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Lessons Learned from Implementing a Patient Prioritization Tool Designed with End-Users in a Pediatric Emergency Ward

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Abstract. Introduction. Overcrowding is a common problem in emergency departments. This is true for adult and pediatric emergency department (PED) and issues are potentially important (e.g. quality of care, financial, social, ethical). Optimum is one among several solutions implemented to fight this phenomenon. It is an electronic patient prioritization tool for PED devoted to non-vital emergencies. First usage assessments reported the tool was not used by the PED staffs despite their strong involvement during the development. Aim. This paper aims at understanding why the PED staff did not use the Optimum system that has been designed with them and for them, through a user-centered design process. Method. PED staffs answered answer a short survey about their usage of Optimum. Depending on their answer (user vs. non-user), they either underwent an individual semi-structured interview or an unstructured one. Interviews were audio-recorded and transcribed and, from each interview, meaningful semantic units representing the reasons for using/non-using Optimum were extracted and organized iteratively following a grounded approach by three ergonomics experts till a consensus was reached. Results. 12 interviews have been performed with 6 physicians, 5 nurses and 1 auxiliary nurse. Overall, the prioritization tool Optimum have received a mixed response from the PED staff: Optimum display is neither understood nor trusted by users. Moreover, it is mainly used to estimate the PED attendance rate and not to prioritize patients. Discussion. This study shows how much it is difficult to implement new tool in wards despite a user-centered development and without being included in the daily used patient management tool.

Keywords. Pediatric emergency, patient prioritization tool, usage assessment, human centered design process, overcrowding

1. Introduction

Overcrowding is a common problem worldwide in emergency departments (EDs) [1-2]. Although there is no consensual definition [1,2], crowding can be defined as a mismatch between the ED's human and material resources and the large, often unpredictable number of patients. In extreme cases, it may lead to overcrowding when the number of patients compels the EDs to operate beyond its capacity [3–5]. Usually, EDs are

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considered overcrowded when all of their rooms, chairs, stretchers and waiting rooms are full [1]; A more simple form of overcrowding "*exists when there is no space left to meet the timely needs of the next patient requiring emergency care*" [1].

Several solutions have been tested to prevent EDs from being overcrowded. Educational initiatives have been proposed to reduce the rate of low-acuity visits and flyer-patients, and more generally to reduce the pediatric ED (PED) use [6]. Organizational adjustments have also been studied: for instance by employing someone dedicated to managing beds' occupation [7], or by scheduling staff according to the busy and light times for patient arrivals [8], or by increasing the number of beds. Finally, other initiatives implemented electronic patient triage systems to help optimize patients' triage and prioritization [9]. However, data used by electronic patient triage systems must often be entered manually by the clinicians; this is not possible when the ED is overcrowded, and therefore limits the system's usage and potential impact [10]. To be fully efficient, those systems must display reliable information without requiring supplementary data entry: the Optimum tool has been developed with this goal in mind [11, 12].

2. Context of the study

Optimum is a homegrown electronic patient prioritization tool developed to help clinicians prioritize patients (except vital emergencies) and manage patient flow in real time by automatically retrieving and analyzing data available in the ED's electronic health record (EHR). Optimum is not incorporated into the EHR. It was developed in Lille academic hospital following a human-centered design (HCD) process involving the PED staffs at each step of the process to maximize its usability and acceptance [11, 12]. A work analysis through interviews and shadowing allowed identifying the prioritization rules and patient flow strategies applied by the healthcare professionals during busy periods. Results were turned into functional specifications in collaboration with the PED's head physician. Early mock-ups based on these specifications were presented to a focus group comprising three physicians, two nursing nurses, two human factors specialists and 2 software engineers. Based on healthcare professionals' feedback, a revised mock-up was designed and evaluated through user testing. Results highlighted that the Optimum triage is 98% identical for physicians and 86% for nurses and that users understand the icons and the arrangement of the graphical user interface (GUI) [11].

The GUI displays the distribution of patients in the various steps of the care process using columns and blocks arrangements and, for each patient, the level of delay in his/her care process along with a proposed prioritization to help the PED staff to manage patient flow. A preliminary study confirmed that the indicators mirrors the actual patient progress in the care process and its usefulness [12, 13].

Optimum was implemented in December 2016. Two meetings were organized respectively with medical and nursing staffs to present Optimum's aims, features and indicators. The implementation was fully supported by the PED head physician who incited the staffs to use the tool. In the PED, four monitors display Optimum: 2 in physicians' rooms (main office and residents' office) and 2 in the nursing rooms.

One month after the implementation, shadowing and interviews showed that Optimum was very seldom used. Clinicians expressed they lacked knowledge on the tool. Therefore, another meeting was organized to present Optimum again to the medical and nursing staffs, and explanatory posters were put up beside each Optimum screen. At month 6, a second round of observations showed no change in the usage.

The present study was performed 12 months after Optimum implementation on demand of the HF project owner and carried out by two independent HF experts. It aims at understanding why the PED staff does not use the Optimum system that has been designed with them and for them, through a HCD process.

3. Method

PED's physicians, nurses and nursing auxiliaries were contacted by email 12 months after the Optimum implementation to answer a short electronic survey about their usage of the tool. Depending on their answer, they were categorized as users or non-users. Then, all were interviewed individually: semi-structured interviews for users, unstructured ones for non-users.

Semi-structured interviews were inspired by the critical incident technique [14, 15]. Appointments with the users were made one month before the interviews; for the interview, clinicians were asked to note at least three examples of critical incidents they faced with Optimum, i.e. significant situations during which Optimum proved to be helpful, useless, or disturbing. An email reminded this instruction one week before the appointment. During the interview, the participants had first to relate the situations they identified. Then, 8 questions were asked dealing with: the type of situation, the information sought on Optimum, the impact of having the information and the outcome on the work process and the patient. Besides, participants were asked to explain how they were introduced to Optimum, whether they had been trained, by whom and when, and how they would qualify their usage of Optimum. For the non-user group, unstructured interviews aimed to explore the reasons for their non-usage.

All interviews were audio-recorded and transcribed. Meaningful semantic units representing reasons for using/non-using Optimum were extracted and organized following a grounded approach [16] by two HF experts till consensus arose.

4. Results

Nine persons out of 21 declined the interview invitation. Twelve interviews were performed including 6 physicians (including the head of the service), 5 nurses and 1 nursing auxiliary. Among them, 7 were users (6 physicians, 1 nurse) and 5 non-users (4 nurses, 1 nursing auxiliary). On the day of the interview, none of the interviewees had identified "incidents". They all reported generic situations. During the analysis of the themes tackles during the interviews, we reached saturation with physician users but not with other users and non-users.

4.1. Optimum usage

Overall, the PED staff expressed mixed attitudes towards Optimum. Three main profiles of users emerged: *i)* advanced user, *ii)* sporadic user and *iii)* non-user.

(1) **Advanced user** (n=1; physician head of the PED). He was a driven force for the development of Optimum; he took part to the design phase of the HCD process and to each evaluation session performed after the Optimum

implementation. He has a sound knowledge of the Optimum features and of the underlying prioritization algorithm. He reported using Optimum almost daily because it allows him having an overview of the PED crowding and estimating physicians' and nurses' workload. The delay indicator allows him identifying patients who have been waiting for too long and investigating the causes of those "extra-delays". He uses Optimum to detect the beginning of an overcrowding period in order to quickly and efficiently reorganize the PED staff, and, if need be, to ask other units for more human resources.

(2) **Sporadic users** (n = 6; 5 physicians, 1 nurse). One physician reported using sometimes Optimum to know which patient to call next and to manage residents during overcrowding situations. The others (5/6) do not use Optimum as a prioritization tool neither during overcrowding situations nor during quiet periods: they do not know the underlying prioritization algorithm and are therefore not confident in the system and in the information it provides. At best, they use Optimum to get a global picture of the department's crowding and to identify patients whose wait time is abnormally long. Interviewees explained they initially looked at Optimum's screens because they were placed beside the EHR they constantly used. They gradually noticed that Optimum provided a better overview of the PED situation than the EHR and supplied a very useful delay indicator whose color evolves: "*It is the only information not provided by [the EHR]*". Interviewees insisted on the "red" delay indicator: "*I watch Optimum only when I see the delay indicator is red. For me, this means we are late to care this patient*".

(3) **Non-users** (n = 5, 4 nurses, 1 nursing auxiliary). These healthcare professionals said they did not use Optimum. They considered Optimum as a useful tool for physicians' but not for nurses' work: "*There are no relevant information for us. We spend much more time with patients than physicians, we are always communicating with other nurses and nursing auxiliaries. We know which patient must be cared first*". Furthermore, all nurses criticized the stress issuing from the indicator displaying the patients who are waiting for hospitalization discharge: they related this information is completely unnecessary because they know they have to care these patients and discharge them to empty the PED.

In sum, Optimum is neither used as a prioritization tool nor understood by most of the users. Only two physicians (including the head of the department) perfectly knew Optimum's features. For example, whereas the delay indicator was the mainly used information, only two physicians and one nurse knew its actual meaning: 2 interviewees thought its color varied depending on whether an action or a visit to the patient was needed, 1 thought that it was related to the patient's emergency level; 5 ignored the calculation of the indicator.

4.2. Weaknesses and strengths of Optimum and its implementation

Several weaknesses were reported. Despite their involvement in the design process, nurses and auxiliaries pointed out their lack of training and consequently their lack of knowledge and misuse of Optimum. Besides, the staff highlighted that Optimum's logic and look-and-feel are too different from the EHR's (e.g. icons are different, patient data are more detailed in the EHR, information arranged in columns vs. in rows), which

requires an extra effort to understand and use Optimum. Even if they acknowledged how interesting Optimum may be for physicians, nurses and nursing auxiliaries pointed out Optimum is not designed for their work: to make it more useful, they suggested to add an alert to inform nurses when they have to take patients' vital signs.

Two main strengths were reported. The first one concerns the delay indicator: it allows them identifying and discharging patients who have been waiting for too long and so, avoiding patient's frustration and clear the PED by releasing beds. The second one concerns the patient's prioritization feature. Eight interviewees related an automatic triage feature could be very helpful for their patient management activity: they acknowledged Optimum's added value and agreed it provides a more relevantly patients' prioritization than the EHR.

5. Discussion

This study aimed to understand why, 12 months after its implementation, the PED staff do not use the electronic patient prioritization system that has been designed with them and for them. Only the PED's head and a physician use Optimum as a prioritization tool; others do not use Optimum at all or not as a prioritization tool. Interviews highlighted two main causes depending on the users' profile. From the medical staff's point of view, the lack of understanding of the prioritization rules led not to trust the provided information. From a nursing's point of view, two main issues were expressed: a lack of relevance of Optimum for their tasks probably due to a lack of involvement in the design process from what they said, and a lack training.

These results are surprising given the PED staffs' involvement during the tool design and evaluation process, and the several meetings and supports provided. Different lessons can be drawn based on these results. As regards the medical staff, we should have ensured the correct understanding of the underlying rules implemented in the system along with the data on which the system is based, i.e. their own prioritization rules, validated by themselves during a validation session, based on reliable data of their current EHR. It should be noted here, that, due to turn-over, part of the medical staff left the PED during the period of the study, but some of them were involved from the beginning. As regards the nursing staff, the feeling of not being involved in the process is more difficult to understand. Indeed, they attended less the meetings, but 2 to 3 representatives were there at each meeting and were involved in the design and evaluation sessions as the physicians were. Our hypotheses are that Optimum may be helpful for them only in some conditions that have not been correctly highlighted during the definition of the usage context, or the nurses' needs have evolved.

Results led us to suppose also that Optimum would be more used if it were integrated into the ED's EHR. Indeed, the differences in the display (e.g. icons and arrangement) between the EHR and Optimum bothered the interviewees. Integrating the patient prioritization tool (incl. the delay indicator) into the EHR would help improve its visibility, its understanding, and its perceived reliability and, consequently its usage.

From a methodological perspective, one may be surprised that, despite several reminders, interviewees did not note any incidents to prepare the interviews. This may question the reliability of the results, and the suitability of the critical incident technique to the emergency care context. Yet, all interviewees reported the same kinds of generic situations indicating that the latter were built on similar experiences with Optimum. It ensures a quite good reliability of the results. Nonetheless, the critical incident technique

may not be the method that suits the best the PED's constraints. Indeed, ED staffs' priority is to provide care to patients in a very fast dynamic context. Asking them to take notes of the context of their interaction with a tool increases their workload and may be detrimental to the care process: this may be the reason why interviewees were not able to note instance of their critical interaction with Optimum. Other methods should be tested to explore the interactions of the ED staffs with health informatic technology. An interesting and promising research area to train the clinicians would consist to use virtual reality technology to immerse PED staff in a virtual overcrowding PED environment in which they have to regulate the patient flow by using the Optimum tool.

Conflict of interest

Authors do not have conflict of interest to declare.

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