A Mobile Electronic Patient Record System for a new Healthcare Professional in Germany: The agneszwei app

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Abstract. In rural regions of Germany, the demographic change is complemented by an impending doctor’s shortage affecting the healthcare of the population negatively. To counter this trend a new healthcare professional named agneszwei nurse was introduced. Giving a brief introduction to these new professionals, this work presents the agneszwei app: A mobile electronic patient record system that has been developed as working appliance specifically for the agneszwei nurses. Here, we want to emphasize the advantages developing such ICT-support following a flexible user-centred process presenting the results of a three month field test with six participants.

1 Introduction

The demographic change and the impending doctors shortage in rural regions require to develop new forms of healthcare that ensure the medical care in all regions of Germany [5]. Such a new form is the agneszwei home-visiting nurse, working as a doctor’s right hand [4]. These home-visiting nurses have a special training in case-management and support physicians of different medical specialities conducting delegable tasks like controlling vital signs, taking blood samples and controlling/treating wounds during the home-visit. Furthermore, they are responsible for case-management task such as providing healthcare tools like bath lifts; applying residential care for the elderly; ascertain/monitoring risk factors and many more. These tasks are delegated to unburden the general practitioner’s (GPs) workload.

To support the nurses during their daily work, a mobile application for Android tablets the agneszwei app has been developed. The app is an electronic patient record (EPR) system supplemented with several specific functionalities for this type of healthcare. This work outlines the development process and presents insights into the application. Furthermore, we present results of a field test conducted during a period of three months with six nurses to evaluate the app as a working appliance. The results of the field test emphasize that (i) following a flexible, user-centred design process is beneficial when developing such specialized ICT tools and that (ii) the usage of tablets as
a highly-mobile and light-weight platform is promising in the field of home-visiting medical practitioners.

2 Methods

A user centred design process [1] was carried out to implement the agnes\textsuperscript{zwei} app. The process started with workshops and interviews with several GPs employing agnes\textsuperscript{zwei} nurses and proceeded with private interviews with such nurses. The interviews were established to eliminate the bias introduced when employees are observed by its employers during interviews as observed during the workshops and group interviews. Furthermore, we observed actual work of the nurses by attending several of their working days including home-visits. Such home-visits were not arranged and the nurses introduced us as trainees to the patients. Before the actual implementation was started, a shortened version of the specification was send to the future users requesting feedback. Additionally a complete specification was handed out to the customer and discussed during a final workshop.

During the implementation, we carried out two user studies, each with six participants. We applied user guided walk-through’s [6] to evaluate the user experience and the currently implemented functionalities. User guided walkthrough’s are specifically suitable for early evaluations testing of not fully implemented prototypes. The participants perform typical given workflows, which are recorded and later discussed. These user studies identified not only more than 60 bugs (e.g., typos, crashes and inappropriate interaction patterns), but also 38 new features (e.g., missing data-fields) not specified during the requirement analysis. A list of features and a more detailed description of the implemented functionalities is presented in Ahrndt et al. [2].

After finishing the development process, we conducted a field test. This test was started in the middle of August, 2013 and ended in the middle of November, 2013. Beginning and the end of the field tests were marked with workshops. During the field test, we performed phone and personal interviews. Furthermore, we established a phone support hotline for rapid help. During the introductory workshop, we handed out the application and a manual to the participating agnes\textsuperscript{zwei} nurses. The field test started with only a brief introduction of field test goals, which were to evaluate the app, to find failures and to identify missing features. During the field test, we visit all nurses and run through the whole application using a sample patient. At the end, we performed a workshop with a guided group discussion. Such form of interview technique is helpful to motivate critical discussions and to confront each participant with ideas, opinions and perceptions of other participants. Furthermore, we handed out a questionnaire to elevate the nurses’ opinions. The nurses were asked to complete the questionnaire at home and to send it back anonymously.

3 Results

The agnes\textsuperscript{zwei} app provides an EPR system extended with functionalities used within the case-management. It satisfies identified top-level requirements such as privacy issues,
offline capability, usability requirements as well as functional requirements. For example, there are several risk-assessment tools implemented (diabetes, stroke-risk, decubitus, fall-risk, dementia, medical adherence etc.). These assessment tools are completed with the possibility to assign and track goals for patients building a case-management lifecycle as illustrated in Figure 1. Here, the assessment tools are used to identify risks. Then the healthcare professional can assign/arrange goals associated with this risk and can apply given or individual counteractions. The process is tracked using the assessment tools again and is provided with optional reminders until the goal is reached. Furthermore, the app contains a calendar, a contact-management (for doctors and other contacts), the possibility to document home-visiting’s, printing functionalities and links to several information sources for the regions where the nurses work in. The EPR itself contains fields for all patient-related data relevant for the nurse’s work, e.g. core data, social anamnesis, medications, diseases based on ICD-10 code system, tools, dependents/caretaker, and a gallery for documentation purposes.

To evaluate the agnes\textsuperscript{zwei} app and the applied development cycle, a field test was conducted within a period of three months with six participants. Each participant was an experienced agnes\textsuperscript{zwei} nurse with more than three years of working experience. During approximately 2000 working hours, the agnes\textsuperscript{zwei} nurses treated 174 patients (mean = 29). The phone and private interviews established during the field test originated a positive feedback about the app, the provided functionalities and the usage of a tablet as platform. This positive feedback was emphasized during the group discussion and by the questionnaire. Table 1 lists the answers derived from the questionnaire. The agnes\textsuperscript{zwei} nurses stated that they were mostly happy using the app. Furthermore, the nurses stated that the manual was useful; however they would rather prefer to have training before using the system. Besides this, they stated that they feel themselves able to provide guidance using the app to other nurses. Additionally, the answers indicate that the nurses would recommend the application as working appliance to other/new agnes\textsuperscript{zwei} nurses. Another interesting aspect is the rather positive reaction of patients from nurses’ point of view. During the development process we talked to patients stating that the nurses will use tablet in future and already received positive feedback regarding this. One should notice that all patients are older than 65 years, multi-morbid and living in rural regions.

In addition, we identified 1 critical, 7 major and 6 minor failures.\footnote{Classification of failures according to TL9000, for further information visit \url{http://www.tl9000.org/}} The critical issue was a crash in the documentation functionality leading to an unplanned update during the field test. Furthermore, the nurses’ formulated 25 missing features within the app. Interesting point here is the difference between the statement that the professionals rarely missed functionalities and the actual list of new features. One explanation might be that most of the features are minor extensions to already existing functionalities like additional input fields for documentation purposes and additional or other risk assessment instruments. The list of features was presented and discussed in the group-discussion leading to a priority order and a restriction to 11 features that will be implemented next.
Fig. 1. Besides providing access to patient data, the agnes\textsuperscript{\tiny two} app also provides functionalities to support the case-management. Here a case-management lifecycle was implemented providing several assessment-tools and the possibility to assign goals to patients and track the achievement of such goals. The screenshot on the top left shows the Morisky questionnaire [7] used to determine the medication adherence of a patient. Once the questionnaire is answered a score indicates the medication adherence. A more fine-granular questionnaire based on the WHO dimensions of medication adherence can be used to identify suitable retaliatory actions. Such actions are then used to arrange goals with a patient. The screenshot on the bottom right shows an example goal for a high Morisky index indicating a low medical adherence with the retaliatory action to equip the patient with a pill dispenser. The end date is used to remember the nurse to track the achievement of the goal and to monitor the effects of the applied action.
Table 1. Listing of questions and associated answers derived from the questionnaire. The nurses were asked to answer the questions given likert scales reaching from 1 (the most positive answer) to 5 (the most negative answer). The results are given as arithmetic middle of the answers.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answers</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happiness</td>
<td>absolutely, rather, uncertain, better not, absolutely not</td>
<td>mean = 1.25</td>
</tr>
<tr>
<td>Manual</td>
<td>absolutely, rather, uncertain, better not, absolutely not</td>
<td>mean = 1.50</td>
</tr>
<tr>
<td>Training required</td>
<td>absolutely, rather, uncertain, better not, absolutely not</td>
<td>mean = 1.00</td>
</tr>
<tr>
<td>Provide help</td>
<td>absolutely, rather, uncertain, better not, absolutely not</td>
<td>mean = 2.00</td>
</tr>
<tr>
<td>Recommend App</td>
<td>absolutely, rather, uncertain, better not, absolutely not</td>
<td>mean = 1.75</td>
</tr>
<tr>
<td>Patient reaction</td>
<td>positive, rather positive, uncertain, rather negative, negative</td>
<td>mean = 2.25</td>
</tr>
<tr>
<td>Use of App</td>
<td>rarely, partly, regularly, frequently, always</td>
<td>mean = 2.75</td>
</tr>
<tr>
<td>Missing functions</td>
<td>rarely, partly, regularly, frequently, always</td>
<td>mean = 1.25</td>
</tr>
<tr>
<td>Functions not found</td>
<td>rarely, partly, regularly, frequently, always</td>
<td>mean = 2.00</td>
</tr>
</tbody>
</table>

3.1 2.1. Specific technical and legal challenges in Germany

The biggest issue found within the missing features is the missing connection between agnes\textsuperscript{2} app and the ambulatory information systems (AIS). This link is required to eliminate documentation failures and further would unburden the healthcare professionals from documenting the same issue twice (at the home visit and again at the GPs office). We identified this requirement during the requirement analysis but were not able to establish such a connection through the missing standardization process for interoperability between medical systems in Germany. In fact, standards like the ones developed by HL7 are nearly non-existent in Germany nowadays. A work-a-round is to implement an agnes\textsuperscript{2} app specific connection plugin for each AIS instance, which is a very expensive way to establish interoperability.

Other issues are related to the German privacy law. We identified the requirements to provide a calendar, contact-management, printing functionalities and backup system. The German privacy law forced us to integrate the calendar and contact-management into the app instead of using the existing system default contact and calendar app. The same applies for the backup functionality of Android and cloud-based printing. Although the use of already existing apps and system services would ease the development process significantly and may also increase the usefulness of such an app enabling use cases not perceived by developers, the safety of the patient data cannot be ensured when exchanging data with other apps or cloud-based services. We were forced to implement these functionalities on our own as the USA PATRIOT Act\textsuperscript{2} is not reconcilable with the German privacy law. It enables the US government to access data processed by US-based companies or foreign affiliated companies.

\textsuperscript{2} Uniting and Strengthening America by Providing appropriate Tools Required to Intercept and Obstruct Terrorism Act (USA PATRIOT Act), for further information visit http://w2.eff.org/patriot/
4 Discussion

The results have shown that using tablets is promising for the field of home-visiting medical practice personnel. Not only the nurses appreciate the replacement of paper-based systems, they also value the replacement of notebook-based system using lightweight and highly mobile technology. After a short settling-in period to touch-based user interfaces (only two out of the six nurses had experience with touch-based devices) the nurses were able to conduct their normal workflow. Furthermore, the results emphasize that a flexible user-centric approach is promising to handle the requirements of the different stakeholders involved (e.g., future users, customer). Especially, the closed-feedback loop during the implementation helped to identify missing requirements and to adjust the development process in a timely manner. The results presented in Table 1 and the findings during the field test have shown that we satisfied the majority of requirements and that we were able to avoid expensive subsequent work.

References