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TControl: A mobile app to follow up tobacco-quitting patients

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ABSTRACT

Background and Objective: Tobacco smoking is a major risk factor for a wide range of respiratory and circulatory diseases in active and passive smokers. Well-designed campaigns are raising awareness to the problem and an increasing number of smokers seeks medical assistance to quit their habit. In this context, there is the need to develop mHealth Apps that assist and manage large smoke quitting programs in efficient and economic ways.

Objectives: Our main objective is to develop an efficient and free mHealth app that facilitates the management of, and assistance to, people who want to quit smoking. As secondary objectives, our research also aims at estimating the economic effect of deploying that App in the public health system.

Methods: Using JAVA and XML we develop and deploy a new free mHealth App for Android, called TControl (Tobacco-quitting Control). We deploy the App at the Tobacco Unit of the Santa Maria Hospital in Lleida and determine its stability by following the crashes of the App. We also use a survey to test usability of the app and differences in aptitude for using the App in a sample of 31 patients. Finally, we use mathematical models to estimate the economic effect of deploying TControl in the Catalan public health system.

Results: TControl keeps track of the smoke-quitting users, tracking their status, interpreting it, and offering advice and psychological support messages. The App also provides a bidirectional communication channel between patients and clinicians via mobile text messages. Additionally, registered patients have the option to interchange experiences with each other by chat. The App was found to be stable and to have high performances during startup and message sending. Our results suggest that age and gender have no statistically significant effect on patient aptitude for using TControl. Finally, we estimate that TControl could reduce costs for the Catalan public health system (CPHS) by up to € 400M in 10 years.

Conclusions: TControl is a stable and well behaved App, typically operating near optimal performance. It can be used independent of age and gender, and its wide implementation could decrease costs for the public health system.

1. Introduction

Tobacco smoking is a major risk factor for active and passive smokers in certain respiratory [1] and circulatory diseases [2] as well as in some types of cancer [3,4] and infections [5], among other diseases. Because of this, both public and private medical institutions in an increasing number of countries provide services for people who want stop smoking.

NRT (Nicotine Replacement Therapy), in the form of nicotine patches and/or nicotine gum, is effective at treating short-term nicotine withdrawal. Depending on the treatment and replacement, the chances of patients managing to quit smoking are increased by between 50% and 70% with NRT [6]. However, NRT alone becomes ineffective after about 8 weeks of starting the treatment and its effect in maintaining a smoke-free patient over a longer period of time (years) appears to be quite modest, as demonstrated by the meta-analysis of different studies [7,8]. In light of this, some countries, such as the USA [9], the UK [10] and

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Australia [11], have published evidence-based guidelines to recommend effective tobacco cessation interventions ranging from brief instructions for quitting to extensive counseling combined with pharmaceutical adjuncts [12].

Patient-doctor contact and follow-up are very important psychological aspects of the process of quitting smoking, because they provide support and help maintain patient reinforcement [13–15]. For example, a recent study [16] confirmed that proactive telephone counseling is effective in the short-term reduction of cigarette consumption and in increasing the percentage of smokers who attempt to quit by more than 5%, when compared to people without phone counseling. In addition, it was found that text messaging can double the likelihood of smoking cessation for patients that have neither continuous contact with their caregivers nor personalized follow-up [17]. This is consistent with the finding that smoking cessation interventions via mobile phone-based text messaging have a positive effect on long-term patient outcomes [18]. For example, S-PC [15,19] is a web-based e-medicine service that manages a central database of information on patient progress in a smoke quitting program being run at the public hospital Santa Maria in Lleida, Spain. Originally, S-PC uses mobile text messaging to follow up and manage patient progress. It evolved and became integrated in SHUITE (Simple Health Universal and Integral Treatment Environment), a non-free "Software as a Service" cloud framework responsible for managing patient and clinical information.

Thus, depending on the penetration of mobile phone usage, having Apps that automatically manage smoke quitting patients and their patient-doctor communication might be a very effective way to improve smoke quitting treatment outcomes. That penetration appears to be high. For example, 90% of U.S. adults use a mobile phone. 64% of those adults have smartphones that are also used as their primary source of Internet connectivity [20]. Furthermore, 62% of smartphone users use that phone to look up information about a health condition [21]. Spain has the second highest smartphone penetration in the world, and 88% of the Spanish population owned a smartphone in 2015, up 3% from 2014 and 19% from 2013 [22]. In addition, 70% of Spanish smartphone users connected to Internet daily through this device. More than half of these users navigate for more than thirty minutes.

There are documented benefits for smoke quitting patients of keeping patient-doctor contact through text messaging and there is a high penetration of smartphones [17]. Hence, developing Apps for automating the contact and follow-up between patient and doctor during the process of quitting smoking could have significant impacts in smoke quitting programs in the Spanish health systems.

Taking all this into account we set out to evolve S-PC into a smartphone mobile health (mHealth) App that is efficient and free. In this study we report the development and limited evaluation of this App, which we now call TControl. TControl was developed to (a) be generally applicable in smoking cessation treatment programs, (b) automate much of the work that needs to be done by the clinicians, (c) allow professionals to maintain an efficient and personalized support and follow-up of patients, (d) give patients the psychological support required to stop smoking successfully, and (e) decrease the time clinicians need for managing the patients and reduce the average length of waiting lists. TControl can be freely downloaded from Google Play or the Android App Store. We study T-Control stability, usability, aptitude and performance. We also use mathematical modeling to estimate the economic effect that deployment of TControl might have at the level of the Catalan public health system.

2. Methods

2.1. TControl

TControl is designed to revamp, update and extensively expand the current system of communication with the SHUITE server, offering an App that was not previously available for smartphones.

Fig. 1 shows the overall operation of TControl. The SHUITE server is responsible for sending/receiving messages to/from TControl. All communication between the SHUITE server and the TControl App is encrypted using the HTTPS protocol. The server also provides the patient with a list of hospitals that use TControl for patient support in their smoke quitting programs.

Patients can use TControl to send weekly reports from a smartphone to the SHUITE server by filling a small form, via Internet. SHUITE receives these reports and stores them in an evergrowing database of clinical histories and message texts. The database is encrypted and hosted on a secured server.

SHUITE interprets the weekly reports to monitor patient status. Depending on that status, the clinician will be sent a warning to contact the patient, which s/he can do either using the chat tool of TControl or outside of the App.

TControl can also be used for semi automated self-monitoring and psychological support of patients, via achievements. The App also throws push reinforcement messages scheduled by the clinician to enhance the willpower of the patient. Achievement and reinforcement messages can be sent to a particular patient or to every member of a health plan group. TControl can also be used by the patients to chat with a clinician or a community of patients, managed by a clinician.

2.2. TControl design

Currently, there are many alternative technologies for developing applications for mobile devices. The TControl was implemented using JAVA and XML, which are the native languages for the Android platform. Two important design requirements were that the application should be compatible with Android (the most popular mobile operating system) and guarantee optimal performance. Functional requirements were collected from the clinicians of the Tobacco Unit of the Santa Maria Hospital.

Usability criteria have been seriously taken into account when implementing TControl. As a consequence, users' access to any functionality is a single click away, using a unique menu button (located at the top left of the screen). That button appears or disappears at the user's will, making navigation simple and intuitive and improving the appearance of the App.

The possibility of allowing the App to push notifications to the application was ruled out in favor of querying the SHUITE server periodically and using the Android inbuilt lns (local notification system) to display the interactive user messages. We optimized this process to minimize device-server communication and decrease use of Internet data by the device. The reason for choosing lns was that using a third party's software to implement a complete and efficient push notification service would require users to pay a fee, making it impossible for TControl to be a free App.

Ad-hoc webservices are used to establish communication with SHUITE using a secure HTTPS[1] protocol and exchanging data in JSON[2] format. The implementation ensures low data capacity requirements in the device and avoids legal problems with clinical data that remain securely stored only in the SHUITE server and

[1] HTTPS. Communication over Hypertext Transfer Protocol (HTTP) within a connection encrypted by Transport Layer Security (TLS).

[2] JSON. JavaScript Object Notation. Open standard format that uses human-readable text to transmit data objects.