The contribution of age and time-to-death on health care expenditure for out-of-hospital services: An exploration using whole of population linked administrative data

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Abstract

Objectives: Controversy persists over the relationships between health care expenditure, time-to-death and age, undermining attempts to generate convincing predictions for policy. This paper explores the relationships between time-to-death (TTD), age and health care expenditure for Medicare funded, out-of-hospital services in the last five years of life, assessing if the relationship varies across different types of out-of-hospital services.

Methods: Medicare Benefit Scheme claims for five years before death in Western Australia (1990-2004) pertaining to out-of-hospital primary care, specialist or diagnostic and therapeutic services were used to determine the total and mean per capita health care expenditure (HCE) according to age and TTD. Data were evaluated using univariate linear regression (age) and segmented time-trend regression analysis (time-to-death).

Results: Changes to out-of-hospital HCE for the last five years of life did not consistently show a positive association with changes in the number of decedents. Only primary care services demonstrated a linear relationship for HCE and age. For TTD a linear relationship was observed for all three service types within each retrospective period.

Conclusions: This study has identified significant differences in the relationship between age, TTD and out-of-hospital HCE across service type, further highlighting potential shortcomings in methods that use single, all-service, all-cause models to predict future HCE. These results build on our previous study and suggest that such predictions should either use separate models, or models capable of accounting for the different relationships of HCE with TTD and age across types of services in order to predict future HCE accurately.

Introduction

Population ageing has important implications for health care expenditure (HCE) and thus is of interest to policy makers. Since 1985, HCE has been steadily rising,[1] a trend attributed to a number of factors, including: population growth, higher prices, higher per capita utilisation of health services and improved ‘quality’ (that is, advances in technology and techniques) of health care.[1] A number of commentators have argued that an ageing population, coupled with the ensuing rising per capita utilisation, will significantly add to future health care costs.[2-3] For example in Australia it has been estimated that the population over 65 years will more than double in the next 30-40 years[1, 4] and the resultant rise in per capita utilisation is estimated to add the equivalent of 1.78% of gross domestic product (A$11.6 billion in 2000 dollars) to the cost of health care by 2031.[1]

Accurately forecasting the additional expenditure on health care due to population ageing is important and to that end a number of economic studies conducted in recent years have suggested that age is the primary driver of growing HCE.[5-9] A contrasting viewpoint is that proximity to death, rather than age *per se,* is a more important driver of HCE[5, 8, 10-13] suggesting ‘dying’ as opposed to ‘ageing’ is the real driver of increasing HCE.

In a previous study[13] we evaluated the distribution of HCE for in-patient care in the last three years of life to determine the relative influence of age and time to death (TTD). We found that age was positively associated with HCE until five months prior to death, but thereafter HCE was not significantly associated with age.[13] Importantly, we also observed that the relationship was modified by cause of death, leading us to propose that single, all-service, all-cause linear models may be incapable of fully explaining the relationship and that this may be partly why the debate regarding age and TTD remains unresolved in the literature.

A significant portion of HCE arises from out-of-hospital care. Since the patterns of HCE in this setting have not been investigated thus far this study aims to examine the relationship between age, TTD, service type and HCE for Medicare funded out-of-hospital services in the last years of life and evaluate changes in their relationship over time.

Methods

Sources of data

Records of all deaths of individuals aged 18+ years occurring in Western Australia (WA) between 1 January 1990 and 31 December 2004, from colorectal cancer, lung cancer, female breast cancer, ischaemic heart disease or cerebro-vascular disease were extracted from the WA mortality register. For each decedent, all Medicare Benefit Scheme (MBS) claims five years prior to death originating in WA were extracted and linked via the WA Data Linkage System (WADLS).[14] For each decedent the following data were used:

- Mortality register: encrypted patient identification, age at death, gender, cause of death (International Classification of Diseases (ICD) coding) and date of death.
- MBS: encrypted patient identification, age at service, gender, MBS item group, date of service, scheduled fee at the time of service (Australian dollars) and number of services.

Case selection and stratification

Cases (decedents) were stratified for separate analyses according to broad service type by collapsing the 16 MBS groups into three groups: primary care services (services delivered by a general practitioner), specialist services (services delivered out-of-hospital by a specialist physician) and diagnostic and therapeutic services (pathology testing, radiology, allied health treatments, etc delivered out-of-hospital). To facilitate the evaluation of temporal changes, cases were allocated to one of three mutually exclusive groups according to the year of death as follows: era 1 (1990-1994); era 2 (1995-1999); and era 3 (2000-2004). Each MBS record was categorised into one of the following age groups based on the age at MBS claim; 18-19, 20-24, 25-29, ... ,90-94, 95+ years.

Assignment time to death

TTD for each MBS claim in months was calculated and each record was categorised as belonging to one of five look-back periods; fifth, fourth, third, penultimate, and last year of life. Individuals with no MBS records in a particular look-back period were recorded as having zero expenditure in that period.

Determining Medicare funded health care expenditure

The Medicare funded out-of-hospital health care expenditure associated with each MBS claim was assigned based on the Medicare Schedule fee recorded on the claim record at the time of service. All dollar values were adjusted to 2007 price levels, using Australian Bureau of Statistics' Consumer Price Index (CPI) data.[15] For each era the total and mean per capita Medicare-funded HCE in the out-of-hospital setting for the relevant population groups (gender, age group, broad service type and time to death) was calculated.

Evaluation of Medicare funded HCE by broad service type according to age

For each era the gender-specific mean HCE in the last year of life as a function of age for each service type was represented graphically and the distribution evaluated subjectively. Univariate linear regression was performed in STATA Version 10.0 to quantify differences in the rate of change of HCE with increasing age according to gender and service type.

Evaluation of changes in Medicare funded HCE according to proximity to death

For each era the gender-specific mean per capita HCE as a function of TTD in months for each service type was represented graphically and the distribution evaluated subjectively. Segmented time-trend regression analysis (using auto-correlated standard errors due to the non-independence of the time related variables) was performed in STATA with segments constructed to represent the TTD look-back periods under investigation.

Results

The study population comprised 60,498 decedents of which 31,313 (52 percent) were male and 29,185 (48 percent) were female (table 1). Decedents made 7,079,257 MBS claims during the last five years of life with 3,285,628 (46%) pertaining to primary care services, 923,128 (13%) specialist medical services and 2,870,501 (41%) diagnostic and therapeutic services. While the number of decedents was inversely associated with time era, except for primary care service claims, the number of MBS claims was positively associated with time era.

Changes in out-of-hospital HCE generally showed a positive association with changes in the number of decedents (table 2). The exception was those who died from ischaemic heart disease, which accounted for both the greatest number of deaths and highest out-of-hospital HCE in all eras. For this group, the number of deaths fell with each subsequent time era while the out-of-hospital HCE in the last five years of life increased substantially. In addition, the number of deaths attributed to cerebro-vascular disease halved in era 3; however, this could be an artefact of ICD coding changes introduced in 2000.

Across the study period, in each year prior to death, the proportion of MBS claims for primary care services decreased (table 3), while the proportion of specialist and diagnostic and therapeutic episodes services increased (except for specialist services in era 2 which declined). Primary care service costs increased with proximity to death with very little difference across the three time eras. In contrast, costs of specialist and diagnostic / therapeutic services increased both with proximity to death and across the study periods.

Changes in Medicare funded out-of-hospital HCE by service type according to age

Figure 1 shows mean per capita Medicare funded out-of-hospital HCE according to age in the last year of life in the three time eras (*columns*) for each service type (rows). For primary care services the high r-squared values show the linear modelling explained the relationship between age and HCE quite well. Across all age groups, gender and eras the mean HCE in the last year of life was positively associated with age with higher mean per capita costs consistently observed for females.

For specialist services the relationship between HCE in the last year of life and age was not explained well by the linear model, indicating that HCE for this service type is not linearly associated with age. The mean per capita HCE for specialist services in the last year of life tended to increase with age over the younger age groups subsequently falling in a linear manner over the older age groups. Differences in the age group(s) accounting for the highest mean HCE were observed across the eras in each gender. HCE in the last year of life for diagnostic and therapeutic services showed a similar non-linear pattern to that observed for specialist services.

Changes in Medicare funded out-of-hospital HCE according to proximity to death

Figure 2 shows the actual and predicted mean per capita monthly HCE for Medicare funded out-of-hospital services according to proximity to death for the three service types (rows) across the three eras (columns) in males and females. Due to the similarity between the fifth and fourth years prior to death, these two look-back periods were reported together (segment 1). In addition, there was a substantial increase in the mean monthly HCE occurring at about 2 months prior to death thus the last two months of life were separated from the preceding 10 months forming segments 5 and 4 respectively.

There was good agreement between the actual and the predicted (fitted) mean per capita monthly HCE, indicating a linear association between HCE and time to death within each of the look-back periods. This was different to that observed for HCE and age as described above. Within each service type only minor change in the association between HCE and proximity to death across the three eras was observed; however, there were significant changes across the service types.

For primary care services the rate of monthly per capita HCE did not change significantly until the last year of life, increasing by an average of less than $1 per month between the 60th and 13th month. In segment 4 (12 to 3 months prior to death) a small but statistically significant increase of approximately $2.50 per month was observed in both genders. The most significant increase occurred in the last two months of life, where HCE increased at a rate of between $70 (era 1) and $100 (era 3) per month and $55 (era 1) to $60 (era 3) per month for females and males respectively.

The overall pattern, as described above for mean per capita HCE in primary care, was also observed for specialist services in the first era. In subsequent eras the increase in the rate of monthly per capita HCE occurred earlier and with increased magnitude over the study period. Males in era 2, showed a significant increase in monthly HCE in segment 3 (24-13 months before death), which was also observed in era 3; while in females the corresponding “early” increase in the rate of monthly HCE was limited to era 3. Of note, monthly per capita HCE for this service type fell dramatically in the last month of life in all eras, a finding not observed for primary care.

Monthly HCE for diagnostic and therapeutic services followed a similar trend to that described above for specialist services. The magnitude of this change in rate increased with each subsequent time era. However, in contrast to specialist services, except in era 1, monthly per capita HCE for diagnostic and therapeutic services did not reduce in the last month of life.

Discussion

Between one half and one third of total health spending in OECD countries is spent on the elderly with those aged 65+ years utilising approximately four times more health services than their younger counterparts.[16-17] In Australia in 2002-2003 one-third of total government expenditure for health services went to the elderly population .[18] Current HCE forecasts predict that an ageing population is likely to significantly increase HCE in the coming decades. Controversy persists regarding whether age or TTD drive HCE.

This study examined the relationship between age, TTD and Medicare funded out-of-hospital HCE showing a positive linear relationship between age and HCE in the last year of life for primary care services across all three time eras. However, a linear relationship was not observed for specialist and diagnostic and therapeutic services, with a variable and inverse relationship seen between age and HCE in last year of life for all three eras.

The effect of TTD on mean HCE for out-of-hospital services also manifested some inconsistency across the three service types and time eras evaluated. An increase in mean HCE was observed only in the two months prior to death for primary care services, whereas the increase began earlier for both specialist and diagnostic and therapeutic services. The sharp drop in HCE for specialist services observed in the last two months prior to death may reflect an attempt to ration by general practitioners as gatekeepers or self-ration by specialists; however, this is beyond the scope of the current study.

These findings have major implications for both forecasting HCE and evaluating the relative influence of age and TTD. Previous research has focused on HCE, as a whole, or limited analyses of hospital costs in the in-patient setting.[2, 6, 13, 19-21] No previous studies have investigated variation in HCE in the out-of-hospital setting and few investigated HCE stratified according to types of service. Our findings indicate separating HCE according to broad service types is imperative to evaluate the effect of age, since any positive linear association between age and HCE for primary care services would be "masked" or "diluted" by non-linear associations between age and cost for specialist services and diagnostic and therapeutic services. This would result in age being erroneously classified as a non-significant contributing factor to HCE, hence the controversies found in the literature regarding TTD and age.

The concerns of recent studies have primarily been with the following questions: (i) To what extent is ageing *per se* the driver of HCE? (ii) To what extent does the proximity to death drive HCE? (iii) To what extent does the correlation between ageing and proximity to death confound demographically-based forecasts of HCE (the ‘age neutrality hypothesis’),[8] such that proximity to death rather than age *per se* drives HCE? The last point still remains largely an open question, in part due to disagreements over the sampling and econometric methods employed. Our study suggests the persistence of controversy in the literature may result from a failure to separate different types of health services in single, all-service, all-cause models of HCE. These models of past, current and future HCE do not accurately reflect the sub-level relationships at play between major demographic factors, different forms of health services, illnesses and cause of death, leading to potentially inaccurate conclusions regarding the interaction of age, TTD and HCE. Resolving this argument is important because the more HCE is driven by proximity to death and the less by age *per se* the more likely aged-based forecasts of future health-care spending will be overestimates.

Strengths and Limitations

This study was population-based rather than sample-based, providing enhanced external validity compared with studies using institutional or response-based sampling from a base population .[22-23] The MBS data used in this study were collected by the Australian Government and, hence, were subject to reviews, which aimed to ensure the correct Medicare benefits were claimed for the appropriately provided services and to prevent and detect fraudulent claiming of MBS items.[24] Health service providers who claim MBS payments undergo random and targeted compliance audits.[25]

A limitation in the current study was the restriction of the study population to individuals who died from five selected leading[26] causes of death meaning that the results cannot be generalised to all causes of death in the general population. The use of individuals with a known date of death provided a homogenous data set allowing influence of TTD and age to be evaluated without the problem of differences in the profile of HCE associated with acute versus chronic conditions.

Since services funded by Medicare in the out-of-hospital setting all result in a MBS claim regardless of who provided the service, the coverage of out-of-hospitals services captured by our data was 100% of services funded by Medicare

Conclusions

This study has identified significant differences in the relationship between TTD, age and out-of-hospital HCE across service type, further highlighting potential shortcomings in methods that use single, all-service, all-cause models to predict future HCE. These results build on our previous study and suggest that such predictions should either utilise separate models, or models capable of accounting for the different relationships of HCE with TTD and age across types of services in order to predict future HCE more accurately.

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Figure legends

Figure 1 The distribution of out-of-hospital HCE for Primary care, Specialist services, and Diagnostic & therapeutic services according to age in the last year of life across three time eras

HCE: Out-of-hospital health care expenditure.

Fitted values: Mean HCE in the last year of life as predicted by the linear regression analysis.

Linear models shown in each panel should be interpreted as follows: $y = a + \beta x$

Where:

y = Mean HCE in last year of life for age group x

a = Constant term: Mean HCE in the last year of life for the baseline age group (20-24yrs)

β = Slope parameter (Beta co-efficient): Rate of change in mean HCE per change of one age group from the baseline.

age group refers to the number of subsequent age groups after the baseline age group (1, 2 3 etc).

Figure 2 Out-of-hospital HCE for Primary care, Specialist services, and Diagnostic & therapeutic services according to time to death across three time eras

HCE: Out-of-hospital health care expenditure.

Fitted values: Mean HCE per month as predicted by the segmented time trend analysis conducted within the relevant look-back period.

Segment 1: Look-back period 60-37 months prior to death inclusive.

Segment 2: Look-back period 36-25 months prior to death inclusive.

Segment 3: Look-back period 24-13 months prior to death inclusive.

Segment 4: Look-back period 12-3 months prior to death inclusive.

Segment 5: Look-back period 2-0 months prior to death inclusive.

Table 1 Number and proportion of decedents and MBS claims by time era and gender

Time era at death	Number of decedents		Number of MBS claims					
			Primary care services		Specialist services		Diagnostic and therapeutic services	
	n	%[a]	*n*	%[b]	*n*	%[c]	*n*	%[d]
Era 1 (1990-1994)								
Male	11,528	19.1	466,960	14.0	126,772	13.7	320,811	11.2
Female	10,615	17.5	622,068	18.7	133,611	14.5	345,209	12.0
Total	22,143	36.6	1,089,028	32.7	260,383	28.2	666,020	23.2
Era 2 (1995-1999)								
Male	10,192	16.8	486,008	14.6	149,453	16.2	479,687	16.7
Female	9,564	15.8	634,932	19.1	154,585	16.8	484,426	16.9
Total	19,756	32.6	1,120,940	33.7	304,038	33.0	964,113	33.6
Era 3 (2000-2004)								
Male	9,593	15.9	474,732	14.3	171,107	18.5	598,873	20.9
Female	9,006	14.9	600,928	18.0	187,600	20.3	641,495	22.3
Total	18,599	30.8	1,075,660	32.3	358,707	38.8	1,240,368	43.2
Total	**60,498**	**100.0**	**3,285,628**	**100.0**	**923,128**	**100.0**	**2,870,501**	**100.0**

[a] As a percentage of the total number of decedents.
[b] As a percentage of the total number of MBS primary care claims
[c] As a percentage of the total number of MBS specialist claims
[d] As a percentage of the total number of MBS diagnostic and therapeutic claims

Table 2 Number of decedents and Medicare funded out-of-hospital HCE in the last five years of life, according to gender, time era and cause of death

Time era at death	Cause of death														
	Colorectal cancer			Lung cancer			Female breast cancer			Ischaemic heart disease			Cerebro-vascular disease		
	n	A$(k)[a]	A$(k)[b]	*n*	A$(k)[a]	A$(k)[b]	*n*	A$(k)[a]	A$(k)[b]	*n*	A$(k)[a]	A$2007[b]	*n*	A$(k)[a]	A$(k)[b]
Era 1 (1990-1994)															
Male	909	6,374	7.0	1,938	9,801	5.1	n/a[c]	n/a[c]	n/a[c]	6,768	25,040	3.7	1,913	7,286	3.8
Female	860	6,219	7.2	799	4,803	6.0	1,047	9,724	9.3	5,312	24,099	4.5	2,597	10,692	4.1
Total	1,769	12,593	7.1	2,737	14,604	5.3	1,047	9,724	9.3	12,080	49,140	4.1	4,510	17,978	4.0
Era 2 (1995-1999)															
Male	979	9,301	9.5	1,807	12,047	6.7	n/a[c]	n/a[c]	n/a[c]	5,724	28,066	4.9	1,682	8,334	5.0
Female	791	6,962	8.8	838	6,429	7.7	1,014	11,077	10.9	4,559	26,996	5.9	2,362	12,931	5.5
Total	1,770	16,262	9.2	2,645	18,477	7.0	1,014	11,077	10.9	10,283	55,062	5.3	4,044	21,265	5.3
Era 3 (2000-2004)															
Male	1,114	12,263	11.0	2,125	17,872	8.4	n/a[c]	n/a[c]	n/a[c]	5,406	30,953	5.7	946	4,999	5.3
Female	880	9,446	10.7	1,146	11,204	9.8	1,124	15,400	13.7	4,569	30,598	6.7	1,289	7,623	5.9
Total	1,994	21,709	10.9	3,271	29,075	8.9	1,124	15,400	13.7	9,975	61,551	6.1	2,235	12,622	5.6

[a] Total cost of episodes in thousands (June 2007 Australian dollars).
[b] Cost of per capita in thousands (June 2007 Australian dollars).
[c] Not applicable to males.