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# Public Hospital Spending in England: Evidence from National Health Service Administrative Records*

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## Abstract

Health spending per capita in England has almost doubled since 1997, yet relatively little is known about how that spending is distributed across the population. This paper uses administrative National Health Service (NHS) hospital records to examine key features of public hospital spending in England. We describe how costs vary across the life cycle, and the concentration of spending among people and over time. We find that costs per person start to increase after age 50 and escalate after age 70. Spending is highly concentrated

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in a small section of the population, but the degree of concentration is lower for older age groups. For those aged 25 and under, a third of all hospital spending is accounted for by 1 per cent of the population under 25 and a fifth of spending is accounted for by 1 per cent of patients under 25. For those aged 65 and over, these figures fall to 22 and 13 per cent, respectively. There is persistence in spending over time, with patients with high spending more likely to have spending in subsequent years and those with zero expenditures more likely to remain out of hospital.

## Policy points

- Those who live in the richest 20 per cent of areas in England spend about four-fifths as much on public hospital care as those who live in the poorest 20 per cent of areas, at all points of the life cycle.
- The increase in costs after age 50 reflects age-related declines in health status. The challenge for policymakers is to design policies and institutions that meet the increased needs of the older population in the most cost-effective way.
- Spending is highly concentrated among a small group of individuals, and is relatively persistent over time, even at younger ages. How the care of these patients is managed has important implications both for patient health outcomes and for costs of the health care system.
- Equity – the availability of services to all citizens equally on the basis of need – was a founding principle of the NHS and remains a key policy goal. Given this aim, future research should further examine the extent to which the distribution of health spending mirrors that of underlying medical need. Such research would be aided by more detailed information on the characteristics of NHS patients, and linking survey data to administrative records would be an important step.

## I. Introduction

Medical spending per capita in England doubled in real terms between 1997 and 2010; however, very little is known about the distribution of this spending across the population, either in cross-section or over time. In this paper, we use National Health Service (NHS) administrative inpatient and outpatient hospital data to examine how publicly-funded hospital spending varies across the life cycle, the concentration among particular groups and the persistence of spending over time.

In an international context, England is an interesting case to study as: (i) health spending as a percentage of GDP is close to the OECD average, but a higher share of spending is publicly financed (83 per cent compared

with an OECD average of 73 per cent in 2013);[1] and (ii) almost all hospital care is provided by hospitals owned and run by the state. This may lead to important differences in the distribution of spending across the population relative to countries where private financing and provision of health care is more common, such as the United States. Understanding these differences could help provide an insight into differences in clinical outcomes across countries and institutional systems.

In a domestic context, analyses of the distribution of spending are particularly timely given the unprecedented slowdown in the growth of NHS funding since 2010, which has led to a gap developing between what the NHS receives and what it is predicted to spend based on patient need. It has been estimated that productivity gains of between 3 and 6 per cent per annum would be required to ensure that the NHS can meet demand, in terms of both quality and activity.[2] Understanding where costs arise could therefore help identify where there might be large gains from improving performance. Moreover, with the population aged 65 expected to grow by 22 per cent over the next decade,[3] ascertaining the relationship between costs and age is essential for predicting and potentially controlling the growth of future health expenditure. All costs and spending in this paper are given in 2014 US dollars, to allow direct comparisons to other papers in this issue.

The existing literature on per-person hospital spending in England is very limited, as payments for care provided (Payment by Results) were only introduced in 2003 and did not become fully operational until 2008.[4] Work to date has focused on measures of access and contacts with health services, typically with reference to capturing inequities in use.[5] This paper, together with the one by Aragón, Chalkley and Rice in this issue, therefore represents the first systematic attempt to investigate patterns of patient-level expenditure.

Our principal findings are fourfold. First, medical spending varies significantly across the life cycle. Spending increases after age 50 and escalates after age 70. Average hospital spending for an 89-year-old man is around three times higher than the average spending for a 70-year-old and almost nine times more than for a 50-year-old. Spending is higher for women during childbearing years, but this pattern is reversed at older ages, with average spending higher for men at all ages from 55. On average, the costs associated with men aged 65 and over are equivalent to the costs of treating a woman three to five years older.

Second, average spending per person is higher in more deprived areas, with differences increasing slightly with age. For those under 25, the ratio

[1]http://stats.oecd.org/index.aspx?DataSetCode=HEALTH_STAT#.
[2]Appleby, Galea and Murray, 2014.
[3]Office for National Statistics, 2012.
[4]Department of Health, 2012.
[5]Morris, Sutton and Gravelle, 2005; Cookson, Laudicella and Donni, 2012.

of average spending per person in the most deprived quintile group of local areas to average spending in the least deprived quintile group of local areas is 1.22, rising to 1.26 for those aged 25–64 and 1.35 for those aged 65 and over. However, this does not control for differences in underlying medical needs. Given the existing literature on the positive relationship between deprivation and need, it is likely that this gradient would reduce, or even reverse, if underlying medical needs were taken into account.[6]

Third, hospital spending is highly concentrated in a small fraction of the population. Cross-sectional concentration is highest at younger ages. The top 1 per cent of spenders account for a third of hospital spending in the population of the under-25s. The corresponding figure falls to 22 per cent among those aged 65 and over. The concentration is lower when the sample is restricted to *patients*, who have positive expenditures. For the under-25s, 1 per cent of patients account for 20 per cent of spending, while 1 per cent of patients aged 65 and over account for 13 per cent of spending, within their respective age groups. These concentrations fall when averaging over multiple years as a larger proportion of the total population have some positive hospital spending over an extended period.

Fourth, spending is relatively persistent over time, particularly at the top of the spending distribution, with around two-fifths of the top 20 per cent of spenders within the population in any given year still in the top 20 per cent of spenders in the following year. Persistence is lower over a two-year period. The difference between one- and two-year persistence is larger for the older age groups, which is likely to reflect their higher out-of-hospital death rates.

The remainder of this paper is structured as follows. Section II sets out recent trends in aggregate health spending and the institutional background for public health care in England. Section III describes the data and our method of calculating individual hospital costs. Section IV examines how spending varies over the life cycle and across the distribution of local area deprivation, while Section V examines the concentration of spending across individuals and over time. Section VI concludes.

## II. Public health care in England

### 1. UK health expenditure

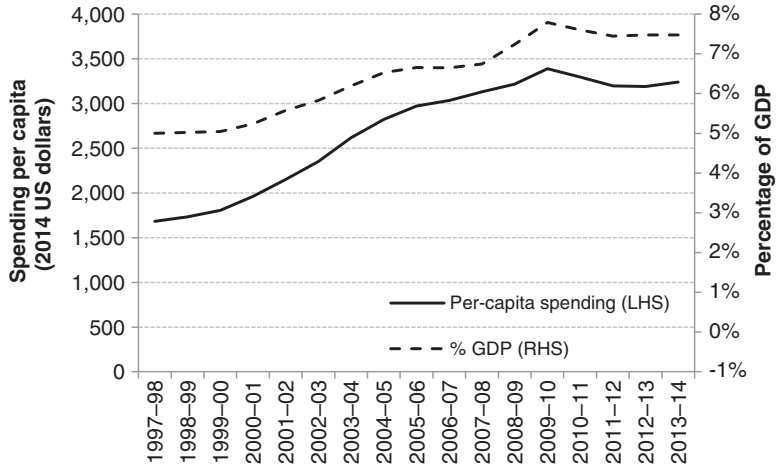
As in many developed countries, levels of health expenditure in England have risen over time. Figure 1 shows the share of health spending in national income and health spending per capita in the UK between 1997–98 and 2013–14.[7] Average spending per capita doubled between 1997–98 and 2009–10,

[6] Smith, 1999; Banks et al., 2006; Cookson, Laudicella and Donni, 2012.

[7] Aggregate figures are only available for the United Kingdom as a whole. However, funding allocations mean that patterns for England are very similar to those for the whole of the UK.

FIGURE 1

*UK public health spending: per capita (2014 dollars) and as a percentage of GDP*




*Note:* Real spending refers to 2014 prices and uses the ONS household total expenditure implied price deflator. Prices are converted from pounds to dollars using an exchange rate of 1.58.
*Source:* Nominal health spending data from HM Treasury, Public Expenditure Statistical Analyses. GDP from Office for Budget Responsibility, Economic and Fiscal Outlook, March 2015.

increasing from $1,700 to $3,400, while health care spending as a share of GDP rose from 5.0 per cent to 7.8 per cent. After 2010–11, growth in both series was halted as public spending restraints were put in place following the Great Recession. Health spending as a share of public spending rose throughout the period, as other areas of public spending shrank after 2010–11. In 2013–14, health constituted 17.9 per cent of all public spending and 31.5 per cent of all public service spending.

The UK is close to the OECD average in terms of levels of health spending as a share of GDP, but a higher-than-average proportion of spending arises from public sources. In 2013, the UK government accounted for 83.3 per cent of total health spending, compared with 48.2 per cent in the US and 76.3 per cent in Germany.[8] A small private sector accounts for remaining health expenditures. In 1990, around two-thirds of this spending came from out-of-pocket payments by individuals, with the rest covered by private insurance companies. By 2013, each source accounted for roughly half of private expenditures. Unfortunately, detailed data are not available for private health spending. As a result, the remainder of this paper focuses upon spending from government sources.

[8]http://stats.oecd.org/index.aspx?DataSetCode=HEALTH_STAT#.

## 2. Institutional background: the English National Health Service

This paper focuses on publicly-funded health care in England. Health care in England is primarily funded through general taxation and is provided free at the point of use to all residents (subject to some requirements on the duration of residency) through the National Health Service.[9]

Primary care within the NHS is principally provided by general practitioners (GPs), who treat patients for conditions and illnesses that do not require specialist care or refer patients for specialist secondary care where necessary. GPs act as 'gatekeepers' for elective secondary care, as NHS patients cannot self-refer. As NHS patients face no prices for secondary care, services are rationed by need and waiting lists.

Secondary or hospital care is typically provided by publicly-owned NHS hospitals. In 2012–13, NHS hospitals accounted for 44 per cent of all NHS spending.[10,11] Following referral from their GP, patients attend an outpatient consultation. Patients may then be discharged without further treatment, receive further outpatient care (for example, physiotherapy) or be admitted to hospital to receive further treatment as an inpatient. Emergency care that cannot be provided by a GP is available via accident and emergency (A&E) departments, which are almost exclusively based at NHS hospitals. Patients are then admitted for inpatient treatment or referred for outpatient care where necessary. Due to data constraints set out in Section III, this paper focuses exclusively on inpatient and outpatient care.

One important institutional feature of the NHS is the way in which hospitals are compensated for providing treatment. An 'internal market' operates within the NHS, with buyers (commissioners) separated from suppliers (hospitals). Commissioning groups manage regional budgets and fund care for the population resident within their boundaries. Suppliers are hospitals, or groups of hospitals, known as NHS acute trusts. Suppliers are paid by commissioners for providing secondary or hospital care services to the local population.

Hospitals are compensated by commissioners for providing care in two ways.[12] First, hospitals receive payments per patient for the care they provide,

[9] There are limited co-payments for prescriptions and optical and dental care. The majority of fees are waived for individuals who: are aged under 16; are aged over 60; receive treatment for a chronic condition; or receive certain income-tested benefits.

[10] Lafond et al., 2014.

[11] A limited amount of publicly-funded care is provided by non-NHS providers. In 2012–13, this accounted for 4 per cent of the total cost of hospital treatment (Lafond et al., 2014). These episodes are excluded from our analysis.

[12] In 2009–10, hospitals received 80 per cent of their income for directly providing care. This is paid through the two methods described above. They also received central funding from the Department of Health for general hospital running costs (7 per cent of their budget) and education and training (7 per cent), in addition to clinical income from other sources including private patients (6 per cent) (Department of Health, 2012).

under the 'Payment by Results' (PbR) framework.[13] These types of payments accounted for 58 per cent of hospital income in 2012–13.[14] The payments hospitals receive depend on three factors:

- *The type of care provided.* Healthcare Resource Groups (HRGs) are used to group together procedures that use similar levels of NHS resources.[15] National tariffs or prices are set for each HRG in each year; these aim to reflect the average cost of providing a particular bundle of care. The number of HRGs has increased over time, and by 2014–15 there were over 1,200. To give an example of how prices vary across HRGs, in 2014–15 the tariff for the HRG corresponding to an elective coronary artery bypass graft (heart surgery) was \$11,470, while the tariff for an HRG to cover migraine and headaches without other complications was \$935.
- *Length of stay.* Hospitals receive additional per diem payments if patients stay longer than the threshold specified in each HRG. For example, the threshold for an ordinary stay for an elective coronary artery bypass graft is 14 days, after which hospitals receive an additional \$330 per day.
- *Adjustment for local differences in cost.* A 'market forces factor' (MFF) multiplier is applied to the tariff to adjust for unavoidable variation in the cost of providing care across hospitals.[16]

The total payment received by a hospital under Payment by Results is thus given by the national tariff for the HRG plus adjustments for length of stay, multiplied by the market forces factor.

Second, hospitals also receive income from locally-negotiated contracts. This is known as 'non-tariff income' and covers services for which no national prices are agreed, including specialist drugs and services. The lack of national prices for such services makes it extremely difficult to accurately cost these treatments or to assign expenditure to individual patients. As a result, we restrict our individual medical spending estimates to treatments covered by the framework of national tariffs.

## III. Data

The Hospital Episode Statistics (HES) are administrative data and contain the universe of publicly-funded inpatient and outpatient hospital care in England. HES records treatment at the episode level, with an episode defined as a

[13]Department of Health, 2012.

[14]Lafond et al., 2014.

[15]HRGs are similar to the Diagnostic Resource Groups (DRGs) that are used in the US.

[16]For example, the MFF for Guy's and St Thomas' in London in 2014–15 was 1.277, compared with 1.046 for Leeds Teaching Hospitals. This reflects the unavoidable higher costs associated with providing care in central London, as compared with Leeds (a smaller city in northern England).

period of treatment under the care of a single consultant. These data contain basic patient characteristics, such as their age, sex and local area of residence, in addition to a hospital identifier, dates of admission and discharge, and information on the treatments provided including the associated HRG code. Patients can be followed over time using the pseudo-anonymised identifier provided.

Our main focus is publicly-funded individual-level doctor-led hospital spending. This includes all inpatient and outpatient treatment that can be costed using the framework of national tariffs outlined in the previous section.[17] Treatments without a national tariff are excluded from the analysis; these include non-consultant-led outpatient episodes, including some common treatments such as physiotherapy. In total, approximately 10 per cent of inpatient episodes and 25 per cent of outpatient episodes are excluded from the analysis.[18] Similarly, A&E attendances are also excluded from the cost estimates.[19]

We estimate the cost of each episode by combining episode-specific HRGs and provider codes in the following way. First, we match the episode-specific HRG to the appropriate annual national tariff. Second, we adjust costs for cases in which patients have an unusually long length of stay. Finally, we use unique hospital codes to apply the provider-specific market forces factor to account for regional variation in costs.

We aggregate the data using anonymised individual identifiers to produce annual estimates of hospital spending for each individual. This yields a data set with 39.4 million individuals and 93.6 million individual–financial-year observations between 2010–11 and 2014–15. HES data only include individuals who received hospital treatment in a particular year. This means that the remainder of the population, who have zero hospital expenditure by definition, are excluded from the data. We therefore augment HES with age- and gender-specific estimates of the national population from the Office

[17]Our cost estimates represent the payments received by hospitals to reimburse them for carrying out these procedures. These costs are approximations of the average cost faced by the hospital when providing these treatments. However, they do not exactly reflect the average cost due to the time required to analyse cost data and decide upon an appropriate tariff. For example, 2014–15 tariff prices were set using cost data from 2010–11 (Monitor and NHS England, 2014). These costs do not capture payments received by hospitals to finance the general running of the hospital (for example, fixed costs relating to property).

[18]Examples of inpatient treatment costs that are not included are: certain high-cost drugs (for example, AIDS/HIV antiretrovirals), certain high-cost devices (for example, bone-anchored hearing aids) and certain specialist procedures (for example, cleft lip and palate, and IVF). Outpatient care that is excluded includes family planning clinics and dental care.

[19]We capture the cost of subsequent treatment for patients who are admitted as an inpatient following an A&E attendance. However, the data do not contain any details of emergency treatment prior to inpatient admission. As a result, the costs of treatment received prior to admission (for example, triage costs), or by patients who are never admitted, are omitted.

for National Statistics (ONS) to account for individuals with zero expenditure.[20] All monetary figures are given in 2014 US dollars.[21]

## IV. Variation in hospital spending

In this section, we examine how average medical spending varies across individuals of different ages and with different characteristics. Understanding how costs vary over the life cycle is important in understanding the impact of a growing and ageing population. Similarly, examining how costs vary across individuals gives an insight into who benefits from health spending, and how the demands on the system are likely to develop as the population changes.

### 1. Hospital population

Figure 2 shows the proportion of individuals at each age who receive NHS inpatient or outpatient care for which we can estimate costs, in 2010–11

FIGURE 2

*Share of the national population using NHS hospital services*


*Note:* For each year, the graph shows the proportion of the national population with (at least one) inpatient admission to an NHS hospital or outpatient attendance that can be costed under the Payment by Results framework.
*Source:* Authors' calculations using HES data and the ONS national mid-year population estimates.

[20]Population data are available on the ONS website: http://www.ons.gov.uk/ons/taxonomy/index.html?nscl=Population+Estimates+by+Age+and+Sex.

[21]We calculate spending in nominal GBP and convert to 2014 GBP using the ONS household total expenditure implied price deflator. Figures are converted to 2014 USD using an exchange rate of 1.58. Annual exchange rates are available from the Internal Revenue Service (IRS) website: http://www.irs.gov/Individuals/International-Taxpayers/Yearly-Average-Currency-Exchange-Rates.

and 2014–15. There are two key points to note. First, the proportion of the population who use any hospital services increases with age. For example, 64 per cent of 80-year-old individuals received hospital care in 2010–11. This compares with only 30 per cent of 40-year-olds. Second, the proportion of the population using hospital services at all ages over 40 is greater in 2014–15 than in 2010–11. This may be explained by two factors: first, a genuine increase in hospital activity; and second, an increase in the number of HRGs for which national tariffs exist (from 1,074 to 1,236), which allows a larger proportion of treatment to be costed.

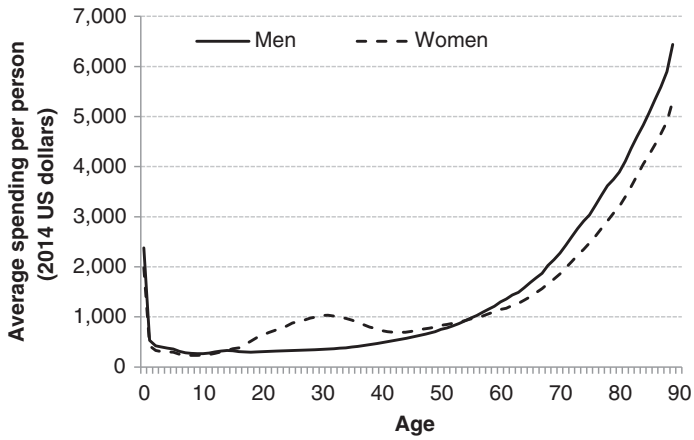
In the subsequent analysis, we present two types of statistics. First, using gender–age-specific weights, we account for individuals with zero medical expenditure in a given year. This analysis therefore examines the distribution and persistence of medical spending across the entire national population. In the second set of statistics, we exclude individuals with zero expenditure. This analysis therefore examines the distribution and persistence of spending across the patient population (i.e. only those who use hospital services and therefore appear in HES).

## 2. Medical spending over the life cycle

Figure 3 examines average spending between 2010–11 and 2014–15 by age and gender. There are three main points of note. First, average spending is

FIGURE 3

*Average hospital spending, by age and gender (2010–11 to 2014–15)*




*Note:* Expenditure estimates are a weighted average of one-year hospital expenditure between 2010–11 and 2014–15. Annual population numbers are used as weights. We account for individuals with zero expenditure by weighting expenditure estimates by the proportion of individuals of each age and sex who are observed in hospital in a given year.
*Source:* Authors' calculations using HES data and the ONS national mid-year population estimates.

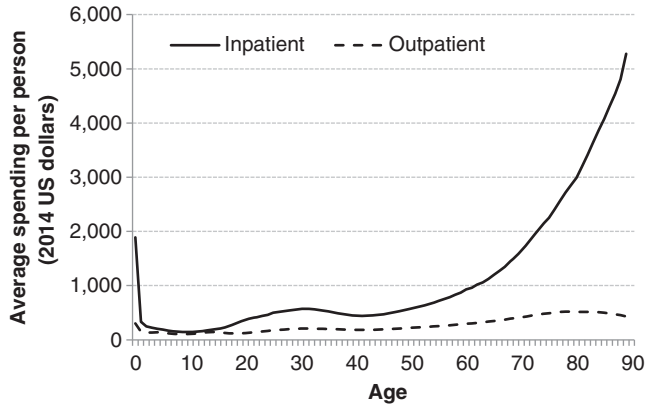
higher for women during childbearing years, with the average spending for a 30-year-old female three times more than the average spending for a male of the same age. This is mainly driven by maternity care, with the entire cost of the delivery of a healthy baby assigned to the mother (and not to the child).[22] However, there remain substantial costs associated with children under the age of 1, with approximately two-thirds of all newborn children (who account for approximately 8 per cent of all inpatients in a given year) receiving costed outpatient or inpatient treatment in the first year of life.[23]

Second, average spending increases for both genders after the age of 50, with particularly sharp growth after the age of 70. For example, average spending for an 89-year-old man is $6,442, almost three times more than for an average 70-year-old man ($2,273) and almost nine times more than for an average 50-year-old man ($751). Finally, the age gradient is steeper for men than for women from age 55. However, the magnitude of this difference is relatively small, with the average spending on a male being approximately equal to spending on a female aged three to five years older.

Figure 4 breaks down expenditures by inpatient and outpatient care. It does not distinguish between genders, but patterns are similar for males and

FIGURE 4

*Average hospital spending, by age and hospital service (2010–11 to 2014–15)*




*Note:* Expenditure estimates are a weighted average of one-year hospital expenditure between 2010–11 and 2014–15. Annual population numbers are used as weights. We account for individuals with zero expenditure by weighting expenditure estimates by the proportion of individuals of each age and sex who are observed in hospital in a given year.
*Source:* Authors' calculations using HES data and the ONS national mid-year population estimates.

[22]In 2014–15, 66 per cent of newborns were assigned the HRG code PB03Z, with a tariff of $0. This means that the majority of birth costs appear at adult ages in Figure 3, and not at age 0.

[23]This includes the costs of birth-related complications assigned to children, in addition to subsequent hospital use.

females. It shows that both outpatient and inpatient spending increase after the age of 50, but the growth rate and the levels are different across the types of care. Spending on outpatient services increases gradually up to the age of 82, peaking at an average annual cost of $516, before falling slightly at the oldest ages. In contrast, inpatient spending grows sharply after the age of 60, increasing up to the age of 90 and an average cost of more than $5,000. This indicates that the rapid increases in hospital spending over the life cycle are driven primarily by large increases in inpatient spending at older ages. This is likely to reflect an increased use of emergency (inpatient) care at older ages, and future work could examine the relative importance of elective and emergency care explicitly.

### 3. Distribution by local area deprivation

Understanding the distribution of medical spending by income is important for the incidence of a very large component of public spending. There are two potential sources of variation in medical spending by income. The first is differences in underlying medical need by income group. As rates of morbidity typically decrease with income, this would suggest a negative relationship between income and need.[24] The second, and often offsetting, source of variation is differences in access to and the use of health care for a given medical condition or level of morbidity.[25]

HES data have two limitations in assessing the relationship between income and medical spending. The first is that HES data do not contain information on the income of patients. We therefore proxy individual income through the deprivation of their local area of residence, as measured by the Index of Multiple Deprivation (IMD).[26] The HES data contain the Lower Layer Super Output Area (LSOA) of the patient, a statistically-constructed area used for administrative purposes. In 2010, LSOAs had an average population of 1,600 with a standard deviation of 306. To test the assumption that IMD does proxy for income and wealth, we considered the correlation between local area IMD and measures of income and wealth contained in the English

[24] Smith, 1999; Deaton, 2003; Banks et al., 2006; Hernández-Quevedo et al., 2006; Cookson, Laudicella and Donni, 2012.

[25] This difference is not always offsetting. Delays in accessing care, or initial receipt of lower-quality care, may result in the need for more, and more costly, future treatment. As a result, patients from more deprived areas may require more expensive care in the longer term if their initial medical needs are not sufficiently met.

[26] IMD scores provide an index of nine dimensions of deprivation, including income, education and the health care access of the local population. We use the income dimension only, to avoid double-counting the impact of local health provision, and use the version produced in 2004. We verify the suitability of this proxy below by comparing deprivation levels with survey data on income. We use scores from 2004 in order to facilitate this comparison with survey data from a similar period. Deprivation scores change little over time on average, and the findings of our analysis would be little changed if later scores were used instead.

Longitudinal Study of Ageing (ELSA) in 2006 and found the expected strong, negative relationships between income, wealth and local area deprivation.[27] The second limitation is that HES data do not contain enough information to capture need, either for patients contained within the data or for individuals who have zero expenditure (and therefore are not included in the data) but who potentially should be receiving hospital treatment. The relationship between hospital spending and income will therefore reflect a combination of potential differences in need and in access conditional on need.[28]

Table 1 shows average hospital spending by IMD quintile group, gender and age category for NHS patients.[29] The first block shows spending for all individuals, the second one shows it for those under 25, the third for people between 25 and 64, and the final block is for individuals aged 65 and over. The table provides three points of note. First, for all age groups and both genders, average hospital spending increases with local area deprivation. Second, the gradient becomes somewhat steeper for older age groups: for the under-25s, the ratio of average spending of those living in the most deprived quintile group to that of those living in the least deprived quintile group is 1.22, compared with 1.26 for those aged 25–64 and 1.35 for those aged 65 and over. Third, the relative steepness of the gradient for the two genders varies by age. For those under 25, the gradient is much steeper for women: the ratio of average spending in the most to least deprived quintile group is 1.28 for women but just 1.15 for men. Among the older age groups, the gradient is similar for men and women, with ratios of 1.28 for men and 1.25 for women aged between 25 and 64, and 1.36 for men and 1.35 for women aged 65 and over.

Taken together, these results suggest that those in the most deprived areas consume more hospital resources than those in the least deprived areas. However, it is important to again emphasise that these calculations do not

[27]For example, in ELSA wave 3 (2006), mean total net (non-pension) wealth and mean total net financial wealth both decrease monotonically with local area deprivation. On the total net non-pension wealth measure, mean wealth is 4.5 times greater in the least deprived quintile group than in the most deprived quintile group; on the total net financial wealth measure, mean wealth is 5.3 times higher in the least deprived quintile group than in the most deprived quintile group.

[28]A large literature using survey data documents differences in health care utilisation conditional on need; see, amongst others, Wagstaff, van Doorslaer and Paci (1989), Wagstaff and van Doorslaer (2000), van Doorslaer, Koolman and Puffer (2002), van Doorslaer and Koolman (2004), van Doorslaer, Koolman and Jones (2004), van Doorslaer, Masseria and the OECD Health Equity Research Group (2004) and Bago d'Uva, Jones and van Doorslaer (2009).

[29]Age–sex-specific population data are unavailable (at the time of writing) at the LSOA level for 2014. As a result, our analysis is constrained to look across the IMD distribution for patients only. When available, future work should include these population-adjusted estimates. If detailed population data were available, the inclusion of individuals with zero expenditure could have two potential impacts. First, if need for health care is greater in more deprived areas, leading to greater use of hospitals in these areas, we would expect to see a larger difference between spending in the most and least deprived areas. On the other hand, if access to hospital care is better in less deprived areas, leading to fewer individuals with no hospital use, then the difference would be smaller or even reversed.

TABLE 1

*Mean medical spending (patients only), by age, deprivation quintile group and gender*

| | *All ages* | | | *Under 25* | | | *25–64* | | | *65 and over* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Men | Women | All | Men | Women | All | Men | Women | All | Men | Women |
| Everyone | 2,858 | 2,957 | 2,779 | 1,731 | 1,649 | 1,809 | 2,371 | 2,444 | 2,319 | 4,738 | 4,986 | 4,521 |
| *Deprivation quintile* | | | | | | | | | | | | |
| Least deprived | 2,613 | 2,723 | 2,520 | 1,560 | 1,541 | 1,581 | 2,101 | 2,148 | 2,067 | 4,146 | 4,368 | 3,939 |
| Second | 2,782 | 2,895 | 2,690 | 1,595 | 1,553 | 1,637 | 2,201 | 2,247 | 2,169 | 4,422 | 4,656 | 4,212 |
| Third | 2,895 | 3,003 | 2,811 | 1,693 | 1,619 | 1,765 | 2,343 | 2,419 | 2,291 | 4,716 | 4,958 | 4,544 |
| Fourth | 2,972 | 3,068 | 2,898 | 1,798 | 1,695 | 1,895 | 2,483 | 2,572 | 2,422 | 5,125 | 5,417 | 4,885 |
| Most deprived | 3,002 | 3,083 | 2,938 | 1,905 | 1,778 | 2,019 | 2,647 | 2,747 | 2,575 | 5,605 | 5,947 | 5,321 |
| Most:Least ratio | 1.15 | 1.13 | 1.17 | 1.22 | 1.15 | 1.28 | 1.26 | 1.28 | 1.25 | 1.35 | 1.36 | 1.35 |

*Note:* All figures are in 2014 US dollars. Estimates show expenditures for a single financial year. Estimates are a weighted average over all years between 2010–11 and 2014–15. Annual patient numbers are used as weights for each year. The sample only includes individuals with positive expenditure in at least one year. Deprivation distribution is defined using the income dimension of the 2004 ONS Index of Multiple Deprivation.

take account of need. Existing evidence suggests that, while GP services are typically used more intensively by poorer individuals, specialist and hospital care utilisation tends to be pro-rich once medical need is accounted for.[30] It is therefore likely that the gradient we estimate will be ameliorated or reversed once need is taken into account.

## V. The concentration and persistence of medical spending

### 1. Cross-section concentration

We expect hospital spending to be concentrated in a relatively small share of the population, as a large fraction of the population have no hospital spending at all in a given year and some conditions are much more costly to treat than others. The concentration of health care spending will in large part reflect the concentration of medical need, and indeed the potential to incur large costs is why health care is typically financed through the state or through private insurance. However, understanding the degree of concentration is important for at least three reasons. First, establishing how much spending is concentrated at the top of the distribution could help guide cost reduction exercises or help predict a large part of future spending. Second, large differences in the concentration of spending across countries may indicate variation in costs or the quality of treatment provided, which could explain differences in spending or clinical outcomes. Third, the concentration of hospital spending shows the distribution of more than $100 billion of public spending in England. This may be entirely consistent with the distribution of need, but does show the degree of insurance against large medical costs provided by the state provision of health care.

Table 2 shows mean medical spending for each age category, by gender and population spending quintile group. As shown in Figure 2, the share of the population with positive hospital spending is below half for those under 65. This results in zero entries for the first three quintile groups for the under-25 age group and in two empty quintiles and a very small value for the third quintile group for the 25–64 age group. For the population aged 65 and over, there is positive spending in the highest three quintiles only. For both men and women under 25 or aged 25–64, the ratio of the average spending of the top quintile group to the average spending across the population is approximately five. For those aged 65 and over, a woman in the top spending quintile group spends eight times the average female spending, while a man in the top quintile group spends just under five times the average male spending.

Table 3 examines the concentration of medical spending among *patients*, or those with positive expenditure. There are three points of interest. First,

[30]Van Doorslaer, Koolman and Jones, 2004; Morris, Sutton and Gravelle, 2005; Allin, Masseria and Mossialos, 2011.

TABLE 2

*Mean medical spending, by age, population spending quintile group and gender*

| | *All ages* | | | *Under 25* | | | *25–64* | | | *65 and over* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Men | Women | All | Men | Women | All | Men | Women | All | Men | Women |
| Everyone | 883 | 908 | 859 | 437 | 400 | 475 | 776 | 667 | 884 | 2,021 | 2,787 | 1,402 |
| *Spending quintile* | | | | | | | | | | | | |
| Bottom | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Second | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Third | 46 | 41 | 51 | 0 | 0 | 0 | 10 | 0 | 21 | 240 | 264 | 221 |
| Fourth | 390 | 360 | 419 | 202 | 185 | 219 | 277 | 210 | 344 | 1,080 | 1,238 | 952 |
| Top | 4,672 | 4,403 | 4,933 | 2,204 | 2,027 | 2,388 | 3,801 | 3,362 | 4,232 | 11,851 | 12,900 | 11,001 |

*Note:* All figures are in 2014 US dollars. Estimates show expenditures for a single financial year. Estimates are a weighted average over all years between 2010–11 and 2014–15. Annual patient numbers are used as weights for each year. The sample includes individuals with zero expenditure in at least one year, using ONS mid-year population estimates to estimate the non-hospital population.

TABLE 3

*Mean medical spending, by age, patient spending quintile group and gender*

| | *All ages* | | | *Under 25* | | | *25–64* | | | *65 and over* | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Men | Women | All | Men | Women | All | Men | Women | All | Men | Women |
| Everyone | 2,858 | 2,957 | 2,779 | 1,731 | 1,649 | 1,809 | 2,371 | 2,444 | 2,319 | 4,738 | 4,986 | 4,521 |
| *Spending quintile* | | | | | | | | | | | | |
| Bottom | 186 | 183 | 189 | 187 | 183 | 190 | 181 | 174 | 186 | 194 | 197 | 192 |
| Second | 383 | 363 | 399 | 361 | 346 | 375 | 364 | 345 | 377 | 439 | 409 | 464 |
| Third | 868 | 845 | 886 | 705 | 651 | 757 | 764 | 699 | 810 | 1,202 | 1,262 | 1,149 |
| Fourth | 2,247 | 2,177 | 2,304 | 1,458 | 1,332 | 1,579 | 1,909 | 1,688 | 2,063 | 3,560 | 3,752 | 3,392 |
| Top | 10,599 | 11,198 | 10,122 | 5,949 | 5,741 | 6,151 | 8,642 | 9,321 | 8,168 | 18,257 | 19,229 | 17,410 |

*Note:* All figures are in 2014 US dollars. Estimates show expenditures for a single financial year. Estimates are a weighted average over all years between 2010–11 and 2014–15. Annual patient numbers are used as weights for each year. The sample only includes individuals with positive expenditure in at least one year.

as expected, the average spending for those in the top quintile group rises with age. Second, spending is highly concentrated in the top quintile group in all age groups: the average spending for those in the top quintile group is four times higher than the average in the next quintile group for the under-25s, four-and-a-half times greater for the 25–64 age group and five times greater for those aged 65 and over. Finally, although average spending across the whole distribution and within each quintile group increases with age, the spending distributions of the three age groups do overlap. The average spending of a patient in the top quintile group of the under-25 distribution ($5,949) is a third of the average spending of a patient in the top quintile group of the 65-and-over distribution ($18,257), but significantly more than that for patients in the next quintile group down of the 65-and-over distribution ($3,560).

**2. Concentration over time**

In this subsection, we examine the concentration of medical spending over time, by averaging medical spending across multiple years and by estimating persistence of spending or how spending this year is related to spending in subsequent years. This analysis will indicate the extent to which high spending reflects the treatment of short-term episodes of poor health relative to long-term conditions that require continuing care. Again, this may be entirely in line with population need, but may have important implications for how we expect future health care spending to develop as the population grows and ages.

The major limitation of using our data to undertake analysis over time is that we only observe deaths that occur in hospitals. Zero expenditure in the year that follows treatment may therefore signify either that the patient no longer needs hospital care or that the patient has died. The averaged concentration and persistence parameters therefore represent the lower bound of true levels of persistence. However, Aragón, Chalkley and Rice (this issue) have obtained mortality data linked to HES and do address medical spending around the time of death.

*a) Persistence in the population spending distribution*

Table 4 shows correlations, both in levels and in logs, between individual hospital spending in one year ($t$) and spending in the next one ($t+1$), two ($t+2$) or three ($t+3$) years, between 2010–11 and 2014–15.[31] Correlations are shown by gender and age group. The correlation in levels falls over time and is lower

[31] We assign an annual cost of zero for individuals who do not appear in HES in a given year. For example, an individual who appears in HES in 2012, but not in the previous or following years, will have a positive cost estimate in 2012 and zero costs in all other years. There are, however, two exceptions. First, individuals born in later years in the period are excluded from the preceding years of analysis (for example, an individual born in 2012 will be excluded from the analysis in 2011). Second, individuals who are recorded as dying in hospital are excluded from the analysis in future years (for example, an individual who dies in hospital in 2012 will be included in the analysis up to and including 2012, but will be excluded from the 2013 and 2014

TABLE 4

*Correlation of medical spending in year t with spending in years t+1, t+2 and t+3, by age and gender*

**Spending in levels**

| | *All* | | | *Males* | | | *Females* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *t*+1 | *t*+2 | *t*+3 | *t*+1 | *t*+2 | *t*+3 | *t*+1 | *t*+2 | *t*+3 |
| Under 25 | 0.32 | 0.22 | 0.17 | 0.33 | 0.22 | 0.17 | 0.32 | 0.22 | 0.18 |
| 25–64 | 0.31 | 0.21 | 0.17 | 0.32 | 0.20 | 0.16 | 0.30 | 0.21 | 0.17 |
| 65 and over | 0.26 | 0.14 | 0.10 | 0.26 | 0.13 | 0.09 | 0.25 | 0.14 | 0.10 |

**Spending in logs**

| | *All* | | | *Males* | | | *Females* | | |
|---|---|---|---|---|---|---|---|---|---|
| | *t*+1 | *t*+2 | *t*+3 | *t*+1 | *t*+2 | *t*+3 | *t*+1 | *t*+2 | *t*+3 |
| Under 25 | 0.36 | 0.25 | 0.20 | 0.35 | 0.25 | 0.20 | 0.36 | 0.25 | 0.21 |
| 25–64 | 0.38 | 0.27 | 0.24 | 0.41 | 0.30 | 0.26 | 0.37 | 0.26 | 0.22 |
| 65 and over | 0.41 | 0.27 | 0.21 | 0.41 | 0.26 | 0.19 | 0.41 | 0.28 | 0.22 |

*Note:* Displayed estimates are correlation coefficients. Estimates are a weighted average over all years between 2010–11 and 2014–15, using annual patient numbers as weights for each year. Individuals who die in year *x* are excluded from the analysis in subsequent years and individuals who are born in year *x* are excluded from the analysis in earlier years. The sample includes individuals with zero expenditure in at least one year, using ONS mid-year population estimates to estimate the non-hospital population.

for people aged 65 and over than for the younger two age groups. There are no substantial differences between males and females. Correlations in logs are stronger than those in levels and increase with age in year *t*+1.[32]

These results suggest that there is some persistence in medical spending. However, the extent of this persistence is likely to vary across the spending distribution, and this would not be captured by the previous correlations. We therefore now examine the persistence of spending among different groups in greater detail.

analyses). As noted above, this may underestimate the true level of persistence if only a small proportion of decedents are captured by the data. Individuals who never appear in HES are assigned a zero cost in all years, using population estimates to calculate the size of this non-patient population in each year. For the natural logarithm of spending, we bottom-code individual spending and set all values that are less than 10 per cent of the annual mean of medical spending to 10 per cent of the mean. We use an identical method for Tables 5 and 6.

[32]The contrasting pattern in the correlations in levels and logs across age groups is interesting. It might be due to individuals experiencing large costs in one year but zero or low costs in adjacent years. Individuals with this pattern will lower the correlation, but more so in levels than in logs due to the concavity of the log function. This pattern of expenditure might be more likely in older ages, with death outside of hospitals not observed in the data. Hence, the correlation in logs is higher at older ages. This is consistent with the observation that when we top-code spending at $5,000 per year and examine the correlation in levels, we find a similar pattern to the correlation in logs, with correlations stronger at older ages.

TABLE 5

*Transition matrices for hospital spending from year t to years t+1 and t+2, by age and spending group*

**Under 25**

| *Spending group in year t* | *Spending group in year t+1* | | *Spending group in year t+2* | |
|---|---|---|---|---|
| | Zero | Positive | Zero | Positive |
| Zero | 67.1% | 32.9% | 60.8% | 39.2% |
| Positive | 48.5% | 51.5% | 58.0% | 42.0% |

**25–64**

| *Spending group in year t* | *Spending group in year t+1* | | *Spending group in year t+2* | |
|---|---|---|---|---|
| | Zero | Positive | Zero | Positive |
| Zero | 63.7% | 36.3% | 56.0% | 44.0% |
| Positive | 38.4% | 61.6% | 46.4% | 53.6% |

**65 and over**

| *Spending group in year t* | *Spending group in year t+1* | | *Spending group in year t+2* | |
|---|---|---|---|---|
| | Zero | Positive | Zero | Positive |
| Zero | 60.9% | 39.1% | 53.1% | 46.9% |
| Positive | 24.3% | 75.7% | 31.5% | 68.5% |

*Note:* The table shows the percentage of individuals, by age–spending group in year *t*, who are in each age–spending group in years *t*+1 and *t*+2. Estimates are a weighted average over all years between 2010–11 and 2014–15, using annual patient numbers as weights for each year. The sample includes individuals with zero expenditure in at least one year, using ONS mid-year population estimates to estimate the non-hospital population. Individuals who die in hospital in year *x* are excluded from the analysis in subsequent years and individuals who are born in year *x* are excluded from the analysis in earlier years.

Table 5 considers transition between zero and positive hospital expenditure over the next one and two years. There is a high degree of persistence in both zero and positive spending. In each age group, the majority of individuals with zero expenditure in year *t* also have zero expenditure in year *t*+1. This is also true when examining the transition over a two-year period. For the under-25s, 67.1 per cent of those with zero spending in one year also have zero spending in the following year, while 60.8 per cent have zero spending two years later. These figures are smaller for people aged 65 and over, but remain high at 60.9 per cent and 53.1 per cent respectively.

A similar pattern exists for those with positive spending (i.e. patients). In all age groups, the majority of individuals with positive expenditure in year *t* will have positive expenditure in year *t*+1. For the under-25s, of those with positive expenditure in year *t*, 51.5 per cent have positive expenditure in year *t*+1. This relationship strengthens for the older age groups, with 75.7 per cent

(68.5 per cent) of the over-65s with positive expenditure in year *t* remaining in the positive expenditure group in year *t*+1 (*t*+2).

Table 6 examines the persistence of spending for individuals at the top of the medical spending distribution. For all age groups, around two-fifths of patients in the top spending quintile group in a given year will remain in the top quintile group the following year. As expected, two-year persistence is lower. The difference between one- and two-year persistence is larger for the older age groups, which is likely to be attributable to their higher out-of-hospital death rates. We are therefore underestimating the persistence for individuals who are still alive.

*b) Persistence in the patient spending distribution*

The persistence in high spending found in Table 6 for the entire population is not surprising given that ill health in a certain period exhibits strong state dependence.[33] In Figures 5 and 6, we examine the evolution of spending for *patients*, or individuals who have positive expenditure in any given year. Figure 5 shows the transition from patients in the top and bottom positive spending quintile groups in year *t*, to positive spending quintile groups and a zero expenditure group in year *t*+1.[34] Figure 6 presents the same information for year *t*+2.[35]

TABLE 6

*Percentage of the population in the top quintile group of spending in year t who remain in the top quintile group of spending in years t+1 and t+2, by age*

| | *Share of top quintile group in year t who remain in the top quintile in:* | |
|---|---|---|
| | *Year t+1* | *Year t+2* |
| Under 25 | 39.2% | 31.2% |
| 25–64 | 43.0% | 32.7% |
| 65 and over | 41.9% | 31.4% |

*Note:* The table shows the percentage of those in the top quintile group of spenders in year *t* who remain in the top quintile group of spenders in years *t*+1 and *t*+2. Estimates are a weighted average over all years between 2010–11 and 2014–15, using annual patient numbers as weights for each year. Individuals who die in hospital in year *x* are excluded from the analysis in subsequent years and individuals who are born in year *x* are excluded from the analysis in earlier years.

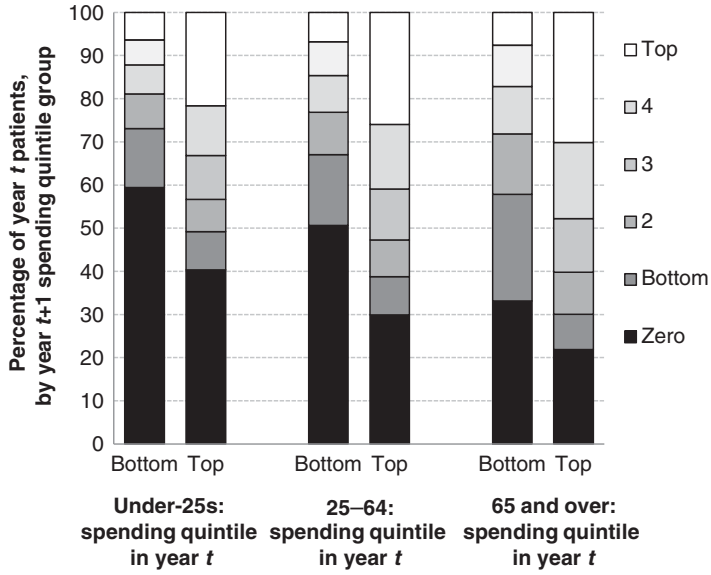
[33]Contoyannis, Jones and Rice, 2004.

[34]For simplicity, we do not show the transitions of individuals in year *t* spending quintile groups 2–4. In all cases, these individuals are more likely to transition to the zero spending group in the following year. If expenditure remains positive, these individuals are most likely to appear in the same spending group in year *t*+1 or *t*+2.

[35]Individuals who die in hospital in year *t* are excluded from the analysis. It should again be noted that zero expenditure in years *t*+1 and *t*+2 may be due to the individual's death in a previous year. As a result, the probability of transition from a positive expenditure group to the zero expenditure group over time may be overestimated.

FIGURE 5

*One-year spending transitions: spending quintile group in year t+1 for highest and lowest spending quintile groups in year t, by age*

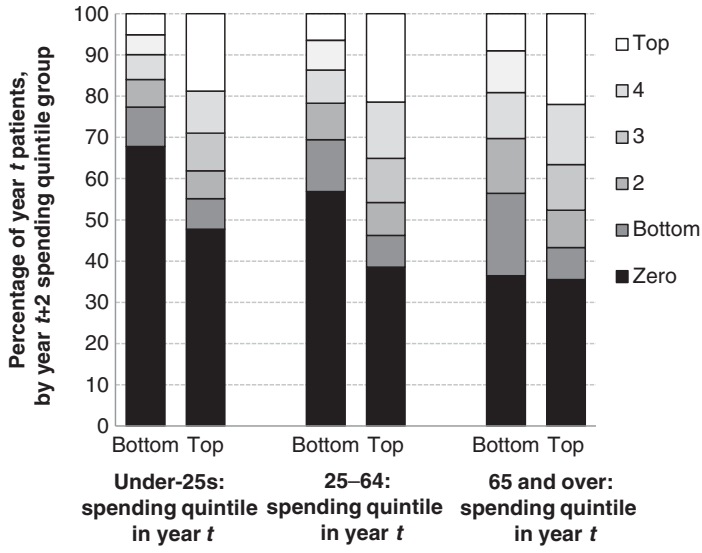



*Note:* The figure shows the percentage of patients in each year $t+1$ spending group, by year $t$ positive spending quintile group. Estimates are a weighted average over all years between 2010–11 and 2014–15, using annual patient numbers as weights for each year. The sample only includes individuals with positive hospital expenditure in year $t$. Individuals who die in hospital in year $t$ are excluded from the analysis.

Figures 5 and 6 reveal three main points of interest. First, persistence in spending remains at the top of the expenditure distribution. Conditional on positive spending in the following year, individuals in the top quintile group in year $t$ are likely to appear in the top quintile group in years $t+1$ and $t+2$. However, as expected, this persistence is lower than that found when examining the spending distribution of the entire population. For the population aged 65 and over, 30.2 per cent of individuals in the top positive spending quintile group in year $t$ remain in the top quintile group in year $t+1$, while 22.0 per cent remain there in year $t+2$. This compares with 41.9 per cent and 31.4 per cent, respectively, when examining the entire population. Second, regardless of their spending quintile group in year $t$, all individuals aged below 65 are most likely to appear in the zero expenditure group in year $t+1$ (and in year $t+2$). Finally, in all age groups, individuals who appear in the bottom quintile group in year $t$ are the most likely of all the quintile groups to appear in the zero expenditure group in years $t+1$ and $t+2$, while individuals in the top quintile group are the least likely to appear in the zero expenditure group.

FIGURE 6

*Two-year spending transitions: spending quintile group in year t+2 for highest and lowest spending quintile groups in year t, by age*




*Note:* The figure shows the percentage of patients in each year $t+2$ spending group, by year $t$ positive spending quintile group. Estimates are a weighted average over all years between 2010–11 and 2014–15, using annual patient numbers as weights for each year. The sample only includes individuals with positive hospital expenditure in year $t$. Individuals who die in hospital in year $t$ or $t+1$ are excluded from the analysis.

A comparison of Table 5 and Figure 5 also indicates that among people aged 65 and over, even a small amount of medical spending in one year substantially decreases the probability of having zero expenditure in the following year. In Table 5, individuals aged 65 and over with zero expenditure had a 60.9 per cent probability of having zero expenditure in the following year. By contrast, Figure 5 shows that individuals of this age in the bottom positive quintile group in year $t$ – who had a mean spend of less than $200 – had a 33.1 per cent chance of having zero expenditure in year $t+1$. This compares with the under-25s, where the probability of zero expenditure in year $t+1$ is similar for the bottom spenders (59.4 per cent in Figure 5) and those with zero expenditure (67.1 per cent in Table 5) in year $t$.

Table 7 shows further measures of the concentration of medical spending across the entire population by age. It shows, for each age group, the Gini coefficient[36] and the percentage of total age-specific spending accounted for

[36]The Gini coefficient is a measure of inequality. It is generally bounded between 0 and 1, where 0 corresponds to perfect equality and 1 corresponds to maximum inequality.

TABLE 7

*Measures of the concentration of medical spending across the national population, by age*

| | *Medical spending averaged over:* | | |
|---|---|---|---|
| | *1 year* | *2 years* | *3 years* |
| **Under 25** | | | |
| Gini coefficient for medical spending | 0.89 | 0.85 | 0.81 |
| Percentage spent by top 1% of spenders | 32.9% | 27.1% | 24.3% |
| Percentage spent by top 10% of spenders | 81.3% | 57.4% | 40.0% |
| **25–64** | | | |
| Gini coefficient for medical spending | 0.90 | 0.85 | 0.82 |
| Percentage spent by top 1% of spenders | 31.5% | 25.1% | 22.1% |
| Percentage spent by top 10% of spenders | 82.8% | 58.7% | 40.7% |
| **65 and over** | | | |
| Gini coefficient for medical spending | 0.86 | 0.81 | 0.77 |
| Percentage spent by top 1% of spenders | 21.9% | 16.2% | 13.7% |
| Percentage spent by top 10% of spenders | 77.3% | 52.2% | 35.3% |

*Note:* Estimates are a weighted average over all years between 2010–11 and 2014–15, using annual patient numbers as weights for each year. The sample includes individuals with zero expenditure in at least one year, using ONS mid-year population estimates to estimate the non-hospital population.

by the highest-spending 1 per cent and 10 per cent of the population. The table illustrates that spending is highly concentrated among a small share of individuals at all ages, but that there are significant differences across age groups, with spending least concentrated among people aged 65 and over. Just over a fifth (21.9 per cent) of all spending among people aged 65 and over is accounted for by 1 per cent of the population, compared with 32.9 per cent for the under-25s and 31.5 per cent for those aged 25–64. Spending becomes significantly less concentrated for all age groups when averaging over more years. For example, when averaging over three years, 10 per cent of the population under 25 accounted for 40.0 per cent of spending, less than half the percentage accounted for by 10 per cent when averaging over only one year. Similar results are found when looking at the older populations, and the Gini coefficients show a similar trend.

Table 8 shows the same measures for the patient distribution. There are three points of note. First, in all cases, spending is less concentrated among patients than among the entire population. Second, the differences in the spending accounted for by 10 per cent of each population become much smaller when averaging over three years. This reflects the fact that the size of the patient population is much closer to the size of the entire population when averaging over a number of years. Finally, the share of spending accounted for by 1 per cent of the patient population is highest for the under-25s. However, a larger share of spending is accounted for by 10 per cent of the patient population

TABLE 8

*Measures of the concentration of medical spending across patients, by age*

| | *Medical spending averaged over:* | | |
|---|---|---|---|
| | *1 year* | *2 years* | *3 years* |
| **Under 25** | | | |
| Gini coefficient for medical spending | 0.65 | 0.65 | 0.65 |
| Percentage spent by top 1% of spenders | 19.6% | 15.1% | 11.1% |
| Percentage spent by top 10% of spenders | 52.4% | 41.9% | 31.6% |
| **25–64** | | | |
| Gini coefficient for medical spending | 0.70 | 0.69 | 0.68 |
| Percentage spent by top 1% of spenders | 17.3% | 13.2% | 9.7% |
| Percentage spent by top 10% of spenders | 51.9% | 45.7% | 34.9% |
| **65 and over** | | | |
| Gini coefficient for medical spending | 0.72 | 0.68 | 0.66 |
| Percentage spent by top 1% of spenders | 13.3% | 9.1% | 6.3% |
| Percentage spent by top 10% of spenders | 56.1% | 45.1% | 34.2% |

*Note:* Estimates are a weighted average over all years between 2010–11 and 2014–15, using annual patient numbers as weights for each year. The sample only includes individuals with positive hospital expenditure in at least one year.

among those aged 65 and over (56.1 per cent) than among the under-25s (52.4 per cent). This is reflected in the higher Gini coefficients for older age groups.

## VI. Conclusion

This paper has examined the concentration and persistence of public hospital spending in England by age and gender and has provided four principal results. First, hospital spending rises steeply at older ages. For example, the mean hospital expenditure for an average 89-year-old man is three times greater than that for an average 70-year-old and nine times that for an average 50-year-old. Women have higher medical costs during childbearing years, but men are more expensive from age 55. Second, without correcting for need, those in more deprived areas have modestly higher hospital costs than those in richer areas. However, we re-emphasise that the relationship may look very different if we could control for need. Third, hospital spending is highly concentrated in a small number of patients. For the under-25s, 10 per cent of residents accounted for 81.3 per cent of hospital spending among this group. This figure is only slightly lower for those aged 65 and over, at 77.3 per cent. The concentration remains high when looking only at *patients* (who have positive spending), 10 per cent of patients accounting for 52.4 per cent of spending among the under-25s and 56.1 per cent of spending among those aged 65 and over. Finally, individual-level health spending is relatively persistent over time, particularly

at the top of the distribution, with high spenders in one year much more likely than the rest of the population to be a high spender in subsequent years.

The overall patterns and results provided by this paper are in keeping with existing policy and academic work published elsewhere.[37] The main contributions of the paper are therefore twofold. First, we bring together a set of statistics that have previously not been explicitly calculated for England, in order to characterise public health spending. Second, the statistics are calculated to be broadly comparable to those produced for other countries for this special issue, allowing for much more discussion and analysis of the similarities and differences in patterns across countries.

The paper faces two major limitations, which must be taken into account when interpreting the results. The first is the very limited information on the underlying health and socio-economic characteristics of patients. This makes it difficult to provide an accurate measure of the socio-economic gradient in health care use, correcting for need. Such work should be possible using upcoming linkages between HES and survey data such as the English Longitudinal Study of Ageing. Partial information on need available within existing data, such as the number and type of co-morbidities for each patient, could also be further examined. Multiple morbidities are likely to be an important determinant of high expenditures,[38] and extending this work to examine the roles of co-morbidities in explaining expenditures, and how they vary across different socio-economic groups, would be a useful avenue for future research to explore.

Second, we only observe deaths in hospital. This means that we are underestimating persistence, as we anticipate that a high fraction of those who transition from high expenditure to no expenditure will have died rather than regained their health. The paper by Aragón, Chalkley and Rice in this issue uses HES data linked to mortality data in order to capture deaths outside hospital, and is therefore able to provide a more complete picture of medical costs at the end of life.

## References

Allin, S., Masseria, C. and Mossialos, E. (2011), 'Equity in health care use among older people in the UK: an analysis of panel data', *Applied Economics*, vol. 43, pp. 2229–39.

Appleby, J., Galea, A. and Murray, R. (2014), *The NHS Productivity Challenge: Experience from the Front Line*, London: King's Fund.

Aragón, M. J., Chalkley, M. and Rice, N. (2016), 'Medical spending and hospital inpatient care in England: an analysis over time', *Fiscal Studies*, vol. 37, pp. 405–32 (this issue).

Bago d'Uva, T., Jones, A. and van Doorslaer, E. (2009), 'Measurement of horizontal inequity in health care utilisation using European panel data', *Journal of Health Economics*, vol. 28, pp. 280–9.

[37] See, for example, Department of Health (2011) and Crawford and Stoye (2015).

[38] Kasteridis et al., 2014.

Banks, J., Marmot, M., Oldfield, Z. and Smith, J. P. (2006), 'Disease and disadvantage in the United States and England', *Journal of the American Medical Association*, vol. 295, pp. 2037–45.
Contoyannis, P., Jones, A. M. and Rice, N. (2004), 'Simulation-based inference in dynamic panel probit models: an application to health', *Empirical Economics*, vol. 29, pp. 49–77.
Cookson, R., Laudicella, M. and Donni, P. L. (2012), 'Measuring change in health care equity using small-area administrative data: evidence from the English NHS 2001–2008', *Social Science & Medicine*, vol. 75, pp. 1514–22.
Crawford, R. and Stoye, G. (2015), 'Challenges for health spending', in C. Emmerson, P. Johnson and R. Joyce (eds), *The IFS Green Budget: February 2015*, London: Institute for Fiscal Studies.
Deaton, A. (2003), 'Health, inequality, and economic development', *Journal of Economic Literature*, vol. 41, pp. 113–58.
Department of Health (2011), *Resource Allocation: Weighted Capitation Formula*, 7th edition.
— (2012), *A Simple Guide to Payment by Results*.
Hernández-Quevedo, C., Jones, A. M., López-Nicolás, A. and Rice, N. (2006), 'Socioeconomic inequalities in health: a comparative longitudinal analysis using the European Community Household Panel', *Social Science & Medicine*, vol. 63, pp. 1246–61.
Kasteridis, P., Street, A., Dolman, M., Gallier, L., Hudson, K., Martin, J. and Wyer, I. (2014), 'The importance of multimorbidity in explaining utilisation and costs across health and social care settings: evidence from South Somerset's Symphony Project', University of York, Centre for Health Economics (CHE), Research Paper no. 96.
Lafond, S., Arora, S., Charlesworth, A. and McKeon, A. (2014), *Into the Red? The State of the NHS' Finances*, London: Nuffield Trust.
Monitor and NHS England (2014), '2015/16 National Tariff Payment System: national prices methodology discussion paper', https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/310128/NT15-16MethodologyDiscussionPaper.pdf.
Morris, S., Sutton, M. and Gravelle, H. (2005), 'Inequity and inequality in the use of health care in England: an empirical investigation', *Social Science & Medicine*, vol. 60, pp. 1251–66.
OECD (2015), 'Focus on health spending: OECD health statistics 2015', http://www.oecd.org/health/health-systems/Focus-Health-Spending-2015.pdf.
Office for National Statistics (2012), 'National population projections, 2012-based projections'.
Smith, J. P. (1999), 'Healthy bodies and thick wallets: the dual relation between health and economic status', *Journal of Economic Perspectives*, vol. 13, no. 2, pp. 144–66.
van Doorslaer, E. and Koolman, X. (2004), 'Explaining the differences in income-related health inequalities across European countries', *Health Economics*, vol. 13, pp. 609–28.
—, — and Jones, A. (2004), 'Explaining income-related inequalities in doctor utilisation in Europe', *Health Economics*, vol. 13, pp. 629–47.
—, — and Puffer, F. (2002), 'Equity in the use of physician visits in OECD countries: has equal treatment for equal need been achieved?', in OECD, *Measuring Up: Improving Health Systems Performance in OECD Countries*, Paris: Organisation for Economic Cooperation and Development.
—, Masseria, C. and the OECD Health Equity Research Group (2004), 'Income-related inequality in the use of medical care in 21 OECD countries', in OECD Health Project, *Towards High-Performing Health Systems: Policy Studies*, Paris: Organisation for Economic Cooperation and Development.
Wagstaff, A. and van Doorslaer, E. (2000), 'Measuring and testing for inequity in the delivery of health care', *Journal of Human Resources*, vol. 35, pp. 716–33.
—, — and Paci, P. (1989), 'Equity in the finance and delivery of health care: some tentative cross-country comparisons', *Oxford Review of Economic Policy*, vol. 5, no. 1, pp. 89–112.