Building Continents of Knowledge in Oceans of Data: The Future of Co-Created eHealth
A. Ugon et al. (Eds.)

doi:10.3233/978-1-61499-852-5-461

Preliminary Evaluation of an Electronic Patient Prioritization Tool for Pediatric Emergency Department

Jessica Schiro [a 1], Pierre-François Gauthier[a] François Dubos[b]. Sylvia Pelayo[a], Romaric Marcilly[a]
[a] *Univ. Lille, INSERM, CHU Lille, CIC-IT/Evalab 1403 - Centre d'Investigation clinique, EA 2694, F-59000 Lille, France*
[b] *Pediatric Emergency Unit & Infectious Diseases, Univ. Lille, CHU Lille, UDSL EA 2694, F-59000 Lille, France*

Abstract. The study presents the evaluation of the reliability of the information displayed on the user interface of a homegrown electronic patient prioritization tool dedicated to pediatric emergency department (namely Optimum). Two ergonomists shadowed physicians and nurses throughout their shift in order to (i) identify consistencies and discrepancies between the actual step of the patients in the care process and their assigned step in Optimum and (ii) to understand the causes of the discrepancies. Even if some discrepancies are noted, results show that Optimum provides a quite good reflection of the actual position of the patients in the care process. The use of ethnographic methods allows to understand the cause of the discrepancies.

Keywords. Patient prioritization tool, Patient flow, Pediatric emergency department, Human Engineering, Evaluation,

1. Introduction

Managing the patient flow in an emergency department (ED) is a difficult but crucial task [1]. A mismatch between the resources of the ED and the number of patients can lead to overcrowding and long waiting times. The literature describes several attempts to manage patient flow more efficiently. One of them is the development of patient triage systems: at patient's arrival in the ED, a triage nurse assesses the severity of patient's issue in order to prioritize their attendance to by clinicians [2]. Based on the patients' reason for admission and priority level, electronic patient triage systems prioritize the patients in order to decrease waiting times and facilitate immediate treatment whenever possible [3]. Nonetheless, clinicians must often enter manually the data used by today's electronic patient triage systems which is time consuming and not possible when the department is overcrowded, and therefore it limits the system's usage and potential impact [4]. To be fully efficient, electronic patient triage systems must display reliable information without requiring supplementary data entry.

[1] Jessica Schiro, CIC IT 1403, Maison Régionale de la Recherche Clinique, 6 rue du professeur Laguesse, 59000 Lille, France ; jessica.schiro@univ-lille2.fr

2. Study context

Following a user-centered design process [5], we developed an electronic patient prioritization tool for the pediatric ED as a monitoring screen, namely Optimum. Optimum is devoted to non-vital emergencies: vital emergencies are always considered with the highest priority. Optimum automatically retrieves data from the patient management software (PMS) and calculates in real time the priority level of each patient. On the graphical user interface (GUI), a strip represents the patient, his/her motive for emergency, age, suggested prioritization, waiting time, and a delay indicator [5]. This strip moves through several parts of the GUI representing the main steps of the emergency care process following the actual progress of the patient (cf. Figure 1). The five main steps of the emergency care process, as highlighted by a work system analysis, are:

- **Step 1, triage**: a nurse assigns a level of emergency to the patient according to the declared motive for emergency, past-medical history and vital constants,
- **Step 2, first medical appointment**: a physician examines the patient, makes a first diagnosis, and orders thorough examinations, tests, and/or care,
- **Step 3, care/examination**: a nurse performs the care ordered and/or the patient undergoes examinations,
- **Step 4, next medical appointments**: a physician meets the patient again once the cares are performed and/or examination results are available (the physician may order other cares and/or examinations),
- **Step 5, waiting for discharge**: a physician prepares the documents to discharge the patient

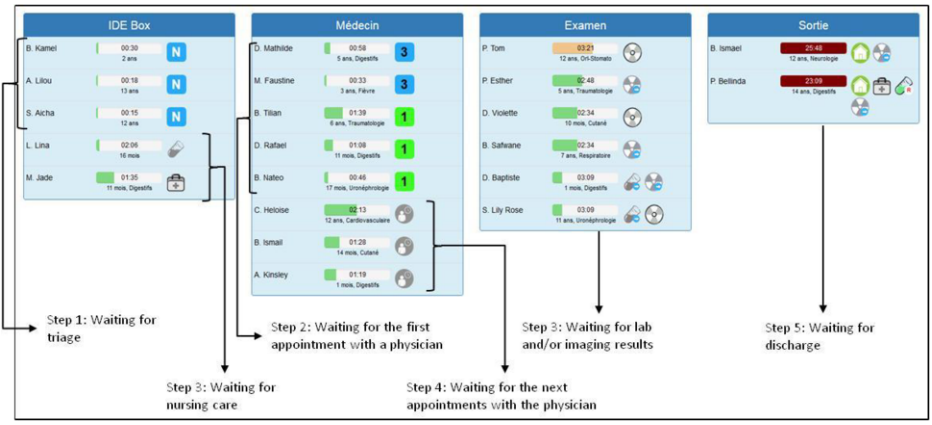

Figure 1. GUI of Optimum. The 5 steps are represented in 6 parts (step 3 is divided in two parts).

For the suggested prioritization in the strip to be useful, it must be displayed in the part of the GUI that corresponds to the actual position of the patient in the process. If not, clinicians may experience difficulties to find the patient on the GUI rendering the system useless. Therefore, before Optimum is fully deployed and its impact assessed, it is necessary to evaluate whether the patient step assignment by Optimum is an exact reflection of the actual process. The paper at hand reports on a preliminary study aiming (i) to assess the reliability of Optimum's step assignment and (ii) to understand the causes of potential discrepancies.

3. Methods

The study was carried out in the pediatric ED of Lille academic hospital in January 2017, one month after the pilot deployment of Optimum. Four monitors displayed Optimum in 2 physician offices (main office & residents' office) where physicians complete the patients' records, and in 2 nursing rooms where cares are performed. The patients cannot see the monitor. The head of the department and all participants gave their consent for the study.

3.1. Data collection

Two ergonomists shadowed nurses and physicians throughout their shift. For each patient care observed, they noted:

- the step of the process the patient is actually in (triage, first medical appointment, care/examination, next medical appointments, waiting for discharge): a step starts with the healthcare professional calling the patient and ends as soon as the same professional calls another patient.
- the step of the process in which the patient is assigned on Optimum GUI when the professional calls him/her.
- contextual information: current level of strain in the department, profile of the professional, motive of the emergency, interactions between professionals.

For each patient care that they observed, the ergonomists performed informal-on-the-fly interviews with the professionals as soon as their workload decreased. These interviews allowed to collect data to understand the potential discrepancies between the actual step of the patient and its position on Optimum.

3.2. Data analysis

In order to identify consistencies and discrepancies between patients' actual step in the care process and their assigned step in Optimum, data were computed into a similarity matrix. It allowed to compare the step of the process in which the patient was supposed to be according to the Optimum when the healthcare professional started to take care of him/her with his/her actual step. Cohen's Kappa was calculated to assess the degree of consistency between the actual step and the assigned one.

4. Results

Observations were carried out over 7 working days for a total of 33h45. Eighty-five patient cares were observed corresponding to 62 different patients (some patients were seen twice by the same shadowed professional). Table 1 presents the number of patient cares observed. Some steps (#1, #3, & #4) were more often observed than other because they were more systematic (e.g. #5: some patients leave without waiting for the official discharge).

Overall, the agreement between the step of the patient as displayed in Optimum and his/her actual step is quite good (Cohen's $\kappa = 0.65$)[6]. Nonetheless a few discrepancies were observed (cf. Table 2).

Table 1. Number of patient cares observed and of professional observed according to the step of the process.

Step of the care process	Professional	Number of patient cares observed	Number of professionals observed
1. Patient triage	Registered Nurse	21	4
2. First medical appointment (diagnosis/prescription)	Physician	23	5
3. Nursing care / examination	Registered Nurse	12	6
4. Next medical appointments	Physician	19	6
5. Waiting for discharge	Physician	10	4

Most inconsistencies were observed at the first step. The motive for emergency must be entered in the PMS so that the patient appears on Optimum. Yet, depending on the strain in the department, this data is entered at two different moments. When the department is overcrowded, it is more likely entered at patient arrival together with administrative data (e.g. ID) by the front desk orientation nurse: in this case, the patient is displayed in the "triage step" and therefore the nurse looking at Optimum knows that this patient must be seen for triage. On the contrary, when the department is not overcrowded, the motive for emergency is entered during the "triage step"; therefore the patient is not displayed on Optimum in time when the nurse calls the patient.

Table 2. Similarity matrix.

		Actual step of the process the patient is in					
		1. Patient triage	2. First medical appointment	3. Nursing care / examination	4. Next medical appointments	5. Waiting for discharge	*Total*
Step of the process the patient is in according to Optimum	0. Not yet in the PMS	12	0	0	0	0	*12*
	1. Patient triage	**9**	1	0	0	0	*9*
	2. First medical appointment	0	**21**	3	0	0	*24*
	3. Nursing care / examination	0	1	**9**	3	2	*16*
	4. Second medical appointment	0	0	0	**16**	2	*18*
	5. Waiting for discharge	0	0	0	0	**6**	*6*
	Total	*21*	*23*	*12*	*19*	*10*	*85*

We observed one anticipation: the patient was displayed on Optimum one step in advance. The resident entered a care order in the PMS; therefore, the patient moved in the "care" part on Optimum. Yet, the resident extended the appointment by asking a senior physician for a second opinion causing this slight discrepancy.

We observed also several types of delays: the patient was displayed on Optimum one or two steps late.

- At the end of the "triage" step, nurses are supposed to enter the patient's "triage number" along with values of physiological parameters in the PMS. On Optimum, the patient moves then from the "triage" step to the "first medical appointment" step. Yet, sometimes nurses examined two or three patients in a row before entering their data which was causing a delay in the changes on Optimum GUI.
- Sometimes physicians gave verbally the care orders to the nurses. Therefore, nurses started to perform the cares while the orders were not yet entered in the PMS. In those cases, the patients were still in the "first medical appointment" step on Optimum while actually in the nursing "care / examination" step in the department.

- When the decision was made that a patient can be discharged, healthcare professionals did not enter immediately in the PMS last data about the patient (e.g. final diagnosis, results of the examination). They sometimes saw several patients in a row before making the inputs. It prevented patients to move in time in the last step "waiting for discharge" on Optimum GUI.

5. Discussion

This preliminary study aimed (i) to assess the reliability of the care process' step assignment by an electronic patient prioritization tool (ii) and to understand the causes of potential discrepancies with the actual care process. Overall, results highlight that the moves of the patients on Optimum GUI follow quite well their actual move in the care process. Nonetheless, a few discrepancies were observed. Observation and interview methods showed their added value by uncovering the causes and the consequences of those discrepancies.

Discrepancies highlight limits of Optimum. Optimum is built on the assumption that data input in the PMS is the last action of the professionals before seeing another patient; however, sometimes, entries are done during the consultation. As a consequence, a nurse relying on Optimum to know which patient must be seen next will not find immediately the patient since (s)he is still with the physician. A second limit is that data are sometimes entered too late in the PMS for Optimum to display an exact image of the patients' distribution in the department. However, this gap does not negatively impact the care process. Indeed, due to verbal communications that anticipate data entry, nurses and physicians manage to coordinate efficiently medical and care/examination steps.

This preliminary study was necessary to assess the reliability of the information displayed on the monitoring screen of an electronic patient prioritization tool dedicated to pediatric emergencies. Overall, Optimum provides most of the time a quite good reflection of the actual care process. The results are sufficiently good to allow this tool to undergo an evaluation of its usefulness for healthcare professionals' work and organization, and ultimately on the strain in the department and on patients' waiting time.

References

[1] N. Jayaprakash, R. O'Sullivan, T. Bey, S.S. Ahmed, S. Lotfipour, Crowding and Delivery of Healthcare in Emergency Departments: The European Perspective. *Western Journal of Emergency Medicine* **10** (2009),233-239.

[2] G. Lachenal, C. Lefève, V.K. Nguyen, *La médecine du tri. Histoire, éthique, anthropologie*, Presse Universitaire de France, Paris, 2014.

[3] A. Azadeh, M. Hosseinabadi Farahani, S. Torabzadeh, M. Baghersad, Scheduling prioritized patients in emergency department laboratories. *Comput. Methods Programs Biomed* **117** (2014), 61–70.

[4] M. Twomey, L.A. Wallis, J.E. Myers, Limitations in validating emergency department triage scales, *Emerg Med Journal* **24** (2007),477–479.

[5] J. Schiro, N. Leroy, R. Marcilly, Contribution of Human factors in the design of a patient scheduling system for the pediatric emergency department. In *Actes de la 27ème conférence francophone sur l'interaction Homme-Machine*, Toulouse, 2015.

[6] J.R. Landis, G.G. Koch, (1977). The measurement of observer agreement for categorical data. *Biometrics* **33** (1977), 159–174.