DESCRIPTION OF TECHNICAL SPECIFICATIONS AND CONTENT OF THE MHEALTHCARE PLATFORM AND THE MHEART TOOL ADAPTED TO THE CARDIAC TRANSPLANT PATIENT.

AUTHORS

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ABBREVIATIONS

QoL: Quality of Life

mHealth: mobile health.

eHealth: use of information and communication technologies for health.

App: mobile application.

HTxR: heart transplant recipients.

HSCSP: Hospital de la Santa Creu i Sant Pau.

HIS: hospital information system.

IT: information analyst.

SSL: secure socket layer.

TLS: the transport layer security.
LOPD: Spanish law concerning data protection (Ley Orgánica de Protección de Datos Personales).


CHA: complementary health approaches.

OTC: over the counter.
MHEART® PROTOTYPE TECHNOLOGICAL DEVELOPMENT

To carry out the technological development a private firm with experience in development and integration of Health Care systems applications, i.e. Trilema Salud Group (previously named Nabelia mHealthcare) was hired. The firm’s corresponding technical team consisted of 1 analyst, 5 developers, 1 designer and 1 project leader. The HSCSP's scientific advisory team was formed by 2 information analysts, 4 pharmacists, 4 doctors, 2 nurses and 1 psychologist.

From a technical point of view, the mHeart® platform was composed of two well differentiated environments. The first environment is an API REST which manages all the mHeart® platform logics. This environment has a multitude of REST Services in order to obtain an provide the data. Those REST Services are developed in JAVA 8 using both Spring framework and Hibernate. Moreover, REST API is beyond a firewall to avoid hacking and unauthorized accesses. The mHeart® database collects and compiles all the information recorded by the end-users, i.e. patients and professionals. This confidential data flows directly from client to server fully encrypted. The second environment consists of three different applications, i.e. web-based and mobile-based application version for both Android and iOS. Those three applications connect with REST Services to send and to obtain data from users’ information system databases. Android and iOS mobile-based applications are developed in the native language of their own platforms. Web application is developed in JavaScript using jQuery framework and making AJAX queries to services.
The mHeart® prototype is a home-based mobile phone app and website application for use by patients as a kind of diary. Professionals use it via web as an aid in their clinical practice that allows them to consult the different variables recorded by the patients. Access to the tool is multiplatform (Smartphone, tablet, computer) and it can be used simultaneously on several different devices. It is available in Castilian Spanish. It is compatible with Android (Google) and iOS (Apple) and can be downloaded for free from the Store under the name “mHeart”.[1,2] The supporting web page can be accessed through the link[3].

FUNCTIONALITIES OF THE PATIENT PROFILE

At a functional level, patient access to a private profile which is structured in modules. These modules are equally visible in the App (Figure 3) and on the web (Figure 4) via a menu.

TREATMENT MODULE.

In consultation mode patients can view lists of drugs prescribed by professionals and inactive medication. (Figure 5) Moreover, they can add other therapies, over the counter medications (OTC) and Complementary Health Approaches (CHA) [4] to consult with the health professional about interactions with their current prescription. The recommendations can be viewed graphically in the form of traffic light signals linked to a written recommendation if necessary. (Figure 6)

AGENDA MODULE

Here the content of diverse modules is uploaded, enabling the patient to find all programmed activities (Table 6) on the platform. Which are shown in different colours and generate a Push text alert on the patient mobile phone. (Figure 7)

Tabla 6. Distinct kinds of activities scheduled on the mHeart® agenda.

| Medication schedule. | The patient can visualize the medication schedule, receive alerts for due drug doses and record drug intake of a single drug or several drugs at the same time. (Figure 8) If a dose is canceled, the reason for it will need to be |
| **Bio measures.** | Biomesures (e.g. blood pressure) can be registered by the patient directly from the agenda if they have already been programmed. (Figure 8 and 10) Frequency will be set by the patient or the professional in the self-control module. |
| **Adherence tests.** | The patient can answer the adherence test programmed by the professional (Figure 11 and 12). |
| **Personal agenda.** | The patient can add personal events and reminders. |

**SELF-CONTROL MODULE.**

The self-control module allows the patient to record vital signs (e.g. blood pressure) and biomeasurements (e.g. weight). (Figure 13) Recording can be done manually (Figure 10) or automatically by using wearables. When the patient enters values, which are not within reasonable limits, a message indicating “Invalid format” appears. In the case of some biomeasurements, limit values emit the warning “contact your healthcare team via the platform”. The records can be viewed in graphic form through the App and in graphic and table form on the WEB. (Figure 14 and 15)

**SYMPTOMS MODULE.**

As if they had self-care diaries, patients will be able to select symptoms or adverse side effects derived from their medication from a list provided. They will indicate the starting date, the finishing date and relevant comments. Some of these symptoms generate an alert to the clinician. (Figure 16)

**TELECONSULTATION AND MESSAGING MODULE**
A two-way videoconference or chat for patient-professional communication. Files can be attached. (Figure 17)

HEALTH EDUCATION AND ADVICE MODULE.

Updated healthy lifestyle and prevention information is available (Appendix 1). Texts, photographs or multimedia files are incorporated in accordance with this population’s needs.

PERSONAL AND CLINICAL DATA MODULE.

Through the platform patients can consult their sociodemographic data, documented allergies, relevant past medical history and contact professionals.

FUNCTIONALITIES OF THE PROFESSIONAL PROFILE

Professionals gain access through the web and can organize their list of patients according to various criteria and filter by rapid search fields or systems. Within each patient profile, the same modules are viewed but with broader editing rights; patient registration, prescription and therapy monitoring, programming self-control tests, opening communications with patients. (Figure 18)

REGISTRATION OF NEW PATIENTS.

When new patients are registered, their sociodemographic data is automatically uploaded from the HIS. (Figure 19 and 20) This information must be verified and completed with the patient’s or carer’s contact details.

PRESCRIPTION MODULE.

Professionals prescribe from a drop-down list of drugs imported and automatically actualised from the Spanish National Formulary. Other therapies can be added to the patient’s prescription in free-form data entry (e.g. relaxation exercises prescribed by a psychologist). Each prescription can be accompanied with personalized comments (e.g. “Anti-rejection treatment. It is recommended that you take this on an empty stomach”). From this module possible drug interactions can be addressed.
MESSAGING AND VIDEO CONSULTATION MODULE.

When professionals want to text patients, an alert in the form of a Push-up message is generated in the patients’ device. Professionals can check whether the message has been read. This module permits messages to be sent to groups of patients selected in accordance with demographic data or a common drug. Moreover, preventative health promotions can be set for specific periods of time (e.g. a reminder about flu vaccination programmed for October; a reminder for patients on corticoids to avoid sugar in their diet).

CONSULTATION REGARDING THERAPEUTIC ADHERENCE.

Identification of a non-adherent patient by professionals is done by the combination of diverse mHeart® functions as detailed in Table 7.

Table 7. Consulting adherence to therapy in mHeart®.

<table>
<thead>
<tr>
<th>Type of information registered by the patient:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Doses taken versus total of doses prescribed.</td>
</tr>
<tr>
<td>2. Reasons for non-adherence (drop-down list).</td>
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</tbody>
</table>

Professionals can see adherence information from 2 different perspectives:

1. A traffic light system alerts the profesional of a drop in the patients’ weekly adherence in the main patient list module.

2. Adherence presented graphically and through data tables in the treatment module.

Adherence tests included in the mHeart® platform.

The professional sets up the frequency. Test results are shown graphically:
1. Haynes-Sachett test [5,6] (adapted to include reasons for non-adherence). (Figure 11)
2. Morisky Green test.[7] (Figure 12)
REFERENCES


3. Trilema Salud Group. mHeart web. https://salud.trilema.es. Archived at:


