A Mobile Platform for Emergency Care

Eleonora LOSIOUK\textsuperscript{a,1}, Silvana QUAGLINI\textsuperscript{a}, Massimo PESENTI CAMPAGNONI\textsuperscript{b}, Giordano LANZOLA\textsuperscript{a}

\textsuperscript{a}Dept. of Electrical, Computer and Biomedical Engineering, University of Pavia, Italy
\textsuperscript{b}AUSL Valle d’Aosta, Italy

\textbf{Abstract.} The paper describes the adaptation of a mobile platform initially developed for designing and administering questionnaires to a new context supporting checklists in emergency care. We took part in the checklists formalization process together with the domain experts and recognized that some tasks would highly benefit from the inherent features offered by the mobile technology. Thus we exploited the robustness of the model already designed for navigating among questionnaires and implemented additional functionalities that improved the usability of the mobile application, making it suitable for the paramedic staff and the volunteers that manage emergency cases.

\textbf{Keywords.} Emergency Outpatient Unit, Medical Informatics, Guideline Adherence, Patient Outcome Assessment, Questionnaire Design.

\section*{Introduction}

The ever increasing amount of scientific knowledge together with the inherent complexity of the emerging practices are turning the whole decision-making processes very hard to afford for clinicians and error-prone [1]. A promising approach to cope with the growing complexity of healthcare and the difficulty to grasp the associated amount of information relies on the use of computerized systems [2] as the enabling technology for decision support systems based on the implementation of clinical practice guidelines [3]. In some fields, it is well known since a long time that guidelines improve the quality of care [4], decrease the variability among clinical practices and reduce the overall costs [5]. A particular kind of clinical guidelines, emerging in the past few years, is given by \textit{checklists}. Those were originally meant as tools supporting decisions in order to minimize errors in time-tight complex activities, such as those faced by airline pilots, or as quick references in the manufacturing and repair industry. The introduction of checklists in the medical area is rather recent, but examples are already documented in the literature. Their adoption is mainly oriented to support the correct use of technology, as in addressing the proper control of the laparoscopy equipment to prevent surgical errors and mortality [6], in improving surgical safety in resource-limited countries [7], or in preparing for the separation from cardio-pulmonary bypass [8]. Nevertheless checklists are also entering the core of the clinical practice as in discriminating people with normal cognitive capabilities against ones with cognitive complaints [9], in screening individuals for post-traumatic stress disorder [10], or in preventing missing information during transitions of care across clinical settings [11].

In this paper we describe our attempt at providing a mobile platform facilitating the dissemination and exploitation of checklists. A suitable set of those, designed by a...
first-aid department and addressing the procedures adopted by paramedic rescue teams and volunteers working on board of emergency vehicles, has been formalized and is being rendered through our platform.

1. Methods

Since checklists play the role of "lightweight guidelines" it is important that they are easily available at any time and at any place where decisions are to be taken. In order to facilitate their fruition the mobile environment was chosen, and to this aim we adapted G-quest, that is a platform originally developed by the authors for the remote administration of questionnaires and the collection of their answers [12]. In order to carry out this adaptation, we borrowed many of the ideas available in the literature concerning the formalization and use of computer-interpretable clinical guidelines [3]. However, through discussions with the domain experts, we identified the following additional features and requirements specific to the emergency context that should be exploited by the platform while rendering the checklist.

- Because of stress and lack of time, accuracy and attention decrease while facing emergency situations. The layout of each screen should be as simple and intuitive as possible, preventing wasting time during the consultation of a checklist;
- The interaction with the platform depends on the number and role of the operators on the ambulance. If the same operator needs to access the checklist and take care of the patient at the same time, full vocal interaction could be very useful. However, the noisy environment makes this kind of interaction difficult. Thus, multiple interaction modes should be available;
- The ambulance operators are well-trained on the use of emergency protocols. However, while knowing the overall procedure, the chaotic context may cause them to forget some details such as how to modulate drug dosages for elderly or paediatric patients. Thus, a visualization of the recommended dosages and an algorithm for computing the actual dose should be provided;
- Risk assessment is very important for assigning a severity code that is used to decide the patient destination and, in case of a transfer to the hospital, to prompt for his initial assessment (e.g., the Cincinnati scale score for stroke is useful to prompt for thrombolisis). Thus, risk scores calculations should be provided.

In Figure 1 we illustrate the whole lifecycle involving the definition and dissemination of checklists that starts as usual with a consensus process. Once defined, checklists can be moved from the paper form to an electronic format through an editor exploiting the customary building blocks (e.g. start/stop, input/output, decision and processing) augmented with the functionality required to define the emergency-specific features. Finally, once they have been encoded into a computer interpretable format, checklists can be downloaded by a mobile application that enables their rendering.
2. Results

The platform is being developed based so far on eight checklists selected by the emergency staff that address the following problems: pediatric or adult cardiac arrest; airways obstruction, ventilation and oxygenation management; pediatric or adult seizure; chest pain; generic pain. In their paper versions, many ambiguities have been detected, such as undefined semantics, too qualitative or contradictory statements, and incomplete decision paths. After resolving them, checklists have been rendered into an electronic format and downloaded on G-quest, where they are permanently saved and may be easily searched by their names. This way they can be accessed and used by the paramedic staff to rehearse the most appropriate procedures on their way to the emergency setting, or as a reference tool as they are operating on the patient. As an example Figure 2A shows the recommendations from the generic pain checklist.

The layout of each screen emphasizes the upper part which includes important information about a task to be accomplished or a question to be answered as part of the decision process represented by the checklist. In the bottom part there is instead some additional information better characterizing the task or a set of possible answers for the question. Contextual information or reference material, that on paper checklists was usually available in the appendixes, is now shown on the mobile platform through a pop-up window that opens whenever the user presses a button located next to some items during the consultation process, as shown in Figure 2B. This is important because emergency checklists, besides the plain flowchart representing the decision process, also include useful information (e.g. drug dosages, details on the accomplishment of specific maneuvers, etc.) that on the paper format is unlinked from the location where it is referenced and is therefore quite difficult to find.

In addition to visually providing help through pop-up windows, we also adopted an alternative approach exploiting the speech synthesizer embedded in the mobile platform, so that the operator can listen to instructions when he is busy with the patient. This functionality is accessed through a different button, which causes the rendering of the synthesized text associated to the specific recommendation, question or answer, or
plays a pre-recorded audio file. This latter option could be used for sending out the chest compression pace useful in the cardio pulmonary resuscitation procedure.

Figure 2. Some screenshots illustrating the exploitation of a checklist (A), a pop-up help window (B) and its final assessment questionnaire (C) on a mobile platform.

An interesting set of enhancements proposed by the first-aid department team concerns the possibility of sending emails or searching the web. Those have been implemented by placing some links on the action bar. Emails may be sent to the expert team in order to notify problems, suggestions, or simply request clarifications about the current checklist. To this aim the email automatically includes contextual information about the specific point reached in the decision process (i.e. the screen).

The adaptation of G-quest to the new context of checklists and the new functionalities introduced are not in contrast with its original function, so that it is still possible to represent questionnaires. In Figure 2C we illustrate an example of an assessment questionnaire that could be administered, of course out of the emergency context, to assess the users’ perception about the checklist efficacy.

3. Discussion

This paper describes an ongoing project which has not been tested yet in its final context of use. Its contribution deals with the development of a platform fostering the adoption of checklists in the clinical practice and overcoming the problems arising from their distribution using a paper format and narrative definitions. The project is part of a wider set of activities turning a mobile platform as an integrated hub for first-aid and emergency operators. Additional services include the possibility of capturing patient images for getting remote advice from specialists or shooting video-clips for documental, legal or liability purposes. An interesting functionality still to be developed involves linking a checklist to the patient EHR. The downstream path could be used to exploit any available patient data to support the decision process, while the
upstream one could record into the EHR any resulting action. The link will be provided exploiting the same Application Programmer Interface (API) already used to transfer the demographic data of the patient and his major past health related issues to the emergency team. That API is part of the basic information infrastructure available to first-aid departments managing emergency vehicles and addresses privacy and security issues according to the Italian regulations. The functionality available with G-quest that transparently synchronizes any data entered by the user into the questionnaire helps in automatically documenting the actions undertaken. This may be used to accomplish an ex-post analysis after each mission or even to assess the overall efficacy of a checklist by correlating first-aid interventions with the health outcomes, possibly exploiting an ontology server [13]. Finally, the possibility of deploying checklists by downloading them makes them easily updatable whenever the need arises to do so. This is an important feature since emergency protocols are updated very frequently.

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References