D5.3

Software requirements specification of an integrated EHR web app for HCP - V3

ABSTRACT

This deliverable, which is the updated version of deliverable D5.2 [9] , aims to present the new functionalities and features of the integrated web app - Healthcare Professional Application (HCP App).

This updated version of software requirements specification of HCP App is the result of both - technical improvements and software development and the continuous collaboration with the final users (co-design / co-creation sessions).

For a suggestive overview on the updated version of HCP App and further development, two different sections were created in the document, namely: *Features implemented into version2 and Features that will be implemented in version 3 of the application*.

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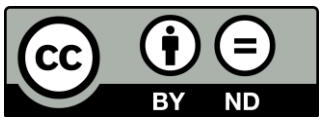

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ACRONYMS

Acronym	Term and definition
CA	Certification Authority
CRUD	Create, Retrieve, Update and Delete operations on a data record
D2D	Device to Device
GUI	Graphical User Interface
HCP	Healthcare Professional
HR	Health Record
IEHR	InteropEHRate
IPS	International Patient Summary
IT	Information and Technology
RSA	RSA is a public-key cryptosystem that is widely used for secure data transmission.
S-HER	Smart Electronic Health Record
SHA1	SHA-1 (Secure Hash Algorithm 1) is a cryptographic hash function which takes an input and produces a 160-bit (20-byte) hash value known as a message digest

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1 INTRODUCTION

1.1 Scope of the document

The current deliverable is the third report of WP5 - Incremental EHRs integration and addresses specific aspects and findings concerning the actual software requirements specification of HCP App, as they look like after the second version of InteropEHRate project implementation.

At this stage of project implementation, the deliverable aims to present the most significant features of the current version of HCP App which exploits an updated form of D2D protocol and covers the import/export data directly from/to the S-EHR App on the smart-phone. Focus groups of final users were organized in this particular stage of HCP App development, in January - April 2021, and their results were considered in designing the updated version of GUI of HCP App.

Moreover, the deliverable includes a specific section dedicated to the HCP App features that will be implemented in the version 3 of the application.

1.2 Intended audience

The document is intended to different categories of professionals, such as:

- Technical staff: developers, IT health consultants, analysts, web designers, interested to have an overview about the design and specific implementation of HCP App;
- Healthcare providers interested in how to use an application like HCP App from the perspective of end-users.

Both categories are interested and contributing by participating in focus groups / co-design sessions during each development cycle, in order to improve and enrich the HCP App capabilities.

1.3 Structure of the document

The report is structured in four chapters, as following:

Section 1. Introduction: Presents a summary concerning the purpose and objectives of the deliverable, its structure and relation to other tasks and deliverables.

Section 2. Overall description: Presents relevant aspects concerning the healthcare professionals needs related to use of HCP App and the significant aspects about the HCP App software. Relevant aspects concerning the assumptions and dependencies in implementing HCP App are also presented.

Section 3. HCP App features: Presents the major aspects concerning the features and characteristics of HCP App, such as: exchanging healthcare data with S-EHR Mobile App, exchanging healthcare data with InteropEHRate Health Services, features implemented in version 1 and version 2 and features that will be implemented in version 3.

Section 4. Conclusions and next steps: Presents the conclusions and next steps concerning this particular stage of elaborating HCP App functionalities.

1.4 Updates with respect to previous version

The current deliverable is the third of the three deliverables of Task 5.1, the set of project activities dedicated to software requirements specification and design of HCP App and is the updated version of the previous deliverable D5.2 [9] Software Requirements specification of an integrated EHR web app for HCP – V2.

On the technical and technological side, this deliverable presents a number of updates and improvements from the ones presented in the deliverable D5.2 [9] . Some of the most important updates that are brought to this level are the ones regarding the changes in the used technologies (most of them are connected to the updates of these technologies), changes regarding the used external libraries and changes regarding the system interface. All these updates are presented particularly in the sections 2 - Overall Descriptions and 3 - HCP App features.

One of the major updates that have been made to the HCP App in this second version was the integration of the second version of the D2D library sitting at the core of the functionalities related to the Medical visit abroad scenario.

Moreover, the deliverable presents a summary of GUI updates of HCP App compared to the situation presented at the time the deliverable D5.2 [9] was made. All the improvements and updates were implemented with respect to the requirements specific to HCP App in its second version

Taking into consideration the specificity of our target group, the design of the user interface was improved from the perspective of healthcare providers, based on valuable feedback gathered from the end users within iterative co-design / co-creation sessions from December 2020 - January 2021.

Significant work was put on developing functionalities that enabled the HCP app user to send the patient's data from one HCP to another HCP within the same Hospital without using the D2D library again.

Furthermore, an important feature developed in the period between drafting the two deliverables is the security integration in the application. The HCP needs to be authenticated for using the HCP App.

A new entry (a third option) in the Home page of the application was developed for the Inpatient encounter. The HCP can now select a patient from a list of inpatients.

These functionalities will be explained in a more detailed way on Section 3.

2 OVERALL DESCRIPTION

This section addresses the main aspects regarding the needs and requirements of the healthcare professionals which pertain to the use of HCP App and to the relevant characteristics of HCP App solution. Two perspectives were explored in drafting this chapter: the technical perspective, as presented in section System interface and the end-users' perspective. Representative aspects about the assumptions and dependencies related to HCP App implementation are also depicted.

2.1 Needs of the Healthcare Professionals

This section presents relevant aspects concerning the needs required of the healthcare professionals from the HCP application.

The Healthcare Professionals (HCP) will be able to see the patient's general identification information on the HOME page of the app (first name, family name and ID). The full IPS profile will be visible in the application with all categories required by the HCP.

The HCP must have access to the patient's health history to be able to provide a special treatment for the medical condition the patient has. Also the practitioner is able to see, in the app, the organization's information of which he/she is the part of (name of the hospital, phone numbers, address etc.) and personal details of the health care professional. The HCP App has a function available for the practitioner to select what sections from IPS profile are required to be downloaded from the S-EHR mobile application.

The HCP App development offers the possibility to modify the retrieved International Patient Summary from an S-EHR application, as needed by the health care professional. By modifying the data, it means that a specific record of a specific category from the IPS should be addable, updatable or even removable from the HCP App. After the modifications were made, the HCP App shall upload the new data into S-EHR app keeping the history of EHRs.

Technically speaking, the communication between HCP App and S-EHR mobile app is done through the D2D protocol having Bluetooth as backbone communication protocol. From the business point of view, FHIR is used for exchanging health information using an interoperability profile. The purpose of using a D2D library is to allow the connection independently of the usage of an internet connection in view of the exchange of the messages and healthcare related data between a healthcare practitioner and a citizen.

2.2 HCP App software specifications

This chapter presents a summary of technical updates and improvements of HCP App software made in the second version of the application, version from which the design and development of the third version is continuing. HCP App is a software solution designed such as to provide healthcare professionals with the ability to access and operate patients' data from S-EHR, S-EHR Cloud and EMR. In this stage of implementation, the major capabilities of HCP App concerning the access patients' data from S-EHR are presented.

2.2.1 Technical approach

A clear image of the HCP App development is not complete without the presentation of the updates regarding the technical part, which includes a description of the different tools, principles, modelling methods and other components, and the technological approach, which describes the changes that have emerged in the first version of development for the used technologies. During the following paragraphs, a

description of the aforementioned aspects is presented and explained in detail with their actual use and reasons for the changes made.

One of the most important changes that have been made to the HCP App was the integration of the second version of the D2D library, which is the library that sits at the core of the functionalities related to the Medical visit abroad scenario. As it is presented in the deliverables D4.1 [4] and D4.2 [5] , the library has evolved, thus providing the HCP App to implement more functionality that brings the application closer to the final form of presentation. Functionalities like certification generator and Public Key loading have been implemented in the second version of the library and thus integrated in the latest releases of the HCP App. The latest change regarding the D2D library will be the refactoring of the logic flow using the approach implemented in R2D library.

From the development point of view, HCP App uses the latest available version of Java; that is Java 16. By using the latest Java technologies, the application conforms to the latest trends and improvements that every new Java update brings. The second advantage of using the newest java version, it ensures the best compatibility with newer Operating Systems.

Other improvements were brought by updating different tools used in the development of the HCP App. Tools like Spring Boot, Thymeleaf, Bootstrap, Zxing bring improvements with each update they provide, providing both performance and functionality changes. The HCP App updates each tool to the latest version and brings the code to the recommended states that are recommended by the changes of each upgrade from each tool.

In order to use the latest version of the aforementioned tools, the main developer tool, IntelliJ IDEA was updated to the latest version each time an update has been provided. The current version that is used for the development of the HCP App is the 2021.1.2 which is fully compatible with Java 16 and the rest of the tools used.

2.2.2 Updated user interface

This section contains a summary of the modifications of the HCP application compared to the situation presented at the time the deliverable D5.14 0was made. All the modifications were implemented with respect to the user requirements of HCP App.

An important feature developed in HCP APP version 2 is the possibility of the HCP to send the patient's data from one HCP App instance to another instance without the involvement of any other separated library developed by other partners. The HCP App now uses a dedicated microservice, for saving and transferring patient's data where it is required. Another major upgrade for the HCP App is the Internationalisation for translating the user interface in other languages. Currently the HCP App supports 3 languages: English, Italian and Romanian. Adding a new internationalization consists in adding the specific properties file.

For more information, the complete presentation of the new features of the HCP application is available in Section 3 HCP APP FEATURES.

2.3 Assumptions and Dependencies

Dependencies represent the interconnection between the HCP App and other elements of D2D library which are at the base of the exchange of data.

One version of the patient consent was implemented into both S-EHR and the HCP App by displaying the identification details of the involved actors. The identification data has a personal character and must be protected. The consent was implemented with an RSA (used for the electronic signature or for the encryption of information) algorithm with SHA1 (used for the integrity of the data) for the signature of the certificate.

The consent defines the details of what information is stored and the type of information is stored: personal number identification, country and other relevant information contained in the identity card. Finalization of the form of the patient consent was made by discussion between the partners.

The data formats used by the HCP-App for describing elements of each IPS category are those defined by HL7 FHIR standard. Data formats use a unitary description of the elements of the IPS section in order to ensure that the same labelling of the data exchanged is used along the system components. The D2D library contains methods for the realisation of the connection between the HCP App and S-EHR and through data is transmitted. Two versions of the D2D library were integrated in the HCP App. The second version of the D2D library has improvements over the first D2D library version by including the call-back system. When the HCP practioner needs data, a request is made for each section of data, this is a new approach compared to the first version of D2D library when all EHRs was transferred immediately after the connection was established.

3 HCP APP FEATURES

This chapter aims to present the main aspects concerning the relevant features and characteristics of HCP App, such as: exchanging healthcare data with S-EHR Mobile App, exchanging healthcare data with InteropEHRate Health Services, features implemented in version 1 and version 2 and features that will be implemented in version 3.

HCP App illustrates graphically through user interfaces how the healthcare data, which is reflecting the patient condition, is exchanged with S-EHR, thus being a valued tool for analyzing the perception of final users about the InteropEHRate solution.

For this purpose, significant work is put on designing compliant GUIs to accomplish the end user needs and requirements, based on the results of focus groups and co-design sessions described in the deliverables D2.1 [1] and D2.2 [2] , as presented hereinafter in *Section 3.3 Features implemented in version 1 and version 2 of the HCP-App* and *Section 3.4 Features that will be implemented in version 3 of the HCP-App*.

3.1 Exchanging healthcare data with S-EHR Mobile App

In first version of the InteropEHRate project, a relevant component for the development of HCP App was the D2D library that uses the Bluetooth protocol in order to exchange the healthcare data with the S-EHR mobile app.

In this paragraph, a highlight of the updates that have been brought to the D2D library is described, as in-depth information about the principles and the implementation method of the transmission protocol is available inside the deliverable D4.5 [6]

One of the changes that have been done for the second version of the D2D library is the usage of the call-back paradigm for the implemented methods. This programming approach brings certain advantages like avoiding dependency between the implementation of the library and the calls of the functions inside the HCP App and aids in case of issues that might appear during the usage of the transmission protocol.

Other upgrades regarding the D2D library are currently in development. These upgrades consist in the refactoring of the entire D2D protocol to expose for the client (in this case, the HCP App) certain APIs that enable the interrogation of the S-EHR mobile app (the server). These upgrades are required for improving the connection time between the HCP App and S-EHR mobile app. In the old version and the current version of D2D library, all the patient's EHRs are transferred automatically at the connection time. This approach significantly decreases the performance. In the new version of D2D library, the transfer of the patient's data will be done only at the HCP's request. When the connection is established, only the primary details of the patient (like demographic information, certificate and consent) will be required. After that, any other data about the patient will have to be interrogated manually by the HCP (like prescriptions, laboratory tests, images etc.). In this way, the performance will be greatly increased.

3.2 Exchanging healthcare data with InteropEHRate Health Services

The HCP App includes the possibility to display the health data in their original version and also translated in the language of the healthcare professional. For this functionality the application uses a set of tools for data interoperability, recognized as IHS (InteropEHRate Health Services).

These components, offered to the HCP App as external services, work with the multilingual knowledge of the health data standards, in order to be able to recognize several codes defined in those standards and so provide a correct translation of them.

The translation of the information in EHR could be done on two different kinds of data:

- Natural text: all the attributes in the EHR structure which contains natural text.
- Concepts: all the attributes in the EHR structure which contains concepts recognized by the imported knowledge.

For this reason there are two different services offered to the HCP App, one for the translation of natural text, using automatic machine translation, and another one for the translation of the concepts found in the EHR. The concept translation is useful also, if the related knowledge is available, to recognize health codes of different health standards, maybe not in use in the HCP App usage country, and due to this provide the correct interpretation of those codes.

It is important to specify that the HCP App can always display the original version of health data, in order to not fall into incorrect or ambiguous translations. Note that this situation could happen if the knowledge to be used is not imported correctly into the underlying system, but also because the automatic natural text translation is not one hundred percent reliable.

The data exchanged between the HCP App and IHS is in FHIR format, as this is the standard for data exchange within the different project's components.

3.3 Features implemented in the version 1 and the version 2 of the HCP-App

The objective for the version 1 of the project was to create a web application with few pages like Home page, Administration and IPS of the Current Patient with the related sections.

The main functionality implemented successfully was data exchange between the S-EHR app and HCP App which was updated with the request of patient consent from the HCP App of data from S-EHR.

Later in the development, starting with version 2, the menu Current patient has become richer for allowing the application to process and display more of the patient's data. Now, the HCP App displays extended types of EHR resources:

- Prescriptions;
- Laboratory tests;
- Diagnostic Imaging;
- Pathology History;
- Document History;
- Vital Signs.

Below are presented the three main sections of the HCP App:

- Home;
- Current Patient;
- Administration.

3.3.1 Home section

For the second version of the HCP-App the Home screen looked like this:

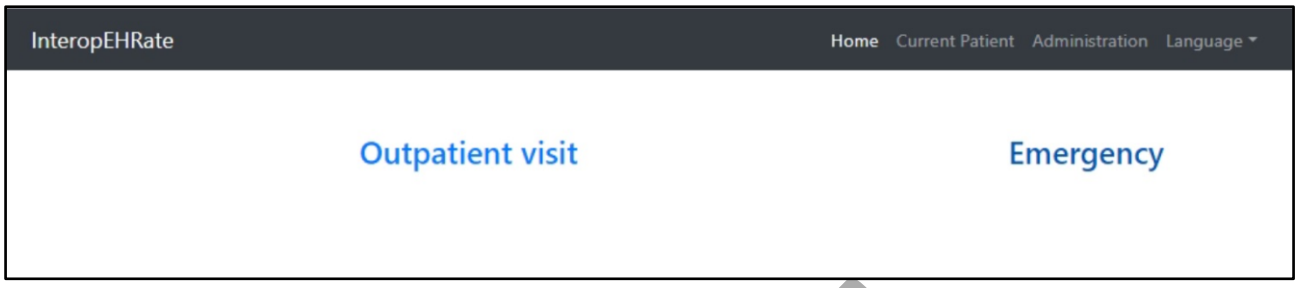

Figure 1 - Home screen with 2 options

Having the 2 options in the Home page, the user can select one of the 2 Scenarios (Medical Visit abroad or Emergency access). After choosing the "Outpatient visit" option, the New Patient screen will be displayed:

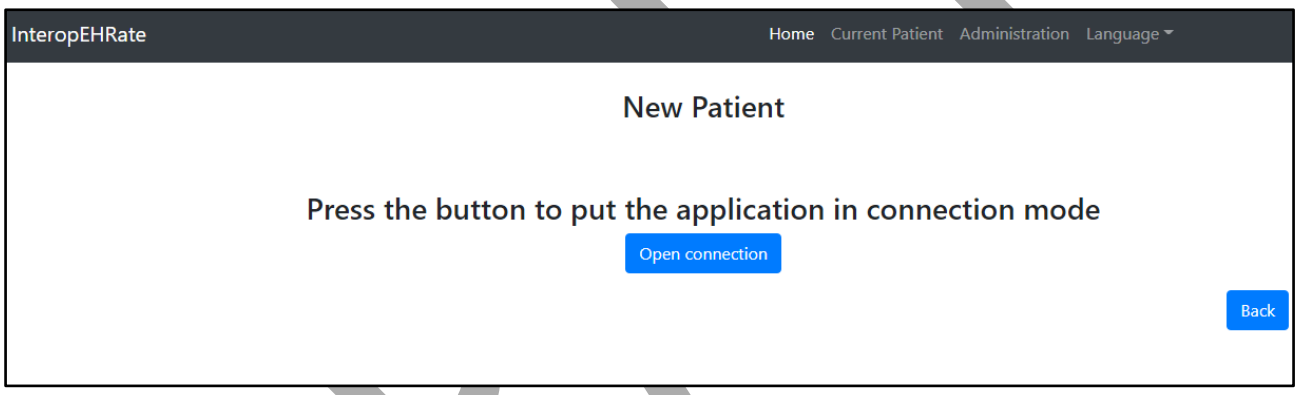

Figure 2 - Start page of the HCP App

After clicking on the "Open connection" button, HCP should present the following screen to the patient who shall scan the QR code with the mobile phone application (S-EHR mobile app).

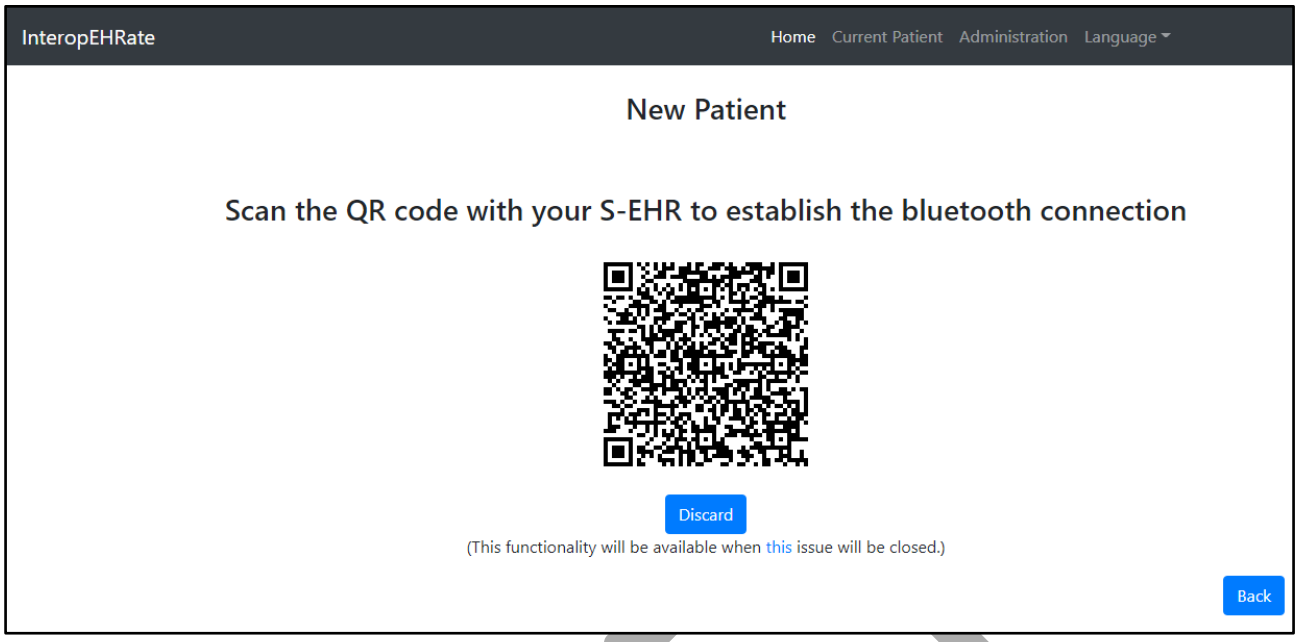

Figure 3 - Page displaying the QR code to be scanned by the S-EHR app

Next screen shows that the data receiving process is in progress. The process ends when the message "Transmission completed" appears.

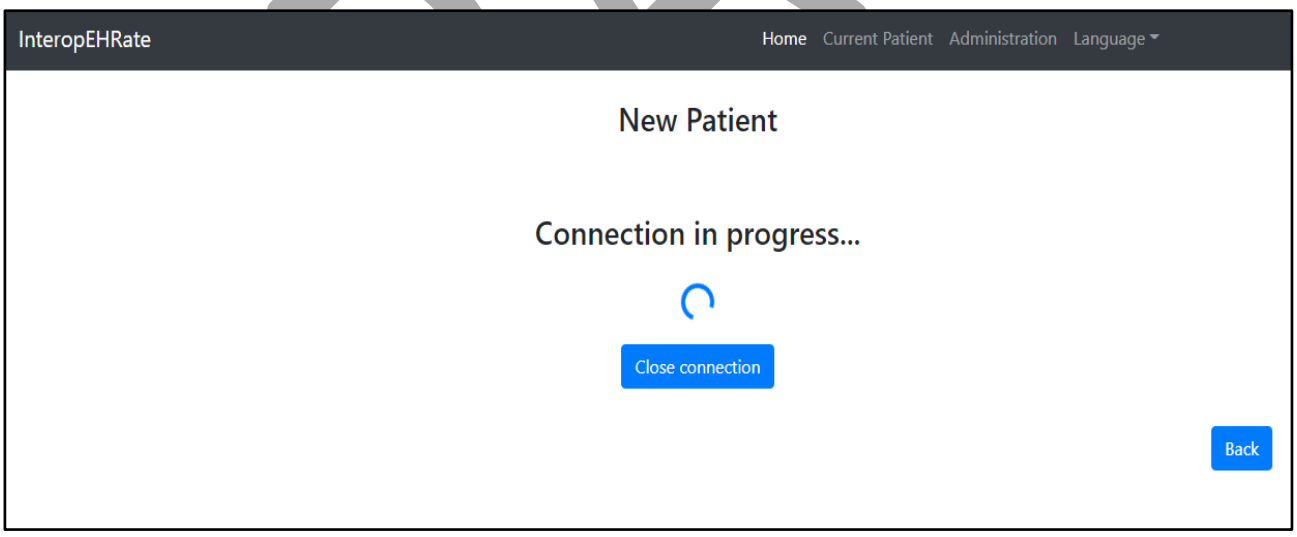

Figure 4 - Page displaying the process of receiving data is in progress

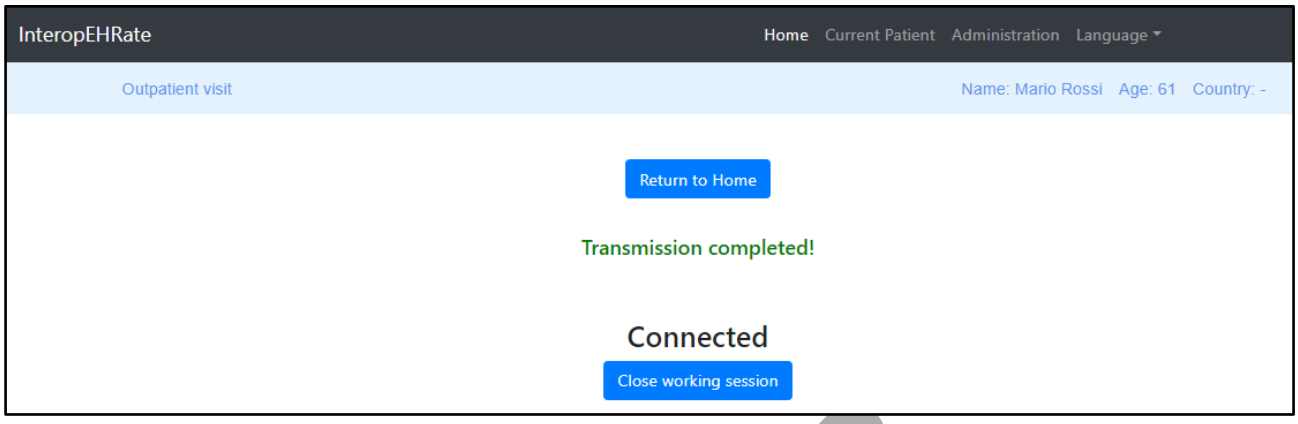

Figure 5 -Transmission completed

3.3.2 Current Patient section

For the Current Patient menu, the development stage for V2 is presented in more details in the Deliverable D5.14 0in *Chapter 3.3.2 CURRENT PATIENT*.

3.3.3 Administration section

First entry from the Administration menu is Organization where the user can see details about the Healthcare organization:

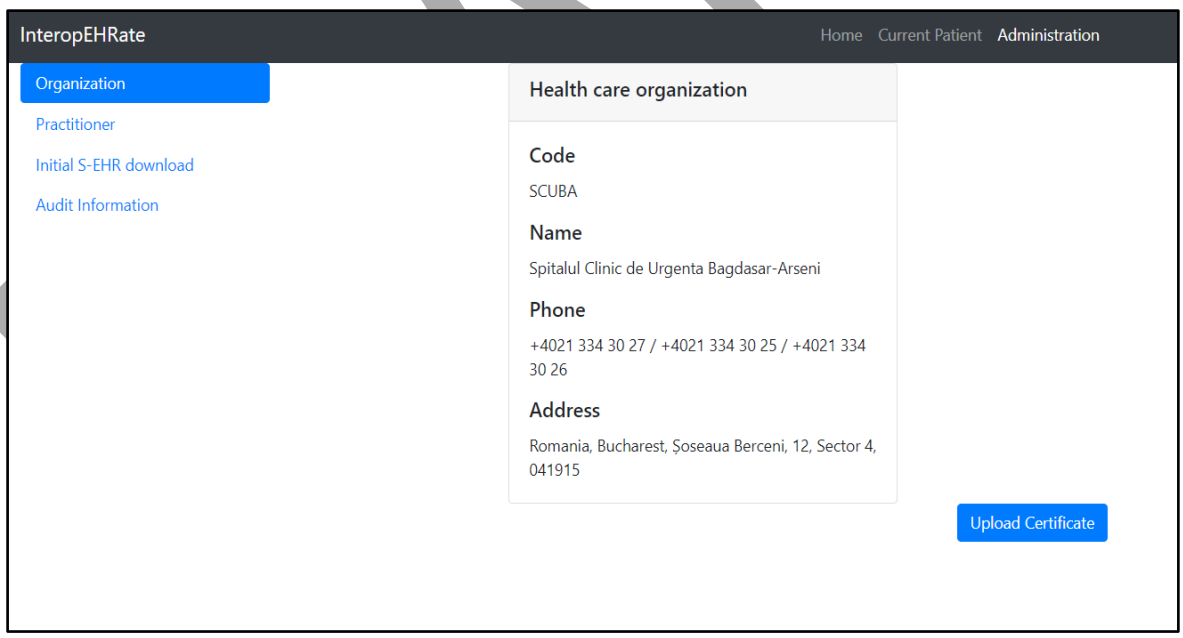

Figure 6 - Information about the organization of the HCP

Section Practitioner contains details about the HCP performing the medical visit:

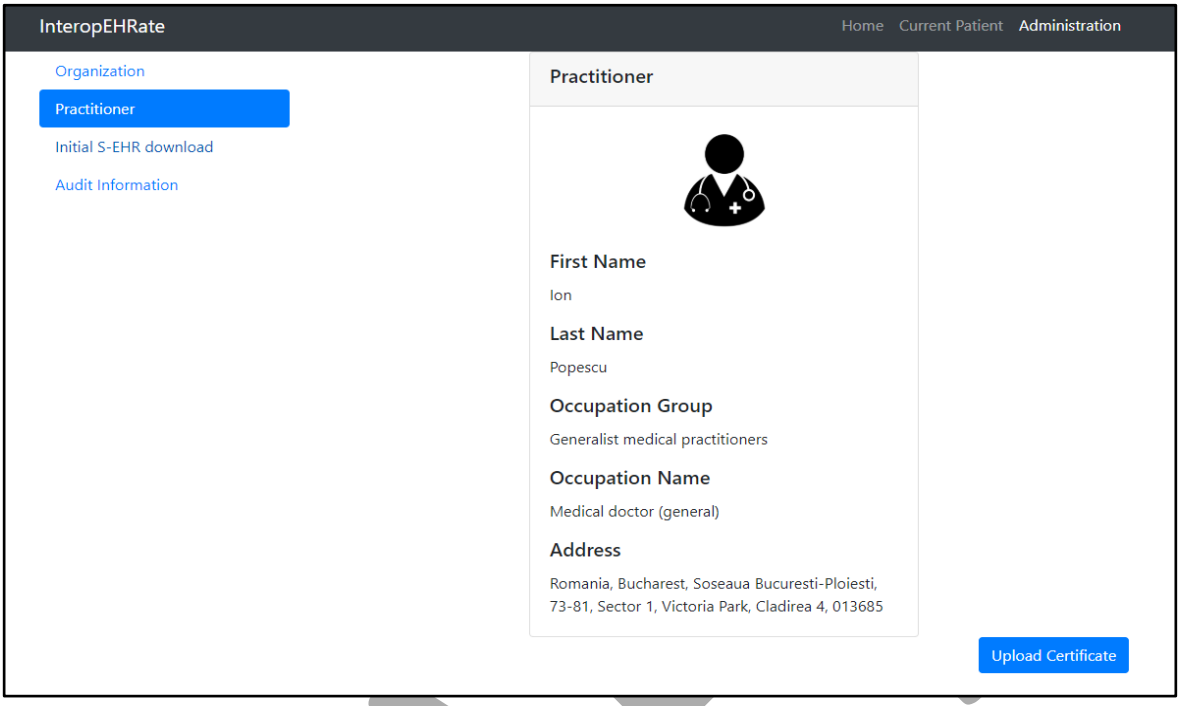

Figure 7 - Information about the practitioner

Initial S-EHR represents the data to be downloaded from S-EHR. HCP selects the IPS category that he/she needs and the data is populated.

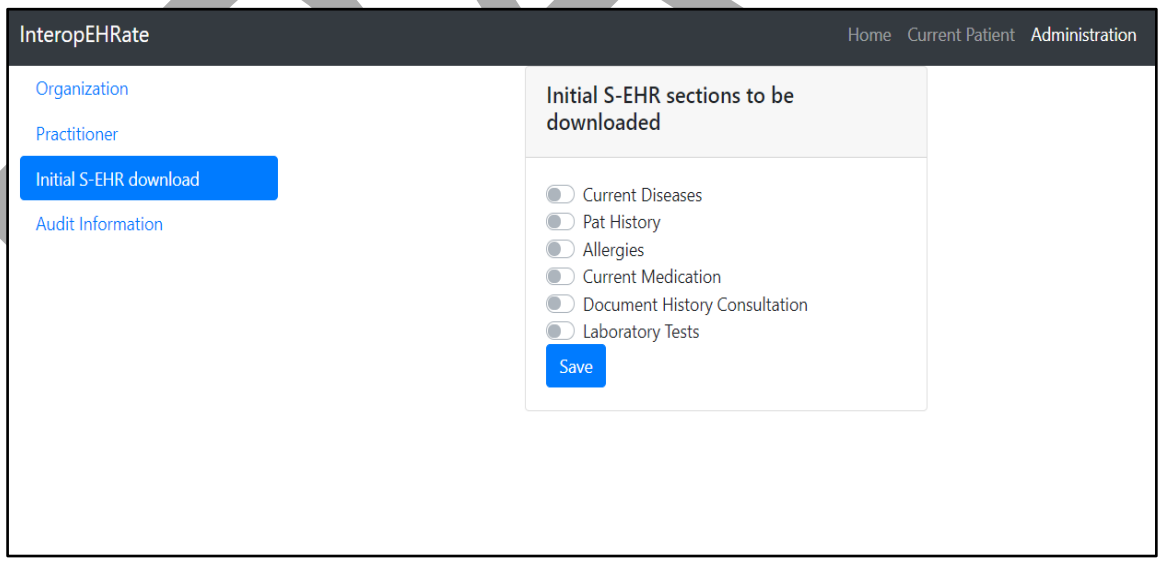

Figure 8 - Choosing the initial information from S-EHR

The audit (e.g.: auditing for admission, auditing of healthcare organization) and consultation mechanism (e.g.: consultation of admission, consultation of auditing for healthcare organization) were implemented in the first version of the HCP-App.

The Audit section that stores the time, type and category from the IPS was selected:

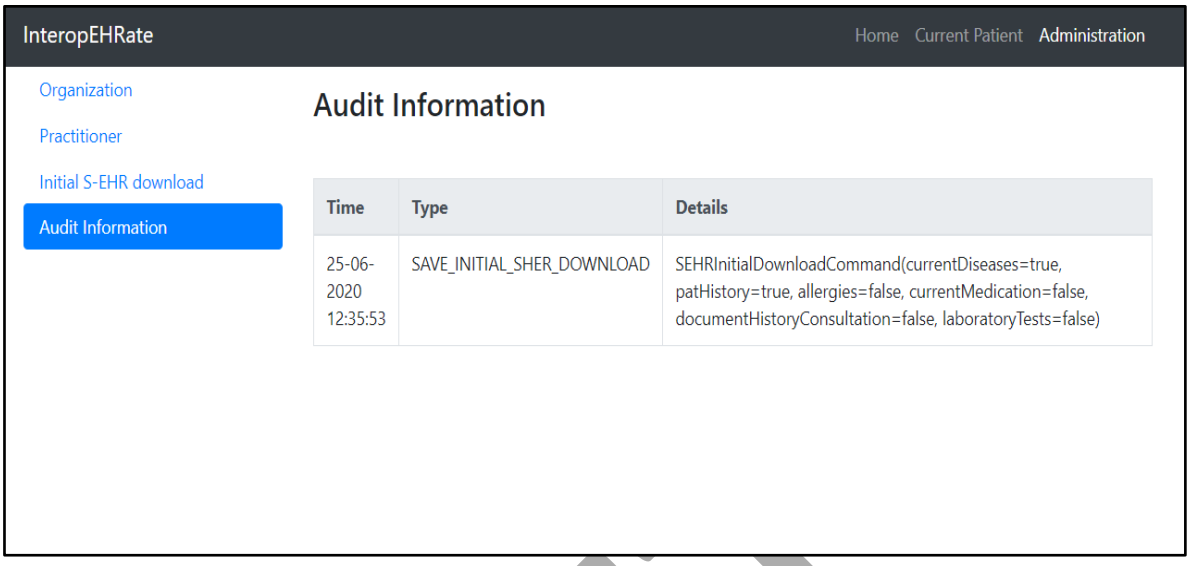

Figure 9 - Displaying the output of the audit mechanism

A Vital Signs nomenclature was implemented in version 2, where the administrator can see the current vital signs options available for the HCP and add new vital signs into the system.

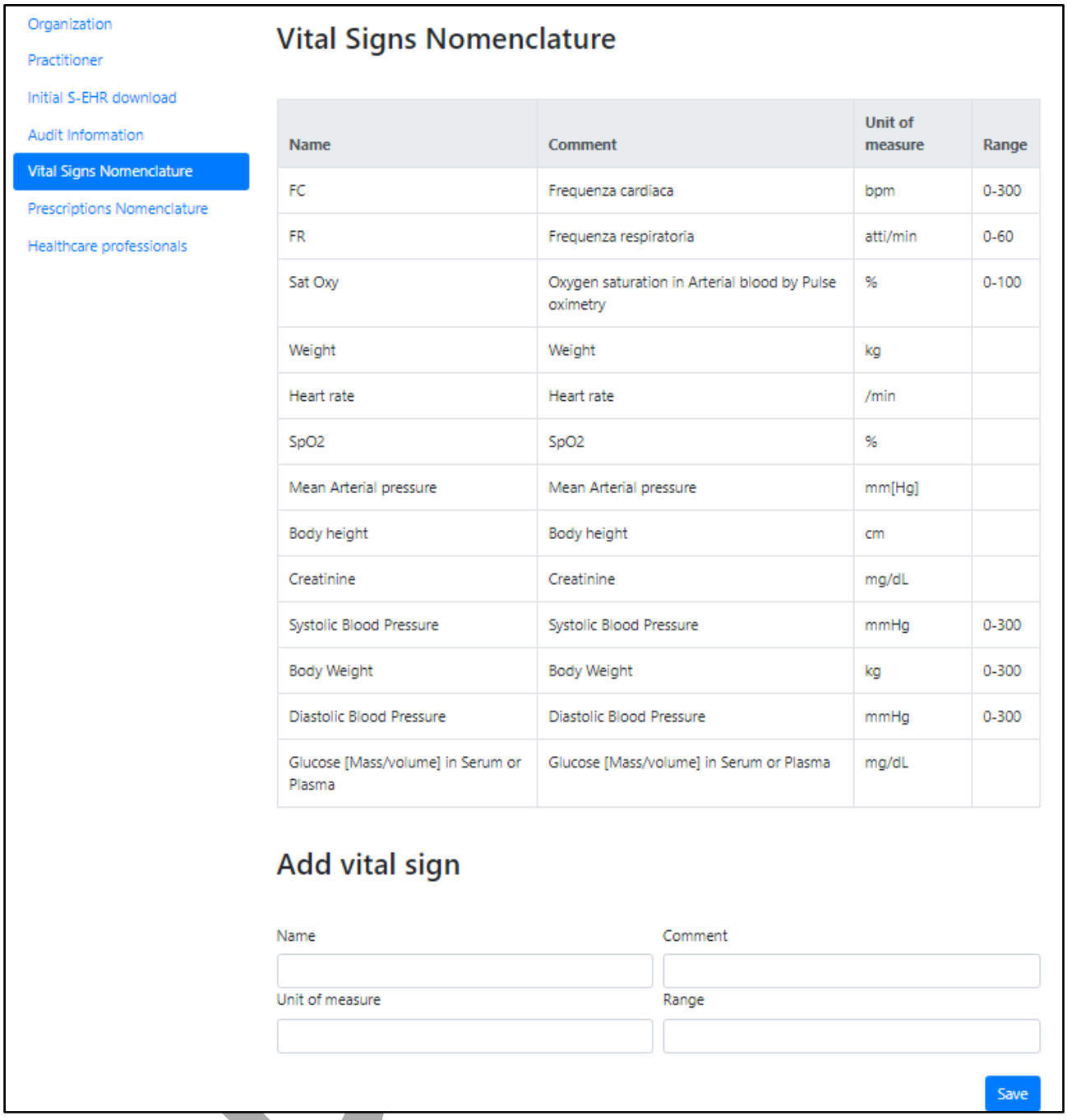

Figure 10 -Vital Signs nomenclature

The same implementation was done for the Prescriptions section.

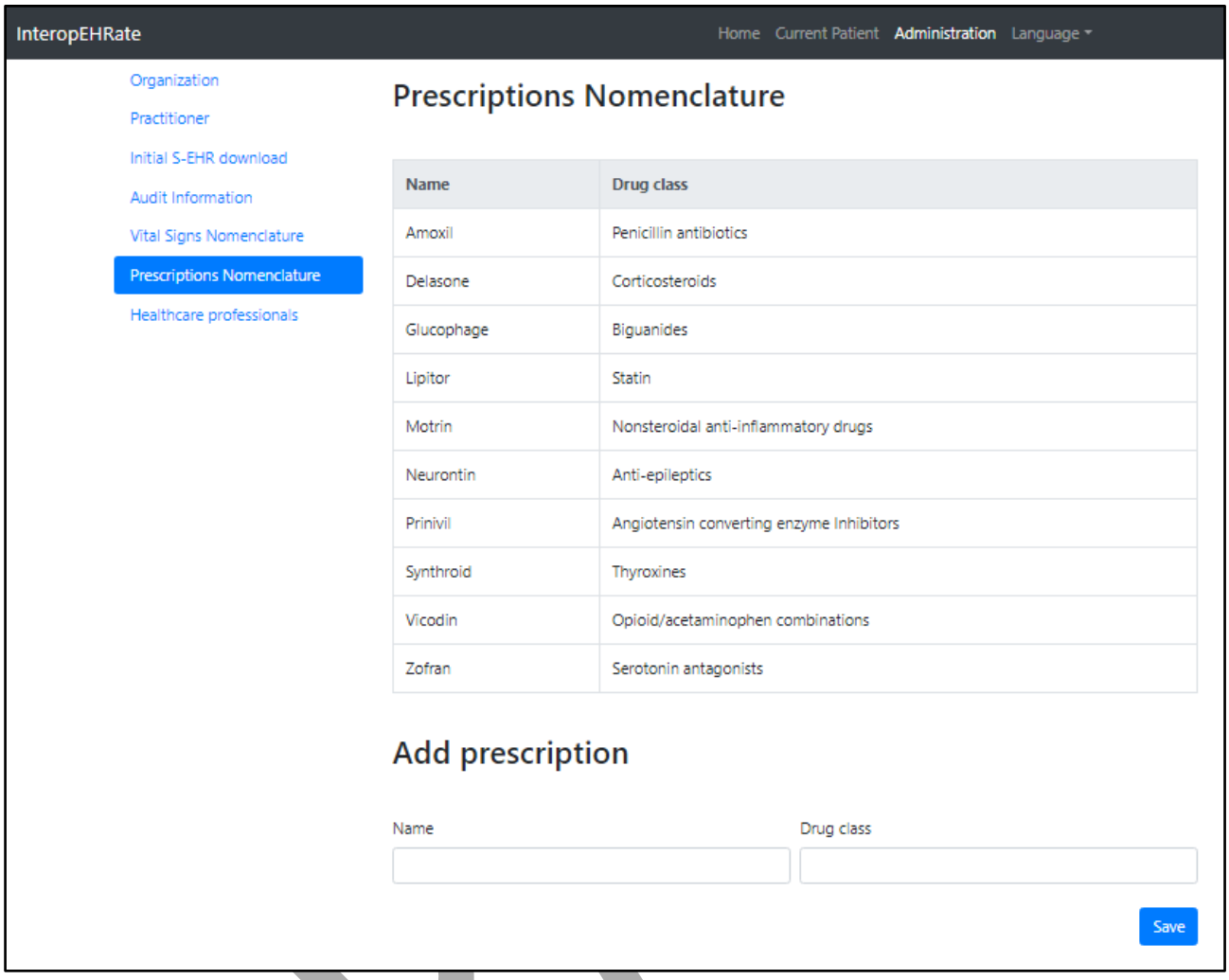

Figure 11 - Prescriptions nomenclature

A new entry was added in the Administration menu called “Healthcare professionals”. Here the user can see data about all HCPs from the Organization.

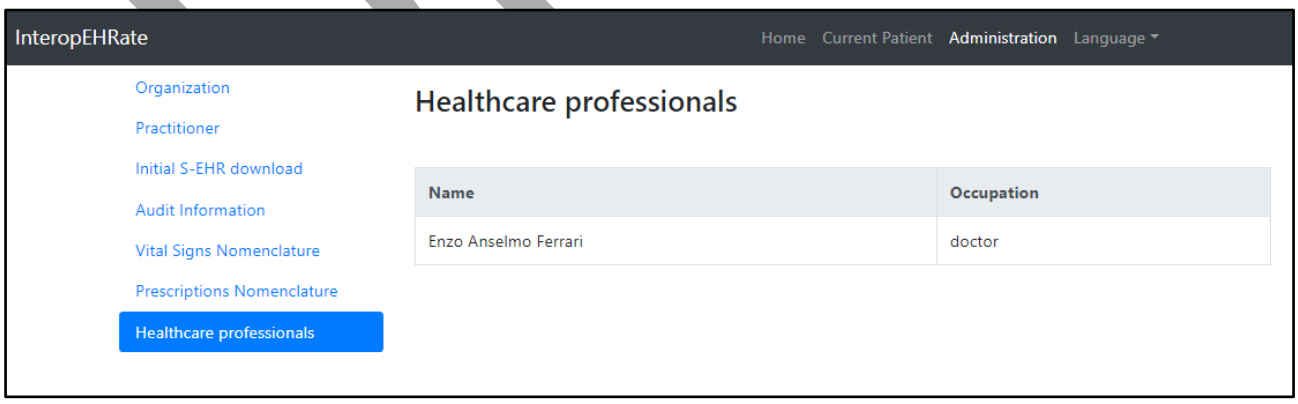

Figure 12 - Healthcare professionals

3.3.4 Backend micro service to transfer a patient between practitioners

- A separated micro service was developed and finalized for creating the possibility of transferring data from one HCP to another. The flow is detailed also in D5.14 0in Chapter 3.3.4
- A preliminary security component was introduced in the HCP App for authentication and authorisation of the user. It is mandatory for the user to be authenticated before using the HCP App. A login page was created for this:

Figure 13 - Login page

- Roles have been introduced as well for restricting the app's functionalities to what the current logged in user should have access to. The user can be an administrator with ADMIN_ROLE or it could be a doctor, nurse etc (DOCTOR_ROLE, NURSE_ROLE)
- A Logout button was added;
- New option is added on the Home page called "Inpatient Encounter". From here the user can select from a list of inpatients:

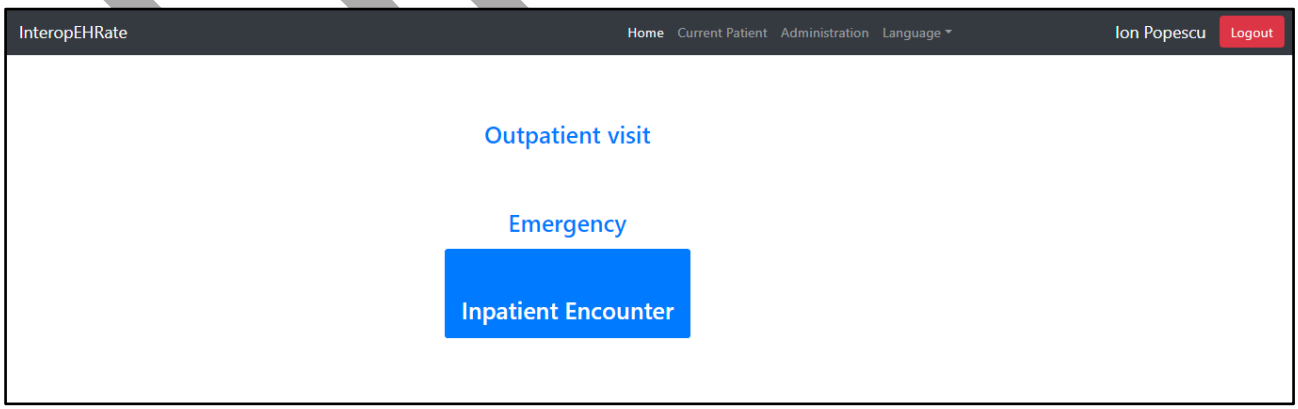

Figure 14 - Inpatient option

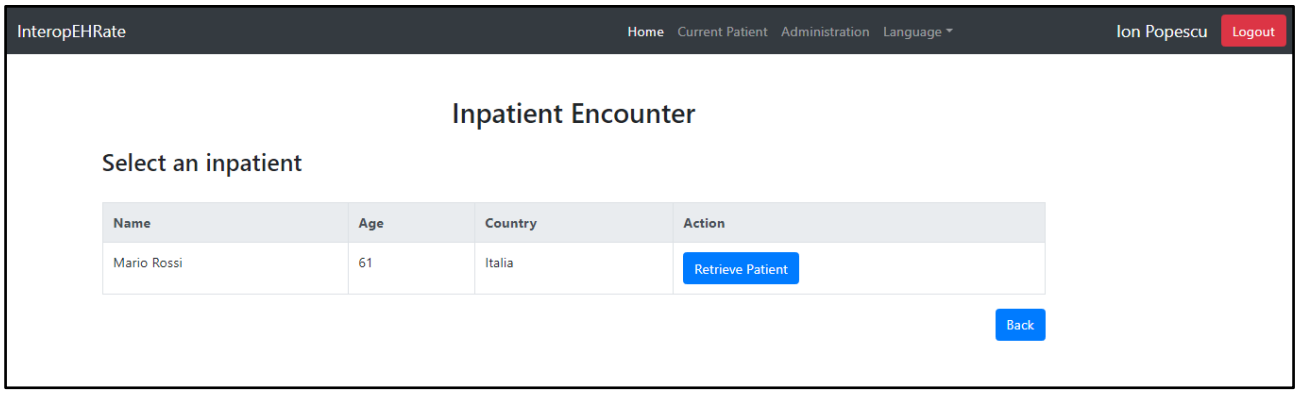

Figure 15 - Table of inpatients

- An inpatient can be retrieved in the corresponding table Inpatient Encounter with its data.
- The HCP App can now generate PDF reports with the new data entered by the HCP in the application: Outpatient report (for Medical visit abroad or Emergency access scenarios) or Hospital Discharge report (for Inpatient scenario).

3.4 Features that will be implemented for the version 3 of the HCP-App

This chapter aims to present the most relevant features planned to be implemented into the version 3 of the HCP-App.

The requirements for HCP App are based on the Scenarios and User Requirements presented in deliverable D2.1 [1] , as they are presented in *Chapter 5.2. HCP App*, as well as on the findings resulted from the Focus Groups assessment in deliverables D2.1, D2.2 [2] and D2.3 [3] . The list of features that will be implemented in version 3 represents a refined version of HCP App requirements depicted in requirements deliverable D2.1 [1] , D2.2 [2] , and its final version, which is in D2.3 [3] .

This refined version of features is fully compliant with both Scenario 1 - Medical visit abroad and Scenario 2 - Emergency access as they are described in deliverables D2.2 [2] and updated D2.3 [3] .

Following the introduction, an extensive and detailed description of the actual requirements is depicted in the following paragraphs. The requirement list that is proposed for the third version can be divided into four types of requirements, as most of them are focused on the manipulation of the data received or sent to or from the HCP App. The four categories have been chosen as a direct consequence of the same type of manipulation of certain healthcare data. The four main categories are the following ones:

- consultation = Includes the viewing process of the healthcare data;
- authoring = Includes the authorization process of the healthcare data. That includes the addition, editing and deletion of healthcare data;
- upload = Includes the uploading process of the healthcare data to S-EHR;
- download = Includes the downloading process of the healthcare data from S-EHR.

Before starting the actual presentation of the requirements, a thorough description of the concept of how the requirements were created needs to be explained further. The concept used in the creation of the requirements of the HCP App agreed in the InteropEHRate project is the macro and micro requirements

model. The macro requirements, also called epics, are complex functionalities used by a final user of a software application and it takes at most one year to implement. An epic is split into several user stories. A user story, also called a micro requirement, is a more simple functionality which takes only one month to implement. Both epics and user stories describe functionalities used by the final user and defined from his/her point of view (describing what the user does or sees or obtains).

Most of the requirements for version 3 focus on the perspective of the health information and the other are developed for the support which provides operating capabilities to the aforementioned healthcare data.

3.4.1 Features to be implemented in version 3 of the HCP-App corresponding to Scenario 1 - Medical visit abroad

Functional requirements:

Requirements related to the consultation action:

The user stories are also present in the issue tracker (GitLab).

- #44 Medical images and reports consultation on HCP App
- #45 Hospital discharge reports consultation on HCP App
    - User story: The HCP sees the designed Hospital Discharge report screen
- #167 Previous visit (diagnosis, treatment plan, medications) consultation on HCP App

Requirements related to authoring:

- #48 Authoring of initial assessment on HCP App
- #53 Clinical History authoring on HCP App
    - User story: CRUD operations on Current Diseases in local database
    - User story: CRUD operations on Pathology History in local database
    - User story: CRUD operations on Allergies history in local database
    - User story: CRUD operations on Prescriptions history in local database
    - User story: CRUD operations on Vital Signs history in local database
- #55 Evaluation Report authoring on HCP App
    - User story: The HCP sees the designed Reason screen
    - User story: The HCP sees the designed Physical Exam screen
    - User story: The HCP sees the designed Conclusion screen
    - User story: The HCP sees the summary of evaluation report in the designed Outpatient Report screen

Requirements related to upload:

- #49 D2D upload by HCP of evaluation report on S-EHR
- #51 D2D upload by HCP of X-ray image and report on S-EHR
- #169 D2D upload by HCP of diagnostic conclusions on S-EHR

- #170 D2D upload by HCP of Treatment Plan on S-EHR

Requirements related to download:

- #65 D2D download on HCP App from S-EHR of a portion of Hospital discharge reports
- #66 D2D download on HCP App from S-EHR of the vital signs and other measures
- #59 D2D download on HCP App from S-EHR of a portion of reports and Medical imaging
    - User story: D2D transfer of a Bundle containing the image report including an image from patient to HCP

Others:

- #168 Treatment plan compilation on HCP App

Non Functional requirements:

- #142 Compliance to organisational regulations
- #190 Automated translation on HCP App of information extracted from natural language in downloaded health history

3.4.2 Features to be implemented in version 3 of the HCP-App corresponding to Scenario 2 - Emergency access

Requirements related to emergency consultation:

The user stories are also present in the issue tracker (GitLab).

- #99 HCP's access to health data of an identified citizen for emergency reasons (with HCP authorization):
    - User story: The HCP is authorized to download and access the HR from the S-EHR Cloud
    - User story: The HCP downloads the IPS to the HCP App (with HCP authorization)
    - User story: The HCP retrieves the citizen's S-EHR cloud information.
- #104 HCP's access to Citizen's medical images for emergency reasons:
    - User story: The HCP downloads medical images from S-EHR Cloud.
- #146 Permanent storage of emergency health data:
    - User story: Permanent storage of IPS in an emergency encounter
    - User story: Permanent storage of Prescription in an emergency encounter
    - User story: Permanent storage of Laboratory Results in an emergency encounter.

Others:

- #188 S-EHR Cloud authentication based on HCP identity issued by healthcare provider [BYTE]
- #189 S-EHR Cloud authentication based on HCP identity issued by local or national authority
- #214 Download on HCP App of referred DICOM Studies

4 CONCLUSIONS AND NEXT STEPS

The current deliverable aims to present the new functionalities and features of the integrated web app - Healthcare Professional Application (HCP App) solution used by healthcare professionals for accessing and creating health data of foreign patients within the InteropEHRate project. The updated version of software requirements specification of HCP App is the result of both technical improvements and software development and the continuous collaboration with the final users (co-design / co-creation sessions).

Taking into consideration the particular requirements of Task 5.1, the deliverable encompasses the updated UI design of the HCP App solution.

Within the deliverable, the HCP App is depicted from two major perspectives:

- Design / Technical perspective
- End User perspective.

This deliverable is the third and final version of the three deliverables of Task 5.1 dedicated to software requirements specification and design of HCP app and is the updated version of the previous deliverable D5.2 [9] .

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