The care pathway of patients hospitalized for influenza before admission to nursing home during the epidemic seasons of 2017-2018 and 2018-2019 in France

Romane Le Goff¹, Léa Antoniali², Andrea Contini¹, Laurence Allard², Oriane Bretin¹, Hélène Bricout²

¹ : IQVIA, Courbevoie, France,
² : Sanofi Vaccins, Lyon, France
Context and objectives of the Valorem study

Nursing home admissions during influenza epidemics

20,000 hospitalizations each year due to influenza

Primarily impacts patients aged 65 and above

About 1% of elderly patients hospitalized due to influenza subsequently require admission to a nursing home¹

What is the impact of influenza on elderly patients’ care pathway before admission into a nursing home?

STUDY OBJECTIVES

- Sociodemographic characteristics and clinical profiles description of patients
- Care pathways’ identification prior to admission into a nursing home

Study design

Focus on the 2017-18 epidemic season

Study conducted on the National Health Data System (SNDS) database and the registry of Medico-Social Care (ESM) – extraction period from 1st Nov 2014 to 31st Dec 2019

1. Patients aged ≥65 admitted to a nursing home (NH) between 27th Nov. 2017 and 30th Sept. 2018
2. With a hospitalization due to influenza* in the 6 months before admission to a NH

*MSO hospitalization with main, related of associated diagnosis for influenza (ICD10: J09-11)

Figure 1. Study design

Inclusion period (10 months)

Index date = EHPAD entry – 6 months

Hospitalization for influenza

EHPAD entry

Follow-up period

3 months

Methods

See Figure 1. Study design for a visual representation of the study design.
Patients’ characteristics

Patients with a hospitalization for influenza before admission to a nursing home

Table 1. Patients’ characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median</td>
<td>87</td>
</tr>
<tr>
<td>Female, n (%)</td>
<td>723 (65.2)</td>
</tr>
<tr>
<td>Vaccination for influenza, n (%)</td>
<td>622 (56.1)</td>
</tr>
<tr>
<td>Death in the 3 months following admission, n (%)</td>
<td>117 (10.6)</td>
</tr>
<tr>
<td>At least one comorbidity (all-cause), n (%)</td>
<td>804 (72.6)</td>
</tr>
<tr>
<td>Cardiovascular</td>
<td>508 (45.8)</td>
</tr>
<tr>
<td>Respiratory</td>
<td>222 (20.0)</td>
</tr>
</tbody>
</table>

During the follow-up period

<table>
<thead>
<tr>
<th>Event</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>At least one visit to GP or a specialist, n (%)</td>
<td>1,086 (97.9)</td>
</tr>
<tr>
<td>Median number*</td>
<td>8</td>
</tr>
<tr>
<td>At least one MSO hospitalization, n (%)</td>
<td>1,109 (100)</td>
</tr>
<tr>
<td>Median duration*</td>
<td>14</td>
</tr>
<tr>
<td>At least one SSR hospitalization, n (%)</td>
<td>643 (58.0)</td>
</tr>
<tr>
<td>Median duration*</td>
<td>39</td>
</tr>
</tbody>
</table>

*among patients who experience the event during their follow-up
State Sequence Analysis (SSA) to build care pathways of elderly before nursing home admission

- Care pathway as a sequence of events
  - Analysis of the consumed healthcare resources (events)
  - Discretization of the sequences with weekly time stamps

Example of a sequence of events

Hierarchical list of events arranged in order of importance for building the care pathways

1. Influenza vaccination
2. Emergency room visits without hospitalization
3. Hospitalization for influenza
4. MSO cardiac/respiratory hospitalization
5. MSO hospitalization (all-cause)
6. SSR hospitalization (all-cause)
7. GP or special consultation
8. Ehpad entry (specific)
9. Absence of event

Methods

- Building a care pathway typology
  - Optimal Matching method is used to evaluate the similarities between sequences
  - Use of a clustering algorithm (Hierarchical Ascendant Classification)
The concept of Optimal Matching

Assessing sequence similarity for cluster grouping

Principle of the method

- We define elementary operations, inspired by Bioinformatics (DNA mutations), and we assign a cost to each one.

Distances between 2 patients = sum of the costs of the minimal operations necessary to make the 2 sequences identical.

How do we make these two sequences identical?

Patient 1

Patient 2
The concept of Optimal Matching

**Example of distance calculation between two sequences**

**How do we go from patient 1 to patient 2?**

**Several possibilities!**

1. **Patient 1**
   - One substitution…
   - And a second substitution!
2. **Patient 1**
   - One deletion…
   - And one insertion!

But which transformation do we choose between these two options?
- It depends on the **choice** of the **system of costs** – can be set **manually** or **automatically derived** from the data
- We choose the **minimal cost** as the **final distance** between the 2 patients

**Example of costs**

<table>
<thead>
<tr>
<th></th>
<th>Indels</th>
<th>Substitution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>1</td>
</tr>
</tbody>
</table>

1. 2 substitutions → **cost = 2**
2. 1 deletion + 1 insertion → **cost = 1** ✅
Clusters of care pathways in patients hospitalized for influenza

Figure 3. Index plot visualization of the clusters

Cluster 1 – Low consultation rate, N=499 (45.0%)
Cluster 2 – High consultation rate, N=94 (8.5%)
Cluster 3 – Short-term rehabilitation, N=282 (25.4%)
Cluster 4 – Medium-term rehabilitation, N=163 (14.7%)
Cluster 5 – Long-term rehabilitation, N=71 (6.4%)

NH: Nursing Home
Epidemic season 2017-18
## Summary of descriptive analysis for identified clusters

### Table 2. Patients’ characteristics in each cluster

<table>
<thead>
<tr>
<th>Characteristics, n (%)</th>
<th>Cluster 1 – Low consultation rate, n=499 (45%)</th>
<th>Cluster 2 – High consultation rate, n=94 (8.5%)</th>
<th>Cluster 3 – Short-term rehabilitation, n=282 (25.4%)</th>
<th>Cluster 4 – Medium-term rehabilitation, n=163 (14.7%)</th>
<th>Cluster 5 – Long-term rehabilitation, n=71 (6.4%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median</td>
<td>87</td>
<td>88</td>
<td>87</td>
<td>87.5</td>
<td>88</td>
</tr>
<tr>
<td>Vaccination for influenza</td>
<td>282 (56.5)</td>
<td>65 (69.1)</td>
<td>156 (55.3)</td>
<td>83 (50.9)</td>
<td>36 (50.7)</td>
</tr>
<tr>
<td>Death in the 3 months following admission</td>
<td>49 (9.8)</td>
<td>11 (11.7)</td>
<td>30 (10.6)</td>
<td>20 (12.3)</td>
<td>≤10</td>
</tr>
<tr>
<td>At least one comorbidity (all-cause)</td>
<td>345 (69.1)</td>
<td>75 (79.8)</td>
<td>208 (73.8)</td>
<td>124 (76.1)</td>
<td>52 (73.2)</td>
</tr>
<tr>
<td>During the follow-up period</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>At least one visit to GP or a specialist</td>
<td>490 (98.2)</td>
<td>94 (100.0)</td>
<td>276 (97.9)</td>
<td>158 (96.9)</td>
<td>68 (95.8)</td>
</tr>
<tr>
<td>Median number*</td>
<td>8</td>
<td>17</td>
<td>7</td>
<td>7.5</td>
<td>5.5</td>
</tr>
<tr>
<td>At least one SSR hospitalization</td>
<td>101 (20.2)</td>
<td>35 (37.2)</td>
<td>273 (96.8)</td>
<td>163 (100.0)</td>
<td>71 (100.0)</td>
</tr>
<tr>
<td>Median duration*</td>
<td>21</td>
<td>21</td>
<td>32</td>
<td>61</td>
<td>111</td>
</tr>
</tbody>
</table>

*among patients who experience the event during their follow-up

>50% with an influenza hospitalization followed by rehabilitation (SSR) before NH admission
Conclusion

- This is the 1st study employing State Sequence Analysis (SSA) and Optimal Matching to analyze longitudinal care-pathways in elderly hospitalized for influenza before NH institutionalization in a context of epidemic season.

- SSA coupled with Optimal Matching is a great tool to:
  - Cluster patients with similar care pathways
  - Allow for a simplified way to visualize the main different pathways

Discussion

Method

- Cluster analysis revealed that:
  - The patient care pathways are driven by either SSR or the rate of consultations
  - A higher rate of comorbidities among patients with many consultations

Results

- After influenza hospitalization, >50% of patients were managed in a rehabilitation unit (SSR hospitalization) suggesting that influenza may lead to loss of functionality and dependance, promoting NH admission

Limits

- Causal inference between influenza hospitalization and NH admission remains to be assessed