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Population ageing in Scotland: Implications for healthcare expenditure using linked SLS-SMR01 data

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Background: It is important for health policy and expenditure projections to understand the relationship between age, death and expenditure for health care (HC). Evidence shows that older age groups incur less acute HC costs than previously anticipated and that time to death (TTD) may be a much stronger indicator for HC expenditure than age alone.

Aim: We estimate the independent effect that TTD and age have on HC expenditure in Scotland and focus on differences in costs by socio-economic status.

Methods: We use the Scottish Longitudinal Study (SLS), linked to hospital admissions. The SLS is a 5.3% representative sample of the Scottish population (~274,000), drawn from the Scottish Census and started in 1991. We analyse costs in the last 5 years of life and employ a two-part model with the first part estimating the probability of accessing HC and the second part estimating costs conditional on positive utilisation. We use Healthcare Resource Group (HRG) based costing and apply English unit costs and the Scottish National Tariff (SNT) and compare results.

Results: As individuals approach death costs increase. This effect is highly significant ($p<0.01$) from the last quarter before death until about the 17th. Individuals in the most deprived quintile incur significantly lower costs than individuals in the most affluent quintile. This effect is influenced by TTD and can only be observed when applying the SNT.

Conclusion: Our study confirms findings from other national research, and in addition shows interesting results for the effect that socio-economic status has on costs. This is of special importance given the representativeness of the sample.

1. INTRODUCTION

Population ageing is a major concern for developed countries in terms of public expenditure that will need to be made available in the next decades to pay for health care (HC). Population ageing is mainly caused by two factors: decreasing mortality rates, as people live longer, and decreasing birth rates. It is usually described as an increase in the proportion of people over the age of 65 in a population (Payne et al. 2007). Population projections from the National Records of Scotland (NRS)[1] show that the number of children under the age of 16 will increase by 1% between 2008 and 2018, followed by a decline until 2033 (GROS, 2009). Over the same period the number of people aged 75 and older is projected to increase by 23% (GROS, 2009). In light of these developments, it has previously been anticipated that costs of HC (along with other public expenditure costs, like social security and social care) will increase (Dang et al., 2001). This is based on the general perception that older people use more HC services as their health deteriorates with increasing age (Payne et al., 2007).

However, there is general agreement in the academic literature, as well as amongst policy makers, that age alone does not drive HC expenditure. The association between age and HC costs seems to reflect a possibly stronger relationship between remaining time to death (TTD) and HC expenditure which has been found to be a much better predictor of acute HC costs than population ageing *per se* (Zweifel et al., 1999 and 2004; Felder et al., 2010; Seshamani and Gray, 2004; Hakkinen et al., 2008).

The present study estimates the independent effect that TTD and age have on HC expenditure in Scotland and focuses on differences in costs at the end of life by socio-economic status. This is of special importance in Scotland with a poor record of premature deaths and areas with very high levels of deprivation. Previous studies analysing Scottish data show a clear association between socio-economic status and premature death (Chalmers and Capewell, 2001).

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[1] On 1 April 2011, the General Register Office for Scotland (GROS) merged with the National Archives of Scotland (NAS) to become the National Records of Scotland (NRS)

A review of the wider international literature also suggests differences in HC costs incurred by socio-economic status, which is mostly measured using individuals income as a proxy for socio-economic status. Research from Sweden shows that people with a lower income incurred higher HC costs (Beckman et al, 2004). A study carried out in Canada looked at differences in HC utilisation between income groups and found that individuals with a lower income were responsible for a disproportionate utilisation of hospital services. This was mainly due to a higher prevalence of diseases (Lemstra et al., 2009). A comparative study of U.S. and Canadian individuals however found a similar pattern of hospital utilisation across socio-economic status (Blackwell et al., 2009).

The relationship between HC costs and socio-economic status is two-fold with the first one being access to HC, i.e. utilisation and the second, once HC services have been accessed, do individuals from more deprived areas cost more?

Preliminary, descriptive analysis undertaken in Scotland suggests a socio-economic gradient in terms of costs incurred towards the end of life, with decedents from more deprived areas incurring lower costs in younger age groups with the effect reversing in the very old age groups (over 75), where significantly higher costs were observed for people living in more deprived areas (Graham and Normand, 2001).

The present study extends this research by estimating the independent effect that TTD, age and socio-economic status have on HC expenditure simultaneously utilising a representative sample of the Scottish population. In addition, two methods of costing hospital episode statistics are compared.

The remainder of the paper is structured as follows. Section 2 describes the linked dataset and data manipulation procedure as well as the costing methods. It also outlines the econometric modelling framework. Results are presented in section 3 and section 4 discusses main findings and concludes.

2. METHODS

Data- Scottish Longitudinal Study

The Scottish Longitudinal Study (SLS) is a dataset of a representative sample of the Scottish population (5.3%), which draws on data from a series of statistical and administrative sources, such as the Census, Vital Events (births, marriages and deaths), data from the National Health Service Central Register (NHSCR), which collects data on migration in and out of Scotland and NHS data on health events of sample members (maternity data, cancer registrations and hospital admissions).

The SLS started with data from the 1991 census from which about 274,000 SLS members were identified based on 20 semi-random dates of birth in any year. It has very low attrition rates and very high rates for successful linkage of events as it collects data that is either required by law (Census, birth registration, death registration, marriage registration) or is a standard administrative function within Scotland. The linkage mechanism is provided by the National Health Service Central Register (NHSCR), which holds a database of people who have at any point been registered with a General Practitioner in Scotland. Compared to other surveys the SLS has a very large sample size.

One main advantage of the SLS over its English equivalent, the Longitudinal Study, is the ability to link with data on hospital admissions. Information on hospitalisations (and its associated costs) together with SLS data on economic activity, socio-economic status, health and demographic provides a novel platform from which to analyse the cost of ageing and the cost of dying. One additional advantage of using linked data is the possibility of including individuals without HC utilisation towards the end of life. Something previous research has been unable to do (or rarely does).

Detailed information on selection, tracing and linkage of SLS sample members as well as on the quality of sampling and linkage methods can be found in a series of SLS working papers by Hattersley and Boyle (2007), Hattersley et al. (2007), Hattersley and Boyle (2009a) and Hattersley and Boyle (2009b).

A subset of the SLS dataset will be used for this study, which is initially based on all traced SLS members enumerated at the 1991 census and/or the 2001 census aged 45 or older at the 2001 census. This data is linked to Scottish Morbidity Records (SMR01) resulting in an initial number of 1,110,169 records (hospital episodes), relating to 141,964 sample members with hospital admissions between 1986 and 2010.

Data- Scottish Morbidity Records

SMR01 has episode-based patient records that relate to all acute inpatient and day cases. A record is generated when a patient completes an episode of inpatient or day case care, which includes discharge home, transfer to another consultant in either, the same or a different hospital, a change of specialty under either the same or a different consultant, or death. Care episodes that are excluded from SMR01 are obstetric and psychiatric specialties. Geriatric long stay episodes were part of SMR01 until 1997 and due to this inconsistency and the nature of the care episodes have been excluded. Every record reflects one episode of care, but patients can have several episodes that form their entire hospital stay. These are called Continuous Inpatient Stays (CIS). A CIS can consist of multiple episodes and lasts from admission to hospital until discharge or death.

Data collected to describe each episode include demographic information, episode management details and general clinical information. Diagnoses are recorded using the International Classification of Diseases (ICD-10; previously ICD-9) while procedures performed are recorded using the ‘Office of Population, Censuses and Surveys Classification of Surgical Operations and Procedures - 4th revision’ (OPCS-4) (ISD Data Dictionary, 2009).

SLS sample members, which could not be successfully linked to SMR01 data and those present at the 1991 census, but not traceable afterwards were discarded from the analysis. This study analyses HC expenditure in the last 5 years of life. Therefore hospital stays that do not fall into this period (N= 519,792) were also deleted.

Costs

The costing method chosen utilises Healthcare Resource Groups (HRGs). HRGs are similar to Diagnosis Related Groups (DRGs), which were first developed in the U.S. in the early 1980's for Medicare to use as a prospective payment system for hospitals. HRGs are a measure of case mix, presenting standard groupings for clinically similar treatments, which consume a common set of health care resources (The Health and Social Care Information Centre, 2010a). Based on procedure, diagnosis, LOS, complications, co-morbidity, discharge method, age and gender, each patient record is grouped in an HRG and reflects one finished consultant episode (FCE) (Street and Dawson, 2002). HRGs incorporate a fixed and variable cost component, thereby avoiding the assumption that the first day in hospital incurs the same cost as each subsequent day. It also allows adequate costing of hospital stays that involve more than one episode. 2006/07 was chosen as the cost reference year. Admissions with ICD9 codes (pre 1992) were converted into ICD10 codes using a look-up file (New Zealand Health Information Service, 2010).

The HRGv3.5 Grouper software is used to assign an HRG to every patient record (The Health and Social Care Information Centre, 2010a). After that episodes that form a CIS are taken account of by selecting the dominant HRG within each CIS. This is achieved through using the 'Spell Converter' software (The Health and Social Care Information Centre, 2010b).

Both, English unit costs and the Scottish National Tariff (SNT) are assigned to the chosen dominant HRG and summarised into quarterly costs. Information on the type of admission was used to distinguish between tariffs for elective and non-elective admissions and LOS information guided the decision about assigning extra per diem costs. Notably the derived SNT does not provide information on extra daily costs if a hospital stay exceeds a trim point and will therefore give less weight to individual LOS.

The initial set up of the data is in long format with each row representing one episode of care. There is no record for periods, in which no hospital costs were incurred, i.e. periods without a SMR01 record. The data are manipulated such that each row now represents one quarter (90 days) before death. Quarters in which no hospitalisation was observed, as recorded by a row of zeros, enter the model as zero cost observations. This results in a total number of 2,095,060 observations (quarters), relating to 104,753 sample members of which 42,668 (40.73%) had died by the end of the observational period (30th April 2010) and who will be subsequently used in regression analysis.

Regression Modelling

Following convention, costs for acute inpatient care are estimated using a two-part model with the first part estimating the probability of accessing HC and the second part estimating costs conditional on positive utilisation. For a comprehensive review of statistical methods to analyse HCE data see Dodd et al. (2006) and Mihaylova et al. (2010).

The following explanatory variables have been identified in order to assess the independent effect that population ageing and TTD have on hospital costs. To represent TTD, a series of 20 quarter dummies (Q) are defined, where 1 represents the last quarter of life, 2 the penultimate quarter of life, etc. The quarter furthest away from death (20th quarter) serves as the reference category. Age at death (A) is measured in 7 categories (<65 years, 65-69, 70-74, 75-79, 80-84, 85-89, 90 years and over) with the youngest age group serving as the reference category. Interaction terms between TTD in quarters and age at death ($Q*A$) are included to capture any combined effect of ageing and TTD on HC costs.

Individuals' gender (S) is included to account for differences in costs incurred by male and female participants, which could either be due to females' higher life expectancy or gender specific differences in morbidities and treatment. To account for differences in costs incurred by socio-economic status a measure of deprivation (D) is included using the Carstairs deprivation score quintiles. These are based on postcode sectors and the lowest quintile (1) represents the most affluent areas, while the highest quintile (5) represents the most deprived areas (Carstairs and Morris, 1991). Interaction terms between TTD and deprivation quintiles ($Q*D$) are included to control for any combined effects. The year of admission (Y) is included to account for advances in medical technology over time. A measure of individuals' health status (H) at baseline is included using information on reported long-term illnesses (yes/no).

The underlying assumption is that the expected value of HC expenditure is a function of these explanatory variables.

The first modelling part employs a probit link and a binomial distribution to estimate the probability of utilising hospital care in any given quarter before death conditional on regressors X (equation (1)).

$$\Pr(HCE > 0) = \alpha + \sum_{a=2}^{7} \eta_a A_a + \beta_2 S + \beta_3 H + \sum_{q=1}^{19} \gamma_q Q_q + (\sum_{q=1}^{19} \gamma_q Q_q * \sum_{a=2}^{7} \eta_a A_a) + (\sum_{q=1}^{19} \gamma_q Q_q * \sum_{d=2}^{5} \mu_d D_d) + \sum_{t=1987}^{2010} \delta_i Y_i + \sum_{d=2}^{5} \mu_d D_d + u_i$$

equation (1)

From the second part of the model estimates of HC expenditure are obtained, conditional on HCE being greater than zero and conditional on the same set of regressors X (equation (2)).

$$E\,[HCE] = g(x\beta) \qquad \text{equation (2)}$$

with xβ representing the linear predictor for HC expenditure (HCE).

Quarterly HC expenditure is estimated fitting a Generalised Linear Model (GLM) clustered on patient identifier. GLMs as an extension of OLS have the advantage of being able to specify a link function, which allows transformation of the mean of regressors rather than the mean of the cost variable and therefore mitigates cumbersome re-transformation of cost estimates. Gamma is chosen as the most commonly applied distributional family and log as the link function (Dodd et al., 2006). A Gamma distribution offers a means to account for heteroscedasticity and places less weight on very high costs.

Predicted probabilities of positive HC utilisation, obtained from the first part of the model are multiplied by cost estimates from the second part of the model in order to derive average cost estimates conditional on having incurred positive HCE (equation (3)).

$$E\,(HCE \mid X) = Pr\,(HCE>0 \mid X) * E\,(HCE \mid HCE>0, X) \qquad \text{equation (3)}$$

One problem that frequently characterises time series data is serial correlation, i.e. observations for the same observational unit (patient) are not independent. There are two layers to this issue: firstly, hospital episodes are not independent. One approach that partly accounts for this serial correlation is the use of a CIS as the basis for the cost variable. However, this leaves a second issue, that of potential correlation between different CISs per patient. Clustering on patient identifier was applied to account for this.

3. RESULTS

Sample characteristics are presented in Table 1. A higher proportion of female SLS members can be found in the decedent group (53.17%). 95% of individuals had accessed hospital services in their last 5 years of life. Aside from the most affluent deprivation score quintile (13.72%) a similar distribution of socio-economic status can be found for the remaining quintiles 2-5. 42.7% of individuals reported a limiting long-term illness in either the 1991, the 2001 or both censuses. On average deceased SLS sample members had 9.7 hospital episodes (SD=10.4) over the last 5 years of their life. Decedents' mean age at study entry in 1991 was 68.6 years (SD=11.4) and in 2001 the mean age was 73.9 years (SD=11.1). The mean age at death was 76.8 years (SD=10.8).

A substantial increase in mean quarterly hospital costs as people approach death was observed especially during the last year of life for both, English unit costs and the SNT (Figure 1). Figure 2 shows, the distribution of mean quarterly costs (English unit costs and SNT) in the last quarter of life over deprivation score quintiles. No marked differences in costs can be observed on an absolute scale between deprivation score quintiles.

Probability of HC utilisation

Selected regression results are presented in Table 2.[2] Results for the first modelling part, the probability of hospital utilisation are presented in Table 2, column (1). Up to the 15th quarter before

[2] The full regression output is available from the lead author

death, the admission quarter has a highly significant and positive association with the probability of being admitted to hospital ($p<0.01$) (results only presented for the last 12 quarters before death). The size of the effect is increasing as people approach death. Considering interaction effects between TTD and age and TTD and socio-economic status, results show that people in the youngest age group (<65 years) and in the most affluent deprivation quintile (1) who are in their last quarter of life are more likely to being admitted to hospital than people in their 20th quarter before death. People in the older age categories (5-7) are more likely to access hospital care compared to individuals in the youngest age category ($p<0.05$). Results for interactions (not presented) reveal that this effect is influenced by TTD.

Socio-economic status has a small effect only on the probability of using hospital services. Individuals in the 3rd ($p<0.1$) and 4th ($p<0.05$) quintile are more likely to access hospital care than individuals from the most affluent quintile. Again, results for interaction terms reveal that this effect is influenced by TTD up until the 10th quarter before death (results not presented).

Male SLS members are more likely to access hospital care than their female counterparts ($p<0.01$) and individuals, who had stated that they suffered from a long-term illness also have a higher probability of being admitted to hospital ($p<0.01$).

Cost Estimation – English Unit Costs

Regression results for the 2nd modelling part estimating costs given positive HC utilisation and applying English unit costs are presented in Table 2, columns (2) and (3) (coefficients have been re-transformed). Column (2) presents selected results without deprivation and TTD interaction effects and column (3) presents selected results for a model including these interactions.

Costs increase as people approach death. They are estimated to be about 90% higher in the last quarter of life compared to the 20th quarter before death. The association between TTD and costs is significant up to the 17th (column (2)) or 11th (column (3)) quarter before death. Age at death is a significant predictor for mean quarterly costs for all but the second youngest age group. Compared to the youngest age group, costs incurred by the oldest age group are estimated to be about 50%

higher. Some of the interaction terms between TTD and age show a significant association with costs, i.e. the effect on costs of being in a particular quarter before death compared to the 20th quarter also depends on age. This effect can however only be observed for the last quarter of life and the oldest age groups.

On average, male individuals incur significantly less costs than females (~10%). Individuals, who reported a long-term illness incur significantly higher costs compared to those without any long-term illnesses (5%). The socio-economic status does not seem to have a significant association with costs incurred when using English unit costs. Column (3) shows some selected results when including interaction effects between TTD and deprivation. Only a very small effect can be observed for the 4th quarter before death and socio-economic status (results not presented).

Cost Estimation – SNT

Regression results applying the SNT are presented in Table 2, columns (4) and (5). Column (4) presents selected results without deprivation and TTD interactions while column (5) presents selected results for a model with these interactions included.

The association between TTD and costs is highly significant up to the 12th quarter before death. Costs in the last quarter of life are estimated to be 55% higher than in the 20th quarter before death. Age at death only appears to be a significant predictor for mean quarterly costs for the oldest age group and the 4th youngest age group. Again, interaction terms between TTD and age show a highly significant association with costs up until the 8th quarter before death and mainly for the two age groups mentioned above.

Again, male individuals incur significantly less costs than females (~7%). Having a long-term illness does not seem to have an effect on costs incurred in the last 20 quarters of life when using the SNT. Also, contrary to results obtained from the model using English unit costs, the socio-economic status shows a significant association with quarterly costs incurred towards the end of life (column (4)). Individuals from more deprived areas seem to incur significantly less costs than individuals from the most affluent areas, with the size of the effect increasing as deprivation score quintiles increase.

Column (5) shows results for a model including interaction terms between TTD and socio-economic status. A highly significant association ($p<0.05$) can be observed for the most deprived quintile and quarters 1-11 before death (results not presented). Individuals coming from the most deprived areas seem to incur lower costs in their last 11 quarters of life compared to the 20th quarter before death and also compared to people from the most affluent areas.

Cost estimates for the application of English unit costs vary from an average of £2,340 in the last quarter of life to an average of £161 in the 20th quarter before death. Applying the SNT produces similar average cost estimates of £2,345 in the last quarter of life and £188 in the 20th quarter before death. Average cost estimates by deprivation quintile and admission quarter before death for English unit costs and the SNT are presented in Table 3.

4. DISCUSSION

Using a representative sample for the Scottish population, the SLS, the present study shows that TTD, age at death and the interaction between these two have a significant effect on HC costs and so confirms findings from other previous research. TTD influences HC expenditure differently for different age groups.

The main focus of this analysis was to test whether findings from other research that showed differences in HC utilisation and costs by socio-economic status also translates into differences in costs incurred towards the end of life given evidence that ‘poorer’ people seem to die prematurely.

Results found for the effect that socio-economic status has on costs in this study are very interesting. First of all, the type of costing method seems to influence the effect that deprivation has on estimated hospital costs at the end of life. Applying the SNT to cost hospital stays shows a significant association with socio-economic status, whereas applying English unit costs does not. The difference between costing methods mainly lies in the fact that the SNT does not offer means to account for very long stays through the application of additional per diem costs and so places less weight on very long stays. Contrary to findings from previous research that suggested that ‘the poor cost more’ (Cookson and Laudicella, 2009), this study found a reverse effect, with ‘poorer’ people costing less in their last 5 years of life. This is interesting as people from more deprived areas are more likely to be admitted to hospital, but do not seem to incur higher costs once hospitalised. People from more deprived areas are known to have longer stays at hospital, often due to a lack of available care in their own homes. Any deprivation category effect that might be present could have been modified by including LOS into the set-up of the cost variable when using English unit costs, but not when using the SNT.

Limitations

The study has several limitations. In the dataset inpatient stays were considerably longer on average in the past than they have been in more recent periods. This raises the issue of how to account for this without over-estimating recent costs or under-estimating historic costs. Employing data from a cohort, which ages over time, may mean that the two effects, a) LOS decreases over time and b) LOS increases with age, might cancel each other out. Without access to full historic costs (in this instance episode costs for 1980 thru to 2007) this problem is difficult to overcome. This leads to another limitation, which is the use of the trim point LOS in HRG based costing applying English unit costs. 2006/2007 was chosen as the reference year with respective tariffs and trim point information. But the trim point can change over time, such that applying the same trim point value for all time periods observed may have also introduced bias, but full historical data on trim points was not available.

Summary

This study uses a representative sample of the Scottish population and offers important insights into the relationship between TTD, ageing and costs for acute inpatient care in Scotland, providing valuable information on the role socio-economic status plays at the end of life.

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Glossary of Terms

CIS: Continuous Inpatient Stay
DRG: Diagnosis Related Group
FCE: Finished Consultant Episode
HCE: Health Care Expenditure
HRG: Healthcare Resource Group
ICD-9; ICD-10: International Classification of Diseases
ISD: Information Services Division
LOS: Length of Stay
NHSCR: National Health Service Central Register
NRS: National Records of Scotland
OPCS4: Office of Population, Censuses and Surveys Classification of Surgical Operations and Procedures (4th revision)
SLS: Scottish Longitudinal Study
SMR01: Scottish Morbidity Records (in particular acute inpatient care and day cases)
SNT: Scottish National Tariff
TTD: Time To Death

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Appendix

Figure 1: Mean quarterly costs in the last 20 quarters of life

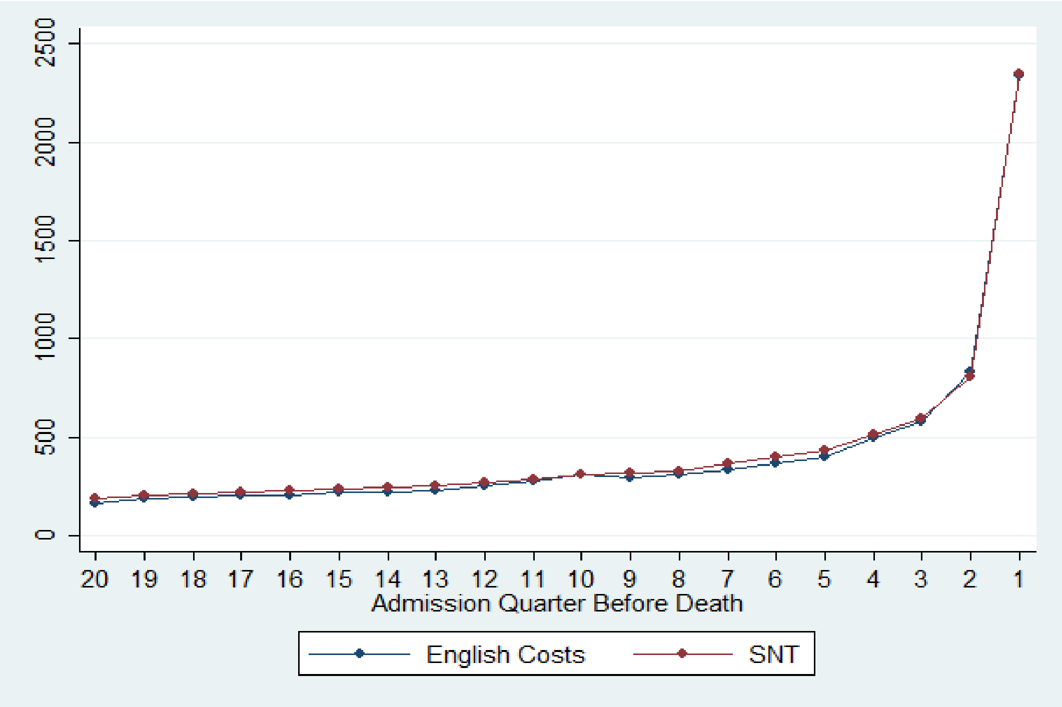

Figure 2: Mean costs in the last quarter of life, by deprivation quintile

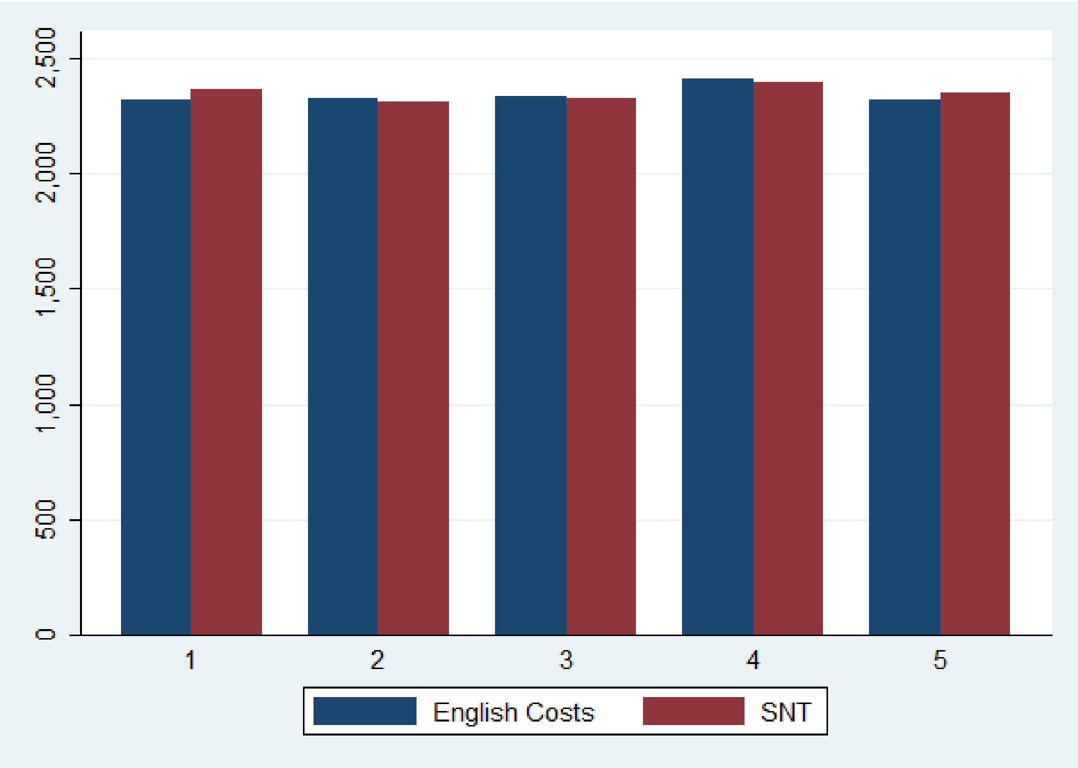

Table 1: Sample Characteristics (Decedents)

VARIABLE	FREQUENCY (%)
Male	19,978 (46.82)
Female	22,686 (53.17)
Missing Gender	4 (0.01)
Number of HC users	40,633 (95.23)
Number of non-users	2,035 (4.77)
Deprivation Score Quintile 1	5,855 (13.72)
Deprivation Score Quintile 2	9,822 (23.02)
Deprivation Score Quintile 3	9,886 (23.17)
Deprivation Score Quintile 4	8,826 (20.69)
Deprivation Score Quintile 5	8,221 (19.27)
Deprivation Score Quintile (missing)	58 (0.14)
LTI - Yes	18,213 (42.69)
LTI - No	24,327 (57.01)
LTI (missing)	128 (0.03)
	MEAN (SD)
Age at death	76.8 (10.8)
Age at study entry (1991)	68.6 (11.4)
Age at study entry (2001)	73.9 (11.1)
Number of Hospital Episodes	9.7 (10.4)
Sample Size	N=42,668

Table 2: Regression Results: Probit (1st Part) and GLM (2nd Part)

	1st Part Probability		2nd Part (English Costs)		2nd Part (English Costs)		2nd part (SNT)		2nd part (SNT)	
VARIABLE	**β**	**SE**	**β**	**SE**	**β**	**SE**	**β**	**SE**	**β**	**SE**
Column	**(1)**		**(2)**		**(3)**		**(4)**		**(5)**	
TTD=1	2.14***	(0.04)	1.939***	(0.0518)	1.850***	(0.0915)	1.545***	(0.0494)	1.581***	(0.0612)
TTD=2	1.16***	(0.04)	1.476***	(0.0557)	1.404***	(0.0967)	1.331***	(0.0507)	1.384***	(0.0637)
TTD=3	0.95***	(0.04)	1.492***	(0.0608)	1.327***	(0.0997)	1.313***	(0.0510)	1.343***	(0.0638)
TTD=4	0.80***	(0.04)	1.422***	(0.0597)	1.204*	(0.101)	1.315***	(0.0529)	1.339***	(0.0668)
TTD=5	0.72***	(0.04)	1.257***	(0.0572)	1.182*	(0.0991)	1.245***	(0.0536)	1.319***	(0.0673)
TTD=6	0.57***	(0.04)	1.280***	(0.0602)	1.206*	(0.102)	1.235***	(0.0548)	1.290***	(0.0681)
TTD=7	0.50***	(0.04)	1.288***	(0.0694)	1.123	(0.105)	1.231***	(0.0548)	1.280***	(0.0690)
TTD=8	0.42***	(0.04)	1.339***	(0.0686)	1.254**	(0.108)	1.188***	(0.0556)	1.279***	(0.0706)
TTD=9	0.40***	(0.04)	1.232***	(0.0634)	1.091	(0.105)	1.172***	(0.0555)	1.239***	(0.0716)
TTD=10	0.31***	(0.04)	1.881*	(0.323)	2.199*	(0.439)	1.168***	(0.0567)	1.247***	(0.0722)
TTD=11	0.24***	(0.04)	1.528**	(0.168)	1.590*	(0.256)	1.146**	(0.0565)	1.183**	(0.0701)
TTD=12	0.19***	(0.04)	1.172**	(0.106)	1.112	(0.0635)	1.153**	(0.0735)	1.168**	(0.0589)
TTD 13-19	Not presented									
Age 65-69= (2)	-0.01	(0.04)	1.040	(0.0862)	1.047	(0.0845)	0.987	(0.0804)	0.988	(0.0784)
Age 70-74= (3)	-0.0006	(0.03)	1.160**	(0.0657)	1.165**	(0.0654)	1.075	(0.0623)	1.083	(0.0618)
Age 75-79=(4)	0.05	(0.03)	1.226***	(0.0657)	1.241***	(0.0659)	1.156**	(0.0595)	1.169***	(0.0587)
Age 80-84=(5)	0.07**	(0.03)	1.259***	(0.0812)	1.269***	(0.0760)	1.066	(0.0588)	1.078	(0.0582)
Age 85-89=(6)	0.07**	(0.03)	1.320***	(0.0677)	1.336***	(0.0679)	1.078	(0.0589)	1.090	(0.0581)
Age > 90= (7)	0.08**	(0.03)	1.531***	(0.0776)	1.548***	(0.0788)	1.149**	(0.0614)	1.170***	(0.0608)
TTD x Age	Not presented									
Dep Quintile 2	0.04	(0.03)	1.021	(0.0162)	0.913	(0.0896)	0.984*	(0.0093)	0.981	(0.0505)
Dep Quintile 3	0.06*	(0.03)	1.019	(0.0164)	0.930	(0.0916)	0.978**	(0.0096)	0.981	(0.0501)
Dep Quintile 4	0.06**	(0.03)	1.016	(0.0167)	0.908	(0.0924)	0.970***	(0.0096)	0.943	(0.0491)
Dep Quintile 5	0.04	(0.03)	1.007	(0.0173)	1.025	(0.0908)	0.948***	(0.0098)	1.091	(0.0545)
TTD x Dep Quintile	Not presented									
LTI	0.07***	(0.006)	1.049***	(0.00851)	1.049***	(0.0083)	0.995	(0.0057)	0.996	(0.00574`
Male	0.04***	(0.006)	0.894***	(0.00873)	0.894***	(0.0084)	0.933***	(0.0055)	0.933***	(0.00549`
Year 1987-2010	Not presented									
Constant	-1.16***	(0.1)	2026***	(0.0970)	2164***	(0.120)	2217***	(0.0817)	2171.13	(0.0886)
Observations	849,640		93,803		93,803		116,371		116,371	

*** p<0.01; **p<0.05, *p<0.1

Robust standard errors in parentheses

Deprivation Score Quintile 1 (most affluent) serves as the reference category

Age category 1 (<65) serves as the reference category

TTD=20 serves as the reference category

Table 3: Mean cost estimates in GBP [SD] by Deprivation Score Quintile

Admission quarter before death	Deprivation Quintile 1	Deprivation Quintile 2	Deprivation Quintile 3	Deprivation Quintile 4	Deprivation Quintile 5
English Unit Costs					
1	2318 [338]	2325 [333]	2331 [324]	2405 [313]	2316 [295]
2	849 [208]	846 [207]	817 [184]	832 [181]	840 [178]
10	380 [151]	300 [115]	311 [113]	288 [100]	284 [97]
20	161 [90]	160 [86]	165 [83]	156 [74]	167 [78]
SNT					
1	2366 [312]	2307 [306]	2325 [305]	2394 [296]	2346 [285]
2	837 [215]	791 [204]	798 [198]	807 [198]	806 [196]
10	308 [97]	306 [92]	314 [91]	322 [91]	299 [83]
20	175 [71]	187 [72]	191 [72]	181 [65]	201 [71]