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A Workflow Model to Analyse Pediatric Emergency Overcrowding

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Abstract. The greatest source of delay in patient flow is the waiting time from the health care request, and especially the bed request to exit from the Pediatric Emergency Department (PED) for hospital admission. It represents 70% of the time that these patients occupied in the PED waiting rooms. Our objective in this study is to identify tension indicators and bottlenecks that contribute to overcrowding. Patient flow mapping through the PED was carried out in a continuous 2 years period from January 2011 to December 2012. Our method is to use the collected real data, basing on accurate visits made in the PED of the Regional University Hospital Center (CHRU) of Lille (France), in order to construct an accurate and complete representation of the PED processes. The result of this representation is a Workflow model of the patient journey in the PED representing most faithfully possible the reality of the PED of CHRU of Lille. This model allowed us to identify sources of delay in patient flow and aspects of the PED activity that could be improved. It must be enough retailed to produce an analysis allowing to identify the dysfunctions of the PED and also to propose and to estimate prevention indicators of tensions. Our survey is integrated into the French National Research Agency project, titled: “Hospital: optimization, simulation and avoidance of strain” (ANR HOST).

Keywords. Pediatric Emergency Medicine, workflow, modelling, peak of activity, crowding indicators.

1. Introduction

In many countries, Emergency Departments are facing problems associated with increased demand in their services (1, 2). The arrival patient flow to the emergency department is stochastic and keeps increasing. This rise has generated a strategic interest in optimizing the technical and human resources while mastering the costs. This situation creates a set of unique challenges for the patient, family, and care providers (3).

This problematic is the main challenge of the HOST ANR French project. The objective is to elaborate an innovative methodological approach for the anticipation of the tensions of the complex care production system and more especially of the emergency paths in the Pediatric Emergency Department (PED) of the CHRU of Lille in France. The problematic of strategy, the performance assessment and traceability of the patient course are integrated into the suggested approaches.

The objective of this paper is to provide a complete picture of the PED delivery processes and detailed data on all aspects of the patient journey in order to identify bottlenecks that potentially contribute to overcrowding.

2. Methods

We used a structured method research design which comprised five major steps:

1. Several visits were piloted in the PED of CHR of Lille with researchers and physicians (the HOST ANR project partners) to build a model of the patient path and PED treatment processes as the basis for a patient mapping form to collect data;
2. Each Research Assistant (RA) partner of the project spent a continuous 10 days mapping exercise during which they independently observed and manually recorded patient journeys through the PED for a sample of presentations;
3. In order to validate an all-day observations, a PED staff meets the research assistant regarding their observations of patient flow;
4. The analysis of data obtained during steps 1-3 to construct dynamic models of the process. This model is constructed with the Business Process Management Notation (BPMN) which is an international standard.
5. Model simulation and its comparison with the real scenarios of patient path. The goal of this step is to optimize the model.

The first design characteristic lead on the use uses an observational tool, done by EVALAB partner of our HOST ANR project which is in compliance with the ISO standard EN 9241-210: "Process of human-centred design for interactive systems".

The second design characteristic lead on the use of a Workflow approach. The Workflow produces a model that describes precisely the activities flow in the patient path using an internationally standardized language: the BPMN (4).

3. Results

3.1 Background

Our work represents the first step of the national ANR HOST project realization and discusses the emergency handling system. Modeling patients' paths at PED is faced with a high amount of complexity. This complexity stems from the inherent dynamics of the processes and the distributed organization structure of hospitals, as they are divided into several autonomous wards and ancillary units. For treatment, patients visit different units according to their illness. However, the pathway of the patients through the PED is confronted with uncertainties. Because it is in the nature of diagnostics to gain additional information about the patients' diseases, the necessary medical treatments are often not completely determined at the beginning of the treatment process. Further, the duration of the examinations and treatments are stochastic, due to the individuality of the patients. Additional problems for the patient-modeling in PED arise from complications and emergencies. The immediate need of treatment for emergency patients causes disturbances in the schedule. Complications, which may

occur during a treatment, result in waiting times and changed pathways for other patients. This results in variable pathways and stochastic processing times.

3.2 *The Workflow model and the patient mapping form*

The Workflow model (

Figure 1) shows the major stages, activities and actions of the patient journey in the PED as identified by the workshop participants managed by EVALAB partner. There are three major stages: Stage 1, (Patient Arrival and Initial Assessment), Stage 2, (Patient (re)orientation and treatment) and Stage 3 (Patient Destinations). The patient can be orientated or reoriented to one of these units knowing that some of them are represented by a sub-process in the global process Workflow model. The decision points, at which the patient journey is dependent on a combination of treatment characteristics and the availability of physical resources, are represented by gateways in the global model.

Due to the 2-years data collection in the PED of the CHRU of Lille, we have anonymous information about 23150 patients' admissions in 2011 and 24039 in 2012. They were used to determine qualitative and quantitative patterns to adjust the Workflow model. We have identified three profiles: summer profile (**Figure 2**), winter profile (**Figure 3**) and crisis profile (**Figure 4**) knowing that we used the same simulation parameters (time slots) for all these profiles.

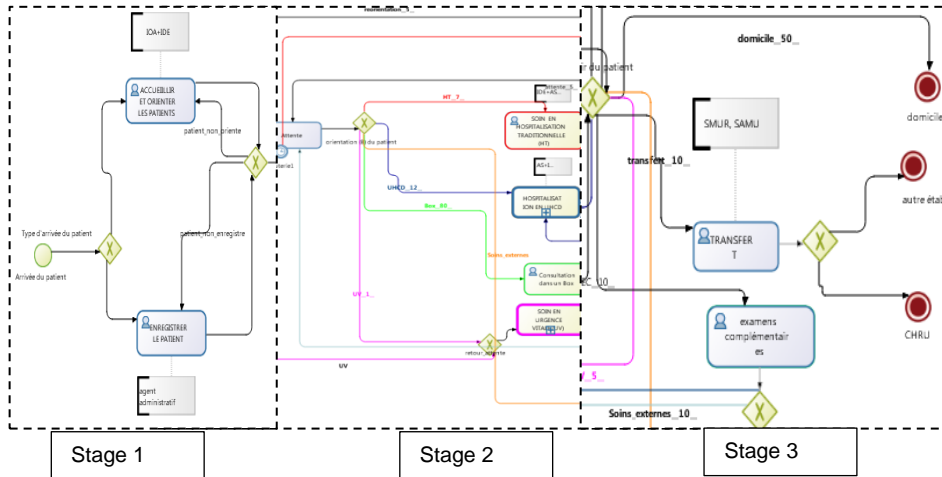


Figure 2. Global Workflow model for the PED

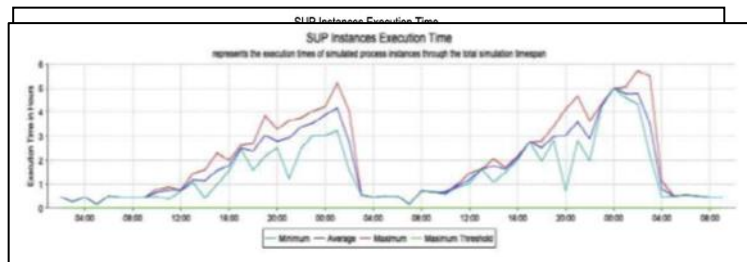


Figure 1. Average waiting time (summer profile)

For each step of the patient journey, expressed within the Workflow model, we developed the correspondent interface form to minimize the possibility of recording errors. So the data record can be done in real time according to the progress of the patient path process in the PED. The Workflow model is connected to a real data base. The collected data is useful for future analyses which are displayed in output simulation interfaces. Patient flow mapping through the PED was carried out in a continuous 2 years period from January 2011 to December 2012. The dataset obtained from the data collection exercise (after improvement) is injected in the simulation module of our Workflow tool. Simulation parameters can be chosen according to a special load profile: Injection period (time window of the staff medical activity) and number of the instances (number of patient cases distributed with a repartition type). There are 2 kinds of repartition: The constant repartition which dispatches instances injection in a constant way along the period and the direct repartition which dispatches instances injection in the start of the period. Thanks to this simulation tool, we can measure the waiting time, each resource's consumption, and at any time, we can find the service states for each patient process for the entire patient journey in the PED.

Figure 3. Average waiting time (winter profile)

Figure 4. Average waiting time (crisis profile)

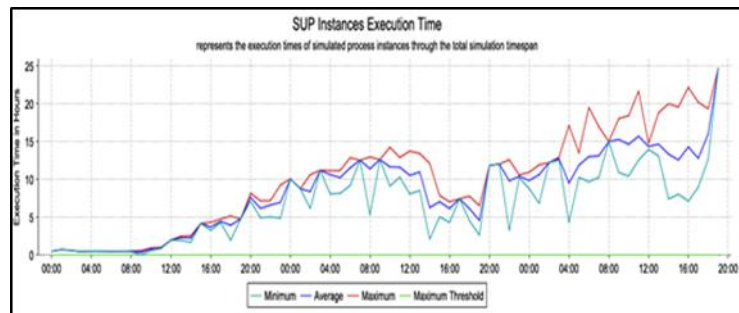
4. Discussion

The Workflow mapping model was limited to the PED itself. Therefore, the outcomes are valuable, primarily, for internal PED management. Nevertheless, the mapping process does shed light on the impact of external factors such as inpatient bed availability (first tension indicator) and on the impact of internal factors such as the sudden increasing of patient flow (second tension indicator). This latter generates a peak of activity of medical staff then a bottleneck (third tension indicator). The data used to adjust the model were collected during two years (2011-2012) within a specific PED and is limited in its general application to other time periods and departments. There were some patients for whom admission was sought, but inpatient beds were unavailable. The patients were eventually discharged after stays in excess of ten hours, having been treated in the PED. The statistical impact was to increase mean time in the PED for discharged patients. On the other hand the mean time interval from bed request to bed availability was artificially reduced due to the removal of the data for these patients from the admitted patients list.

Another limitation is the connection of the Workflow model with the database which is not already established to automate the simulations. In fact, for the moment, we inject manually data in the simulation module in order to generate graphs.

5. Conclusion

The use of Workflow approach to design the patient journey through the PED of CHRU of Lille was effective in facilitating the application of a combination of qualitative and quantitative data to depict and analyze the entire PED activity spectrum. This work will contribute for the re-designing and resourcing the PED. The goal is to develop an intelligent business system which aim to the timely identification of impending access block so that action can be taken to alleviate serious PED over-



crowding.

6. References

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