a greater number of individuals accessing inpatient services; secondly, increased activity observed through either a greater number of admissions in a given year for a given individual or greater intensity of care for a given patient admission. Both potentially reflect combinations of changes in health care need and demand, and changes in the supply of health care through technological innovation.

Figure 8 displays total expenditure against the number of distinct patients admitted in a year across the series.[3] The number of patients admitted has risen steadily over the period, from 6.9m individuals in 1998/99 to 8.3m in 2012/13; an increase of 20%. The ratio of expenditure to patients is reasonably constant from around 2006/07 onwards; however, prior to this we observe expenditure increasing at a faster rate than the number of admitted patients. This appears to suggest that average expenditure per patient was increasing to 2005/06 and remained relatively constant thereafter.

This is confirmed by the observed trend in average expenditure per individual with at least one admission in the year. Figure 9 plots total average inpatient expenditure by sex (left hand side) and similarly by

[3] This is a count of the number of individuals admitted during the year, rather than the number of admissions. Multiple admissions for a given individual in a given year count the same as a single admission.

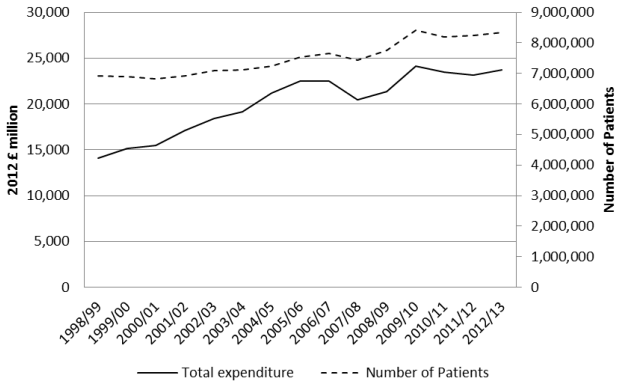

Figure 8: Inpatient expenditure/ Number of patients

type of admission (right-hand side). Total expenditure on women is greater than expenditure on men (see Figure 6), but average expenditures are greater for men in all financial years suggesting greater intensity of treatment presumably linked to greater severity of morbidity. As might be expected, this pattern appears more pronounced for elective than emergency procedures. On the whole, emergency admissions might be expected to consist of a greater proportion of exogenous shocks to health, displaying less variation by sex. Average expenditure on emergency episodes is approximately 45% greater than those for elective procedures across the series.

Figure 9: Average Total Expenditure and by Elective and Emergency Admissions

Overall health care expenditure per capita in England rose by approximately 70% over the period 2000/01 to 2011/12 (Figure 5). Over the same period, average inpatient expenditure increased by approximately 24%. Note however, that the latter figure represents average expenditure for individuals admitted at least once during a financial year, rather than the population as a whole which includes individuals not accessing health care services. Translating inpatient expenditure into per capita of population in England, the rise over this period is approximately 38%.[4]

A potential explanation for the increase in average per patient expenditure observed over the period to 2005/06 is a consistent increase in activity brought about through either increased care provided for a given admission or higher numbers of admissions per person per annum. This can be explored by investigating trends in the number of episodes across time. It might be argued that this measure of activity provides a more accurate indication of what the hospital sector does as it is derived directly from

[4] This figure uses a population of 49.2m in 2000/01 and 53.1m in 2011/12 (ONS, `http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Population\#tab-overview`, accessed on 24 July 2015).

data on episodes of care - an episode being the treatment received under a single consultant. This is less prone to systematic biases due to changes in accounting rules over time inherent in converting activity data to expenditure. Figure 10 presents profiles of the average number of episodes over time. The total number of inpatients admitted per annum across the period to 2005/06 rose by around 600,000 (9% increase on patients admitted in 1998/99 - Figure 8) and the average number of episodes per person increased by approximately 0.3 (20% increase on average episodes in 1998/99). Average episodes continued to rise until 2008/09. Average episodes then decreased to approximately 2 episodes per inpatient per year. A similar rise in episodes to 2008/09 followed by a decline is also observed for elective episodes and to a lesser extent emergency episodes (not shown). On average men have a greater number of episodes than women.

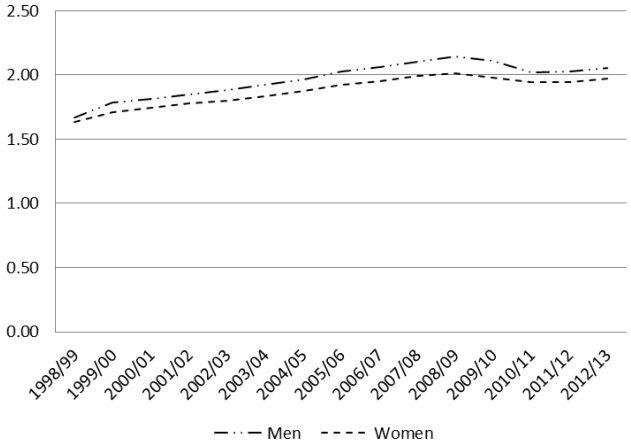

Figure 10: Average Number of Episodes

5.3. Morbidity profiles over time

Figure 11 shows the trend in the average number of comorbidities reported within HES.[5] The observed increase in comorbidity helps to explain the observed rise in activity (episodes of care). However, this might also reflect changing attitudes and protocols to reporting within HES data, for example due to incentives created through Payment by Results which require recording of diagnoses. It is notable that the number of reported comorbidities is increasing at the end of the series, whereas activity appears to level off (with the exception of emergencies). Men are reported to have a greater average number of comorbidities than women.

There is a clear relationship between the number of comorbidites and expenditure (Figure 11; r.h.s.). In the final year of observation (2012/13) the difference in average expenditure for patients recorded without a comorbidity and with a single comorbidity was £1,790; the difference in average expenditure for patients with 1 and 2 comorbidities was £3,478; between 2 and 3, £4,096; between 3 and 4, £4,677 and between 4 and 4+ was £6,133. Complications brought about due to increased comorbidity are clearly more expensive to treat.

[5] The diseases considered are those used to calculate the Charlson Comorbidity Index. See `http://www.hscic.gov.uk/media/16110/Indicator-Specification-Summary-Hospital-level-Mortality-Indicator-methodology-updated/pdf/SHMI/_specification.pdf`, accessed on 24 July 2015.

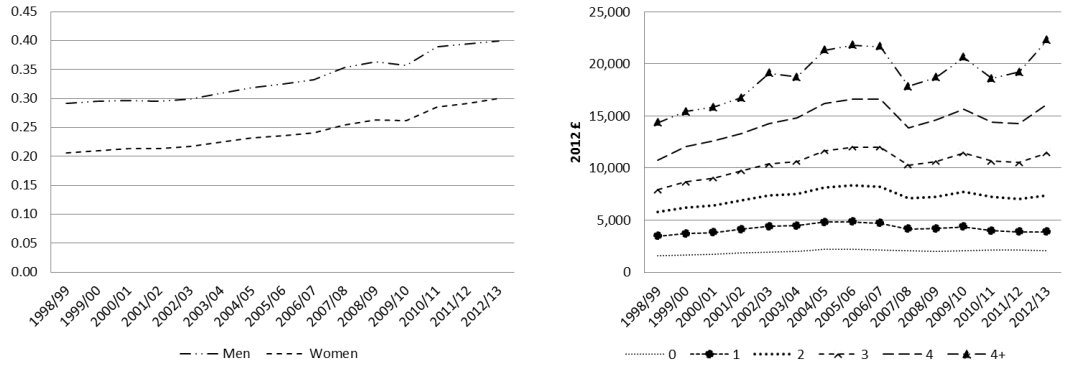

Figure 11: Average Number of Comorbidities and Expenditure by Comorbidity

5.4. Health care expenditure over the life cycle

Figure 12 shows inpatient expenditure and activity per patient across the life-cycle. The age-expenditure curve is based on the population of inpatient health care users in 2012/13. Hence inference is conditional on accessing hospital services. Estimates show that expenditure on average exceeds £4,000 for men older than 74 years and women older than 80 years. Profiles for men and women are generally similar with the exception that women do not display the substantial rise in expenditure across the late teenage years that appears for men. Broadly, expenditure follows a similar pattern across the life course as activity.

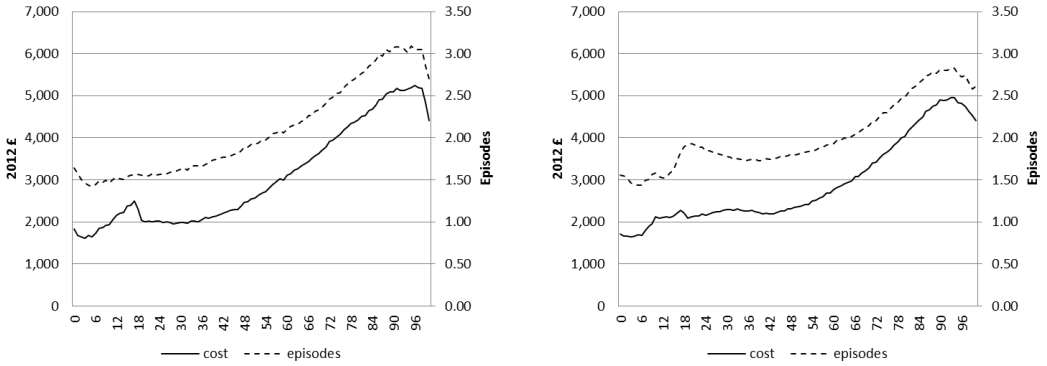

Figure 12: Average Expenditure and Activity by age: Men (l.h.s); Women (r.h.s.)

While there is a general tendency for expenditure to increase with age, expenditures are particularly high in the year leading to death. De Nardi et al. (2015) provide an overview of the literature in this area, which focuses largely on data from sickness funds. Seshamani and Gray (2004) provide evidence on rising expenditure with proximity to death for NHS hospital inpatients and day cases from the Oxford Record Linkage Study. Individuals aged 65 and over at the end of 1970 were selected and their general and psychiatric hospital and death records tracked to 1999. Hospital stays were costed using expenditure data from 1997 to 1999. Their results demonstrate significant increases in average quarterly costs approaching death. Average expenditure in the 20th quarter prior to death was £148. This increased steadily to around the 4th quarter prior to death and then rose substantially to £1,698 in the quarter of death. Expenditures more than doubled from the penultimate to final quarter. This section provides estimates of inpatient expenditure in years approaching death in HES data at our disposal.

Table 1 presents some basic facts on inpatient expenditure in the final years preceding death. Expenditure figures are based on financial years. Accordingly, if an individual dies in May, they will contribute expenditure data for the months April and May; while a death in March will contribute up to 12 months of expenditure data. Data are taken from the financial year 2010/11 and are broken down by sex and age.

From the population of 8.2m inpatient admission in 2010/11 there were 343.8k deaths overall and 4.6k, 53.0k, and 286.2k respectively across age categories 0-24; 25-64, 65+ in the same year.[6] The first two rows of Table 1 compare these rates with death rates observed in the general population (Office for National Statistics 2013). Clearly the death rates in the population of hospital inpatient users is substantially greater than that observed in the general population. This is particularly the case for the young (0-24 years) where deaths per 1000 individuals are over 7 times greater in the population of hospital inpatients compared to the general population. Death rates for inpatients over 65 years are approximately 2.6 times that observed in the general population.

The second panel of Table 1 presents average expenditure in the year of death, next to last year, and second to last year. Figures in parentheses show expenditure as a percentage of total expenditure in the same age and sex group. Expenditure on inpatients in the last year of life in 2010/11 totalled £2.5b; approximately 10.4% of total inpatient expenditure for 2010/11. Average expenditure was £7,134 but varies across age groups, being substantially greater for younger age groups than for those over 65 years. Using US Medicare data, Yang et al. (2003) report a similar finding that spending on inpatient care in the last year of life declines with age at death. Given the larger proportion of deaths amongst those aged 65+ years[7], however, the proportion of total health care expenditure afforded to the final year of death is substantially greater for this age group (19.6%) than for either the age group 0-24 (1.1%), or the age group 25-64 (4.5%). In general, average expenditures in the final year of life are greater for men than women.

Average inpatient expenditure in the next to last year is £6,373 which equates to about 6% of total expenditure, and £5,095 in the second to last year. Expenditure summed across individuals within the final 3 years of life represents one fifth (21.1%) of total inpatient expenditure for 2010/11. This is largely accounted for by the 65+ age group where expenditure across the final 3 years of life amounts to 39% of total expenditure on this age group and 17% of total inpatient expenditure for the financial year. Accordingly, a substantial proportion of total inpatient expenditure in England is accounted for by treatments in the final years of life, and which is largely explained by health care use by the over 65s. This result appears to accord with findings elsewhere. For example, Yang et al. (2003) report time to death as the main reason for inpatient expenditures using US Medicare data.

[6] Deaths are taken from ONS registers and include deaths both within and outwith hospital stays.
[7] 83% of all observed deaths in 2010/11 occurred in this age group.

Table 1: Average expenditure in last years of life

Financial year 2010/11												
	All				Men				Women			
Age	0-24	25-64	65+	All	0-24	25-64	65+	All	0-24	25-64	65+	All
Deaths per 1000:												
HES	2.7	13.5	112.9	42.0	3.4	18.9	116.2	47.6	2.1	9.8	110.1	37.7
Population	0.37	2.5	43.5	8.5	0.44	3.1	44.9	8.4	0.29	1.9	42.3	8.7
Average Expenditure in 2010/11 [£, 2012 prices] (% of total expenditure by age group)												
Died in 2010/11	8,290	8,339	6,892	7,134	7,862	8,351	7,175	7,395	8,851	8,324	6,637	6,884
	(1.1)	(4.5)	(19.6)	(10.4)	(1.3)	(6.0)	(20.5)	(11.8)	(0.9)	(3.3)	(18.8)	(9.3)
Died in 2011/12	16,591	7,860	5,980	6,373	16,780	7,874	6,149	6,563	16,329	7,842	5,820	6,185
	(0.8)	(3.2)	(11.6)	(6.4)	(1.0)	(4.2)	(12.2)	(7.4)	(0.6)	(2.4)	(11.0)	(5.6)
Died in 2012/13	11,416	5,944	4,883	5,095	10,939	5,932	4,915	5,145	12,024	5,959	4,854	5,047
	(0.4)	(1.9)	(7.9)	(4.2)	(0.5)	(2.5)	(8.0)	(4.7)	(0.3)	(1.4)	(7.8)	(3.9)
Died in 2010/11 or later	10,610	7,581	6,109	6,389	10,344	7,593	6,293	6,576	10,961	7,566	5,941	6,209
	(2.3)	(9.5)	(39.0)	(21.1)	(2.8)	(12.7)	(40.7)	(23.9)	(1.8)	(7.2)	(37.6)	(18.8)

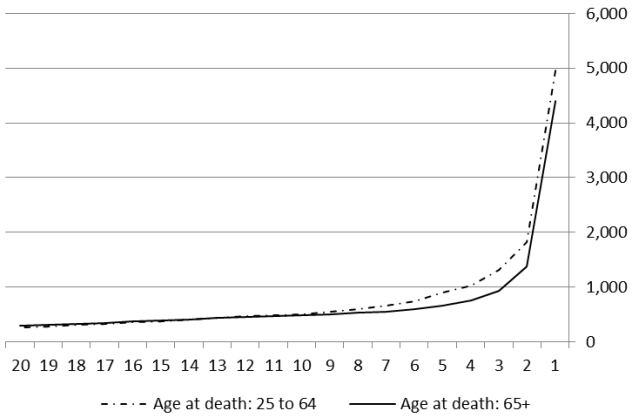

Figure 13: Average Expenditure by Quarter to Death

An alternative way of illustrating the increase in health care costs in the final years of life is presented in Figure 13 which plots inpatient expenditures by quarter to death. These estimates are based on the population of decedents observed to die in the financial year 2012/13. We follow these individuals back in time across successive years of HES and calculate their health care expenditure in each of the previous 40 quarters (Figure 13 plots expenditure (at 2012 prices) for up to 20 quarters prior to death).[8] Where an individual is not observed to have an inpatient episode in a particular quarter, expenditure is assumed to be zero. Quarterly mean expenditure for individuals aged 25 to 64 at death; and for individuals aged 65+ at death are provided. For all quarters, mean expenditure for the age group 65 years and over are lower than for the younger age group. For both groups there is a clear and sharp increase in expenditure in the final year and quarter of life. In quarters preceeding the final four (two) mean expenditure for the 25-64 year age group (65+ years) is below £1,000. Mean expenditure approximately doubles from the 5th quarter from death to the penultimate quarter. For the older age group mean expenditure in the final quarter of life is 3.2 times the expenditure in the penultimate quarter (£4,402 vesus £1,371); for the younger age group mean expenditure is 2.7 times greater than in the penultimate quarter (£4,961 vesus £1,825).

5.4.1. Cumulative expenditure approaching death

Figure 14 shows mean cumulative expenditure as a function of the number of quarters approaching death. In this way, the figure illustrates a ten-year (40 quarters) life-cycle profile of mean cumulative expenditure for individuals observed to have died in 2012/13. Cumulative mean expenditure increases at a diminishing rate as a function of distance from death and are greater for decedents aged 24 to 64 years at death than for decedents aged 65+ years, although the latter group make up by far the largest proportion of all deaths (399,165 deaths versus 64,664).[9] Mean cumulative expenditure across the 40 quarters was £19,547 in the 65+ age category and £20,732 for the 25-64 age category. Approximately 25% of total mean cumulative expenditure falls in the final quarter to death.

[8] We calculate quarters from death on the basis of date of death of the deceased as recorded on Office of National Statistics (ONS) Records and linked to HES data. A quarter is defined as $365/4$ days. To be able to link ONS death records to HES an individual must have had a hospital inpatient stay at some point during the 15 years of HES observations.

[9] In addition, there were 5,407 deaths in the 0 to 24 age category.

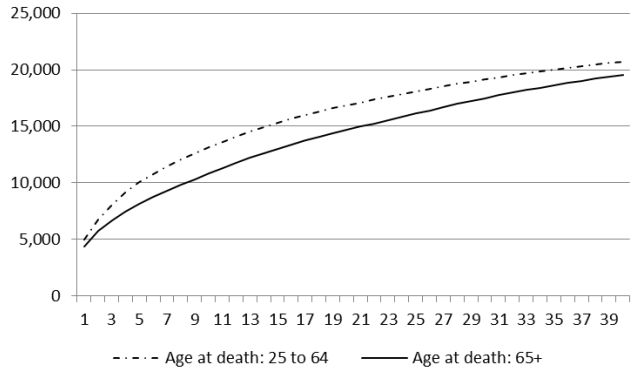

Figure 14: Average Cumulative Expenditure by Quarter to Death

5.4.2. Trends in health care expenditure approaching death

Expenditure in the financial year of death together with expenditure for the general population of inpatient health care users across time is shown in Figure 15. Average expenditure is calculated separately for all individuals and for those observed to die within a given financial year.[10] Average expenditure in the financial year of death was £4,886 in 1998/99 (2012 prices; see Figure 15, l.h.s.). This has increased by 58% over time to £7,700 in 2012/13. The corresponding rise for the population of inpatient users as a whole is approximately 39%. The ratio of average expenditure in the last year to general expenditure, was 2.39 in 1998/99 increasing to 2.71 in 2012/13. While expenditure in the final year of life is greater than for the general population, over time expenditure has risen more substantially for individuals approaching death.

Average expenditure in the financial year of death is greater for emergency admissions than for elective admissions (Figure 15, r.h.s.). This corresponds to the observed pattern of expenditure in the general population of inpatients. The drop in expenditure observed for 2007/08 is far more pronounced for individuals in the last year of life than in the population of health care users. This is likely to be due to the introduction of HRG4 which introduced *unbundled* HRGs (see Appendix B). Unbundled HRGs include elements of activity that are likely to impact more on end of life care than general inpatient activity. In this respect, the observed difference over time in expenditure at the end of life compared to the general population of inpatients is likely to be a conservative estimate.

The increased average expenditure in the financial year of death is reflected in an increase in the average number of episodes (Figure 16). Note that the difference between men and women in the average number of episodes is far greater for those who died within the financial year than in the general population of inpatient health care users. This translates into a greater average expenditure in the financial year of death for men than women, with the difference between the sexes peaking across the series at approximately £713 (not shown).

[10] Accordingly, someone who dies in May will only contribute a month or so expenditure data to the estimate, while someone who dies in March of the following calender year will contribute potentially 12 months of expenditure data. The estimates will therefore be an underestimate of the total mean expenditure if calculated over 12 months prior to the date of death.

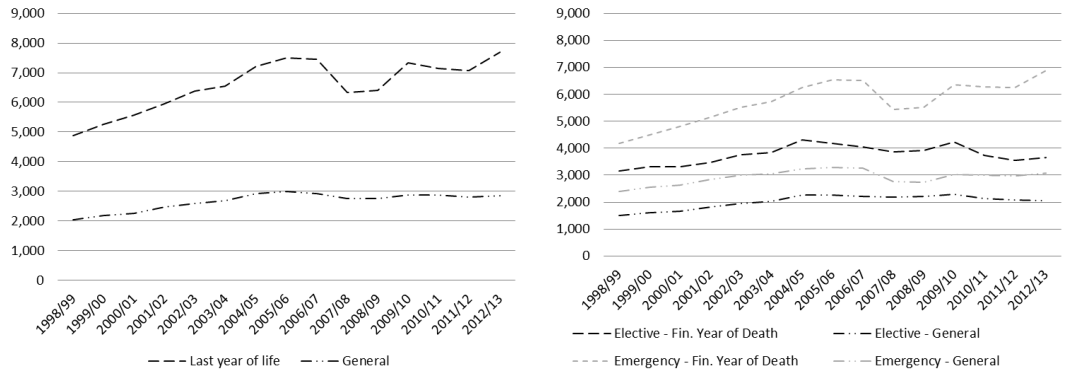

Figure 15: Average Inpatient Health care Expenditure in Financial Year of Death

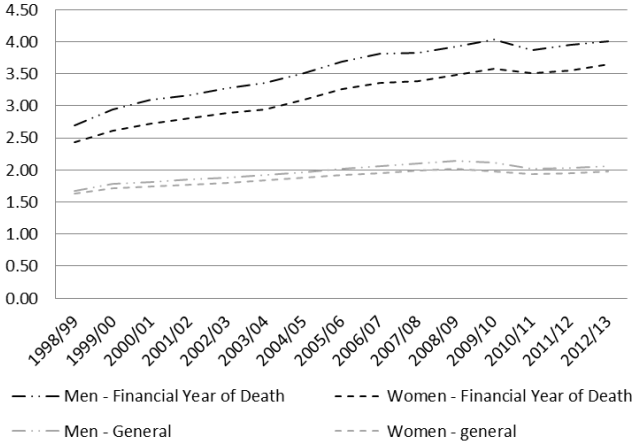

Figure 16: Average Episodes in Financial Year of Death

6. Conclusions

The real terms increase in health expenditure observed in England over the last 20 years, which mirrors that of other countries, raises the spectre of health care spending becoming an ever greater proportion of GDP. In a publicly funded system such as the NHS this would place an ever-increasing burden on government revenues at a time when financial constraints on the government are particularly tight. It is, therefore, necessary to have a better understanding of what is driving increases in order to better forecast and if necessary temper those drivers.

Our supposition is that in order to get that better understanding it is necessary to consider consistent time series and to decompose expenditure. Longer time series give the ability to discern trends as distinct from short term shocks, and decomposition allows trends to be understood better in terms of the complex interactions of volumes of treatments and their underlying costs. We have pursued this line of investigation, focusing on hospital inpatient expenditures over a 15 year period in England.

There are many ways to subset data on hospital treatments; by the nature of the treatment itself; by the characteristics of who the treatment is delivered to or by the characteristics of the supplier of the treatment. Of necessity our examination has been preliminary and incomplete; we have restricted attention to a few key characteristics of treatment (whether it is elective or emergency care) and to a few key characteristics of the recipients (their age, co-morbidities and their proximity to death). Nevertheless our analysis is informative.

In respect of inpatient hospital care it is hard to escape the conclusion that proximity to death is a very substantial driver of expenditure. This is often obscured by the general tendency of health care costs to rise with a person's age. Whilst this effect is evidenced in the data it is proximity to death rather than age per se that seems the more important influence on costs. And whilst in general health care expenditures are rising, it appears that the gap between general expenditure and expenditure in last year of life is also rising indicating that end of life care is becoming more expensive relative to general care. So when it comes to hospital expenditure policy makers may need to pay more attention to the rate at which the population is dying than to the rate at which it is ageing. There may also be important debates to be had as to whether managing the process of death in expensive health care facilities such as hospitals is appropriate.

Beyond proximity to death and general ageing our analysis also points to the disproportionate effect of multiple diseases in generating hospital expenditure. We cannot distinguish between whether the population is getting sicker (perhaps because people are living longer) or whether we are simply getting better at identifying multiple illnesses. In any case there appears to be an underlying trend towards multiple comorbidities and that trend has consequences in terms of increasing expenditure in hospitals. Again there is perhaps a challenge to both policy-makers and health care professionals here regarding how best to manage individuals with these comorbidities.

What we do not find any obvious evidence of is a substantial role for increasing unit costs. Hospital expenditure in England has risen quickly because more people are treated and those who are treated are treated more intensively across multiple episodes in hospital. As noted earlier, England has pursued a number of policies specifically targeted at improving efficiency of the hospital sector and therefore aimed at ensuring that unit costs are kept under control. We cannot establish whether these policies have been effective, because it is possible that in their absence we would have observed similar, or even more benign trends in relation to correlation of activity and expenditure. However, there is the

possibility of answering this question because other jurisdictions in the UK, which have similar health care systems, have not pursued the same policies. Comparative studies of these jurisdictions using the kind of extended decomposed trend analysis presented here is a potential avenue for future research.

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A. Data Sources Figures

Figure 1: OECD Health Statistics 2014 - Frequently Requested Data, http://www.oecd.org/els/health-systems/oecd-health-statistics-2014-frequently-requested-data.htm, accessed on 24 July 2015.

Figure 2: Office for National Statistics. Expenditure on Healthcare in the UK: 2013, Reference Table 7: Percentage Share of Public and Private Healthcare Expenditure, 1997-2013, http://www.ons.gov.uk/ons/rel/psa/expenditure-on-healthcare-in-the-uk/2013/art-expenditure-on-healthcare--2013.html, accessed on 24 July 2015.

Figure 3: OHE Guide to UK Health and Health Care Statistics 2013, Table 2.5.

Figure 4: Office for National Statistics. Public Service Productivity Estimates: Healthcare, 2012, Reference Table 2: Public service healthcare expenditure shares, by output component, 1994-95 to 2011-12, http://www.ons.gov.uk/ons/rel/psa/public-sector-productivity-estimates--healthcare/2012/art-healthcare.html, accessed on 24 July 2015.

Figure 5: OHE Guide to UK Health and Health Care Statistics 2013, Table 2.3.

Other Figures: HES and Reference Costs.

B. Matching costs to activity

As noted in the text we needed to match Hospital Episodes Statistics data to Reference Costs. The NHS Reference Costs are published by the Department of Health, and include the National Schedule of Reference Costs and the Reference Cost Index.[11] They have been published for each financial year since 1998/99. The National Schedule of Reference Costs reports, for different types of hospital, the national average cost for each HRG; these costs are calculated using the information reported by hospitals about their activity and its cost in a financial year. The Reference Cost Index reports for each NHS hospital an index comparing the actual cost of its activity with the cost it would have had if its costs were the national average costs. The costs included in the National Schedule of Reference Costs accounted for half of the NHS expenditure in 2011/12 (Department of Health 2012).

We use the average cost reported in National Schedule of Reference Costs for NHS Trusts (from now on the Schedule), due to it being available for a longer period and that NHS Trusts account for most of the activity reported in the Schedule (over 85% of the costs since 2006/07) (Department of Health 2012). We use the Schedule of the financial years 1998/99 to 2012/13.

The Schedule includes different types of activity and reports for each HRG the number of episodes, the average unit cost of an episode, the highest and lowest reported cost and the interquartile range. These costs are not adjusted for differences in cost across the country and exclude excess bed days (excess bed days are reported separately since 2003/04).

The average unit costs of episodes is reported for different types of activity, and more types of activity have been included over time as the scope of the Reference Cost increased, e.g. in 1998/99 it included elective, non-elective, day cases, outpatients, and critical care, and the following year it additionally included radiotherapy, A&E services and community services. Other types of activity reported in the Schedule in later years include specialist services, pathology and radiology services, and mental health services.

The comparison of costs over time is not direct since there have been changes to the Reference Costs, such as the HRG classification, the trim points that determine excess bed days, and the requirements for the collection of costs from the hospitals. In addition to these general changes there have been some other changes that need to be kept in mind when comparing costs over time. Activity that cannot be assigned to treatments or procedures (given an HRG code starting with 'U') is normally not included in the Schedule, with the exception of 2001/02 and 2002/03 when these U-codes were included. In 2004/05 the NHS was given funding to cover an increase in pensions indexation that occurred the year before, and this increased cost is reflected in the reference costs. From 2005/06 onwards non-elective admissions no longer include the cost incurred in observation wards prior to the admission.

The HRG classification used in the Schedule varies over time, as new versions became available. Between 1998/99 and 2002/03 the Schedule used HRG3.1, between 2003/04 and 2005/06 HRG3.5 and between 2006/07 and 2011/12 HRG4.[12] In 2012/13 HRG4+ was introduced. However, in our data we

[11] More details about the Reference Costs can be found in the following links (both accessed on 24 July 2015):
`http://webarchive.nationalarchives.gov.uk/20130107105354/http://www.dh.gov.uk/en/Managingyourorganisation/NHScostingmanual/DH_129310` (1998/99 - 2008/09)
`https://www.gov.uk/government/collections/nhs-reference-costs` (2009/10 onwards)

[12] Note that within HRG4 the number of HRGs varies from year to year, for details see 'HRG4 2011/12 Reference Costs Grouper Roots' in `http://www.hscic.gov.uk/article/2610/HRG4-201112-Reference-Costs-Grouper-Documentation`, accessed on 24 July 2015.

used HRG4 since 2007/08 and use the HRG3.5 costs from 2005/06 to cost the activity of 2006/07, since the Reference Cost Grouper for that year does not work properly.

The change in the HRG classification from HRG3.5 to HRG4 has an impact on our data because of the increase in the number of HRGs that have zero cost and changes in the way non-elective costs are reported.

Since we are interested in the cost of the activity reported in the Admitted Patient HES, we will use only three types of activity: elective, non-elective, and day case, these three types of activity account for around 42% of the costs reported in the Scheduled (Department of Health 2012).[13] We assign the elective average cost to episodes that are recorded as ordinary elective admissions[14]; the day case average cost to episodes recorded as day case or as regular attender[15]; and the non-elective cost to emergencies[16] and maternity[17]. It is important to note that by using the average cost we are underestimating costs as this excludes excess bed days and procedures that require days of critical care, the costs for which are reported separately in the Schedule. To attach costs to the HES inpatient data we use the HRG code of each episode.[18]

The financial year 2007/08 is the first one for which we use HRG4. As can be seen in Figures 6 and 7 this change of HRG version coincides with a drop in the total cost, particularly for non-electives. We have explored possible causes of this drop and provide some details next.

The first reason why the change in the HRG classification, going from HRG3.5 to HRG4, has an impact on our data is the increase in the number of HRGs that have zero cost. In HRG3.5 only U-codes and mental health HRGs had zero cost. HRG4 introduced *unbundled* HRGs[19], which leave some (*core*) HRGs with zero cost since the cost associated with that episode is recorded separately. So, in HRG4 there are more HRG codes that have no associated cost than in HRG3.5, which will appear as a decrease in the activity in our data, since we only consider episodes with cost; additionally, the proportion of U-codes increases in the two financial years after the introduction of HRG4, probably due to the greater complexity of the HRG allocation process.

To quantify how much of the drop observed on the figures can be explained by the presence of zero cost (*core*) HRGs we identified the zero cost HRGs[20] with most activity in each financial year since 2007/08 and used information available in the Schedule for *unbundled* HRGs or from other years to inpute a cost. The zero cost HRGs with most activity were the following: PB03Z (Healthy Baby), SB97Z (Same day Chemotherapy admission/attendance), SC97Z (Same day External Beam Radiotherapy Admission or Attendance), LA08E (Chronic Kidney Disease with length of stay 1 day or less associated with Renal Dialysis[21]). PB03Z had costs for inpatient, day case and non-elective in the 2009/10 Schedule,

[13] Other costs reported in the Schedule include outpatient, A&E and non-acute activity.
[14] Coded as classpat = 1 & admimeth = 11, 12, or 13.
[15] Coded as classpat = 2, 3, or 4 & admimeth = 11, 12, or 13.
[16] Coded as admimeth = 21, 22, 23, 24, or 28.
[17] Coded as admimeth = 31 or 32.
[18] Up to 2006/07 we use the HRG code recorded in HES, and from 2007/08 we use the HRG code that is produced by the Reference Cost Grouper of the corresponding year. In 2006/07 HES reports HRG3.5 but the Schedule uses HRG4, so it is not possible to match the data, so we used the Schedule for 2005/06 to assign the cost for each episode. From 2007/08 onwards the Schedule reports non-elective activity separated by long stay and short stay, we use the weighted average of these two costs for each HRG as the average cost of non-elective activity.
[19] Unbundled HRGs represent additional elements of care (e.g. chemo- and radiotherapy, high costs drugs), which are always associated with a core HRG that represents a care event (e.g. inpatient, day case, outpatient).
[20] Other than U-codes and mental health.
[21] In 2012/13 this HRG was removed and replaced by two HRGs, LA97A and LA97B, that separate dialysis patients by age.

so we used these costs in previous and later years that do not report it. For SB97Z, SC97Z and LA08E (LA97A, LA97B) we used the national average reference cost from the 2012/13 Schedule for Chemotherapy, Radiotherapy and Renal Dialysis, respectively.[22,23] The costs related to the zero cost HRGs with most activity account for £200-£600 million (in 2012 prices) in the years following the change of HRG classification.

Another change that could be behind the drop observed in Figures 6 and 7 is the way the non-elective costs are reported in the Schedule, up to 2006/07 there was only one non-elective cost and from 2007/08 onwards non-elective activity is separated into long stay and short stay; we use the weighted average of these two costs for each HRG. The effect of this change can be quantified using the information available in the Schedule for non-elective in 2007/08 and 2006/07. We calculated the total cost for the 2007/08 activity (short stay plus long stay) using both the weighted average of the non-elective short and long stay cost for each HRG in 2007/08 and using the non-elective cost for 2006/07. The difference between these two approaches accounted for approximately £400 million (in 2012 prices). It is important to note that this approximation is incomplete as there are HRG codes in 2007/08 that did not exist in 2006/07.

The observed drop in expenditure to 2007/08 would appear to be due substantially to changes in the detailed implementation of the Payment by Results National Tariff which reduced prices for a large number of emergency admissions. As we are unable to explain the total drop in expenditure through the above imputations, in the main body of the paper, we use activity as recorded in HES together with the appropriate HRG classification, including HRG4 from 2007/08 onwards.

[22] See 'National schedule of reference costs: the main schedule' in `https://www.gov.uk/government/publications/nhs-reference-costs-2012-to-2013`, accessed on 24 July 2015.

[23] These national averages are calculated including activity from settings that are not in HES (outpatient and other), but the averages obtained focusing only in the settings relevant for HES (inpatient, day case, regular attenders) are similar, so we simply use the national average.