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Trajectories of Healthcare Services for Elder Persons A Retrospective Study in Sherbrooke, Quebec

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Abstract/Résumé

This is a longitudinal study using health administrative data of a cohort of 65+ adults, living in the city of Sherbrooke, Quebec, Canada from Jan 2011 to Dec 2015. We merged five databases including all individual visits to emergency room (ER), hospitalisations (CH), geriatric wards, admissions to intermediate and long term care (IC, LTC) facilities, and home care (HC) services. The objectives of this study were: 1) to provide a 5-year portrait of the use of health services of the 65+ population in the city of Sherbrooke, Quebec, 2) to identify the most common trajectories followed by elder patients over five years, and 3) to gather evidence on the relationship between the intensity of HC and further ER visits and hospitalisations. The cohort of services' users represents 59% of Sherbrooke's 65+ population. The most frequent trajectory found was ER and CH, which speaks of a health care system hospital - centered. The majority of deaths occurred during a hospital stay (CH, ~55%) or in a long-term care facility (LTC, ~28%). We also found 1 652 (8.4%) admissions to LTC facilities, with 43% of them coming straight from a hospital for an average of one month before LTC admission. Individuals having received at least one home care visit represent 34% of the original cohort and generated 52% of services excluding home care. Data visualisation diagrams indicate that earlier HC visits were followed by less ER visits and even less hospitalisations, when compared with users receiving HC later on our study interval. Finally, we found an important reduction of home care services, mainly for those users with high intensity of services; this fact underlines the system's inability to refocus health care services on home care.

Keywords/Mots-clés: Healthcare, User Trajectories, Home Care, Data Visualisation

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Introduction

Canada faces a rapidly aging population. From 2007 to 2017, the percentage of seniors in the Canadian population grew from 13.4% to 16.8%. Hospitals represent 26.6% of total health expenditure in Canada and are expected to grow at an annual rate of 2.0% per capita. (CIHI 2019). Home care (HC) expenditures in Canada are estimated to represent 25% of total health expenditure, (CIHI, 2014). These services (such as nursing, personal care and supportive housing) allow individuals to enjoy the benefits of living more independently in the community and are assumed to cost less than nursing home care.

To reduce hospital expenditure some countries have adapted HC programs to help adults remain at home (Lewin et al 2014; Tessier et al 2016). There are many differences in HC systems, payment policies, levels of collaboration among different participants and programs, all of which constitute a major difficulty when comparing outcomes.

There are mixed results on the benefits on HC (Boland et al, 2017; Puthenparambil et al, 2017). A recent survey of nurses' opinions concluded that both biomedical and psychosocial client characteristics need to be taken into account when predicting HC needs. (van den Bulk et al 2019). In some studies, HC services led to benefits such as shorter hospital stays, (Lichtenberg, F.R. 2012), fewer readmissions, less likelihood to be hospitalised or institutionalised (Wassef et al, 2018; Tomita et al, 2010), and reduced demand for hospitalisation and emergency services (Lee et al 2019). Another study showed that a reduced need for repeated referrals to the emergency departments and the shortening of the waiting time in treatment centers improved

the quality of life for individuals and provided savings in overall healthcare expenses (Rahman, M., Efird, J.T., & Julie E. Byles, J.E. (2018).

HC services in Canada are not included into the publicly funded coverage through the Canada Health Act in the same way as are hospital and physician services. Differences in provincial administrations of healthcare result in quite large variations in healthcare services throughout Canada. A systematic review of seven Canadian electronic databases for the years 2000–2016 found major knowledge gaps on HC for older adults across the country (Johnson et al, 2018). In Quebec, the province provides publicly funded HC through local organisations called CLSC (Centre local de services communautaires – Local Centre for Community Services) (Government of Canada, 2016). HC services include a wide range of primary (nursing and personal care) and advanced services (rehabilitation, social services). Other non-for-profit organisations are involved, providing mostly support for domestic tasks (e.g. meals-on-wheels, household cleaning). They do not provide professional care and were not involved in personal care at the time of the study.

Given the publicly funded healthcare system, Quebec and Canada are well-positioned to use administrative data for monitoring and planning services to develop learning organizations (Bates DW et al., 2014). However, the challenge is to manage data extracted from different administrative databases and render it informative.

The objectives of this retrospective study were: 1) to provide a 5-year portrait of the use of public health services of a cohort of 65+ individuals living in Sherbrooke, Quebec, 2) to identify their most frequent service sequences, and 3) to gather evidence on the relationship between

HC services and emergency room (ER) visits and hospital (CH) admissions. This study was also a test case, on a small scale, to determine the feasibility of merging databases to better reveal information about healthcare utilization.

Methods

We followed a cohort of all recorded 65+ individuals living in Sherbrooke, Québec, for five years. Sherbrooke is a medium size city (154 600 inhabitants in 2011) with two hospitals, each with 24/7 ER, several long-term care (LTC) and intermediate care (IC) facilities, and many publicly funded community services.

Data collection

We linked five administrative databases coming from the two Sherbrooke hospitals and the two CLSCs. The data linkage was possible using the users' Medicare numbers. We assembled a cohort of individuals aged 65+, living in the city of Sherbrooke, and having used at least one public healthcare service during our study time period (2011-2015). The cohort represented 59% of the 65+ population of Sherbrooke as of January 1, 2011 (Statistics Canada, 2011). All data files have the place and date of the episode of healthcare received, but no information on the user's health status. The study did not include visits to doctors' offices or outpatient consultation services, nor other care providers like friends, family members, etc. We only included HC services given at home, in a retirement residence, or in an intermediate care (IC) facility. These IC facilities are mainly private homes receiving a grant from the government to provide care to certain type of patients, unable to live at home but not requiring the complex services of a LTC facility.

For HC visits we only kept the date of the visit. The visit's length and the specific interventions performed were not retained because of many errors, missing values, and inconsistencies found in the data files. The interventions performed were given by health professionals--nurses, physiotherapists, social workers, etc. and by HC assistants for supporting personal care in activities of daily living.

The linked database has one row for each individual episode of healthcare. An extra row was added immediately after an episode signifying that the person died. The rows were then sorted by user and start date so all episodes of a user appeared together chronologically. The final database contains 760 709 healthcare episodes each from any of the following categories: HC and ER visits, CH, Geriatric ward, LTC facility, IC facility and Day hospital admissions, and Death.

Home care classification

To compare service utilisation of HC users and non-users, we separated the cohort into two groups: those having received at least one HC visit (34%), and those with no HC visit (66%). We also distinguished occasional visits from a period of regular home care support. HC support was defined as a period of time when a user received at least one HC visit over a 14 day-period. Counting the number of HC visits received during a time period is an insufficient measure of the intensity of HC use because the visits may occur over a short or over a long period of time. So, we used the established metric of average weekly visits (AWV) which is calculated as follows: the number of visits divided by the length of the period, multiplied by 7 (Madigan et al., 2012; Riggs, Madigan, & Fortinsky, 2011). The support periods were then categorized into four groups according to the average number of visits per week: fewer than 1 visit/week, 1 to 2 visits/week, 3 to 4

visits/week and more than 4 visits/week. To include this classification in our database, we replaced each sequence of individual HC visits with no more than 14 calendar days between them with one episode of HC support, counting the number of visits that occurred during the period. The remaining visits were labeled as occasional. This reduced the database from 760 709 to 133 884 episodes. We added four more categories of episodes, one for each defined support period.

We used the event sequence visualization tool called EventFlow (Shneiderman & Plaisant, 2019) to picture our database. SPSS was used to perform t-tests for mean differences of services between groups of HC users.

This study was approved by the Ethics Research Committees of the CIUSSS de l'Estrie-CHUS.

Results

The 65+ cohort was composed of 19 758 users, 58% women, and 42% men; in 73% of the episodes, users were aged 75 or more. Table 1 presents the distribution of the episodes over the 5 years of the study. The main observation is the decline of episodes over time. This was mainly due to a drastic reduction of HC visits: in 2011 they counted for 91% of all episodes but only for 75% in 2015.

Table 1: Episodes of care by year and type

	Year					Total	%
	2011	**2012**	**2013**	**2014**	**2015**		
Home care visits	202,978	154,241	144,575	101,869	58,076	661,739	87.0%
Emergency Room	13,088	13,189	12,550	12,516	12,469	63,812	8.4%
Hospitalisation	6,030	5,972	5,713	5,553	5,313	28,581	3.8%
Geriatric wards	516	630	688	642	580	3,056	0.4%
Long term facility	339	333	330	316	341	1,659	0.2%
Day hospital	259	265	274	249	277	1,324	0.2%
Intermediate care	87	82	136	118	115	538	0.1%
Total	**223,297**	**174,712**	**164,266**	**121,263**	**77,171**	**760,709**	**100.0%**

Users' Trajectories

Each user has a distinctive sequence of episodes that starts with a first service received on Jan 1, 2011 or later and ending with the last service received no later than Dec 31, 2015. The individual sequences are unique for each patient, but they have similarities. These were revealed by event sequence visualisation graphics created by the EventFlow software.

Figure 1 shows the EventFlow display of users' episodes. Each user's trajectory over time is represented horizontally, with different colours indicating types of episodes. The software groups those users having similar trajectories since the beginning of the observation period, the average distance between those and the width of the coloured blocks represent average duration of services. For example, the first episode recorded for about 3200 users was an ER visit (in red), immediately followed by a hospitalisation (in blue) for about 1000 of them. It is important to note now that this first visit to the ER did not happen at the same time for all the users displayed. The diagram only shows that ER was the first visit observed for around 3200 users. An occasional home visit (in pale green) was the first episode recorded for about 2000 users, and a period of home support (in dark green) for about 1000 users. The first red column on the top left side of Figure 1 was followed by another red column (ER visit) occurring about 3 months after the first visit, but only for about 400 users. As we move to the right of the diagram, similarities in the trajectories become rarer.

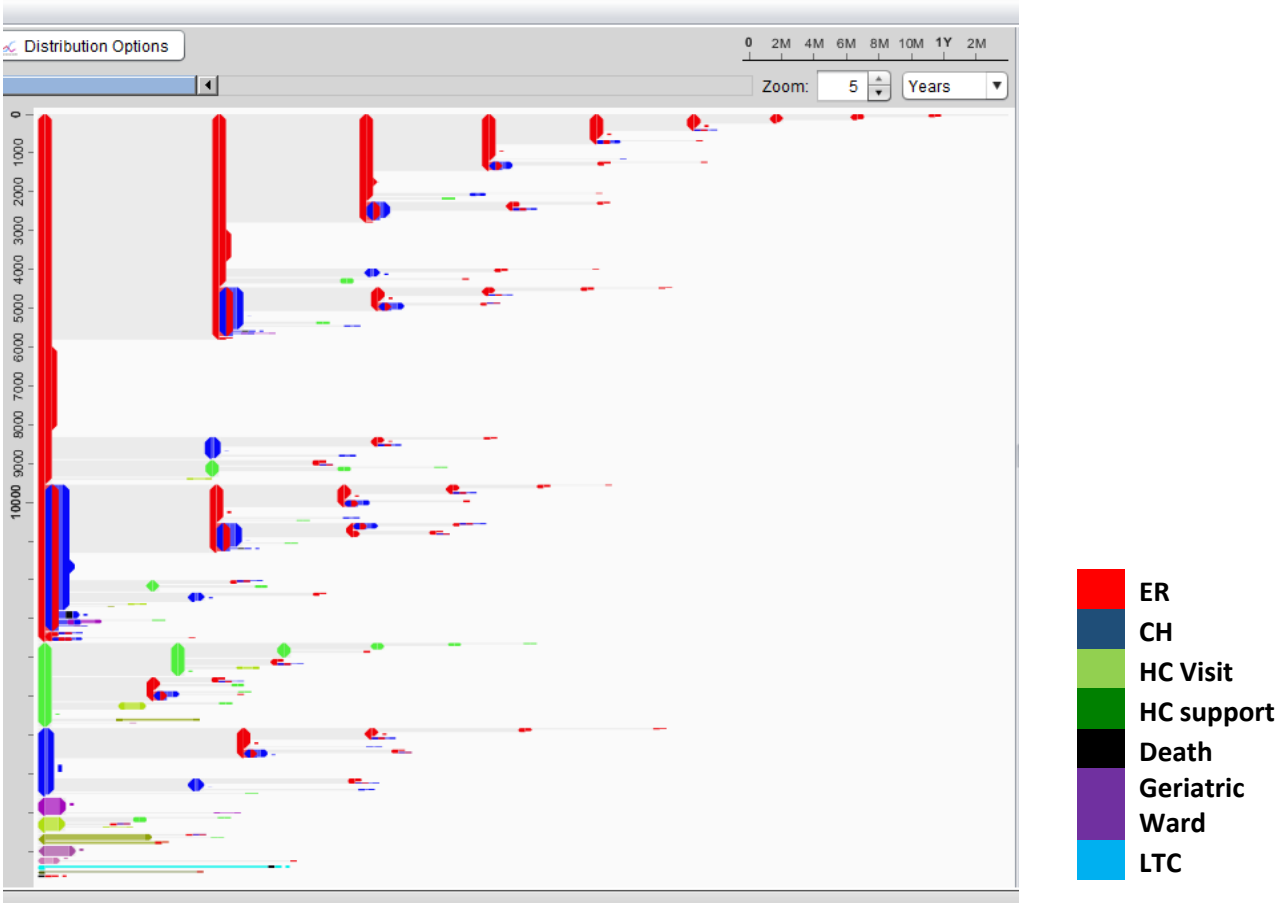

Figure 1 Trajectories of all users

The category with the highest frequency is grouped first and consolidated to a single vertical bar; the consolidation is repeated for the second highest frequency category, and so on until each subset is *aggregated*. The bars' width indicates the average duration of the episode; the distance between bars indicates the median time between groups of episodes.

Trajectories before long-term care and death

We aligned all users' trajectories by category of service, in order to see the trajectories before or after the first occurrence of the category. Figure 2 shows the results for the users who died during the period of study. The majority of deaths occurred during a hospital stay (CH, ~55%) or in a long term care facility (LTC, ~28%), most hospitalisations being unplanned as occurring just after an ER visit.

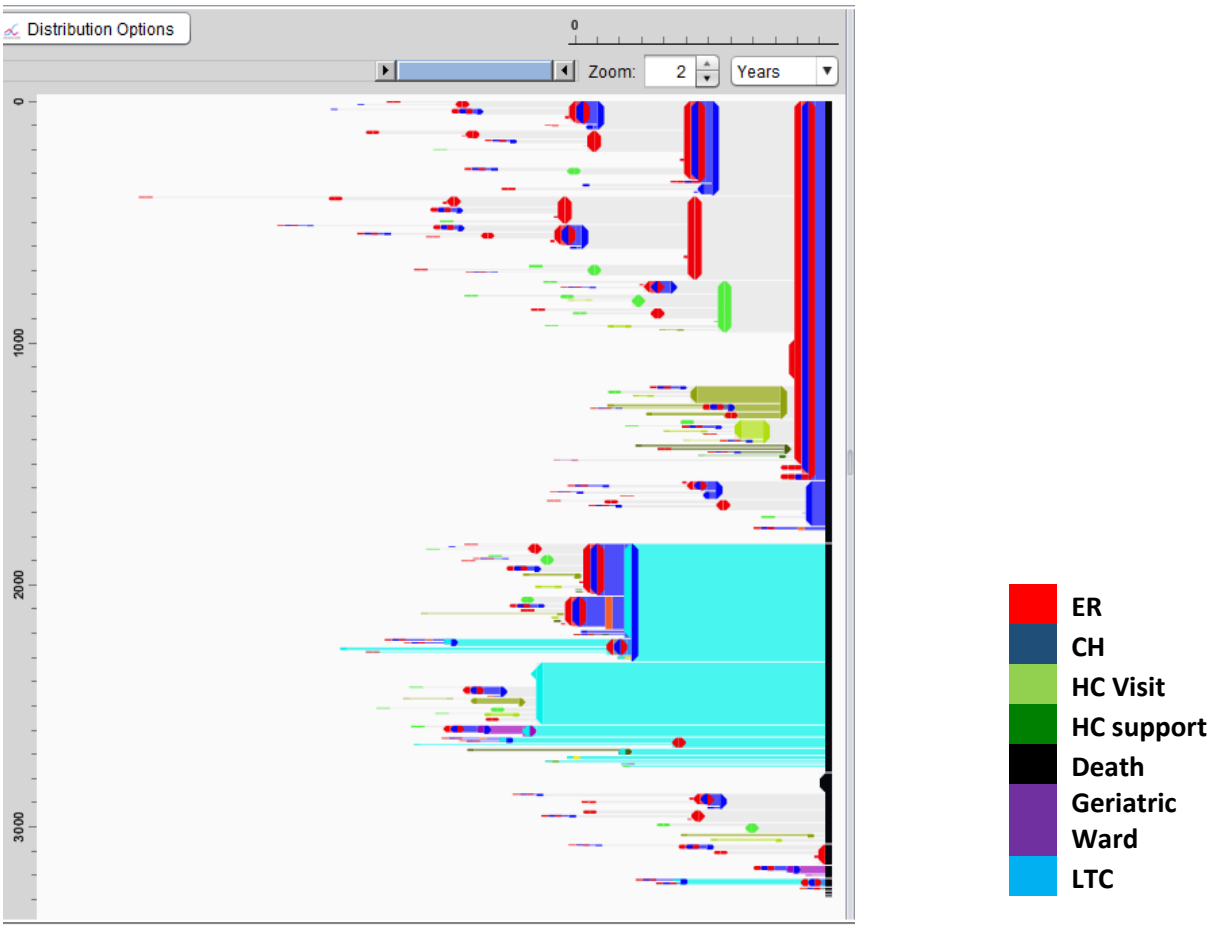

Figure 2 User Trajectories before death

The alignment of trajectories before admission to a LTC facility is shown in Figure 3. We also found 1 652 (8.4%) admissions to LTC facilities, with 43% of them coming straight from a

hospital for an average of one month before LTC admission. Seventeen percent of them had a period of non-acute care of 17 days, on average. We observe that almost all users received home care for at least one year before entering an LTC facility, suggesting that LTC admissions were postponed by HC.

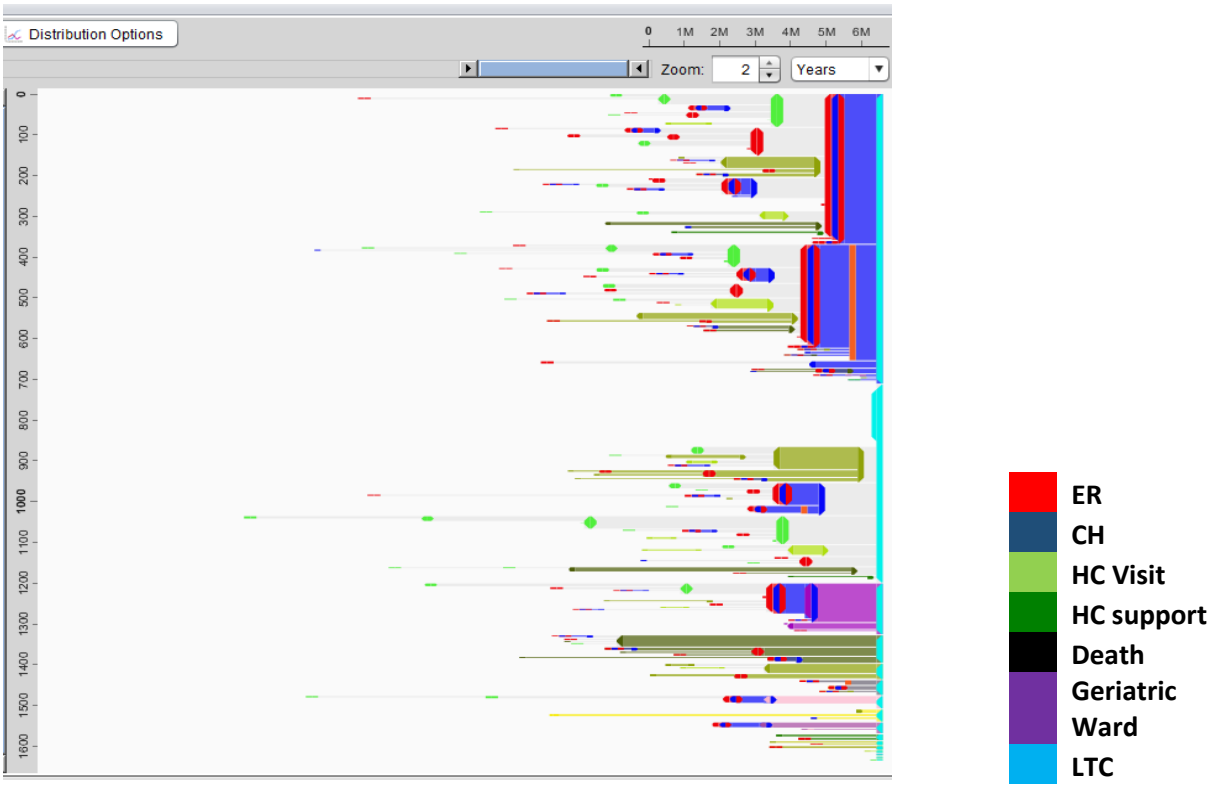

Figure 3 User Trajectories before admission to a LTC facility

Home care users

HC visits count for 87% of all episodes during the five-year period of study. Most of the HC visits (82%) were conveyed to users aged 75 or more, with women being 57% of the older users' group. In Figure 4, home care users appear naturally divided into two groups of similar size but with different trajectories: those in the upper part (48.4%), have many visits to the ER (red

blocks) and hospitalisations (blue blocks) with few HC services (green blocks), the latter appearing sometime after either an ER visit or a hospitalisation. The lower part of the diagram shows home care users that started HC earlier in our observation period and present few ER visits and even fewer hospitalisations (blue blocks); this is suggesting that the lower HC users have less usage of both the ER and hospitalisations than the users in the upper part of the diagram.

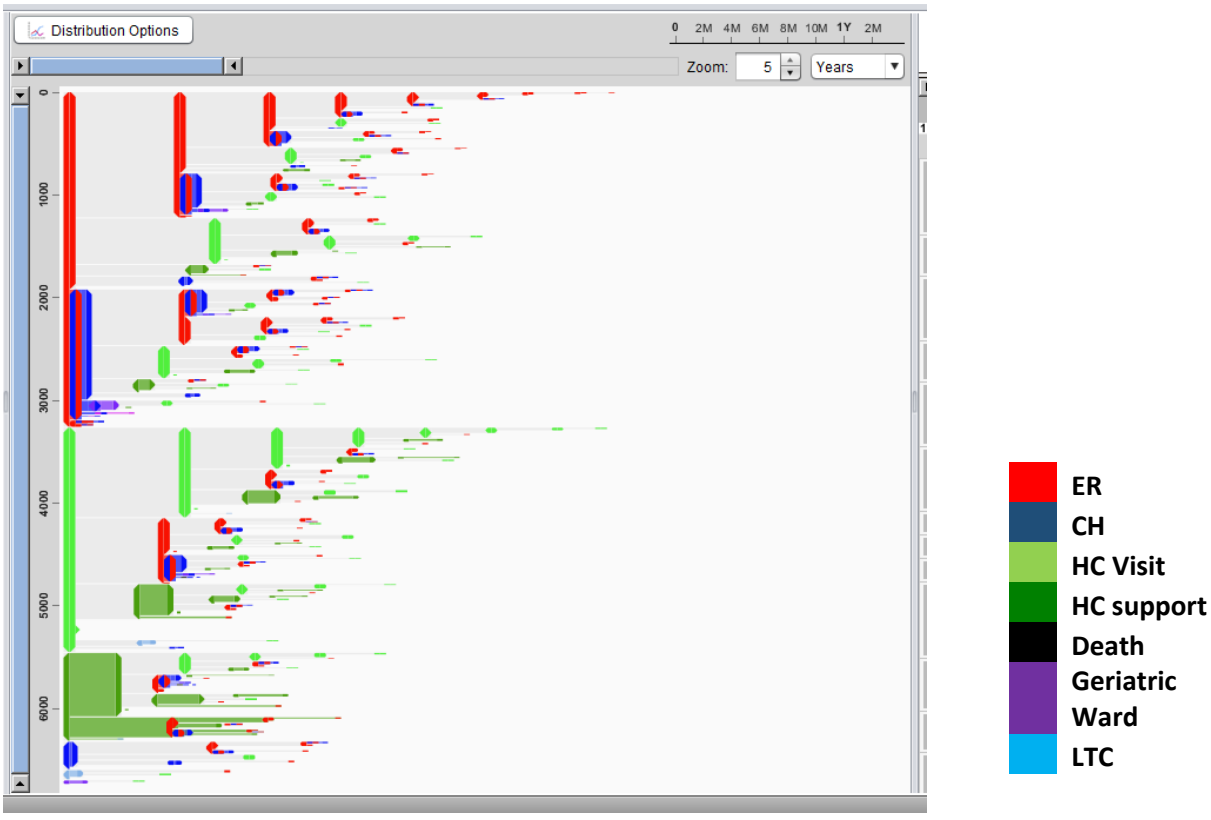

Figure 4 Trajectories of Home care users

To compare service utilisation of HC users and non-users, we separate the 19 758 subjects into two groups: those having received at least one HC visit (34%), and those with no HC visit (66%). Then, we extracted from the database those episodes generated by subjects in each group for comparison. Table 2 shows the distribution of episodes of care by types of episode, comparing HC users with no HC. It is interesting to note that almost half of the ER visits and more than half of the hospitalisations were generated by 34% of HC users. Admissions to LTC and IC were also most common within HC users. The HC users composed 56% of the deaths and experienced about half (52%) of the episodes, despite if they represented only 34% of all subjects.

Table 2: Distribution of episodes by types of episode, HC users and no HC users

Service	# of episodes	By HC users	% of total service	By NoHC users	% of total service
Emergency room	63812	30992	31.3%	32820	33.2%
Hospitalisation	28581	15803	16.0%	12778	12.9%
Geriatric wards	3056	1874	1.9%	1182	1.2%
Long term facility	1659	1259	1.3%	400	0.4%
Day hospital	1324	994	1.0%	330	0.3%
Intermediate care	538	508	0.5%	30	0.0%
Total	**98970**	**51430**	**52%**	**47540**	**48%**

Figure 5 shows the trajectories of users divided by whether they received at least one home care visit. The first subset of non-HC users (66%) show different pathways but the most common one is consecutive ER visits with some hospitalisations. The interval of time between these visits has a median value that shrinks over time, from 4 to 2 months.

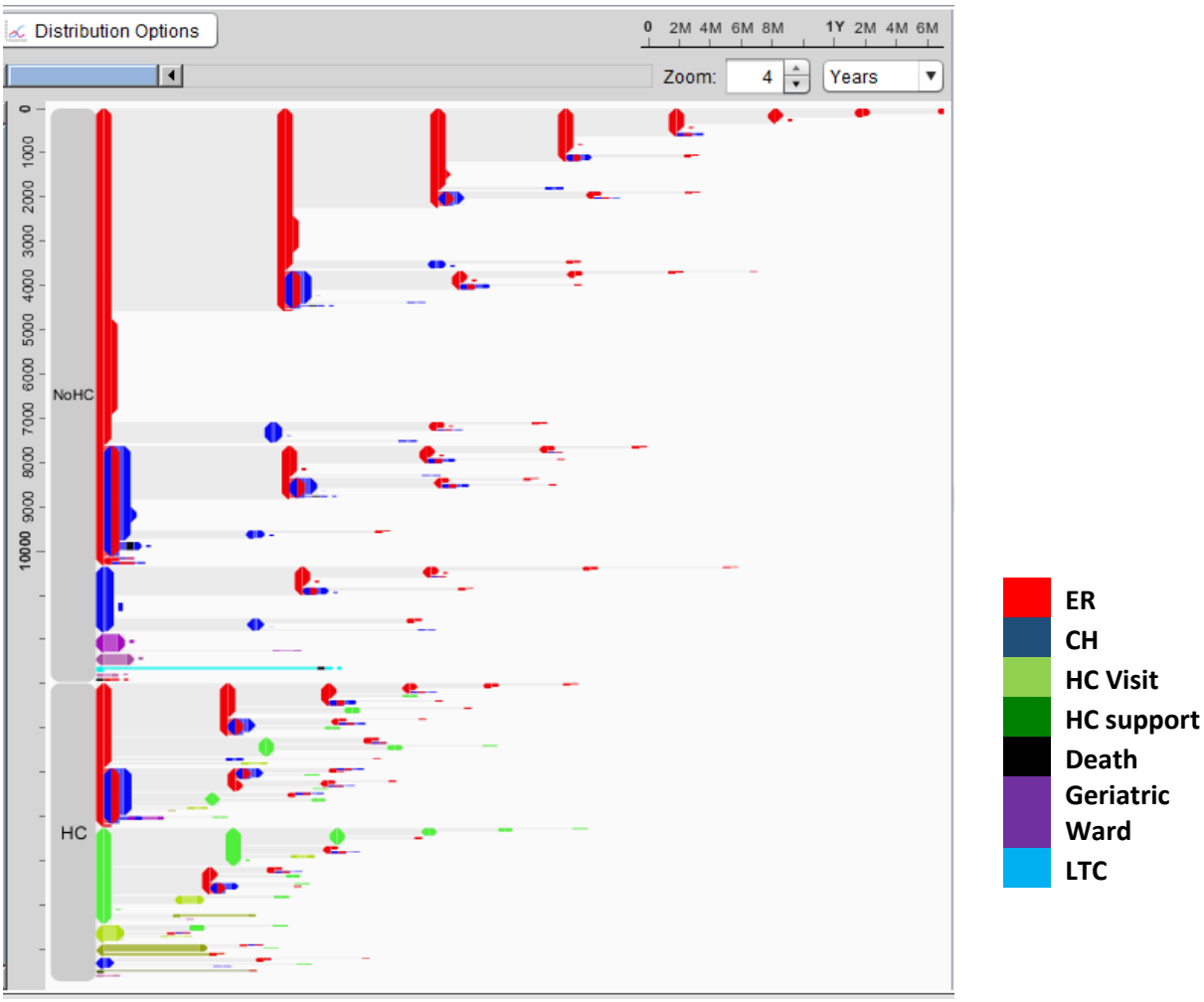

Figure 5 Aggregated sequences of events by HC user (below) and non-users (up)

Effects of Home Care on ER and Hospital stays

We summarized the data set by calculating, for each user, the total number of visits to ER, the total number of hospitalisations, home care visits, and geriatric ward stays. We added the average age and two dummy variables: one indicating if the user died during the period of study and the second one indicating if the user had at least one home care visit.

T-tests, for independent unequal variance samples, showed that HC users had on average 4.58 visits to ER whereas NoHC users had 2.53 (p-value < .001). The average number of hospitalisations was also higher for HC users, 1.34 vs 0.98 for NoHC users (p-value < .001). On both analyses the standard deviations were much higher for the HC group than for the NoHC group: 1.8 times higher for the ER averages and 2.1 times higher for the hospitalisations.

These analysis show that HC users generated extra services, but we cannot say that it is the cause of the extra demand. Most of the HC visits (81%) were conveyed to users aged 75 or more. The extra services generated may be an indication that HC users are frail people requiring more hospital care.

Home care support

In Table 1 we noted the large reduction of HC services over the study period. By combining sequences of visits into support periods, we were able to appreciate how this reduction affected the intensity of HC and the number of HC users. The evolution of HC support in Table 3 and Figure 6 shows important reductions occurred for all groups over time. The decrease was the most important in the high intensity group (more than 4 visits per week).

Table 3: Evolution of Home support visits

Average visits/week	2011	2012	2013	2014	2015	Total
Less than 1	6483	6046	6697	6431	4807	30464
1 - 2	38131	27415	33810	28050	16487	143893
3 - 4	10201	8793	9467	9082	6736	44279
More than 4	144411	107522	89818	53572	25806	421129
Occasional visits	3752	4465	4783	4734	4240	21974
Grand Total	**202978**	**154241**	**144575**	**101869**	**58076**	**661739**
HC users	4149	4392	4336	4265	3842	6765

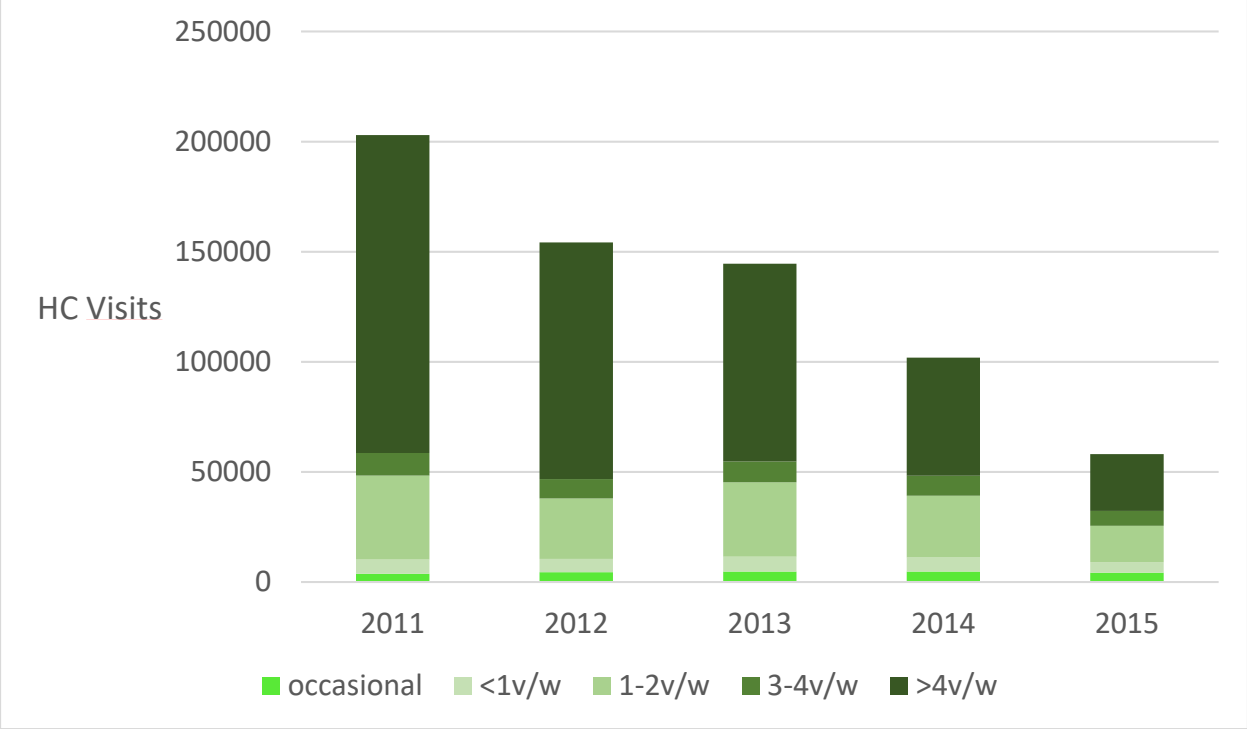

Figure 6 Evolution of HC visits according to the intensity of support

During 2014-15 all HC users were receiving fewer visits per week and we also observed a decline in the number of users since 2013, as shown in Figure 7.

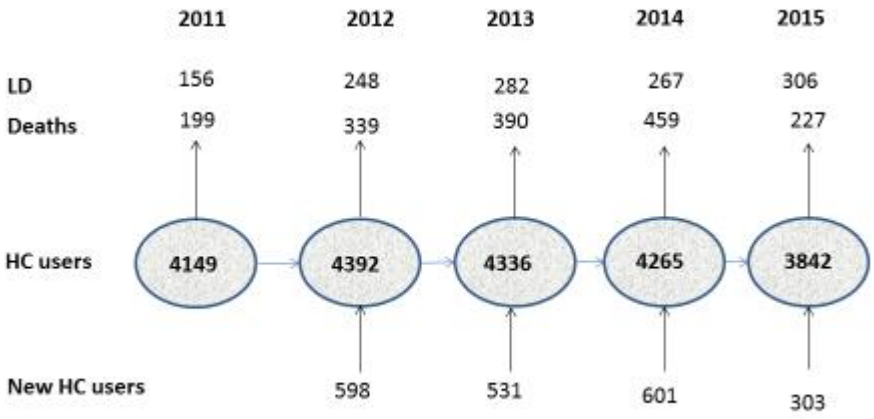

Figure 7 Evolution of Home care users

Discussion

It is evident from our study that the hospital is the most important entry point to the healthcare system, as the most frequent episodes (omitting HC visits) were ER visits and hospitalisations. The current Canadian system was developed around hospital and physician services in the seventies. While suitable for a young population, with acute illnesses requiring mostly acute care, it is now far less appropriate, in the context of an aging population with chronic diseases. This study suggests that what this population may need now is care mainly at home, outside of the hospital. Many countries have implemented new methods of funding long-term care to facilitate this system transition (Hébert, 2011). The Canadian system, still hospital-centered perhaps should focus greater attention to a more home-centered system to adapt to this demographic and epidemiologic transition.

In this context, the decrease in the utilization of home care services during the study period is striking. Despite the aging of the cohort and the likely incidence of new disabilities, the number of HC visits decreased dramatically, particularly for most intensive HC group. The number of people who died or were institutionalised did not explain such a decrease. Moreover, in 2013 the Minister of Health in Quebec decided to prioritize, increasing the budget for public HC by 25%, but this did not increase HC utilization. It is evident that the funding targeted to HC was transferred to other priorities, namely hospital care. This is probably because HC programs became integrated within a single budget envelope of larger institutions which include also hospitals and nursing homes.

The important decrease of HC visits over the study period remains disturbing. This reduction could have important consequences on the health care of patients, their immediate families, and the use of ER and hospital care.

Our analyses revealed that admission to long-term care facilities was preceded by at least one year of home care visits, indicating a probable effect of home care on delaying institutionalisation, but again, more dynamic studies are needed in order to assess this probable effect of HC.

HC users had a larger number of ER and hospitalisations than those who did not received HC, which is a probable marker of users' frailty (81% of HC users were 75 or older). Even though HC users made greater use of ER and hospital care, our data visualisation diagrams indicate that earlier HC visits were followed by less ER visits and even less hospitalisations, when compared with users receiving HC later on our study interval. Explaining the division of these two groups of HC users is not straightforward. Our data shows a "picture" of the episodes in a time interval, with some users starting HC at the beginning of our interval (lower half in the diagram) and other users stating HC by the end (upper half of the diagram). Another reason for the difficulty of explaining this diagram is the fact that we have no information of the users' health status. We observe that both visits to the ER and hospitalisations occur in lesser frequency after HC starts but further analysis is necessary to investigate these phenomena in a dynamic way. Our results are coherent with previous studies that showed that HC is associated with less ER visits, CH admissions and postponement of institutionalization (Wassef et al, 2018; Tomita et al, 2010, Lee et al, 2019).

This study was comprehensive: it included all recorded population 65 years old and over in the given area receiving at least one public healthcare service. We are quite confident that all people over 65 years old that used the public services were included, although a very few numbers of people could have been omitted, given that we used administrative databases. The only publicly funded services excluded from this analysis were visits to doctors' offices; this would not have a big influence on the results, since the vast majority of elderly people have access to a family physician and may consult him/her many times a year.

Since there are no private hospitals and LTC institutions in this area, the study includes all hospitals, ERs and LT care provided to this population. Finally, given that the home care services for professional and personal care are delivered mainly by local CLSCs, it is unlikely that services provided by not-for-profit organisations would have a significant impact. It should be noted that publicly funded home care covers only a small proportion of needs for this population. In previous studies, we showed that services provided by CLSCs represents only 8 to 12% of the required services, (CIHI, 2017; Tousignant, Hébert, Dubuc, & Coulombe, 2007).

Limitations should be acknowledged. The absence of markers of disability or morbidity is the most important one. That is inherent in the utilization of administrative data, which rarely includes these types of variables. The absence of socioeconomic factors known to affect the complex issue of healthcare utilisation was also not available. Finally, the graphical tools used in this study, although capturing the dynamic use of services do not permit to measure the impact of HC to other services, specially to those hospital-based.

The complexity of HC evaluation requires further exploration with novel methodologies. Further research must continue to explore the mechanisms by which HC influences the use of ER and hospitalisations, incorporating other effect modifiers such as the users' health status and their level of autonomy (Dubuc, Hébert, Desrosiers, Buteau, & Trottier, 2006). Other methods, like frailty models and some extensions to the Cox model, may capture the dynamics of repeated time-to-event health episodes in a better way.

Conclusions

The Canadian healthcare system is still hospital based, as our cohort received about 90% of healthcare episodes (other than HC visits) either at ER or during a hospital stay. These facts are at odds with the long-term goal articulated by the Provincial Ministry of Health to provide healthcare services where the users live (MSSSQ, 2008).

We found a possible effect of HC in reducing ER visits, hospitalisations, and admissions to long-term-care. To measure these effects, further analysis should include covariates such like morbidities, level of autonomy, and socioeconomic factors.

This study could be extended to other populations as our methods are applicable to any other region with available administrative data. In applying this methodology to regions, provinces and a whole country, managers and policy makers could use the administrative data to base evidence-informed decision-making and to monitor the impact of policies and programmes. This could become the basis of artificial intelligence applied to learning health organisations.

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