CATCH BEFORE A FALL – AN IPAD APPLICATION FOR OSTEOPOROSIS RISK ASSESSMENT

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ABSTRACT

The Virtual Research Integration Collaboration (VRIC) project provides a framework for the integration of basic science and clinical research. It enables the management of research lifecycles by integrating scientific approaches with everyday work practice in a virtual research environment (VRE). "Catch Before a Fall" (CBaF) is a clinical research project using VRIC. CBaF is aimed at calculating patients' risk factor of developing osteoporosis and of having an osteoporosis related fracture within the next 10 years. Patients' data are collected through CBaF and stored in data structures that match the VRIC architecture for automatic importing via a script written for that purpose. Data analysis is conducted in VRIC and the conclusion of the research process is followed up within that tool. In this paper, we describe how CBaF was designed to follow the VRIC framework, and discuss the technical development work of the application.

KEYWORDS

CBaF, VRIC, iPad, clinical mobile application.

1. INTRODUCTION

Learning and education from mobile devices can give more flexibility and interactivity and opens further possibilities by creating mobile applications and tools for placement trials or clinical education. For instance, the mPLAT project [8] developed windows mobile applications for nursing students and mentors to support placement practice and learning. The Remora project [9] built iPhone and Web applications for social workers to better organize their learning resources when they were on placement. The EASiHE project [10] created a QTI engine on an Android platform to enable offline mobile learning and interactive mobile assessment. As the development of modern mobile technology moves forward, more advanced tools and applications arise to exploit the potential uses of mobile devices outside the education domain, like the case we present of the use of mobile devices to conduct health related research.

Osteoporosis causes weakening of bones which can lead to disabling fractures particularly in the hip and spine. Every year in the UK, there are more than 230,000 fragility fractures, including 70,000 hip fractures. An estimate of 101,000 hip fractures a year is expected by 2020 unless osteoporosis management changes [7]. Some of the changes would include identification of at-risk patients with the purpose of providing care aimed at preventing osteoporosis-related fractures. The challenges improving the identification of at-risk patients are being addressed through research targeted at devising low-cost, non-invasive population screening strategies that can be implemented at a large-scale. Based on the Virtual Research Integration Collaboration (VRIC) [1] framework, the Catch Before a Fall (CBaF) project funded by the National Osteoporosis Society aims to develop a mobile tool to be tested and used for clinical research. It makes use of the iPad in a clinical environment to collect and calculate data in order to provide an overall assessment of a patient's risk factor of developing osteoporosis within a period of 10 years. Linking CBaF with VRIC provides an effective approach to complete the research lifecycle for the clinical researchers involved in this project.

CBaF has been designed as a prototype and proof of concept to be deployed in two surgeries before deployment on a larger scale. For the prototype, an iPad in each surgery will be used to run the application as

a small Web app which prevents the users from being able to navigate away from the application. The iPad will also be deployed in a steel cage to add extra security. As the prototype will only be deployed on two iPads for the initial testing, the Web application has been written specifically to work on the iPad screen and has the resolution hardcoded to ensure maximum compatibility with the device. It is expected that interaction with a device that allows a questionnaire to be presented in a format which is easy to follow and easy to respond to enhances the probability of successful data collection and corresponding clinical benefits.

2. DESIGN

In order to identify time essential information and design its provision with pervasive technologies, a co-design team was formed with a clinical specialist in orthopaedics, a scientifically-trained project manager, and computer scientists with expertise in mobile technologies, human-computer interaction, and programming. The co-design process facilitated a shared understanding of the different concepts contributed by the different groups of people involved [5].

In this project, the user community was heavily involved in the co-design of the tool set, and in particular its front end. It became clear that developing an application for clinical use requires the knowledge and expertise of specialists to provide essential information on the data to be collected, the characteristics of the target population for the clinical trial, and the medical information and terminology relevant to the patient. Continuous feedback was required to ensure that computer scientists built the application keeping the patient and specialists in mind whilst exploiting the features provided by the iPad. Our project adopted an agile approach to development. Agile methods are aimed at promoting a philosophy and attitude towards flexible and cost-effective software development [2, 3, 6]. The characteristics of the project and the time frame available to complete the iPad application presented an opportunity to adopt the agile principles following the strategies that the development team had already used in the development of VRIC, namely: customer involvement; delivering working software frequently within a short time-scale; simplicity; constant reflection and tuning of work to enhance effectiveness; and rapid and flexible response to change.

2.1 CBaF Architecture

The CBaF questionnaire application resides on a server with PHP and MySQL as the tools that manage the system. Data from the questionnaires are stored in the server and, through the administrator application of CBaF, are exportable in XML format. The iVRIC App on the iPad handles the requests of sending the results of the assessment to the printer (Figure 1).

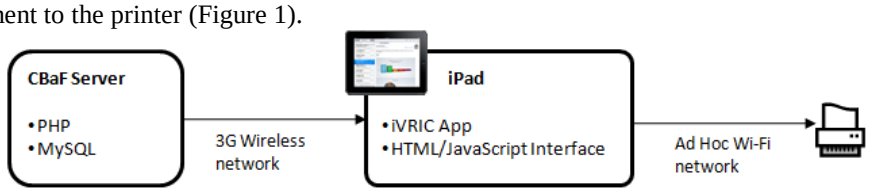

Figure 1. CBaF architectural diagram

2.2 CBAF iPAD tool

The questionnaire application is presented on the iPad on several screens, each one containing between one and three questions. PHP and HTML were used to display the questions to the user whilst JavaScript was used to handle all of the interactions from the user. A patient needs to answer a question by touching on a series of buttons using the touch screen of the iPad, and is required to answer all questions on a given page before moving onto the next page. Once the patient has completed the questionnaire they are shown their results and given the option to print them so that these can be looked at and discussed with their GP to receive professional advice regarding their results.

The use of a mobile device in this project was based on clinicians' requirements regarding the need to enter the patients' data whilst in the surgeries and the need of directors of research to be able to monitor the

trials. The choice of the iPad came from an interest on the part of the clinicians in exploring various uses of this device within the health care environment.

3. IMPLEMENTATION

3.1 CBaF workflow

A patient in a surgery is asked to complete the questionnaire on the iPad, when the results are sent to a printer and handed back to them so that the results can be discussed with their GP. CBaF administrators have an application which allows them to export data collected through the questionnaires and import them into VRIC for further analysis. Diagrams illustrating this CBaF workflow are shown in Figure 2.

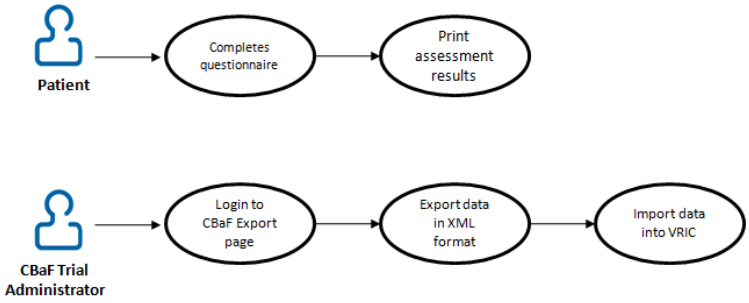

Figure 2. CBaF workflow

Figure 3 shows an application screenshot. The patient answers a questionnaire that currently contains 12 pages. In each page, the user must complete specific questions to continue to the next page. Once the questionnaire is finished, the feedback screen shown in Figure 4 is presented. When all questionnaires from a clinic have been completed, the trial administrator logs into the CBaF export page and downloads the data in XML format. Then, logging into VRIC and entering the corresponding CBaF trial, the XML file is imported. The data is now ready to be analysed and the trial process to continue.

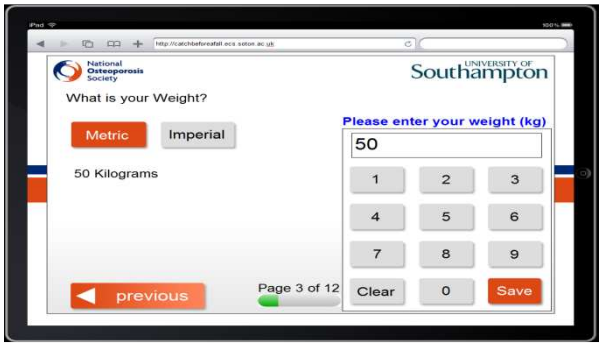

Figure 3. CBaF sample question page

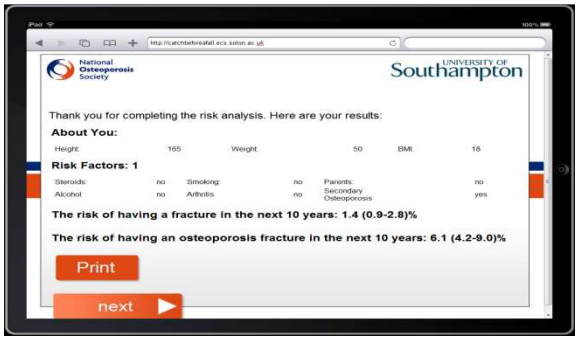

Figure 4. Feedback screen

3.2 Technical challenges and solutions

At the time of defining the technical requirements of the CBaF project (around May 2010), Apple was still developing the iPad's print functionality. Therefore, this particular aspect of the project had to be left undefined until development of printing apps was made available to the computer development community. When Apple released IOS 4.2 it was made public that AirPrint (Apple's printing technology) would only be available to a limited number of printers which did not include the printer model that had originally been ordered for CBaF.

Due to IOS 4.2 having only just been released, existing apps on the market place had not yet been updated with printing features and so the development team was presented with the requirement to create a printing application which would hide the toolbars of Safari (as the questionnaire runs as a Web application) yet still

provide the end-user (staff in the clinics) with a printing feature. However, unless an app is released onto the Apple App Store, it is only allowed to be deployed for a limited time which by default is three months, and this time frame was not suitable for the CBaF trial. After more research it was discovered that deploying the application in Ad Hoc mode would allow deployment of the application for a year before needing to be redeployed. The team decided that the time frame was acceptable and so the iVRIC printing app was implemented as Ad Hoc.

3.3 IVRIC Printing app

The iPad allows websites to be run as web apps when they are launched directly from within the device, removing all of the toolbars provided regularly by a browser and also the ability to print. For the purpose of CBaF, hidden toolbars are an advantage as this action prevents users from navigating away from the web-app. However, printing is required to ensure that the system is not able to store any identifying information about the patient whilst producing a print-out of the results which are then handed to a doctor or consultant. As can be seen removal of toolbars and printing become incompatible. In order to allow printing while hiding the browser toolbars, our web application sends a special http request which the iPad app can recognise and instead of displaying the webpage the http request would have referred to if it was a regular URL, the iPad app invokes the print command from the iPad API, thus the feature incompatibility problem is solved and CBaF requirements are met.

4. EVALUATION

Tests were conducted during the development of the applications by the clinicians and the computer scientist team as Alpha testers [4], and with the purpose of evaluating the interface design of the questionnaire, clinicians conducted controlled tests with patients of the age range and characteristics as the participants in the clinical research. The errors found from the tests were discussed and solved within the co-design team, including the calculation of weight and height using different measuring systems, providing feedback when a question was left unanswered, better locating feedback messages, and design improvements in terms of font size, colours used, length of text provided as help to assist the respondents in understanding the questionnaire, and distribution of the elements displayed on the screen.

5. CONCLUSION

Since this is a work in progress, conclusions of the clinical research trial are still pending. However, the advantages of using mobile devices to conduct the research described are quite clear. Mobile devices support ubiquitous applications which expedite the process of asking patients to complete questionnaires and providing them with a health assessment as soon as the questions are completed. Data from the questionnaire are stored without the need to capture such data from a paper-form and data are left ready to be exported to applications in which analysis will be conducted. Characteristics of the iPad (high resolution screen, light weight) provide a tool which is easily handled by staff and in our particular research, by elderly patients who might also find it easier to touch a screen to respond to a question than to type on a keyboard or use a mouse to tick boxes on a computer screen. The research trial was deployed rapidly and flexibly and without disturbing entrenched information systems or existing clinical workflows. CBaF is planned to be used in clinical practices in February 2011 and our aim is to follow up the success of the application by interviewing staff and patients participating in the research trial.

Mobile technology rapid development provides both more opportunities to enhance apps as well as new challenges to overcome. In our project, printing from an iPad was the issue to solve but rapid development of technologies that attempt to catch up with the newest operating systems and hardware allowed for a fast solution to the printing obstacle. At present, the most important issue to consider is the one of security. The iPad easy-to-carry design poses a risk in our case as it is necessary to keep the device within the clinical centre. The solution implemented involved a cage screwed to a desk, but more flexible approaches are envisaged for the future.

Possible applications for projects like CBaF are other clinical research trials where a pre-assessment of a given condition conducted before the patient enters the appointments with their GP may provide more information on the condition of a patient which could reflect positively on the treatment chosen by the specialist. In addition, appointment time may be reduced or kept within the time allowed as a printed pre-assessment form will allow GPs to form a quick idea on the condition of the patient or gather vital information on the patient's lifestyle relevant to their problems.

ACKNOWLEDGEMENT

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