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A Smartphone App for Bedside Recording of Nursing Handovers in Haemodialysis Units

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Abstract. The purpose of this study is to present the design, development and initial evaluation of a smartphone software (mobile app), for the needs of nursing bedside shift reporting and documentation. The app records and process nursing handovers concerning haemodialysis patient data, and it runs on Android smartphones, offering a structured and friendly user interface. Data are collected, processed, stored and accessed easily, quickly and securely by authorized users. The evaluation, based on discussions and semi-structured interviews with a group of nurses, showed positive feedback on the user interface, structure and functions of the prototype. It can be a useful and efficient tool for the reporting and communication needs between nurses. Conclusions about the limitations of the study and future developments are reported.

Keywords. Mobile Applications, Patient Handoff, Point-of-Care Systems, Nursing Informatics, electronic documentation

1. Introduction

Nursing shift reports or nursing handovers is the most common means of documenting nursing practice and reporting patient state and care between nurses. They benefit nursing profession, patient care and healthcare system, by promoting the efficient communication between nurses, organizing their work, enhancing their professional relationships and team cohesion, improving patient outcomes, maintaining the continuity of care, reducing errors and risks, and ensuring patient safety [1-3]. Bedside nursing shift report may offer additional benefits, such as relationship building among nurses, increased satisfaction both to nurses and patients, better communication among nurses and patients, more accurate, quick and precise documentation, prioritization of the care for the shift [4]; moreover, it is one of the most crucial functions for nurses, and a critical process in patient care for reducing errors and improving patient safety [3,5].

Reporting quality may vary since it depends on the experience, expectations, workload, relationships of nurses, available time and means for handouts recording [2]. It is common for nursing handovers to include a variety of either concise, structured, formal, standardized, electronic information or rich, rough, handwritten, unstructured, informal notes. The lack of structure in nursing handovers is one of the most important

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aspect to be addressed, in order to improve inaccurate, incomplete information, and reduce ambiguity. A structured tool for recording and transferring nursing handovers is highly recommended [2]. However, a specific, uniform structure should be followed for contextually based handoffs rather than for all nursing units [3].

The use of new technologies, especially web and mobile applications, are beneficial for documenting practice, handover reporting and standardizing the communication process between nurses and other healthcare professionals [6-10]. Concerning nursing documentation in Greece, the efforts exploiting web technologies are limited [11].

The aim of this paper is to propose a software application functioning in a smartphone (mobile app), for the needs of nursing bedside shift reporting of a nephrology and haemodialysis hospital unit. The proposed app tries to address aspects raised in bedside nursing shift reporting. The next sections present the design, development and initial (pilot) evaluation of the proposed mobile app for recording nursing handovers.

2. Methods

Our prototype mobile app followed the process of the Software Development Life Cycle [12], with the phases followed: software (app) aims and concept, requirement analysis, design, implementation, testing and evaluation.

In the requirement analysis phase, we formed a small group of nurses working in an haemodialysis hospital unit, in Athens, Greece, to determine the functional and nonfunctional requirements. Through brainstorming discussions, we defined the app's structure, functions, users, data to be recorded, privacy and confidentiality requirements. The app should record the data of the patients visiting the haemodialysis unit, monitor and compare their data from visit to visit. The users would be authorized nurses, who, after being authenticated, should be able to view the list of their patients and select a specific patient to view and process specific healthcare information. For each patient, the user should view the demographic data and a brief health history, view and process the vital signs, interventions conducted, complications and observations noted. The required data to be recorded would be: heart rate, body temperature, systolic and diastolic blood pressure, blood glucose, allergies, diagnosis, medication prescribed, IV lines applied to patient for haemodialysis, data associated with infection, pain, and pressure ulcers. The app would enable photos to be taken and stored in the patient's accountability form so that possible patient complications could be recorded and visualized. The user would access, view and process patient data by clicking, selecting, adding or modifying data in the certain fields. The nonfunctional requirements determined were: performance (system speed), security, ease of learning and use of the application, reliability and availability. The app should operate in a popular mobile platform.

In the design phase, we documented each requirement, sketched different data layouts, screen outputs, data flows and storage, and selected the tools needed for the implementation. Cloud Firestore Database, a free Google NoSQL cloud database to store and sync data, was selected for data organization and storage [13], Flutter, the Google's User Interface (UI) toolkit, for developing the app's UI [14], and Android Studio as the development environment for the app [15]. Due to the prototype nature of the app, the system's architecture was minimal. The security aspects were limited to the functionality offered by the Cloud Firestore Database. In the implementation phase, we developed the app's database and UI. Several tests followed, through various user case scenarios and data, for verifying the app's stability, functionality, confidentiality and availability.

In the evaluation phase, we formed a focus group of potential users to participate in the evaluation through semi-structured interviews. Semi-structured interviews were selected since they are "highly interactive" and "researchers can clarify questions for respondents and probe unexpected responses" [16]. Nurses working in a haemodialysis hospital unit for at least one year, using a smartphone and having basic internet skills (i.e., searching and browsing skills, sending e-mails) were defined as inclusion criteria. An homogeneous group of 10 nurses, 6 women and 4 men, aged from 28 to 51 years old, evaluated the prototype. We defined the extent to which the requirements were met, and recorded any weak points detected from the participants while using the application, by constructing a brief questionnaire of 8 questions. The questions focused on app's ease of use (e.g., when entering or processing data), user-friendliness (e.g., viewing patient history data), and user-connection issues.

3. Results

The prototype's homepage is the user's login page. The authorized user fills in his credentials to access patient information, and when logged in, a page containing the list of the active patients is displayed. This page includes for each patient the full name and diagnosis, while specific buttons enable the selection of a patient to view and process data, the creation of a new nursing handover for the selected patient, or the addition of a new patient (Figure 1a). When selecting a patient, the page displays patient's full name, photo, date of birth, main admission health problem, allergies, medication, diagnosis, responsible physician (Figure 1b). When creating a new nursing handover (new accountable) for the selected patient, data such as values of heart rate, body temperature, systolic and diastolic blood pressure, blood glucose, placement of IV lines, occurrences of pain, infection, and pressure ulcers may be entered and processed (Figure 1c). If an IV line has been placed to the patient or a pressure ulcer has been observed, the app allows the entry of photos (e.g., displaying an infection at the point of entry of the IV line), allowing the visualization of the observation, its comparison and control between shifts, and the effective decision making for an appropriate treatment plan (Figure 1d).

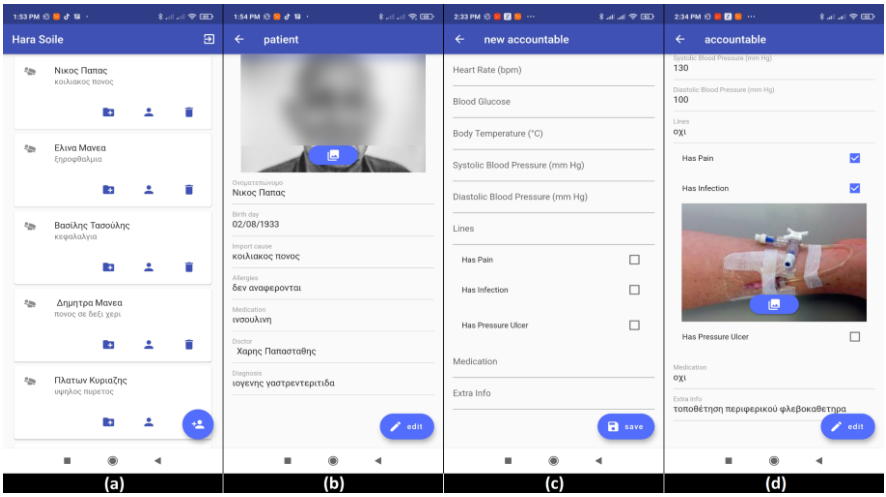

Figure 1. Mobile app's screenshots for recording nursing handovers (a, b, c, d).

A maximum time of 30 minutes was adequate for them to test the prototype. All participants owned an Android smartphone. The majority of them (90%) agreed that the registration, the authentication process, the creation of a new patient are easy. Also, 90% of them reported that it is easy and fast to record and process patients' data. All participants agreed that taking photos is an easy and fast procedure, the UI is user-friendly, and the application performs well both online and offline. All agreed that the structure followed is convenient, the data required for recording the nursing handovers are appropriate, and the mobile app would be very useful to their work. They discussed that the bedside recording and transferring of nursing handoffs from shift to shift, through the app, would support and improve the communication between nurses and the nursing documentation itself. However, some reported that if the prototype had to be utilized in the clinical routine, many nurses would find it difficult to use. They underlined that Greek nurses tend to be reluctant and sceptic with new technology at work, since it would change their working routine and seem intimidating to them due to their limited knowledge and skills. Nevertheless, they said that if nurses were more trained to mobile health aspects, these restrictions could be moderated. None of the participants reported any issues related to the navigation, unclear content or ease of use while viewing and processing the nursing handovers or connecting to the application.

4. Discussion and Conclusions

We proposed a smartphone prototype app for the needs of nursing bedside shift reporting of a haemodialysis hospital unit. We described the phases followed for its development and initial evaluation (concept, requirement analysis, design, implementation, testing and evaluation). The requirements were collected from a group of potential users. We designed and implemented the prototype, which runs on Android smartphones, offering a structured and user-friendly UI for nurses to record and process data related to nursing handovers for haemodialysis patients. Data are collected, processed, stored and accessed easily, quickly and securely by authorized users. We assessed the extend at which the mobile app met the requirements. The majority of evaluators gave positive feedback for the prototype's UI, structure, and functions. They reported the user-friendliness, the ease of use and usefulness of the app. The prototype ensures the confidentiality and the efficient processing of the data, while it succeeds the objectives set at the initial phases. The positive evaluation indicates that the smartphone app for nursing handoffs can be a useful and efficient tool for the reporting and communication needs between nurses.

Similar electronic handover tools in the literature evaluated: community nursing users' perceptions and views on using the app [6]; quality of information transfer, time taken to respond to messages, and users' satisfaction from the mobile app by pediatric and neonatal ICUs professionals [9]; usability and user friendliness of the mobile tool offering interprofessional communication [7]; user experience in visualizing usage patterns among physicians [8]. The results of these electronic handover tools also indicate the efficiency in communication between nurses or other healthcare professionals, their impact on standardization of reporting [6], the reduced delays in patient care [7], the facilitation of the handover process [8], and the improvement of patient care [9]. Our implementation was not tested or evaluated in "real", clinical conditions. No real data of patients in hemodialysis units were entered or processed by nurses. This limitation could be surpassed in a potential evaluation of the prototype in clinical conditions. However, this might raise additional barriers, due to the potential

lack of eHealth literacy, skills and knowledge of nursing professionals, especially in aspects related to the safe and secure implementation of these technologies [17]. In future developments, the app could also be modified in its structure and in the nursing data it records, as to be used in different hospital units other than the haemodialysis, e.g., the intensive care unit. The system's architecture and security issues should be reconsidered when the prototype is further developed for clinical use.

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