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The Concentration of Hospital-Based Medical Spending: Evidence from Canada *

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Abstract

In this paper, we present evidence on the concentration of hospital-based medical spending in Canada. We use longitudinal administrative data from the province of Quebec to document how medical spending is concentrated cross-sectionally, over time and finally near the end-of-life when death occurs at the hospital. Average expenditures rise rapidly with age, starting around the age of 50, and are concentrated in a small fraction of high-cost users. For example, the top 1% of men and women in terms of hospital spending account for 55.5% and 54.8% of total spending respectively. Persistence among high-users is rather low. Fewer than 3% of those in the top quintile of hospital spending stay in the same quintile the following year, fewer than 5% have any spending the following year. Finally, hospital spending among those in their last year of life and who die at the hospital can account for 11.1% of total hospital spending in the population. Most of that end-of-life spending, more than 80%, occurs in the last month of life.

Keywords: Medical spending, concentration, end-of-life.
JEL Codes: I10, I13, I18.

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1 Introduction

The growth of health care spending poses important challenges for many countries around the world. Trends in aggregate spending are well-documented. In particular, annual growth in real per capita health spending has largely exceeded what could be accounted for by economic growth and aging in the OECD. While excess growth of health spending (above economic growth and aging) has occurred in most OECD countries, some countries have seen larger growth than others, in particular, the United States (White, 2007). Canada is no exception according to the OECD, devoting in 2014 close to 11% of its ressources (GDP) towards health care.

While knowing how aggregate health care spending changes over time is of interest, understanding its dispersion is paramount. Indeed, medical spending is often concentrated among "high-spenders" and this group can account for a large share of health spending. Because of limited data, few studies have documented this concentration in Canada. In Ontario, the top 5% of health care users accounted for 58% of health care spending according to Rosella et al. (2014). Using administrative data from British Columbia, Reid et al. (2003) estimate that the top 5% users consume more than 30% of spending on physician services. It is also important to understand whether "high-spenders" are the same from year-to-year or are different groups each year. Ronksley et al. (2015) provide evidence that persistence in high cost groups is low in Ontario and that those patients tend to have multiple re-admissions.

Since the probability of high health care spending increases sharply with age, one focus of the Canadian literature has been on quantifying spending near the end-of-life. In the last year of life, Roos et al. (1987) show that utilization increases substantially in Manitoba. In British Columbia, McGrail et al. (2000) estimates that a 65 year old who dies has costs 16.6 times higher than someone of the same age who survives. In one paper using aggregate data, Dao et al. (2014) demonstrate that taking end-of-life expenditures into account may affect future projections of health care spending.

In this paper, we use longitudinal administrative spending data from Canada to analyze the concentration of medical spending. Since health care is administrated at the provincial level and there is no available administrative dataset that would allow to cover the entire population of Canada, we focus on data from the province of Quebec with administrative data provided by the Quebec Health Insurance Board (RAMQ) from 1995 to 2012. The data used allows to accurately describe medical spending that occurs at the hospital but does not allow to cover medical spending that occurs outside the hospital (clinics, etc). Nevertheless, a large fraction of spending occurs at the hospital and one can argue that high medical spending is likely to occur in that setting.

The paper is structured as follows. In section 2, we briefly describe the institutional setting in Canada and in particular the province of Quebec. In section 3, we describe basic trends in medical spending for Quebec. In section 4, we describe the data used. In section 5, we present results on concentration of hospital spending. We conclude in section 6.

2 Institutional Setting

Since 1972, all provinces and territories in Canada have a public health care system that aims to provide universal health care to the population. Each province funds its own health care system with the help of the federal governement. The *Canada Health Act* of 1984 ensures that there is an equality of care and access between provinces. It outlines the conditions under which provinces can receive federal funding.

2.1 Financing

The Quebec health care system is primarily financed through taxes collected by the provincial and federal governments. In 2012-2013, just under half of health care financing in Quebec comes from the provincial government by way of dedicated income-based taxes. Of the remaining half, 20% is given by the federal governement (through transfers, federal taxes and other programs) and 20% comes from employer and employee contributions

(based on total payroll). The remainder is financed by user contributions (public insurance on prescription medication, contribution to long-term care and supplements for private and semi private rooms in hospitals and other institutions (5%)), by health care contribution differentiated by income (3%) and by other entities such as the Health and Safety at Work Commission and the Quebec Automobile Insurance Fund (2%).

As pressure from increased spending mounted, financing mechanisms were progressively modified as well. The most notable change was the introduction of public insurance for prescription drugs in 1997. The aim of this insurance was to provide coverage to individuals that did not have private insurance. Therefore, only those not covered by a private regime, and Quebecers aged 65 and over, were eligible. The insurance premium is determined by household net income and cannot excced 611 CAD since July 1st 2014. More recently, in 2010, the health contribution was created by the provincial governement. It has successively been a lump sum tax of 25 CAD (Canadian dollars) in 2010, 100 CAD in 2011 and 200 CAD in 2012. Since 2013, it has been replaced by a progressive contribution differentiated by income. Other changes in health care financing reside mainly in differences in proportions of health care financed by each source. As an example, the federal government's transfers to Quebec have represented 9% of spending in 1998, 16% in 2005 and 14% in 2009.

Hospitals are financed publicly on a global budget basis accounting the mix of cases covered. In 2012-2013, only 4% of total hospital expenditure comes from privately based sources (Canadian Institute for Health Information, 2014). The mechanism that accounts for the mix of cases covered, based on diagnostic-related groups (DRGs), allows us to attribute costs to hospital stays in what follows.

2.2 Payment Mechanisms

In 2013, all but a few physicians were paid exclusively by the provincial government for publicly covered services. Nurses, on the hand, are employed by hospitals and clinics and receive a wage from their employers. In 2009, nearly 75% of total physician related spending was paid through fee for service, a system by which a fee is associated to each service and

physicians invoice the government. Blended payments and wages per unit of time respectively accounted for 11% and 7% of total physician expenditure. Fee-for-service payments can be directly imputed to patients in a hospital setting since they are billed to the Health Insurance Board. As for mixed payments, they are not included in the imputed cost for each diagnostic-related groups (DRGs) but are counted in the overall level of expenditures.

3 Basic Trends in Medical Spending

Health care expenditures in Quebec, as in many developed countries, account for an important part of the nation's gross domestic product (GDP). Figure 1 shows total health care expenditure, in 2014 United States (US) dollars, per person (left scale), and as a percent of GDP (right scale). As we can see, spending per person has increased from 1,000 US dollars in 1981, to over 5,000 US dollars in 2012 (Canadian Institute for Health Information, 2014). On the right hand scale we see that total health care expenditure as a percent of GDP increased as well, but at a slower rate than *per capita* spending. Between 1991 and 2006, it remained close to 10% of total GDP, and increased in the past years to reach 12,2% in 2012 (Statistics Canada, 2014).

Table 1 shows total health care expenditures by payers and expenditures, in Quebec, for certain years between 1978 and 2012. The role of the private sector has roughly doubled between 1978 and 2012 (Canadian Institute for Health Information, 2014). Close to 30% of total financing now comes from the private sector. Partly responsible for this increase is drug reimbursements and premiums for employee drug insurance as well as donations, investment income and research (Canadian Institute for Health Information, 2014, p.98).

The bottom part of table 1 shows changes in total health care expenditures by type of services between 1978 and 2012. Costs related to drugs account for 20% of these costs in 2012, whereas it was only 6.5% in 1978. The most notable change in expenditures involves hospital expenditures. The proportion devoted to that category was almost cut in half between 1978 (48.1%) and 2012 (26.4%). The last category in the table, other expenditures,

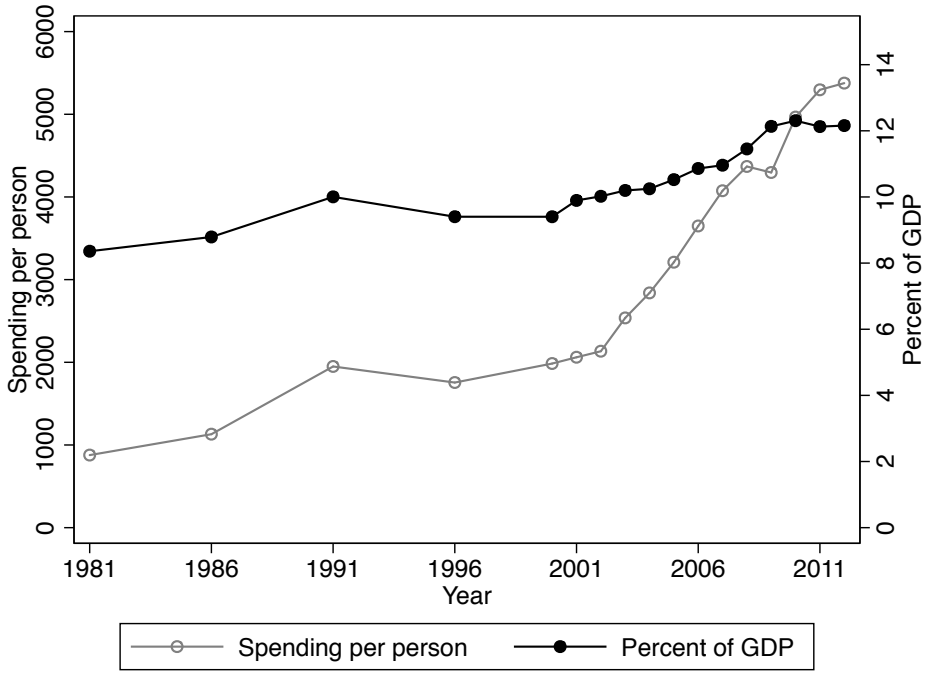

Figure 1: Total health care expenditures, in 2014 US dollars, per person (left scale), and as a percent of GDP (right scale). Data sources : Canadian Institute for Health Information (2014) and Statistics Canada (2014)

	Whole population				
	1978	1988	1998	2008	2012
Payors					
Private	18.1%	23.2%	26.4%	28.6%	29.8%
Public	81.9%	76.8%	73.6%	71.4%	70.2%
Expenditure					
Hospital spending	48.1%	46.6%	31.3%	28.0%	26.4%
Physician related costs	14.7%	13.1%	12.5%	11.8%	13.4%
Drugs	6.5%	10.5%	15.1%	19.8%	19.7%
Other	30.8%	29.8%	41.1%	40.4%	40.6%

Table 1: Percent of total heath care expenditures, by payors and expenditures, in Quebec. National data from the Canadian Institute for Health Information (2014). Other expenditures: other institutions, other professionnals, capital, public health, administration and other health spending.

encompasses expenditure for other institutions (long-term care), 14.5% in 2012, other professionals (9%), capital (6%), public health (2.96%), administration (3.1%) and other health spending (5.2%). Long-term care expenditures, in part due to population aging, is the category that increased the most over the period. The share of total expenditures related to physicians remained relatively constant over time. Of expenditures related to physicians, more than 60% occurs at the hospital (Canadian Institute for Health Information, 2014).

4 Data

Estimaing the cost of hospitalizations requires using two key administrative files. First, the MED-ECHO database, paired with the relative level of resources used (called NIRRU in Quebec) and the cost (in dollars) of the NIRRU, are used to estimate the cost of a hospitalization (excluding costs of services and consultations performed by physicians during the stay). The NIRRU is a measure of the volume of resources used for a patient during a typical hospitalization, and reflects the volume of services administered by the establishment, including the cost of drugs administered at the hospital. It allows evaluating the performance of the facilities in an estimated cost-per-patient perspective. Thus, the NIRRU is a key component of the cost of a hospital stay. The NIRRU is the basis for hospital financing on a global budget basis. However, since this cost measure does not include physician related costs in the fee-for-service system, we use data from the Quebec Health Insurance Board (RAMQ), which allows us to attribute costs of services and consultations billed to the RAMQ by generalist and specialist physicians during a hospital stay.

We link MED-ECHO and RAMQ databases between 1995 and 2012. We have access to a sub-sample of all patients in Quebec. Individuals are included only if they were born on an odd year in April or October, which accounts for almost one twelfth of the hospitalized population in Quebec. This constraint is imposed by the RAMQ which does not allow the creation of data files with more than 135000 cases in any given year. The available RAMQ sample includes patients hospitalized at least once between 1995 and 2012. The

RAMQ merged both datasets based on the health insurance number of each individual. Each individual is followed during the entire period (1995-2012). The dataset is adjusted so that cases of zero expenditures are present. We also adjust population totals by accounting for the fact that we only have hospitalizations for those born in April or October of odd years.

4.1 MED-ECHO

The MED-ECHO database includes all the information related to hospital stays and day surgeries in Quebec. It does not include costs related to psychiatric hospitals, rehabilitation hospitals, long-term care facilities and physicians. For each hospitalization, the entry and exit dates of the patients (and therefore the length of stay) are available, as well as an indicator of death within the hospital. Matched to MED-ECHO is a database containing all diagnostics (in International Classification of Diseases-9 (ICD-9) or ICD-10) observed during the hospitalization. This enables us to observe prevalence of different medical conditions. The data concerning services (departments) visited by the patients during their stay is also available.

For each hospitalization is associated an APR-DRG (All Patient Refined Diagnosis Related Groups)[1] classification, which includes, in addition to the DRG (Diagnotic Related Group) variable, a four-modality intensity variable concerning the gravity of the DRG. Another four-modality variable concerning the risk of death of the patient is also available. To each APR-DRG is associated a NIRRU, the index that is used to measure the total cost of the hospitalization.

The NIRRU is a measure of resources used inside the hospital. This measure covers all costs incurred during the hospitalization (treatments and procedures during the stay, medication used during the stay, intensive care unit, use of a hospital bed, transportation,

[1]The APR-DRG represents the severity of a hospitalization according to three criterion: clinical gravity, mortality risk and intensity of resources used. The clinical gravity is the extent to which there is physiological decay or loss of function of a clinical system. The mortality risk corresponds to the probability of death of the patient and finally, the intensity of resources used corresponds to the relative importance of the diagnostic and therapeutic hospital services used during the treatment of a particular diagnostic.

maintenance and repair, etc.). For each year, DRG and gravity level, a NIRRU value is assigned. This value was originally determined by the costs observed during hospitalizations in the United States in 1994-1995 and adjusted in a number of ways to reflect the Quebec experience. [2]. The cost of each APR-DRG is then divided by the average value of the costs of all APR-DRG, to obtain a relative cost index with an average of one. This calculation is done every year. Note that the NIRRUs for one-day surgeries are calculated using a combination of costs from Canada and Quebec.

The NIRRU units are first converted into costs using information provided by the RAMQ. These are then converted into constant 2014 US dollars using Consummer Price Index (CPI) between 1995 and 2014 and Canada-US exchange rates. This paper uses the NIRRU in 2014 constant US dollars as part of the cost of a hospital stay in Quebec (the remaining part comes from the RAMQ for physician related costs).

4.2 RAMQ services

Data regarding medical services billed to the RAMQ allows us to capture the remuneration of the vast majority of Quebec physicians. As mentioned in section 2.2, in 2009, nearly three quarters of Quebec physicians are paid by fee for service and 11% use a blended payment scheme. The RAMQ databases include all reimbursement demand forms filled by health professionals who receive a fee for each service provided. Physicians paid through fee for service or blended payments must fill out a form for each act, which includes the service code, amount of reimbursement demanded (according to the Health Ministry guidelines), moment at which the act was executed, identity of the patients receiving the act as well as diagnostic code associated with the act. Therefore, RAMQ databases cover costs related to physicians paid through fee for service as well as the "fee for service" part of costs attributed to physicians who receive blended payments. As we did with the cost of a NIRRU, we convert

[2]It is important to note that the NIRRU measures the value of resources used to treat a typical case (specific cases include cases where the patient died or left without authorization). In Quebec, the NIRRU is also weighted by the difference in the average length of stay between Quebec and Maryland by the Health Ministry in Quebec, hospitalizations being systematically longer in Quebec. Furthermore, since the marginal costs of the last days of hospitalizations should be smaller during longer hospitalizations, another adjustment of this type is performed.

costs of acts and consultations into constant 2014 US dollars using CPI between 1995 and 2014 and Canada-US exchange rates.

The reimbursable amounts are fully listed in the Health Ministry documentation: in addition to the base amount for each act and, in some cases, the additional cost of a sub-act. For instance, a bonus is attributed to a visit in medical hematology-oncology when it is done for a patient aged 70 and over. The amounts are also modified by location: reimbursements for acts in distant regions are higher. Another important factor in cost calculations is the remuneration scheme of the physician. Professionals benefiting from the blended payment scheme apply a particular modification according to the moment when the act is performed. In general, the value of the acts is increased by 70% in the evening and 150% at night. This increase can however vary according to the speciality and the type of care.

To find the overall cost of a hospital stay, we add costs of a NIRRU to costs of acts performed during the hospital stay. To obtain an annual measure, we use costs of all hospital stays in a given year per individual.

4.3 Survey Data on Prevalence of Hospital Stays

We attribute zero expenditures in years where the individual does not have a record in the database. However, this can only be done safely for years prior to a year where some hospital stay was observed since we do not have information on vital status of respondents. Hence, a patient who has an hospitalization in 2000 but none in 2001 to 2012 perhaps died in 2001. This situation occurs more often for older individuals. We make use of the National Population Health Survey (NPHS) (Statistics Canada, 2012), a longitudinal health survey of Canadians, from 1994 to 2010, to correct this problem. In particular, we can compute for Quebec respondents, the fraction of respondents who had a hospital stay in the interview year by year, age and year. For example, 83% of those aged more than 65 did not have a hospital stay for a given year in the NPHS. In the administrative database, 89% for this age group. When producing unconditional statistics (including zeros), we adjust by reweighting.

The problem is negligible in the population less than 65 years old where the fraction of zero expenditure cases matches well with the NPHS (93% in the administrative dataset against 92.1% in NPHS).

5 Concentration

5.1 Prevalence and Hospitalizations Dynamics

To give a sense of the prevalence of hospital stays and their dynamics, we present statistics from the NPHS. The top panel of figure 2 shows proportion of individuals who were hospitalized in Quebec, by age groups, between 1994 and 2010. Not surprisingly, we observe that prevalence increases with age. Fewer than 10% of respondents aged less than 60 years old have had a hospital stay between 1994 and 2010. The proportion increases when individuals reach 65, and we find that almost 30% of Quebecers aged over 90 years old had a hospital stay in the same period.

The bottom panel of figure 2 shows entry (full line) and exit rates (dash line), by age groups, to and from the hospital. Entry was defined as having a stay in year t when there was no stay in $t-1$ while exits record whether respondents did not have a stay at t while they had a stay at $t-1$. We see that as age increases, the rate of entry increases. On the other hand, rates of exit decrease with age, implying that it is more common for older respondents to have stays in consecutive years.

5.2 Age

Figure 3 shows unconditional average expenditures age-profiles, with and without adjustments for cohort effects, for men and women seperately. Several steps are involved in producing these numbers. First, we estimate conditional life cycle profiles without adjustments for cohort effects by regressing total hospital expenditure on a set of age dummies (with ages between 0 and 100) among those with positive expenditures. In a second specification, we include cohort effects by introducing birth dummies. Upon estimation, we then

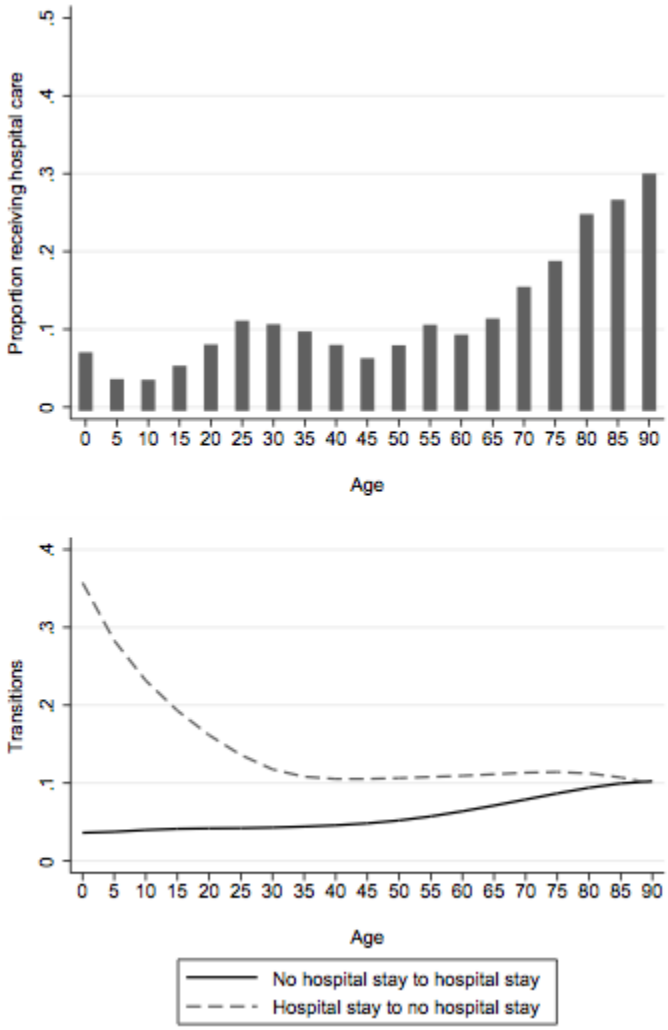

Figure 2: Proportion of individuals who were hospitalized in Quebec, by age groups, between 1994 and 2011 (top panel). Entry and exit rates, by age groups, to and from the hospital (bottom panel). The entry rate is defined as the fraction of respondents who had a hospital stay in year t among those who did not have a stay in year $t-1$. The exit rate is defined as the fraction of respondents who did not have a hospital stay in year t among those who had a hospital stay in year $t-1$. Data sources : Authors' calculations from NPHS (Statistics Canada, 2012)

predict conditional spending for those born in 1925 to isolate age effects. We do a similar exercice for the probability of having any hospital stay in a given year using NPHS data from 1994 to 2010. Once we have both the probability of having any expenditures and the conditional mean of expenditures, we multiply both to obtain unconditional average expenditures age-profiles. The correction for "excess zero expenditures" is particularly important at older ages. If we do not make this correction, unconditional average expenditure age-profiles using only the administrative data would show a large decline after age 85. This decline is mechanically driven by attributing zero expenditures to cases where plausibly the individual has died.

Hospital spending increases sharply with age after age 50. Prior to age 50, spending is flatter with a hump between ages of 20 and 45. For women, this hump can be reasonably attributed to expenditures associated with child bearing. After age 50, spending for males shows a 6-fold increase from around 500$ to reach 3000$ per year among those age 90 and over. A similar pattern is observed for women. As we can see by comparing profiles with and without cohort effects, those born in 1925 experienced lower hospital spending after age 70 than those of younger generations. This is consistent with spending among the elderly increasing faster among the elderly than among other age groups over the period.

5.3 Cross-sectional

Very few studies have documented concentration of medical spending in Canada, and even less so in Quebec. A study by the Ontario Hospital Association (2010, p.5) shows that, in Ontario, "1% of the population accounts for 49% of combined hospital and home care costs" and that "5% of the population accounts for 84% of combined hospital and home care costs". These estimates cover spending over a 1 year period. To the best of our knowledge, no studies have documented spending concentration in Canada over 2 and 3 years.

Table 2 shows average hospital expenditures by quintiles, disaggregated by gender and age groups. To account for the large fraction of zeros, we first present the proportion of zeros for each group and then quintiles of the conditional distribution (conditional on

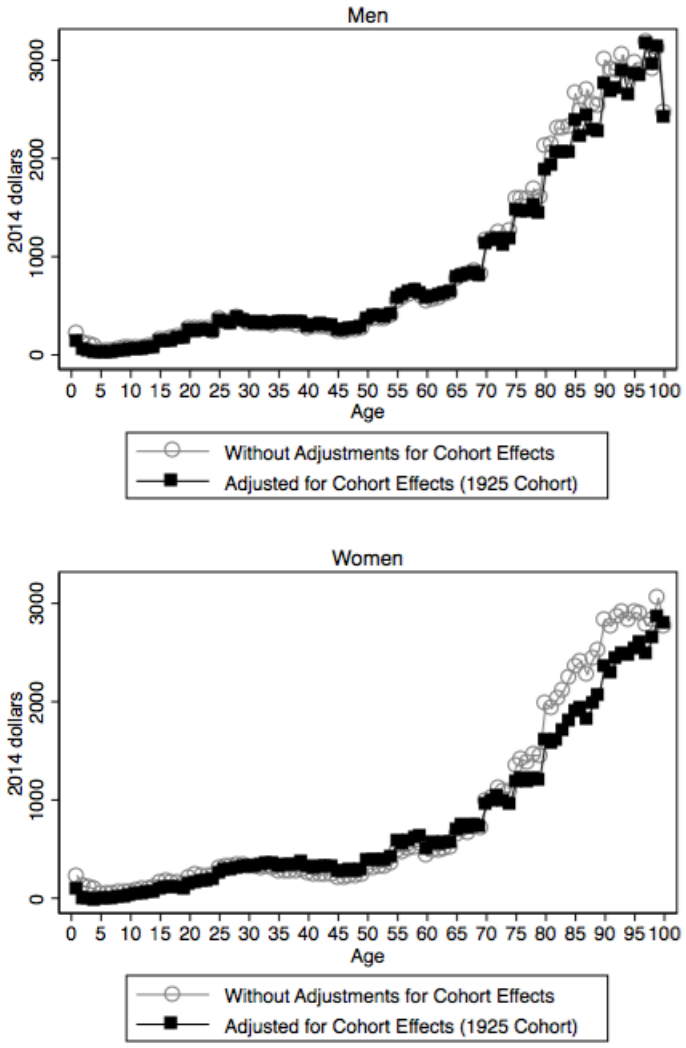

Figure 3: Average hospital expenditures, by age, with and without adjustments for cohort effects. In 2014 US dollars. Authors' calculations from MED-ECHO, RAMQ (1995-2012) and NHPS. When there are no adjustments for cohort effects, we regress total conditional hospital expenditures as a function of age dummies (with age between 0 and 100). To control for cohort effects, we regress total hospital expenditures as a function of age and birth year dummies. We then compute predicted hospital expenditures based on age and birth year for individuals born in 1925. A similar exercice is done using NHPS for the probability of having any hospital stay. The conditional average is then multiplied by the probability of having any expenditures at each age.

spending being positive). For all ages, the fraction with hospital spending is close to 9% with slightly higher prevalence about men. Conditional on spending being positive, average spending amounts to 5012$. Average spending in the bottom quintile is less than 200$ while it reaches 16602$ in the top quintile. This dispersion does not differ much by gender.

While the fraction of those with positive spending increases sharply with age, the dispersion of spending conditional on having expenditures appears to decline with age. For example, the ratio of average spending in the top quintile relative to total average spending is 3.81 among those age 25-64 compared to 2.06 among those older than 65. This potentially reflects that as age increases, the severity of the average case increases substancially.

Table 3 shows the gini coefficient and the percentage of hospital expenditure spent by top 1% and 10% of spenders over 1, 2 and 3 years. We disaggregated the results by gender and then by age groups. In order to calculate gini coefficients and percentage spent over 2 and 3 years, we first calculate average spending for 2 or 3 years (sum of spending over 2 or 3 consecutive years divided by number of years). Percentiles, which are used to calculated the gini coefficients and the share of spending, are recalculated for these averages.

Results show that dispersion in hospital expenditure is large over 1 year period (gini coefficient of 0.97). Dispersion decreases slightly when we use average spending over 2 and 3 years. Once we condition on spending being positive, these statistics are vastly different. For example, the Gini drops to 0.67 for men and 0.62 for women when considering only positive spending. Hence, a significant part of the concentration (one third) is due to the extensive margin (zero vs. positive expenditures). As for dynamics, persistence is lower at the intensive margin (conditional on spending being positive). For example, the gini for men drops from 0.67 to 0.44 once we consider spending over three years. Hence, among those with positive spending in three consecutive years, persistence is lower although it remains substancial.

If we look at percentage of hospital expenditures, we find that top 1% of men (women) spenders account for 55.5% and 54.8% of spending. These estimates are consistent with those reported in other Canadian studies (Reid et al., 2003; Rosella et al., 2014). Once we

	Both	Men	Women
		All ages	
Fraction (> 0)	0.089	0.103	0.073
Everyone	5,012	5,316	4,763
Bottom	157	159	155
Fourth	765	774	757
Third	2,698	2,652	2,724
Second	4,837	5,009	4,727
Top	16,602	16,721	16,476
	Birth to 24 years of age		
Fraction (> 0)	0.05	0.049	0.052
Everyone	2,640	2,632	2,650
Bottom	158	161	155
Fourth	1,046	1,011	1,095
Third	2,539	2,517	2,559
Second	4,708	4,798	4,631
Top	18,640	18,854	18,337
	25 to 64 years of age		
Fraction (> 0)	0.086	0.066	0.106
Everyone	4,107	4,662	3,717
Bottom	162	164	161
Fourth	705	689	721
Third	2,745	2,684	2,769
Second	4,720	4,997	4,583
Top	15,681	15,774	15,557
	65 years of age +		
Fraction (> 0)	0.167	0.169	0.166
Everyone	8,227	8,564	7,947
Bottom	131	137	127
Fourth	597	620	582
Third	2,769	2,777	2,761
Second	5,085	5,105	5,068
Top	16,964	17,159	16,792

Table 2: Hospital expenditure Distributions, in 2014 US dollars. The first row for each panel reports the fraction with positive expenditures during the year. For other rows, averages at different quintiles of the conditional distribution are reported (conditional on having any spending). Authors' calculations from MED-ECHO and RAMQ (1995-2012).

	Total Medical spending averaged over:		
Men : all ages	1 year	2 years	3 years
Gini coefficient on medical spending	0.97	0.95	0.93
Percentage spent by top 1% of spenders	55.5%	44.4%	38.8%
Percentage spent by top 10% of spenders	100.0%	98.9%	95.2%
Women : all ages	1 year	2 years	3 years
Gini coefficient on medical spending	0.97	0.95	0.93
Percentage spent by top 1% of spenders	54.8%	43.6%	38.0%
Percentage spent by top 10% of spenders	100.0%	98.9%	93.1%
Both: Birth to 24 years of age	1 year	2 years	3 years
Gini coefficient on medical spending	0.98	0.96	0.94
Percentage spent by top 1% of spenders	60.6%	45.3%	38.7%
Percentage spent by top 10% of spenders	100.0%	99.0%	95.1%
Both: 25 to 64 years of age	1 year	2 years	3 years
Gini coefficient on medical spending	0.97	0.95	0.93
Percentage spent by top 1% of spenders	55.7%	43.9%	38.3%
Percentage spent by top 10% of spenders	100.0%	99.1%	93.7%
Both: 65 years of age +	1 year	2 years	3 years
Gini coefficient on medical spending	0.96	0.93	0.90
Percentage spent by top 1% of spenders	39.7%	31.2%	26.4%
Percentage spent by top 10% of spenders	100.0%	94.3%	86.2%

Table 3: Measures of the concentration of hospital spending over 1, 2, and 3 years, by gender and age. In 2014 US dollars. Authors' calculations from MED-ECHO and RAMQ (1995-2012).

take average spending over 2 or 3 consecutive years, percentage spent by top spenders falls substancially to reach 38.8% (38%) for men (women). This suggests that persistence at the top is limited.

Measures of concentration of hospital spending for individuals in the first 2 age groups (birth to 24 and 25 to 64) are similar. The last panel of table 3 shows that the gini coefficient is slighly lower for elderly individuals in Quebec and that the top 1% account for 39.7% of total spending which is less than for other age groups. This reflects in large part higher use (fraction of positive spending is higher) and the lower concentration of spending conditional on being positive. For example, conditioning on spending being positive, the gini coefficient of spending over 1 year is 0.58 compared to 0.67 and 0.63 in the 25-64 and less than 25 age groups respectively.

Looking at cumulative distribution function (CDF) plots of average hospital expenditure over 1, 2 and 3 years yields a consistent story as shown in figure 4. The top panel of the figure shows the CDF for individuals aged between 0 and 64 while the bottom panel is for those over 65. Not surprisingly, the CDFs show considerable dispersion beyond the large fraction of cases with zero expenditures. For the elderly, a significant fraction of cases have spending in excess of 10000 over 1 year. Once we aggregate over time, spending becomes less concentrated, in particular because persistence is limited.

5.4 Over Time

We compute transition rates from quintiles in a given year to quintiles in a subsequent year. To account for dynamics in cases of zero expenditures, we add a "zero" expenditure state to the quintiles of the conditional distribution. Note that quintiles are constructed using each year's distribution and thus accounts for age or time related increases in health spending (relative measure). Since the conclusion do not vary much with age, and to limit the extent of the "excess" zero spending problem, we only report a transition matrix for those age 25-64 in table 4.

Looking at adults aged 25-64 in table 4, the fraction of spenders in the top quintile who

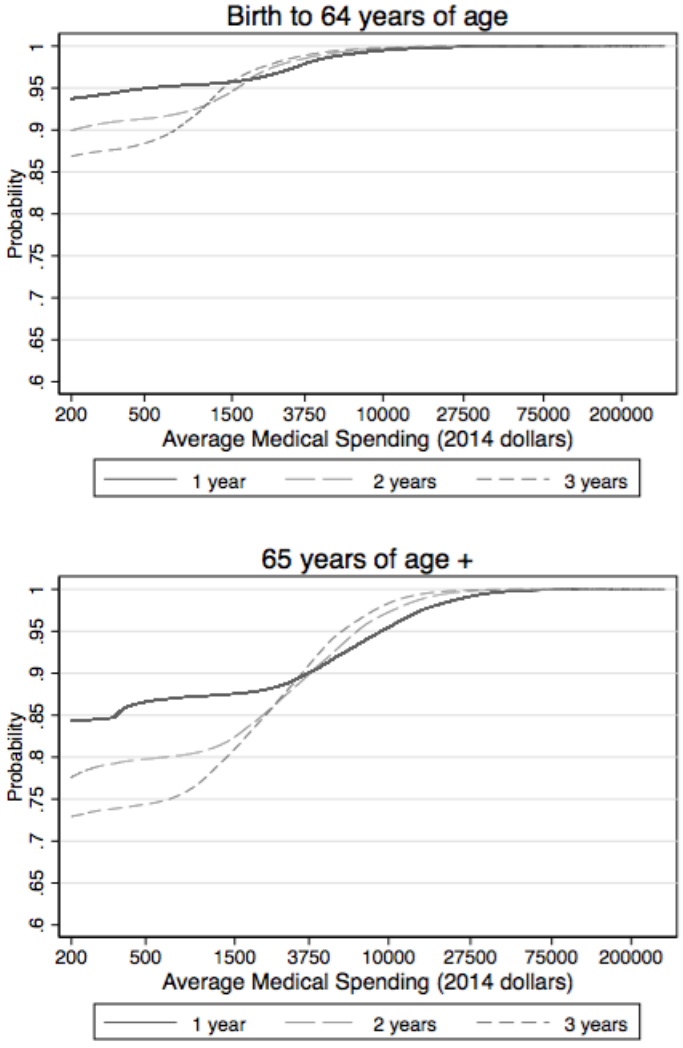

Figure 4: CDF of total hospital expenditures, averaged over 1, 2, and 3 years. In 2014 US dollars. Authors' calculations from MED-ECHO and RAMQ (1995-2012).

remain in the top quintile is very small, 2.5%. Instead, years with positive spending are typically followed by years of zero spending, in all age groups for all time horizons. Hence, we can conclude that high cost users tend to be different from year to year. However, if users in the top quintile have positive spending in the following year, there is a 55.8% chance that they will again be high users (2.75% divided by 100% - 95.02%). Hence, persistence in high cost users is generally low except in cases with multiple years with positive spending. This is consistent with evidence from Ronksley et al. (2015) for Ontario.

	Panel A: One year transition					
Quintile	Next year					
Current year	Zero	Bottom	Fourth	Third	Second	Top
Zero	94.8	1.17	1.11	1.17	0.92	0.85
Bottom	97.1	1.68	0.3	0.31	0.17	0.49
Fourth	97.87	0.5	0.48	0.72	0.18	0.25
Third	98.19	0.31	0.22	0.59	0.22	0.47
Second	98.65	0.14	0.07	0.38	0.33	0.43
Top	95.02	0.61	0.57	0.29	0.76	2.75
	Panel B: Two year transition					
Quintile	Two years later					
Current year	Zero	Bottom	Fourth	Third	Second	Top
Zero	94.71	1.2	1.14	1.17	0.9	0.88
Bottom	97.67	0.91	0.32	0.47	0.19	0.44
Fourth	98.12	0.36	0.62	0.32	0.43	0.15
Third	98.39	0.37	0.23	0.29	0.29	0.43
Second	98.52	0.39	0.15	0.31	0.2	0.44
Top	95.8	0.51	0.49	0.5	0.32	2.44
	Panel C: Three year transition					
Quintile	Three years later					
Current year	Zero	Bottom	Fourth	Third	Second	Top
Zero	94.62	1.19	1.17	1.16	0.95	0.92
Bottom	98.06	0.72	0.27	0.24	0.42	0.28
Fourth	98.62	0.08	0.37	0.42	0.28	0.22
Third	98.22	0.43	0.24	0.56	0.35	0.2
Second	98.81	0.4	0.1	0.35	0.08	0.25
Top	96.5	0.63	0.35	0.49	0.46	1.57

Table 4: Total hospital expenditure transition matrices: 25-64 years old, both sexes. The quintiles are computed over the distribution excluding the zeros while a zero spending category is added as a separate state. Authors' calculations from MED-ECHO and RAMQ (1995-2012).

5.5 End-of-Life

Since spending is likely higher at the end-of-life, a focus on the health economics literature has been to quantify how much of total spending really occurs at the end-of-life relative to other moments. We first look at spending in calendar years around the time of death. Death is recorded in MED-ECHO only if it occurs after an hospital stay. For this reason, our results may not be directly comparable with those using all deaths. As can be seen in table 5, MED-ECHO captures 28500 death in 2012. In the same year, official statistics report 60000 deaths in Quebec. Hence, close to half the deaths in Quebec are recorded. The total expenditures covered by MED-ECHO amount to 3.8$ billions. The average expenditure for someone in his last year of life (calendar year) is estimated to be 14834$. For those older than 65 years old, the estimate is 16304$ compared to average expenditures of 413$ for those who did not die (40 times higher), and 5668$ for those who were hospitalized but did not die at the hospital (2.9 times higher).

Using the fact that 28000 died in 2012, those in their last year of life account for 11.1% of the 3.8$ billions in total hospital spending from our dataset. In their second year to last, hospital expenditures are low, accounting for only 0.7% of total spending. In total, over the last 3 years, they account for 12.3% of total hospital spending.

Mean spending per person	1321
Aggregate spending (billions)	3.8
Deaths	28500
Spending (pct total)	
Year of death	14834 (11.1%)
2nd to last	954 (0.7%)
3rd to last	644 (0.5%)
Sum of last 3 years	16432 (12.3%)

Table 5: Hospital spending in the last years of life for those dying at the hospital. In 2014 US dollars. All spending figures from 2012 RAMQ-MED-ECHO data

Instead of using the last calendar year, we can also start counting from the month of death and compute how expenditures accumulated as we move away from the month of death. To do this, we spread the total cost of the episode over the length of stay of the

patient. Some patients had multiple episodes of care during their last year of life. In figure 5, we compute the cumulative expenditures by month prior to death. One can see that the vast majority of spending in the last year, 11165$, is accounted for in the last month prior to death while the remainder is roughly constantly accumulating in the months prior to death. We find that the lenght of hospital stays tends to be short and highly costly when patients die in the hospital. Fewer patients have long hospital stays leading to death.

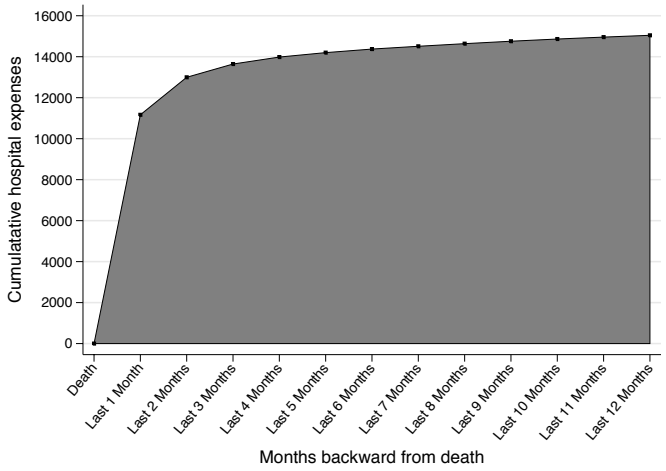

Figure 5: Cumulative hospital expenditure in the last 12 months of life (conditionnal on having expenditures). In 2014 US dollars. Authors' calculations from MED-ECHO and RAMQ (1995-2012).

6 Conclusion

In this paper, we use longitudinal administrative data on hospital stays and costs from Quebec over the period 1995-2012, to document the concentration of hospital spending by age, across patients, across time and near the end-of-life. A number of interesting results emerge. Although we focus on spending among those with hospital stays, average expenditures rise rapidly with age and are concentrated substantially among few cases. For example, more than half of hospital spending is concentrated among the top 1% of cases.

Another important finding is that persistence is limited and we find that few "high

users" remain "high users" over time. Indeed, fewer than 2.5% of those in the top quintile stay in that quintile the following year. This means that "high users" are different from year-to-year and probably are associated with acute episodes of care rather than repeated hospitalizations over a long period of time.

Finally, spending among those who die at the hospital can account for only 11% of total hospital spending as measured in our dataset. Most of that end-of-life spending occurs in the last month of life, with more than 80% of total spending concentrated in the last month of life. Hence, death occuring at the hospital do not account for a large share of total health spending, although is it concentrated in the last month of death.

This study has a number of limitations worth highlighting. First, we cannot separate whether patients who do not appear in a given year were alive and did not use hospitals or whether they were dead out of hospital. Although we addressed this problem using re-weighting to match survey data estimates, this remains a concern. The second limitation is that our measure of hospital-based expenditures is a theoretical measure based on the diagnostic of the patient at the time he is admitted at the hospital. Hence, it does not reflect actual costs. Although diagnostics are re-evaluated during an episode of care and our measure of use of physician services is a measure based on actual use of the patient, this remains a concern. The health care system in Quebec does not enable such a measure of actual cost imputed at the patient level. Finally, our measure of spending only allows to capture spending at the hospital. Spending from consultations, drug prescriptions outside an hospital setting are not included in our cost measure.

Understanding aggregate trends in health spending is useful but an analysis of the composition of spending at the patient level, and its concentration, may help policymakers better target areas for improvements in the delivery of care and for reducing the growth of health spending. As this paper demonstates, there is much to learn from the composition of health spending in the population as aggregate data hide considerable heterogeneity in the cross-section and longitudinal dimensions.

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