Towards a Clinical Decision Support System for Helping Medical Students in Emergency Call Centers

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Abstract. In critical situations such as pandemic, medical students are often called to help in emergency call centers. However, they may encounter difficulties in phone triage because of a lack of medical skills. Here, we aim at developing a Clinical Decision Support System for helping medical students in phone call triage of pediatric patients. The system is based on the PAT (Pediatric Assessment Triangle) and local guidelines. It is composed of two interfaces. The first allows a quick assessment of severity signs, and the second provides recommendations and additional elements such as "elements to keep in mind" or "medical advice to give to patient". The system was evaluated by 20 medical students, with two fictive clinical cases. 75% of them found the content useful and clear, and the navigation easy. 65% would feel more reassured to have this system in emergency call centers. Further works are planned to improve the system before implementation in real-life.

Keywords. Clinical Decision Support System, Pediatric Emergency, Digital Health, Phone call triage.

1. Introduction

Emergency call centers are a key component to regulate patient flow and emergency department crowding [1,2]. They are composed of phone operators who manage patients efficiently and with minimal delays as patients move through stages of care [3]. Phone operators have to assess patients remotely, determine the level of emergency and then decide quickly on the most appropriate medical assistance for the patient [3]. Since recent

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years, the number of calls is continuously increasing in emergency call centers, while the number of phone operators stabilizes [1]. Some catastrophic events (e.g., COVID-19) may also worsen the situation and lead to an overflow of emergency hotlines. In such critical situations, undergraduate medical students are often involved in phone call triage [4,5]. However, they encounter difficulties because of the lack of medical skills.

Clinical decision supports systems (CDSS) could support undergraduate medical students in telephone triage (TT) [3]. Indeed, CDSS-integrated-TT have the potential to improve patient triage by standardizing the decision-making process independently of operators' qualifications or experience [3]. Several CDSS-integrated-TT have been developed, such as "SALOMON" for nurse triage in Belgium [6] ; "TAS", "Personal Health Adviser", "Centramax", and "AXA Assistance" in UK NHS Direct Call center [7] ; or ExpertRN in US [8]. However, these CDSS are hardly transposable from one setting to another, as it depends strongly on the health care organization of country [3].

In France, emergency call centers lack such CDSS, especially for supporting medical students to manage pediatric emergency situations. Here, we aim at developing a CDSS for supporting undergraduate medical students in patient remote triage of pediatric patients.

2. Methods

2.1 CDSS design

To design the CDSS, we followed 5 steps. ***In step 1***, we made a literature review to identify which guidelines used for building the knowledge base of the CDSS. This resulted in selecting local guidelines written by the SAMU of Paris (Service d'Aide Médicale Urgente, one of the greatest emergency call centers in France), but also the Pediatric Assessment Tool (PAT), an internationally accepted tool for the initial assessment of children [9]. ***In step 2***, we extracted decision and action variables from SAMU guidelines and PAT. These variables were then grouped by categories, depending on their type and their importance in the decision process (e.g., variables of the PAT were grouped into the category "severity symptoms to check in first"). ***In step 3***, we designed several interface mock-ups, using Whimsical platform (https://whimsical.com/, access 2021), for displaying the categories of information identified in step 2, until finding the most appropriate interface. ***In step 4***, we implemented the interface and the underlying algorithm, using Shiny extension of R programming language. ***In step 5***, the prototype was tested by 4 medical doctors from SAMU of Paris, and 7 undergraduate medical students from the digital health program of the Université de Paris. This evaluation resulted in improving the prototype (e.g., adding a more meaningful cursor for the selection of the clinical situation), and led to a new version of the CDSS.

2.2 CDSS evaluation

The CDSS was assessed by 20 undergraduate medical students. They tested the system online without supervision, using two clinical cases simulating emergency phone calls. These clinical cases allowed to navigate through various options of the CDSS. After that, medical students had to rate their experience using an anonymous online form including 6 questions related to aesthetics, relevance and confidence. Each item was assessed through a 5-points Likert Scale. Feedbacks could be added in free-text comment sections.

3. Results

3.1 CDSS design

The CDSS displays two interfaces. The ***first interface*** is dedicated to the quick assessment of pediatric patient. It includes two sections (Figure 1):

- 1st section, on the left (area a), allows to add data on gender, age and weight. If the weight is not provided, then an interactive cursor predicts automatically the most likely weight adjusted to the age (based on pediatric standards [10]).
- 2nd section, on the right, has 2 areas. Top area (area b) specifies the type of emergency (e.g., fever). Bottom area (area c) displays 4 quadrants corresponding to the components of the PAT (i.e., respiratory, circulatory, neurological failures), and the severity signs specific to each type of emergency.

Once the user has filled the first interface, he can visualize the ***second interface***, which displays the recommendations of the CDSS. It includes two sections:

- The 1st section on the left, is the same than in the first interface. It allows the medical student to always keep an eye on patient information.
- The 2nd section on the right, displays the recommended actions and some important medical information. Recommended actions (e.g., sending an ambulance +/- with a rescuer team) are displayed at the top. Additional guidelines and advice are also displayed on request through the tab "medical advice to give to the patient", and the tab "to keep in mind". Finally, a summary of all ticked information is displayed on the bottom, with the possibility to add information in free text. In the future, this recap could be sent to the emergency team on ambulance.

Figure 1. CDSS interface. The user first chooses a specific situation on the top of the interface, and then fills patient information on the left (e.g., age, weight). Then, the user selects the patient symptoms from the list of items. Items are grouped by colour according to the type of failure (e.g., red colour for circulatory failure). Additional items, specific to each clinical situation, are displayed in the purple box.

3.2 CDSS evaluation

Twenty undergraduate medical students assessed the system. 90% of them had no experience in phone call triage, and 40% used medical applications at least once a week.

Regarding user interface, 75% of students found the interface easy to use, 60% liked the design, and 75% found the information clear and useful (Figure 2). Regarding confidence, 65% of students said they would feel more reassured with this system in emergency call centers (30% were undecided) and 45% would have more trust in their decision using this system (45% were undecided). Regarding system use, 55% of students said they would use the system in emergency call centers (40% were undecided).
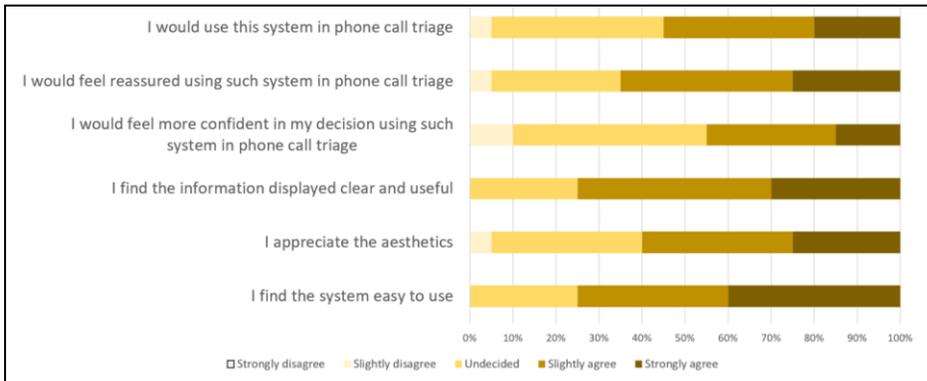

Figure 2. Results of the evaluation.

4. Discussion

We designed a CDSS for helping undergraduate medical students in emergency call centers. The CDSS was designed by and for medical students, with two main objectives: overcoming their lack of expertise in pediatric phone triage and reassuring them in their medical decision. 75% of students found the information useful, and the navigation easy. However, only 45% said they would feel more confident using this system (45% were undecided), and only 55% said they would use the system in emergency call centers (40% were undecided). The high percentage of uncertainty is probably explained by the lack of experience in phone call triage for both children and adults. Indeed, 90% of them had never experienced this task, and therefore may encounter difficulty to determine if the system would reassure them or if they would use it in real life.

This work presents some limits. First, we used a combination of local guidelines and PAT for building the knowledge base, because of a lack of national pediatric guidelines. However, local guidelines were written by a group of medical experts having experienced in a large emergency call center, and PAT is an international well-recognized tool [9]. Other types of representation such as ontologies, could be used in the future to facilitate guidelines implementation. Second, the interface may appear too complex because of high quantity of text (due to our will to provide a maximum of information to medical students to overcome their lack of medical skills). In the future we plan to use other design techniques such as icons for limiting the quantity of text [11].

A few CDSS have been designed for phone call triage [6–8]. However, they targeted specific health professionals (e.g., nurses [6]), and specific organization (e.g., NHS [7]).

Our literature review only retrieved one CDSS designed for medical students, but it was devoted to COVID-19 [4]. We expect that our system could help to standardize medical decision in pediatric phone triage [3], and thus improve the quality of care.

In the future, we aim at improving our system, and then conduct a more robust evaluation, before potential implementation in emergency call center. We expect that the improved system could assist medical students in making quick and appropriate decisions, as well as increasing their medical knowledge in pediatric situations.

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References

[1]   Viglino D, Vesin A, Ruckly S, Morelli X, Slama R, Debaty G, et al. Daily volume of cases in emergency call centers: construction and validation of a predictive model, Scand J Trauma Resusc Emerg Med. 25 (2017) 86. doi:10.1186/s13049-017-0430-9.

[2]   Campbell JL, Fletcher E, Britten N, Green C, Holt TA, Lattimer V, et al. Telephone triage for management of same-day consultation requests in general practice (the ESTEEM trial): a cluster-randomised controlled trial and cost-consequence analysis, The Lancet. 384 (2014) 1859–1868. doi:10.1016/S0140-6736(14)61058-8.

[3]   Islam F, Sabbe M, Heeren P, Milisen K. Consistency of decision support software-integrated telephone triage and associated factors: a systematic review, BMC Medical Informatics and Decision Making. 21 (2021) 107. doi:10.1186/s12911-021-01472-3.

[4]   Vrel JP, Oulmane S, Boukobza A, Burgun A, Tsopra R. A COVID-19 Decision Support System for Phone Call Triage, Designed by and for Medical Students, Stud Health Technol Inform. 281 (2021) 525–529. doi:10.3233/SHTI210226.

[5]   Telion C, Marx JS, Dautreppe C, Carli P. Crise COVID-19 : les étudiants en médecine en renfort de la régulation médicale, Journal Européen Des Urgences et De Réanimation. 33 (2021) 96–101. doi:10.1016/j.jeurea.2021.05.001.

[6]   Brasseur E, Servotte JC, Donneau AF, Stipulante S, d'Orio V, Ghuysen A., Triage for out-of-hours primary care calls: a reliability study of a new French-language algorithm, the SALOMON rule, Scand J Prim Health Care. 37 (2019) 227–232. doi:10.1080/02813432.2019.1608057.

[7]   Cathain AO, Webber E, Nicholl J, Munro J, Knowles E. NHS Direct: consistency of triage outcomes, Emerg Med J. 20 (2003) 289–292. doi:10.1136/emj.20.3.289.

[8]   North F, Richards DD, Bremseth KA, Lee MR, Cox DL, Varkey P, et al. Clinical decision support improves quality of telephone triage documentation - an analysis of triage documentation before and after computerized clinical decision support, BMC Med Inform Decis Mak. 14 (2014) 20. doi:10.1186/1472-6947-14-20.

[9]   Dieckmann RA, Brownstein D, Gausche M. Hill, The pediatric assessment triangle: a novel approach for the rapid evaluation of children, Pediatr Emerg Care. 26 (2010) 312–315. doi:10.1097/pec.0b013e3181d6db37.

[10] Heude B, Scherdel P, Werner A, Guern ML, Gelbert N, Walther D, et al. A big-data approach to producing descriptive anthropometric references: a feasibility and validation study of paediatric growth charts, The Lancet Digital Health. 1 (2019) e413–e423. doi:10.1016/S2589-7500(19)30149-9.

[11] Madar R, Ugon A, Ivanković D, Tsopra R, A Web Interface for Antibiotic Prescription Recommendations in Primary Care: User-Centered Design Approach, J Med Internet Res. 23 (2021) e25741. doi:10.2196/25741.