

Development of a Graphical Interface to Visualize and Analyze the Pathways of Patients During Their Hospital Stay for Thoracic Surgery

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Abstract

The multidisciplinary aspect of patient care is not yet sufficiently taken into account in hospital ward management. By gathering data from the administrative database of hospital stays and the operating theaters management software, we developed a graphical user interface to visualize and analyze the pathways of patients who underwent thoracic surgery in the Nantes University Hospital of France in 2016 and 2017.

Keywords:

Data Display, Critical Pathways, Hospital Records

Introduction

In the last decades, medicine has evolved from organ-by-organ treatments to multidisciplinary patient care. But the hospital organisation and the administrative management of hospital stays are still compartmentalised, and the complexity of patient pathways is little-known. We are not currently able to determine the typical pathways taken by patients during their stay, their relative frequencies, variations, time trends, etc.

Some attempts have been conducted to visualize medical data in a dynamic way, but they focused on the evolution of care and pathology, rather than hospitalization pathways [1,2]. Medicine can benefit from the achievements of other fields, such as social science [3], energy management [4], or multi-parametric visualisation design [5].

Our objective was to develop a management support tool by means of a graphical user interface (GUI) enabling the visualization and the analysis of the patient pathways. We focused on patients who underwent thoracic surgery at Nantes University Hospital of France in 2016 and 2017.

Methods

Data

We based our work on two software databases used in the hospital: the administrative patients management software and the management software for the operating theaters. The first provided us with admission, transfer and discharge data, and the second allowed us to select patients who underwent thoracic surgery in 2016 and 2017.

These two datasets were merged into a single dataset of hospitalization sequences representing the patient pathway among medical units and operating suites. These sequences were the series of what we called "positions": combinations of the code of the medical unit where the patient went through and

an index number in relation to the first surgical intervention. The data management was carried out using Python 3.6.

Interface

Our GUI was composed of two parts. The first was used for displaying a flowchart of all patient pathways within a year by a Sankey diagram. The user was able to adjust the chart through parameters like its length or precision level.

The second part was dedicated to a closer analysis of the datasets. We used a sequential pattern mining (SPM) algorithm to retrieve the most frequent patterns among the patient pathways. SPM allowed us to keep repetitions visible within the patterns and were more adapted to our linear data than algorithms relying on cycles or networks, like in process mining [6]. Then, every pattern was associated with indicators like its support (frequency) or the confidence of sequential rules between its items. The user was able to adjust parameters like the length of the pattern, requirement of specific medical unit codes, or posting of selected indicators.

The GUI was built as an interactive webpage in order to make it portable and easy to use. The SPM was carried out using the SPMF Java library [7] and the Hirate-Yamana algorithm to forbid leaps over consecutive medical units [8].

Evaluation

We evaluated the user experience of the GUI. We devised an experimental protocol with a sample group of managers and a control group of external users (with knowledge only in either medicine, statistics or computer science), and conducted user observations followed by a debriefing. We also designed five exercises to do on either part of the interface, and observed how the users used the GUI to solve them. We focused on usability and recorded all difficulties encountered by users.

Results

We retrieved 3331 total hospital stays in 2016 and 2017.

Examples of the GUI can be seen in the Figures 1 and 2. Figure 1 depicts the flow chart part for 2016, and Figure 2 shows the results of a SPM.

We observed three manager users and three control users. Overall, the user experience evaluation was satisfactory. The GUI was appealing, but some exercises showed that it can be hard to use, especially when users have a low statistical background. Participation in the construction of the tool and knowledge in the operation of hospital records seem to be the most important facilitating factors for its use and

understanding. Some areas for improvement were highlighted, especially in ergonomics. Users were overall satisfied and reported being "interested" or even "very enthusiastic" about this project.

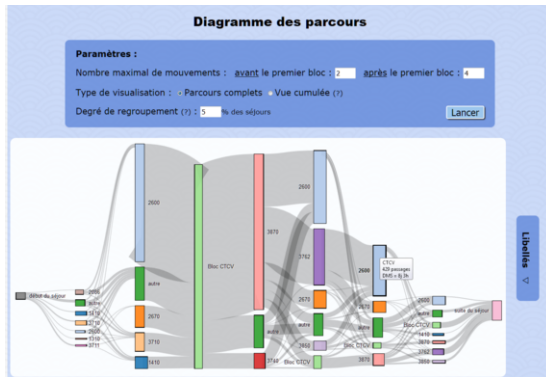


Fig. 1 – Screenshot of the first part of the GUI: flow chart of patient pathways in 2017.

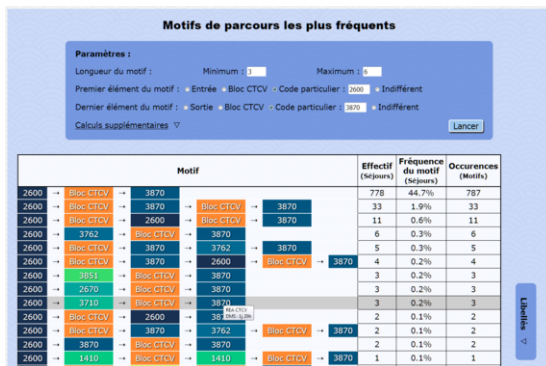


Fig. 2 – Screenshot of the second part of the GUI: SPM beginning and ending with specific medical units in 2017.

Discussion

Overall, the user experience of the application was satisfactory; the professionals enjoyed it, and it helped them understand the patient pathways, correct the way they pictured them, and reorganize the patient coordination management properly. Some professionals from other medical specialities (e.g. surgical intensive care) who took part in meetings about this GUI even asked for a version with their own patient pathways.

However, despite its novelty and its perceived usefulness, this tool remains difficult to use, as it requires a minimum of knowledge in both statistics and hospital record operating. As requested after the evaluation, a guide has been written to help users understand how the GUI works, aside from ergonomic improvements and a context-sensitive help. Integrating users in the development of this tool was a great chance to make it more convenient. Although a small amount of people were targeted, a larger evaluation of the new version should be conducted.

Another limitation of this work is that it was based on data extraction; therefore, we cannot apply it directly elsewhere with other parameters and a new database, such as in years to come or other reasons for hospitalization. A committee shall be

formed to integrate this tool into the hospital information system (IS). But one of the main difficulties of this will be merging two databases from two unconnected software applications. Thus, this work points out the necessity of interoperability within IS.

Conclusions

We developed a GUI to improve the understanding of patient pathways during hospital stays. Based on two management software databases, our tool displays a Sankey diagram of all patient pathways in a year and the results of a SPM procedure. The user-experience evaluation highlighted great interest but also low user-friendliness due to a high level of specialization. This tool allowed managers to better depict the patients flows and to discuss their reorganization in a more informed way.

Despite the need for ergonomic improvement, we managed to create a helpful tool to better understand the patient pathways. Efforts should be made both to pursue this project to adapt it to suit other reasons for hospitalization and to widen its use, and to assess its usefulness on a larger scale.

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Source code: <https://github.com/LucileTrutt/parcoursPatients>

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