Understanding variation and complexity in health care trajectories at the end of life to improve patient care: machine learning methods and provincial administrative health data

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Context

- A major demographic change is expected for the Québec population: the proportion of people aged 65+ will increase from 16% in 2011 to 25% in 2031.
- Concerns and challenges emerge as the prevalence of individuals with multiple chronic diseases increases with age, implying an increasingly complex utilization of health care services and requiring the health care system to continually adjust its service offering to meet these changing needs.
- It also increases the financial burden on and hampers the quality of life of these individuals until their death as the health care system struggles to keep up with the growing demand.

Objectives

Using Quebec administrative health databases (AHDs), we aim to describe patients’ health care trajectories in their last year of life to better organize services around patients’ needs.

To do so, we want to tackle several aspects of the End-of-Life (EoL):

1. Identifying factors influencing health care services at the EoL.
2. Retrieving palliative care services using combined information from AHDs.
3. Analyzing the EoL costs using AHDs, manual billings and financial report.
4. Identifying different patterns of health care utilization using machine learning methods, specifically unsupervised classification strategies.

Population and data source

From Quebec’s AHDs we constituted a retrospective cohort of 830,330 patient at the “EoL”:

- All Quebec population (registered in the insured persons registration file)
- Individuals deceased at age 66 and over between April 1st 2000 and March 31st 2018 (inclusive)
- Extraction of all use of health care services over the last 12 months before the death date:
  - Drug consumption (in-hospital excluded)
  - Community health center care (CLSC)
  - Emergency visits
  - Hospitalization
  - Long-term care
  - Physician services

- Nearly all individuals aged 65 and over are registered within the drug insurance public plan, we were unable to exclude all individuals 65 and over from removing insurance-related data.

Trajectories and ongoing developments to represent the health care complexity

Factors influencing health care at the end of-life

Sébastien Barbart-Artigas & Nevena Veljanovic

Health care utilization at the EoL is currently a hot topic as this is a critical period where most people who are dying utilize considerable amount of acute health care services. First limited to a pathology-related definition, the concept of patient expanded to account for multiple social, economical, political, and environmental factors. In order to identify factors that may influence the use of social and health care services at the EoL, and that could be useful in our analyses, we initiated a systematic literature review.

We will provide a conceptual model of factors influencing social and health care services utilization.

More information on the following poster:

Factors influencing utilization of public health care and social services in the last year of life: a mixed methods systematic review protocol – Preliminary results.

[Barbat-Artigas, CAHSPR 2020]

Palliative care algorithm

Jean-Luc Kaboré

Direct information on “EoL” and palliative care is not systematically present in the AHDs:

- Palliative care does not represent a recognized medical specialty in Quebec.
- Palliative physicians are mainly paid by an hourly rate rather than a fee-for-service basis.
- There is no palliative care unit in all health facilities, although most offer them.

However, various studies demonstrate that it is possible to create a proxy for the use of palliative care by using certain diagnostic variables or care variables in local community service centers.

We propose to use the merged AHD (especially emergency visits, visits, drugs and long-term care plan) to develop an algorithm to identify older adults who have used palliative care during their last year of life. The presence of at least one palliative care service for an individual strongly implies that he/she will receive palliative care until his/her death. This study will allow us to provide a portrait of palliative care in Quebec.

Health care cost at the end-of-life

Fereshteh Mehrabi & Yuliya Legkiyaya

Considering the predicted demographic shift, we are expecting an increasing cost at the EoL. In order to provide useful insight about the cost of specific health care trajectories, we propose to:

- Estimate the individual cost at the EoL, using manual billings, financial reports and administrative health databases.
- Calculate the evolution of the EoL costs during the last year of an individual’s life depending on his/her trajectory.
- Calculate the variation of the EoL costs over the last years depending on the trajectories of individuals.

Conclusion and expected results

This research is an important first step toward the improvement of services and patient care, as it addresses an important gap in knowledge about health care use patterns during the last year of life.

- **Systematic review**: we will provide a list of factors affecting service utilization at the EoL. We believe that building a conceptual model of factors influencing social and health care services utilization at the EoL, and surrounding moderators 1) could be of great interest to guide future research and qualitative surveys and 2) is the first step to develop interventions to positively influence these factors themselves (see related poster).
- **Palliative care algorithm**: we will provide a portrait of the palliative care access in Quebec, which is an actual need of the EoL, Quebec Commission (in addition of the information in the health care trajectories).
- **EoL costs**: Since we expect a major demographic change that could have an impact on the costs of the healthcare system, to identify the most expensive trajectories would be of great interest to the policy makers.
- **Machine learning analyses**: They will allow us to identify and classify trajectories of health care services utilization and the description of these patterns will allow us to better understand the health care use at the EoL, highlighting patterns of health care utilization without a priori constraints or assumptions, and generating questions and hypotheses for the health care system and decision-makers.

Acknowledgements and funding

We thank Denis Roy and Cod Doucet from the “Vice-Présidence – Science et Gouvernance Clinique” (IPRSC) at the Université de Montréal and Monsef Bibi and Frederique Berth from the “Gestion de l’Information” for the data interaction.

This communication is supported by an internal funding of the University of Montreal and the Cost of the EoL is supported by the CRIRANO.

Machine learning (ML) and expected results

Mt. family algorithms include classification algorithms (clustering), which are divided into supervised and unsupervised analysis. While supervised analyses are based on a known training dataset, unsupervised analyses are used to find structure in the data in order to highlight patterns by grouping data points (all individuals) according to their similarities (patterns of health care use), regardless of user knowledge. We will perform several analyses using different methods unsupervised classification (Ward, DBSCAN, p-dimensional, K-mean...).

Illustration of the hierarchical clustering for 10 individuals

Preliminary results of clustering with the hierarchical Ward algorithm, with a cut-off at 4 clusters, N = 25,564, 2014-2018

A) Dendrogram. B) Health care trajectories from day 1 to day 365. 1 to 4) Average days of each service for each group.

- No services **
- Emergency $\rightarrow$ Hospital $\rightarrow$ Home care
- Palliative care drugs $$
- No services / Home care

Emergency $\rightarrow$ Hospital $\rightarrow$ Long-term care

Health care services, Social services, Long-term care, Palliative care drugs, No services / Home care

<table>
<thead>
<tr>
<th>Classification</th>
<th>Group characteristics</th>
</tr>
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<tbody>
<tr>
<td>Medium and long health care services</td>
<td>Medium period</td>
</tr>
<tr>
<td>Short or interrupted health care period</td>
<td>Long-term period $\rightarrow$ Home care $\rightarrow$ Long-term care</td>
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