A Demonstration of 4D Digital Avatar Infrastructure for Access of Complete Patient Information

Project acronym: MyHealthAvatar

Deliverable No. 9.2
Development of Demonstrators

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PP	Restricted to other programme participants (including the Commission Services)	
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ABSTRACT:
This document defines and presents in details MHA high end clinical demos selected for further implementation and evaluation. All demos are close related to the prioritised and final set of Use Cases / Scenarios reported in WP7 and WP9

KEYWORD LIST:
Demo, high end clinical demo, implementation, evaluation, use case, scenario

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[1] **R**=Report, **P**=Prototype, **D**=Demonstrator, **O**=Other

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Contents

1 Executive Summary

This document presents in details MHA demos selected. All demos are close related to the prioritised and final set of Use Cases / Scenarios reported in WP7 and WP9 and attached for further references to the this document in **Appendix 2**.

Chapter 2 presents the demos of the general platform, including a set of examples of key functionalities of the platform, including:

- Settings (web)
- Settings (app)
- Diary(web)
- Journal (app)
- Toobox (web)
- Calendar (app)
- Goal (web and app)

Chapter 3 of this document presents the detailed presentation of the high end clinical scenarios, including:

- Diabetes demo
- CHF demo
- Osteoarthritis demo
- Nephroblastoma demo

2 MyHealthAvatar General Demonstrator

2.1 Introduction

The general Demonstrator is defined as a way to demonstrate the prototype of MyHealthAvatar, with the primary purpose of showcasing its idea, performance, method or features. We are following the general definitions of 'demo' term and our main goal is to define and to present the concept of MHA by demonstrating its clear benefits.

MyHealthAvatar is a non-profit research project to study how technologies are able to help patients and citizens look after their own health and wellbeing. It offers you a place to keep records of your medical information as well as your daily activities and lifestyles. It promotes self-care of patients and citizens for healthy lifestyle and wellbeing.

MyHealthAvatar is a lifetime companion for your daily life and health. It can:

- Remember your activities of daily living, including your movements, locations, food intake, mood, sleep quality and photos
- Record your health status such as heart rate, blood pressure and glucose can also be logged.

- Identify and highlight important events in your life.
- Summarise your lifestyle and assess the quality of your life
- Help you enter your health records (e.g. conditions, medication, immunization, allergy)
- Indicate your risks of developing diseases, such as cardiovascular, diabetes, hypertension and stroke.
- Allow you to share information among friends through social media.

MyHealthAvatar offers a range of smart tools to facilitate data input and revisit, and to discover significant information for your health and wellbeing. It has:

- Tools to automatically collect your steps count, calories consumption, active minutes, locations and movements.
- A chat interface for you to log your food consumption, mood and other health-related information using text, photo, icon and voice through a chat with MyHealthAvatar. The MyHealthAvatar app asks for this information at appropriate time and places, for example, while you are waiting for bus. It also delivers you tips and reminders for healthy behaviours, for example, breakfast recommendations, suggestions for a walk if you have been sitting for too long.
- Map, calendar and clock for you to review your daily activities, movements, step counts and travel distance on any given day. The MyHealthAvtar app allows you to view your daily activities via animation. Especially, the app makes easier for you to access your activities on the same day last week. With these features, you can revisit old times for past experiences, bring to mind cherished moments, and jog your memory about the details of past events.
- A timeline for you to view the change of your step counts, travel distance, active minutes, calories, etc.
- A health profile page presented in a professionally designed layout and graphical illustration for you to edit and view your health information, such as name, address, DoB, contact details, care providers, immunisation, allergies, medical history, medication history, and lab test results (e.g. blood test). You can print off this page in the event of vising a new doctor.
- Tools to predict your risks of developing cardiovascular, diabetes, hypertension and stroke.

The data stored in MyHealthAvatar may include:

- Self-reported personal health record (e.g. condition, treatment)
- Location, movement and activity
- Step counts, walking, climbing up, running, cycling distance, active minutes, calories consumption
- Sleep quality
- Heart rate, blood pressure, spo2
- Food consumption
- Mood
- Photo

2.2 MHA Functionalities

2.2.1 Settings: website

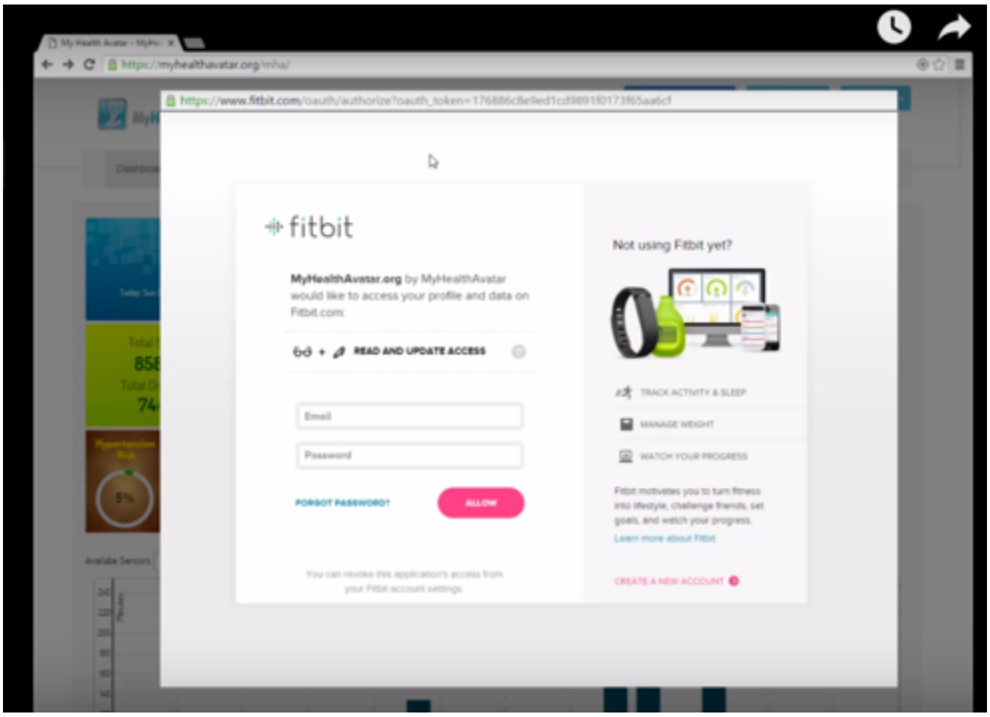
To access the settings of the MHA web application click the drop down menu next to your login name. This reveals four options:

Social Networks: Selecting this option will launch a dialog that allows you to link your social media accounts to the MHA platform. Clicking the “link account” button next to the social media provider will re-direct you to the provider’s site where you can log in and authorize MHA.

My Devices and Apps: Selecting this option will launch a dialog that allows you to link 3rd party sensors and apps to the MHA platform. Clicking the “link Device” button launches a pop-out page that contains a log-in portal for the devices service.

My Profile: The profile page is divided into tabs, here you may enter general information into the General profile tab, this consists mainly of demographic information and basic physical attributes. The health profile tab allows you to record some basic health status information such as whether you are a smoker or if you suffer from diabetes or other ailments.

Mt Goals: This page displays your standard daily goals, you can edit the value and save your changes using the save all button.



Example: Link Fitbit to MyHealthAvatar

2.2.2 Settings: Mobile

Hello and welcome to the MyHealthAvatar platform.

In this video we will be exploring the MHA mobile application’s settings.

To access the settings simply activate the sliding navigation window by either swiping right with your finger or selecting this navigation icon. Then select settings.

Here you will able to see a number of settings categories, Beginning with Display Mode: these options refer to the data source you intend to use with MHA, if you are using the Moves application to gather activity data then selecting this option will tell the application to visualise data from this source.

Step Mode: this provides the option to enable the step sensor, this feature is required in order to calculate your progress towards your daily goals on the overview page.

Diary Message Mode: Enabling this feature will allow the application to ask you about your mood within the diary.

Activity Sensor Mode: This enables the application to detect sedentary behaviour.

Alarm Mode: Enable Diary Alarm turns on sounds when notifications occur.

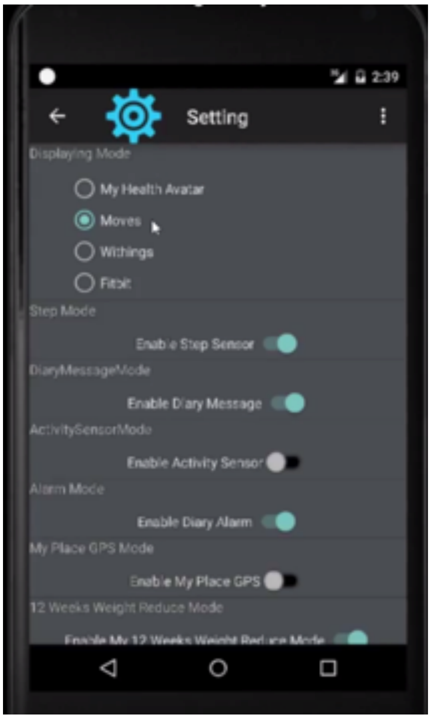
My Place GPS Mode: Turning on this feature will enable the application to ask questions within the diary based on your location as well as post useful location based notifications.

12 Weeks Weight Reduction Mode: This mode starts an NHS based 12 weeks program that provides help and advice over a 12 week period for reducing your weight.

> Upon activating this mode a setting for customising the timing of these tips becomes available.

Diabetes Mode: Turning on this feature enables diabetes result recording and tips within the diary.

> Upon activating this mode a setting for customising the timing of these tips becomes available.



Example: Settings in the MyHealthAvatar App

2.2.3 Diary: Website

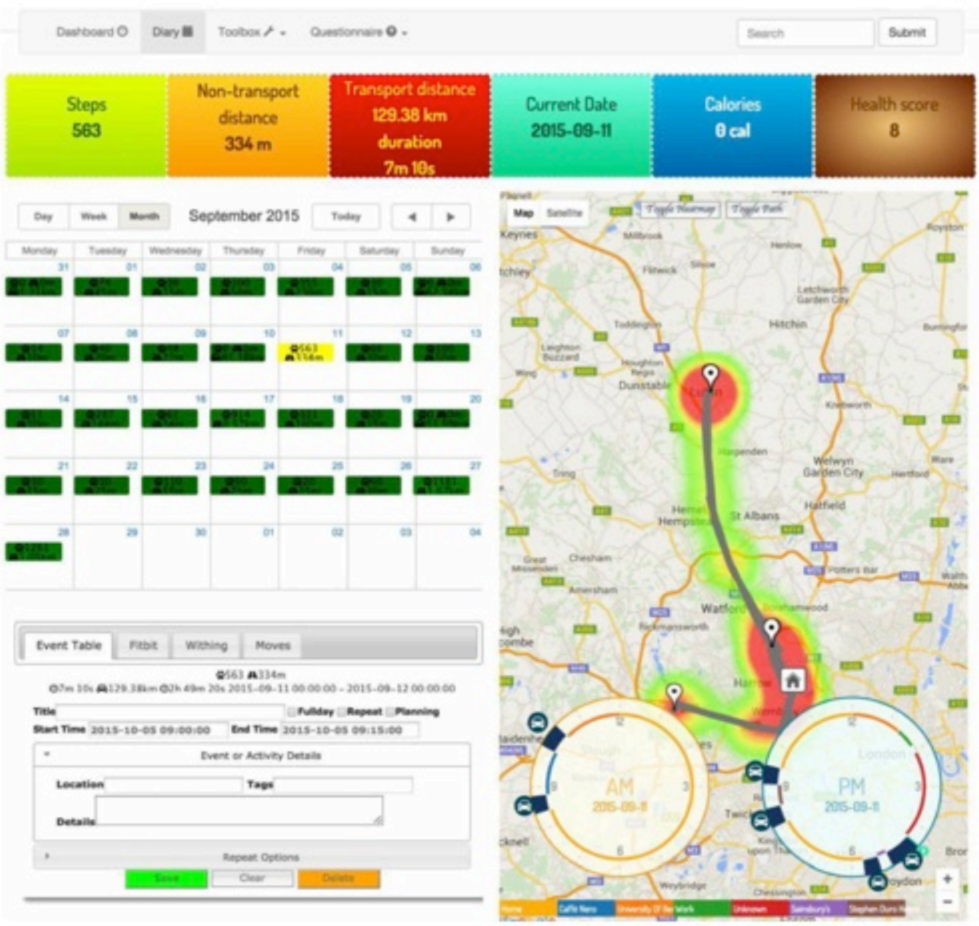
To access the MHA web diary click the Diary tab icon on the main navigation bar. This loads the diary page on the current Month by default, you can scroll through the months using these navigation buttons.

Once a specific day is selected the interface updates to display important values from this day in the coloured bar below the navigation tabs and the interactive map to the right.

The map is an imbedded google map, utilising the standard mouse navigation of Google maps you can click and drag to pan the map and use a mouse's scroll wheel to zoom as well as the zoom buttons.

The map provides an Am and PM activity dial, these dials visualise your activity on this day in an intuitive clock format. Mouse-ing over icons on the dials provides more information on this activity.

Clicking a location icon on the map will bring up a small menu that will allow you either view, add or edit a tag for this location. When adding or updating tags the dialog window provides helpful suggestions comprised of nearby points of interest.



Example: MyHealthAvatar Web based Diary

2.2.4 Journal: Mobile

To access the Journal simply activate the sliding navigation window by either swiping right with your finger or selecting this navigation icon. Then select Diary. Alternatively you may use the quick link button situated in the overview page.

The Journal is structured like a chat wall where your input is displayed on the left and MHA input is displayed on the right.

There are several ways to add data or notes into the Journal, clicking the right most menu button will bring up a contextual list of available actions based on your settings. Here you can add photos, use voice input to dictate notes, or answer questions related to your active programs, missing profile items and health tracking activities.

The left most menu button brings up a tabbed sub menu, here you can select emoticons, dietary events and Diabetes testing events.

To add an emoticon, select it from the menu, this will add it to the input field in the lower middle of the screen, then you can select this input field to add further text or simply press send to input just the emoticon.

To add a dietary event you may enter the name of the food item consumed into the input field and click send, once the item appears in the diary click the Annotation button and select CalsCounter option. Alternatively you can highlight an existing diary event and select a calorie event from the tabbed menu.

Once the calorie calculator interface is launched you will either see your original food item listed in the search field or if you tagged an entry you will need to enter an item into this field.

Click the search icon to begin a search. The application will load a list of possible matches for your search term. Select a search result that best matches your food item and you will see a list of serving portions, you may click the plus icon to expand the dietary information, click the smiley face to add this food portion to your favourites and you can click the note icon to load this portion information into memory, then click the confirm button and then submit to add this item to your diary.

To add a diabetes record use the left menu to bring up the tabbed data entry menu, click or scroll to the diabetes record button. Click this button to bring up the diabetes interface, if this interface does not load and you receive a message informing you to turn on diabetes mode then refer to the Mobile settings video tutorial.

Once the interface is loaded you can add or edit records, if you have not made any records on this day you will need to add a new record, click this button and two records will appear, one for insulin and one for glucose. Select one to begin adding your test result. Once you enter your fasting values and click CONFIRM the value will appear in the record text, click submit to finish and close the interface. In two hours the application will remind you to enter the post meal results into this record.

Example: MyHealthAvatar Journal on the Mobile App

2.2.5 Toolbox: Website

To access this feature simply click the toolbox drop down button on the websites main navigation bar.

You will be presented with a number of predictive analytical tools such as Cardiovascular Disease, Hypertension, Diabetes and Stroke risk calculators.

Select a prediction tool that interests you, such as Cardiovascular Disease (10-year risk)

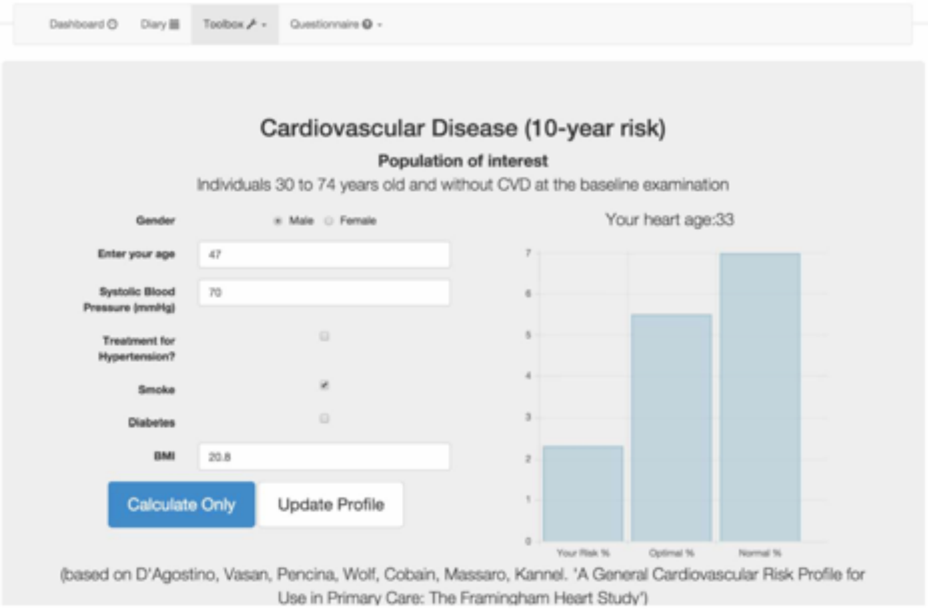
Now you can enter data into the model, such as your current information, or you can enter speculative values such as a higher age or lower blood pressure or BMI.

Clicking the “calculate only” button will run the model and give you results without modifying your profile.

The results will show you your own risk in comparison to an optimal result and an average result.

If you select the Update profile button then the values you entered into the predictive model will be transferred to your profile.

Using more of the risk prediction tools will help you add more information into your profile, for example using the diabetes tool will help you add a number of important values such as weight and height as well as cholesterol.



Example: MyHealthAvatar Toolbox

2.2.6 Calendar: Mobile

To access the Calendar simply activate the sliding navigation window by either swiping right with your finger or selecting this navigation icon. Then select Calendar.

The calendar page displays one month in a standard grid layout calendar. You can scroll the calendar left and right or alternatively click the navigation buttons to change month.

At the bottom of the calendar page is the "Coming Up" bar, this bar shows up and coming events in the order they will happen. To add new events click the Plus icon to the left of this bar. This launches the add event dialog, here you can enter an event title and configure the event as either a singular occurrence or a repeating event.

An event requires a minimum amount of information to be accepted, in the case of a singular event just a title and start date is required, the event will be considered an all-day event in the absence of a start time.

A repeating event requires a title, start date and at least 1 selected day to be accepted.

Repeating events are shown in the calendar by the presence of a solid blue line, singular events are represented by a solid orange line and the turquoise lines represent goal completion values.

Clicking an event in the coming up bar will load some extra information about that event, click and hold over the event to open the event up for editing. In edit mode you can make changes or even remove the event using the minus button.

Clicking a specific day within the calendar will launch the day-view page. Here you will be presented with a breakdown of events, planner items and activity charts for the target day, you can change the day by clicking these navigation buttons, and you can change which sub category of the day you want to view by swiping left and right or by clicking the category headers.

The events tab shows a chronological list of important events on the target day, you can scroll this list and expand headings to reveal deeper information. Clicking geo-location data will launch a dedicated map view where you can view and annotate location data. The first geo-location data header is a summary view of all movement throughout the day.

The Planner tab displays a list of all scheduled events that occurred on this day, you can single click an event to get more information, or click and hold to edit the event.

The Charts tab shows simple bar charts that are colour coded to indicate if they met the goal assigned to this activity or measurement. Values such as weight will be interpolate based on neighbouring data if there is no explicit value set on this day. You may toggle on and off categories you are not interested in.

Example: MyHealthAvatar Calendar on the app

2.2.7 Goals Extended: Platform

Both the web and mobile application will allow you to view and edit your personal goals. We will now view our goals on the web application.

Go to the drop down options menu next to your log-in name and select "My Goals" this will load the standard Daily goals page. Here you can see 8 common goals and the values associated with them, you can change the value of a goal or multiple goals simultaneously. Click save all to confirm any changes.

Within the mobile application ensure you are on the overview page, then click goals button. Once the goals interface is loaded you will see the same goals available as the web application.

Goals are shared between the two applications, changes made in one will be reflected by the other. Here we will change a value within the application (Change a value) now when we refresh the web application we shall see the changes.

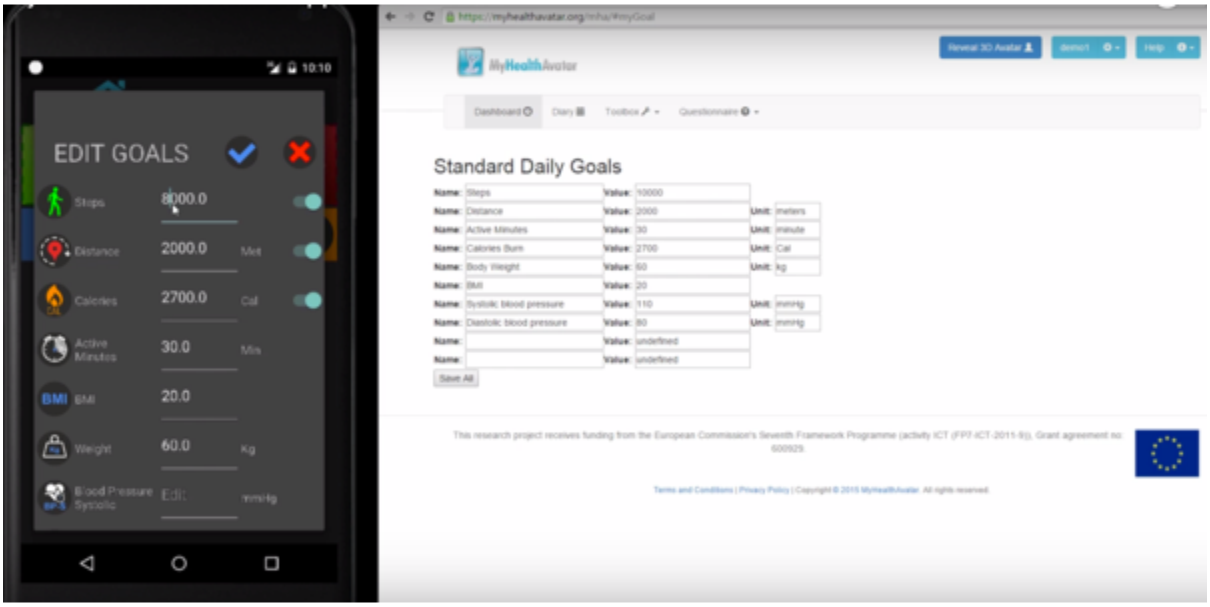
Changes made in the application will be registered on the app the next time you load the app or open the goals for editing.

You may be wondering how do goals effect the application and how the application represents your data?

The current goals effect the goal completion dial on the overview page, they also influence how data is represented in the statistics page and day overview page as well as generate a completion bar within the calendar view.

For example the statistics page uses your goals to calculate whether or not you achieved them. The page displays a coloured bar chart, ensuring steps is active the chart shows a yellow bar to indicate effort below your goal and then a green bar for all activity beyond your goal. The most recent goal has a label and line leading across entire screen.

Goals are also stored historically, at any point that you make changes those changes are recorded, so you can see older goal values represented as they were in the past rather than have all effort compared to your most recent goals.



Example: MyHealthAvatar Goal Setting

3 High End Clinical Demos (HECD)

3.1 Diabetes and Emergency Demo (DIAB-EME)

High end clinical demo (HECD): DIAB-EME

	UAC	3DS	DB	VC	DCU	TOOL	HIS	CHF	OST	DIAB	NEPH	EME
CHF(FORTH)												
OST(FORTH)												
DIAB-EME (BED)	x	x	x	x	x	x	x			x		x
NEPH (ICCS / USAAR)												

Table 2 Use cases (column) vs DIAB-EME

Demonstration for the pre-diabetes and emergency contact

1. Introduction

Diabetes is the world's fastest growing disease. The personal, social and economic costs of the diabetes epidemic are substantial. It is a major cause of cardiovascular disease; the most common reason for commencing renal dialysis; the most common cause of blindness in people under the age of 60 years; the most common cause of non-traumatic lower-limb amputation; and one of the most common chronic diseases in children – to name but a few. Type 2 diabetes in particular is a serious and growing health problem affecting all sectors of the population, and accounts for approximately 85 % of diagnosed cases.

Prediabetes, also commonly referred to as borderline diabetes, is a metabolic condition and growing global problem that is closely tied to obesity [3]. Prediabetes referred to the person's blood glucose, or blood sugar, levels that are higher than normal but not high enough to be diagnosed as diabetes. [4] People are more likely to develop type 2 diabetes if they have prediabetes , heart disease, and stroke. It is estimated to affect more than 32 million EU citizens (nearly 10% of the total EU population), an additional 32 million citizens have not yet been diagnosed, or with pre-diabetes[5].

Cases of prediabetes that are identified early on can be reversed, and therefore preventing them from progressing into full-blown type 2 diabetes. Each year in the UK, 5% to 10% of people diagnosed with prediabetes go on to develop type 2 diabetes [6]. The two principle actions that can be taken to prevent developing of type 2 diabetes from prediabetes are:

- Making changes to your diet and
- Appropriate physical exercise to your lifestyle

While some risk factors such as age, race/ethnicity, gender, family history are not modifiable, patients do have control over their weight, unhealthy cholesterol levels, high blood pressure,

[3] http://www.diabetes.co.uk/pre-diabetes.html (November 2014)
[4] http://vsearch.nlm.nih.gov/vivisimo/cgi-bin/query-meta?v%3Aproject=medlineplus&query=pre+diabetes&x=12&y=10 (November 2014)
[5] International Diabetes Federation. IDF Diabetes Atlas, 4th ed. 2009, http://www.diabetesatlas.org/downloads (November 2014)

smoking, sedentary lifestyle, unhealthy diet and high blood glucose level. These include a long-term commitment of dietary change, exercise, regular self-medication, self-monitoring of blood glucose, regular attendance at clinic and for screening programmes.

However, these healthy behaviours are often NOT achieved in practice by prediabetic patients, despite their value being understood by both patients and medical professional. Studies show only 30% adults who have modifiable risk factors for diabetes have sufficient level of self-awareness. Nearly 80% of prediabetic patients think they are in “excellent” or “good” health, even though they don’t regularly implement good health habits. According to many healthcare professionals, the greatest barrier to treating the pre-diabetic patients is their non-compliance with lifestyle recommendations.

Self-management is described as the lifestyle and medication-taking patterns that people with diabetes engage in, in order to control diabetes and reduce the risk of complications. Evidence suggests that assisting prediabetic patients in self-management can result in significant gains in health status and reduced risk in progression to diabetes. Diabetes self-care is not a unitary concept but rather consists of several unrelated behaviours (e.g. remembering to take medication, reducing saturated fat intake, increasing physical activity, checking one’s feet and so on).

This demonstration (PDIAB-EME) will be designed for the long-term self-management of healthy citizens, especially for those at the risk of developing diabetes in near future, supporting increased role of patients in prediabetes care. The demonstration will utilise the MHA platform to support and empower patients.

MHA provides a unique platform that empowers normal citizens in terms of supporting their life management and healthy lifestyles. It offers a one-stop service for citizens in terms of data collection, and self-management services, such as monitor, record, and education. The system will support the storage of behaviours and daily activities of citizen. It will function as a supportive environment to empower normal citizens in looking after their own health, raising their self-awareness of any potential risk of developing diseases while encouraging their healthy lifestyles in terms of doing routine daily exercises, stopping smoking and controlling their diet. Therefore, naturally many existing functionalities in MHA can be directly used for the needs of pre-diabetic care. In addition, we will incorporate tailored services, such as diabetes risk assessment models for pre-diabetic care, which will be used by the users to understand their personal risk of developing diabetes, and the impact of their behaviour and lifestyles towards the risk.

Also, a known condition in diabetic patients is ‘passing out’ due to hypoglycaemia. In such cases (or due to another reason), if the patient is unconscious, the attending doctor would not be able to access the electronic health records which are necessary for proper diagnosis and treatment. This case will also demonstrate the value of the MHA platform in emergency cases where the patient could be unconscious, it is imperative that certain critical medical data and the next-of-kin of the patient are known to the attending doctor e.g., if the patient is in a foreign country. Key information such as known allergies to drugs, medications currently being taken, pregnancy status in females, past medical history, insulin resistance in pre-diabetes and the food or beverage recently consumed by the patient can help the doctor to more precisely plan the treatment. Though data access in the patient's vital interests is permitted without consent, the patient is empowered by the MyHeathAvatar platform to create his unique ID and link it to the next-of-kin and relevant medical data which can be fetched by the attending doctor. By this, MyHealthAvatar will fully respect the patient's self-determination.

2. Descriptions and design

Objectives

The outcome of this demo is set to empower citizens by providing a supportive environment for the self-management of lifestyles for general health and wellbeing. Our particular focus is cast on risk analysis for diabetes, enabling more effective pre-diabetic care in terms of risk reduction through improving compliance with healthy lifestyle recommendation. This allows the users to play a key role in monitoring and managing their own health.

More specifically, we are aiming at the following objectives:

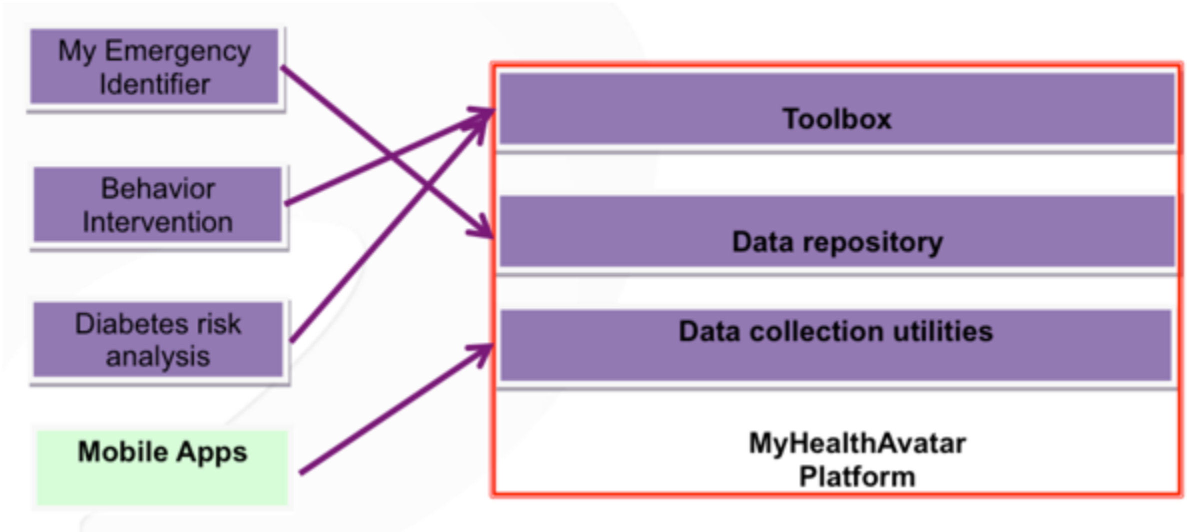
- Enriching the functionalities of the MHA platform in terms of enhancing user experiences in behaviour monitoring and facilitating their lifestyle management
- Incorporating verified risk assessment models for diabetes into the MHA platform
- Incorporating personal behaviour intervention modules that allow for planning and remaindering services for daily physical exercises, diet control and medication where necessary.
- A mobile app that allows for easy access to the platform via mobile devices.
- An emergency identification service, My Emergency Identifier, which will allow the attending doctor to identify the patient, using an appropriate way (e.g. his finger prints), in emergency cases where patient is not in a state to provide ID. The summarised information made available to the doctor in such cases will help improve management regimen and avoid any complications.

Targeted end-users

This demonstration target healthy citizens to facilitate their self-management of lifestyles for general health and well-being, with a particular focus on the risk assessment for diabetes and lifestyle management for reducing the risk.

Also, synthetic patient is used to demonstrate the scenario of emergency contact.

Overall design



Implementation of PDIAB-EME(left) and the MHA Platform

The above figure is a diagram that shows the implementation of PDIAB-EME and its relationship with the MHA platform.

Notably, the implementation of the PDIAB-EME is closely coupled with the implementation of the MHA platform. Many functionalities that are utilised by the targeted end-users of PDIAB-EME have been implemented directly as inherent components of the platform, such as self-monitoring, emergency identifier and behaviour intervention.

Added values of MyHealthAvatar

MHA provides a unique platform that empowers normal citizens in terms of supporting their life management and healthy lifestyles. Whereas in the past, the so-called 'grey area' patients with prediabetes were not looked after by the health care system. As a citizen oriented platform, the MHA platform provides services to the general public that help them identify and mange their risk of developing diabetes. It is a perfect complement to the health care system. It offers a one-stop service for citizens in terms of data collection, and self-management services, such as monitor, record, and education. The system supports the storage the behaviours and daily activities of citizen. It functions as a supportive environment to empower normal citizens in looking after their own health, raising their self-awareness of any potential risk of developing diseases while encouraging their healthy lifestyles in terms of doing routine daily exercise, stopping smoking and controlling their diet. Therefore, naturally many existing functionalities in MHA can be directly used for the needs of pre-diabetic care. In addition, we have incorporated tailored services, such as diabetes risk assessment models for pre-diabetic care, which is used by the users to understand their personal risk of developing diabetes, and the impact of their behaviour and lifestyles towards the risk.

In cases where the (unconscious) patient is unable to provide his identification information and the next-of-kin is not known, the attending doctor can request MyHeathAvatar to provide a limited access to the MyHeathAvatar records and fetch a summary of the data using patient's ID. Hence, MHA provides the summarized medical information relevant to the treatment and also the next-of-kin information to get consent for any medical/surgical intervention required.

3. Implementation

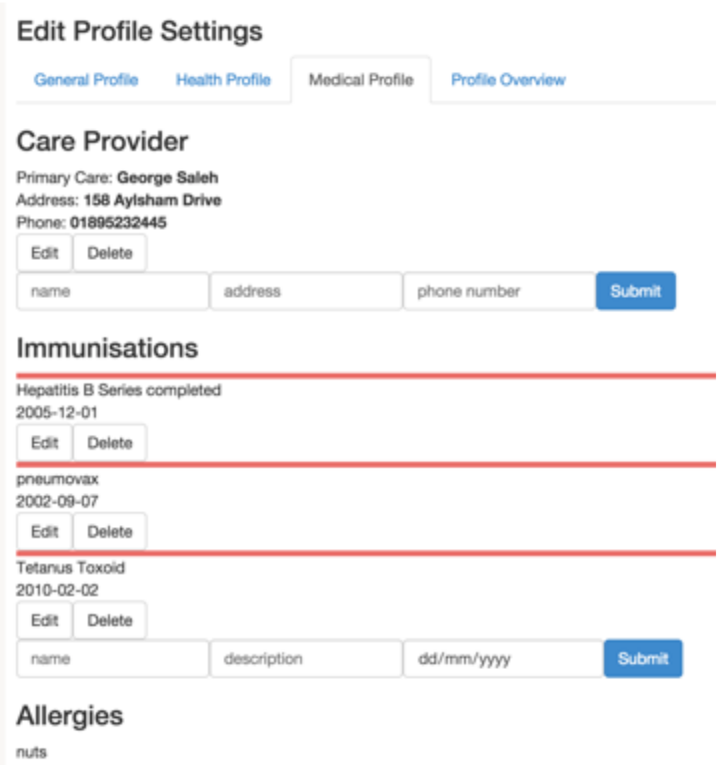
The prediabetes services provided by the MHA platform and its app offers the following functionalities. All of the functionalities are regarded as key services needed for the care of patient in the context of diabetes.

Profile

Profiling plays an important role for self-management as it contains the most basic and important information in healthcare. Currently the following profile information is recorded in MyHealthAvatar

- Name
- Address
- Gender
- Contact doctors
- Allergies
- Immunisation
- Medical history
- Lab test
- Medication

There are a number of ways for the patients to input their profiles. Primarily, they can enter their profiles by web platform:



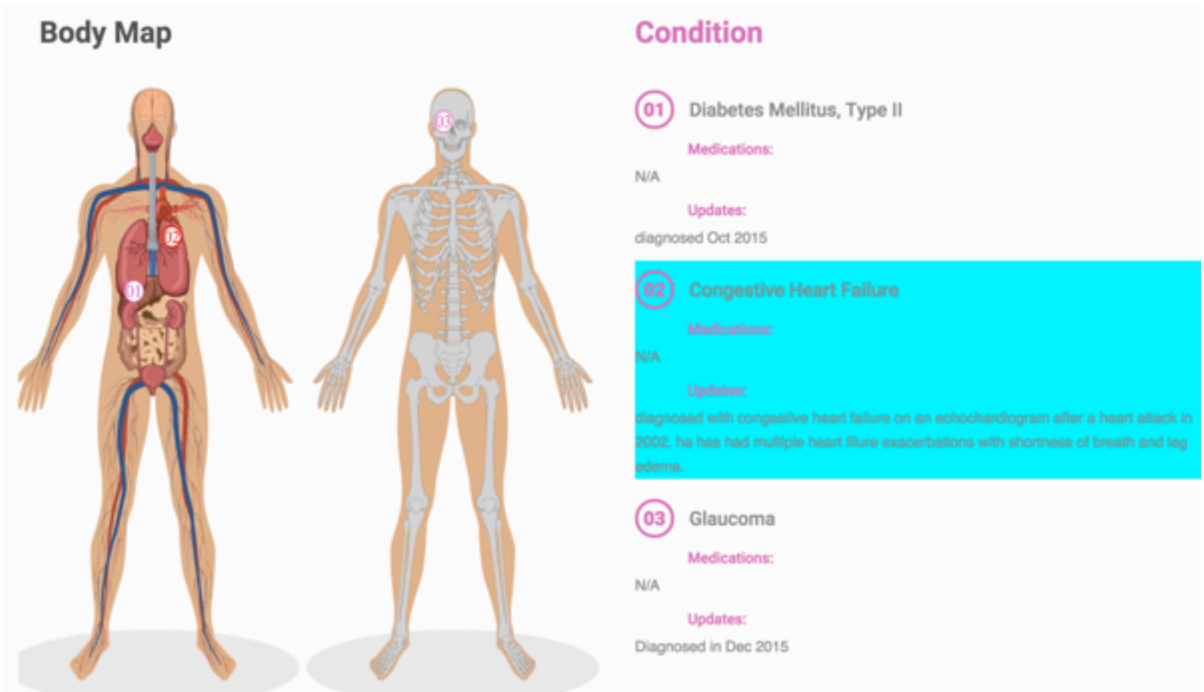
In addition, they can also entering the profile by mobile app. They may also provide profile information via the risk assessment tools.

Profile visualization

Upon the entering of the profile information, the profile can be visualized in a PDF format to allow for a summary view of key clinical information of the patient.

To allow access to the stored data in cases where the patient is unable to provide ID, e.g., unconscious patient, MHA provides the service of identification of the patient, called Profile. Such request will be raised by the attending doctor and the service in MHA will recognise it as a legitimate request by identifying the patient and doctor's ID. Upon successful identification, MHA will grant access to summarized data from the patient's stored records to the doctor. The exception reports and session log of such requests will be stored in MHA to maintain audit trail.

The following figure shows an illustration of profile visualization. Notably, on the web platform, it is also an interactive tool – 2D avatar presented in the profile view allows for interactive illustration of the conditions by the patient themselves.

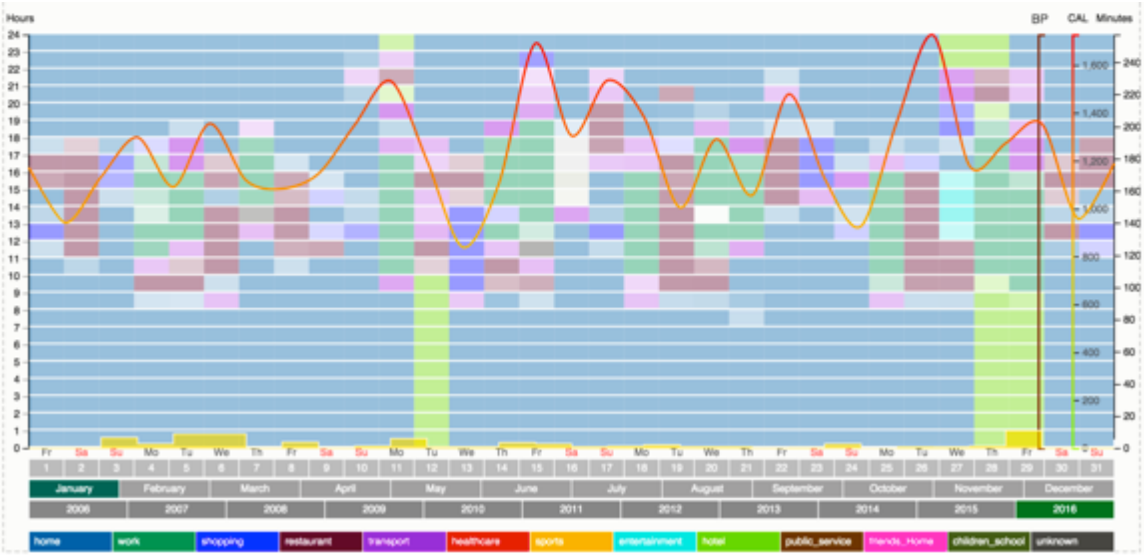


Physical activities

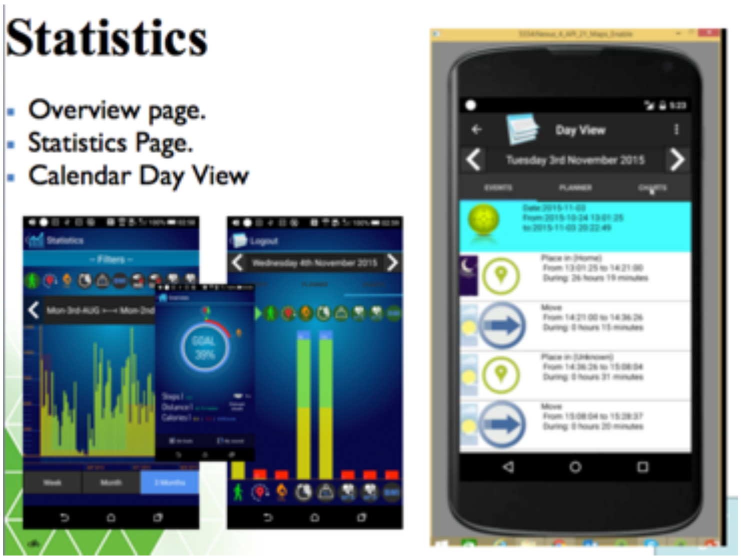
MyHealthAvatar offers a number of ways to record physical activities in a highly automated manner. This is mainly achieved by using self-logging sensors and mobile apps. Currently the following data are captured:

- self-reported personal health record (e.g. condition, treatment)
- Location, movement and activity
- Step counts, walking, climbing up, running, cycling distance, active minutes, calories consumption
- Sleep quality
- Heart rate, blood pressure, spo2
- Food consumption
- Mood

- Photo



Visualization of physical activities via the web platform



Visualization of physical activities via mobile app

Biochemistries

Through the MyHealthAvatar app, the patients are able to enter the results of their medical tests, including

- high sensitivity c-reacting protein (hsCPR)
- Microalbuminuria (mg/dL, milligrams per decilitre) <30 normal, <300 early kidney disease, >300 advanced kidney disease
- blood cholesterol (mmol/L millimoles per litre) <5
- blood low-density lipoprotein (LDL, mmol/L, millimoles per litre) <3
- blood high-density lipoprotein (HDL,mmol/L, millimoles per litre) >1 && <4
- triglycerides (mmol/L) <2
- Diastolic blood pressure (mmHg)

- Systolic blood pressure (mmHg)
- glucose (mmol/L, pre meal: 4-5.9, after meal: <7.8)

In addition, the app also offers the capability of allowing the patients to self record their glucose levels before/after their meals.

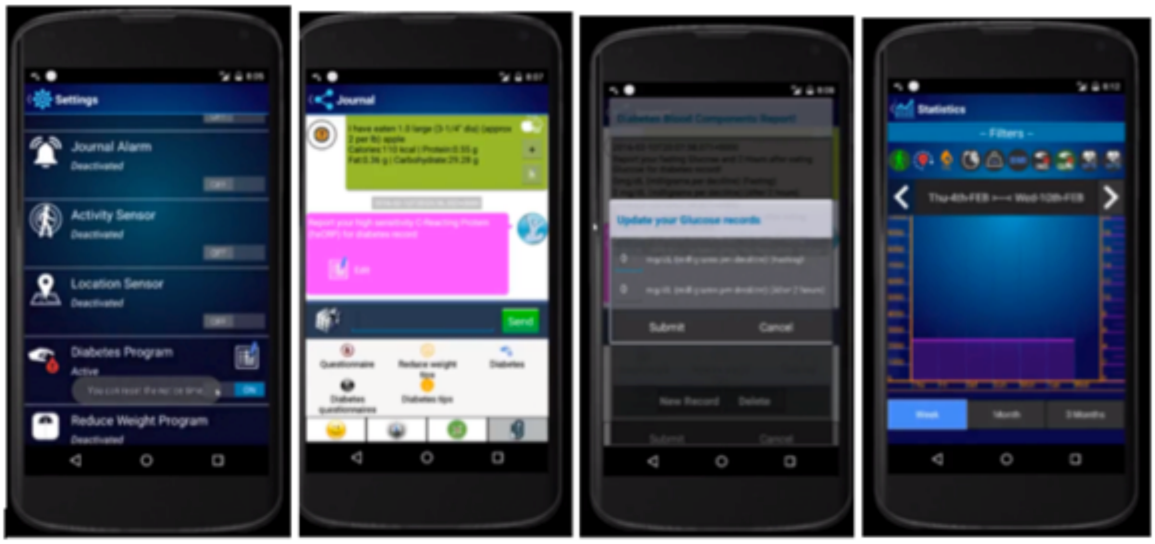
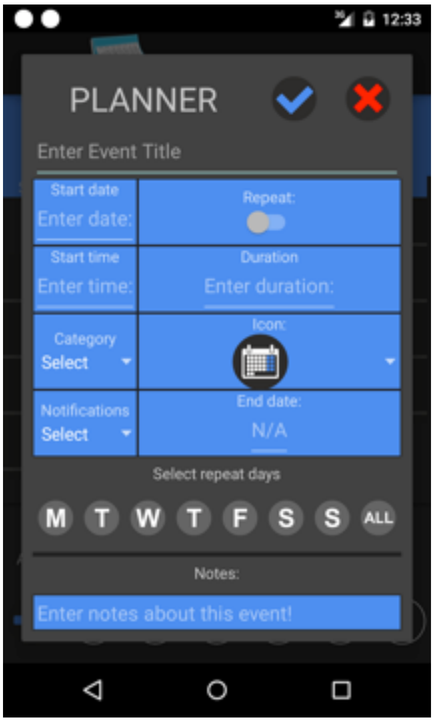


Illustration of entering Biochemistries

Medication and clinical visiting reminder

Both the MyHealthAvatar web-based platform can enter and display planner for time scheduling, which can be used as reminder for medical and clinical visits.



An illustration of the MyHealthAvatar Planner

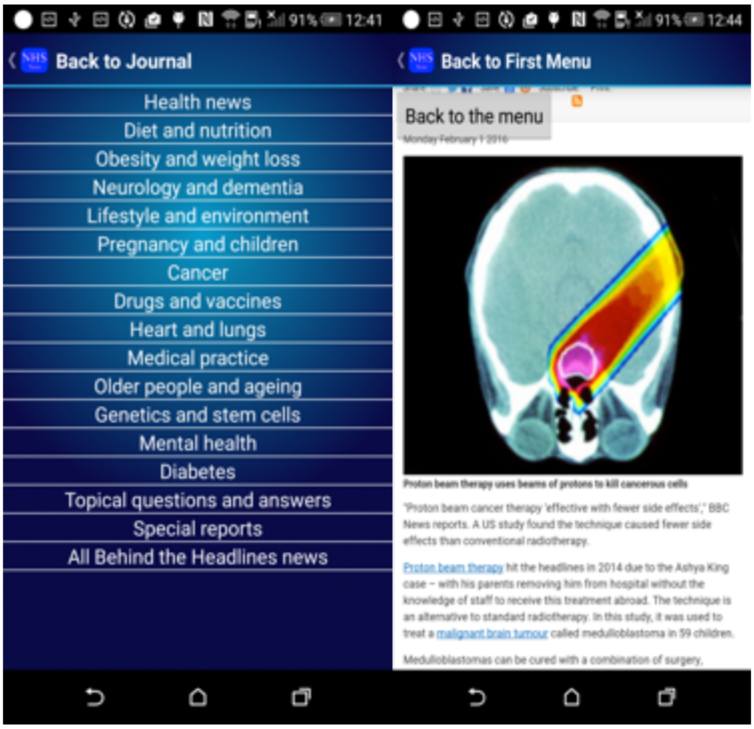
Food intake and calorie calculation

Food intake can be entered by the users through a chat interface. They can inform MyHealthAvatar their food intake and MyHealthAvatar can automatically convert them into calorie intake.

An illustration of recording food intake and calorie consumption

Patient advice

MyHealthAvatar can offer patient education and deliver the latest healthcare news to the patients according to their profiles. For patients with diabetes, MyHealthAvatar can deliver relevant information and news about diabetes.



An illustration of deliverable of healthcare news

Risk assessment

Also, a verified risk assessment model for development diabetes (e.g. the model from the Framingham study) is integrated into the system for raising users' self-awareness of their risk in diabetes.

An illustration of diabetes risk analysis

3.2 Personalized CHF Related Risk Profiles and "Real-Time Monitoring" Demo (CHF)

High end clinical demo (HECD): CHF

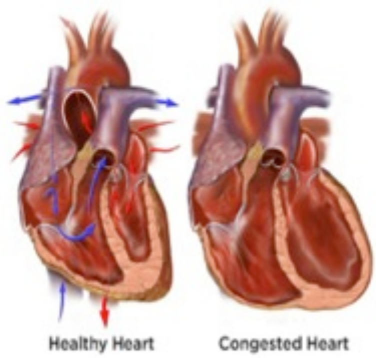
	UAC	3DS	DB	VC	DCU	TOOL	HIS	CHF	OST	DIAB	NEPH	EME
CHF(FORTH)	x		x	x	x	x	x	x				
OST(FORTH)												
DIAB-EME (BED)												
NEPH (ICCS / USAAR)												

Table 3 Use cases (column) vs CHF

Demonstration for the Personalized CHF Related Risk Profiles and "Real-Time Monitoring" (CHF)

1. Introduction

A major challenge related to caring for patients with chronic conditions is the early detection of exacerbations of the disease that may be of great significance. In this use case and demonstration scenario we focus on methodologies that would facilitate the prevention, monitoring, and treatment of heart disease on a daily basis. Heart failure is caused by any condition, which reduces the efficiency of the myocardium, or heart muscle, through damage or overloading. As such, it can be caused by a diverse array of conditions, including myocardial infarction (in which the heart muscle is starved of oxygen and dies), hypertension (which increases the force of contraction needed to pump blood) and amyloidosis (in which protein is deposited in the heart muscle, causing it to stiffen). The major precursor of all cardiovascular diseases is attributed in congenital or acquired factors that lead to atherosclerosis disorders and in some cases to complications from diabetes, kidney disease and hypercholasterolaemia. There are many cases where more than one medications are prescribed due to disease progression or due to the wide appearance of both cardiac and non-cardiac co-morbidities (respiratory comorbidities, renal dysfunction, cognitive dysfunction, depression and in some cases arthritis). To this respect, there is an urgent need for providing information in both the treating physicians, but also the patient him/ herself regarding negative drug interactions.



Congestive heart failure (CHF) is a state in which the heart cannot provide sufficient cardiac output to satisfy the metabolic needs of the body. It is commonly termed congestive heart failure (CHF) since symptoms of increase venous pressure are often prominent. Its pathogeneis factors include: Age, Gender, Increased blood pressure, Smoking, Alcohol, Family and medical histor, Genetic predisposition, Diabetes, Diet habits and Atherosclerosis. It's a pathophysiologic state in which the heart, via an abnormality of cardiac function (detectable or not), fails to pump blood at a rate commensurate with the requirements of the metabolizing tissues or is able to do so only with an elevated diastolic filling pressure.

- <u>*Common causes:*</u>
  - Coronary heart disease
  - Hypertension
  - Valvular heart disease

- *General symptoms:*
  - Shortness of breath
  - Leg swelling
  - Exercise intolerance
- *Diagnosis:*
  - Physical examination : (*blood tests*, *blood pressure*, *body mass index*, etc)
  - Echocardiography
- *Management*:
  - *Improving symptoms*
  - *Preventing disease progression,*
  - *Modulation of lifestyle (Diet, smoking, alcohol, moderate physical activity), Pharmacological intervention*

2. Descriptions and design

Objectives

The outcome of this use case in to create a demonstration service able to empower citizens, patients and doctors by providing a supportive environment for the self-management of patients/citizens with cardiovascular disease risks. enerally, cardiovascular disorders as chronic diseases require a continuous everyday record for patient's status. The proposed demonstration use case is implemented on the following two main pillars:

1) CHF Risk Assessment

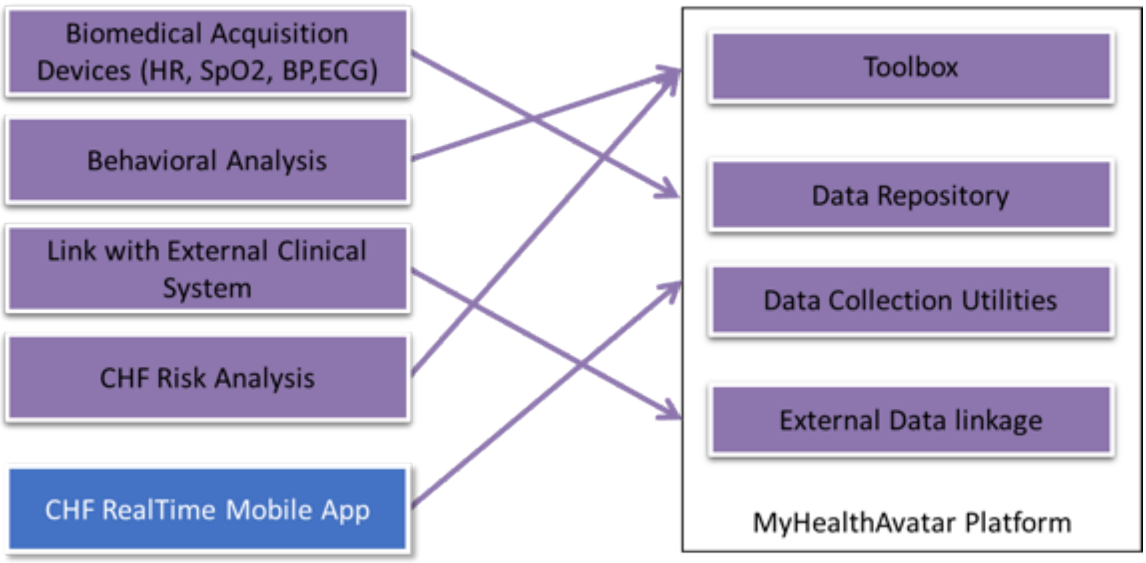
In order to tailor the proposed system to the patient's profile and assist physicians in selecting people who are predisposed by coronary disease, hypertension, or valvular heart disease; we build a CHF related risk profile based on a risk appraisal function that is based on the diagnostic criteria [i.e. the Framingham Heart Study (486 heart failure cases during 38 years of follow-up)]. The predictors used are based on Age, Coronary heart disease and Valve disease status provided by the patient Electronic Health Record (EHR), as well as on HR, on blood pressure and on Body Mass Index (BMI) provided by the pulse oximeter, the blood pressure monitor and the weight scale, respectively. The calculated risk probability may be used to alter the default threshold values (higher risk probability adds more constraint on the physiological patterns). Furthermore, we present what else data regarding patients' health status could be embed into the platform towards the creation of a profile with necessary information for both patient and treating physicians. To this respect an approach of presenting data regarding demographic, physiology, diagnostic test results and disease management (i.e. prescribed drugs) is provided.

2) Real-time patient monitoring

In addition to the above the dedicated clinical personnel should be contacted immediately and possibly intervene in time before an acute state is reached, by changing medication, or any other interventions, in order to ensure patient safety. There is a need to support real-time remote monitoring of patients diagnosed with congestive heart failure and MHA, enhanced with semantic technologies, may host personalized, accurate and up-to-date clinical information. To this end we implemented a real-time patient/ doctor alarming according to rule-based alarms enabling intelligent alerting of the dedicated physician in case of an emergency. The alarming process is based on vital signs monitoring and specifically Heart Rate (HR), Pulse Oximetry, and Blood Pressure acquisition, adapted according each specific patient's medical history and age, and even risk predictor's outcome.

Our main achieved objectives are:

- Incorporating verified risk assessment models for cardiovascular diseases into the MyHealthAvatar platform
- Enhance and expand the functionalities of MyHealthAvatar platform in real time health monitoring and management
- Create a CHF Real Time mobile monitoring app to allow for easy access to the platform alarming will be built according to rule-based alarms enabling intelligent alerting of the dedicated physician in case of an emergency



The figure above is a diagram that shows the implementation of CHF Related Risk Profiles and "Real-Time Monitoring" and its relationship with the MyHealthAvatar platform.

Targeted end-users

This demonstration activity of MHA project targets healthy citizens/patients to facilitate their self-management CHF risk assessment for lifestyle management in order to reduce the foreseen risks and doctors that would be able to assess patient's health status. Synthetic (chimeric) patients will be used to demonstrate the CHF real time patient monitoring scenario.

Added values of MyHealthAvatar

MyHealthAvatar provides a unique platform that empowers normal citizens in terms of supporting their life management and healthy lifestyles. As a citizen oriented platform, the MyHealthAvatar platform provides services to the general public that help them identify and manage CHF related risks. It offers an easy to use service for citizens in terms of data collection, and real time self-management services, such as monitor, record, and alarm. The system will function as a supportive environment to empower citizens and patients in looking after their own health through self-awareness of potential risks of developing diseases. Therefore, many existing functionalities in

MyHealthAvatar will be used for the needs of personalized CHF risk profile assessment and real-time monitoring.

3. Implementation

Congestive heart failure (CHF) is a state in which the heart cannot provide sufficient cardiac output to satisfy the metabolic needs of the body. It is commonly termed congestive heart failure (CHF) since symptoms of increase venous pressure are often prominent. Its pathogenesis factors include: Age, Gender, Increased blood pressure, Smoking, Alcohol, Family and medical histor, Genetic predisposition, Diabetes, Diet habits and Atherosclerosis. It's a pathophysiologic state in which the heart, via an abnormality of cardiac function (detectable or not), fails to pump blood at a rate commensurate with the requirements of the metabolizing tissues or is able to do so only with an elevated diastolic filling pressure. Common causes of the disease include coronary heart disease, hypertension and valvular heart disease. Diagnosis can be achieved through physical examination (i.e. blood pressure, body mass index, blood tests) and echocardiography. A major challenge related to caring for patients with chronic conditions is the early detection of exacerbations of the disease that may be of great significance.

In this use case and demonstration scenario we focus on methodologies that would facilitate the early detection and monitoring of CHF exacerbation, enabling prevention on a daily basis.

Especially, early detection is of upmost importance; hence remote health monitoring systems are in the research focus so as to provide to a doctor the ability to monitor the progress of a patient on a daily basis and issue alerts in case of potential health risks. The objective thus is to create a service able to empower citizens, patients and doctors by providing a supportive environment for the self-management of patients/ citizens with cardiovascular disease risks. To do so we incorporate a pool of verified risk assessment models for cardiovascular diseases into the MyHealthAvatar platform and an external to MyHealthAvatar mobile application for real time monitoring and intelligent rule-based alerting in case of an eminent CHF episode.

We define the “CHF Real-time patient monitoring” and the “CHF Risk Assessment” service in order to:

- assist individualized out self-monitoring of their own health-status,
- provide risk analysis for personal risk monitoring for developing a cardiovascular related episode in the future,
- provide comorbidities and drug interaction information in both the treating physicians, but also the patient him/ herself regarding negative drug interactions (optional).

CHF real-time patient monitoring is realized by a mobile application that monitors and records the vital signs (such as heart rate, oxygen saturation, systolic blood pressure and diastolic blood pressure) of patients with CHF or prone to develop CHF. It exploits sensor technologies to obtain data via Bluetooth, and wireless communications to share data with back-end databases. Vital signs are recorded every second locally in SQLite, and in case of an abnormal measurement detection, an alert record is created accompanied by a notification (Figure 3.2.1). Moreover, the application provides useful charts for visual display of the vital signs' measurements (Figure 3.2 2). Data are sent to the MyHealthAvatar platform at the request of the user/ patient, and namely the list of alerts including the type of the alert, the value and the time it occurred (Figure 3.2.3).

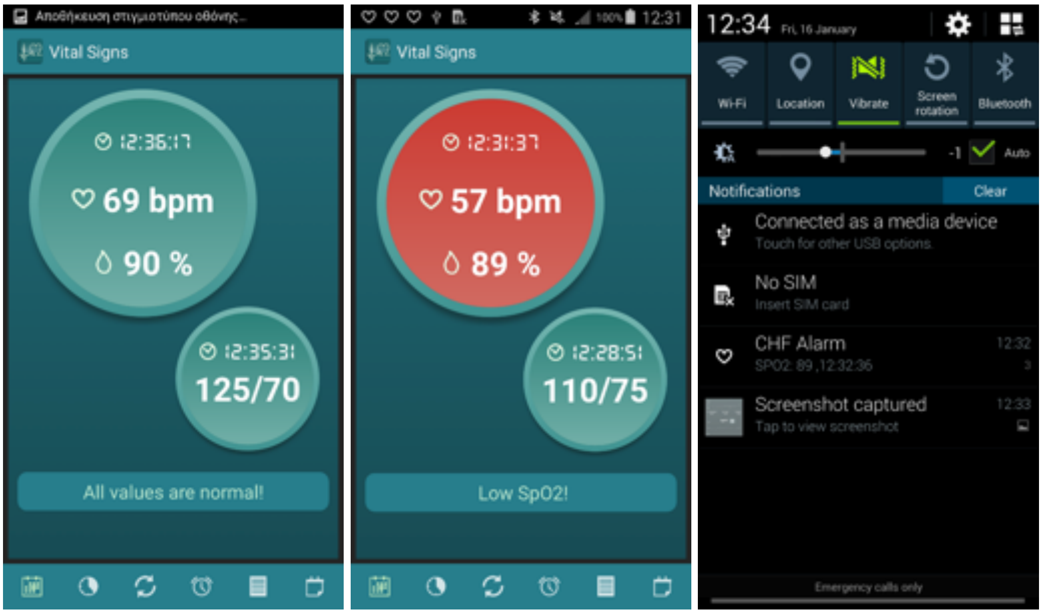


Figure 3.2.1: Vital signs' monitoring

Figure 3.2 2: List of Alerts, Notifications and Vital Signs' Charts

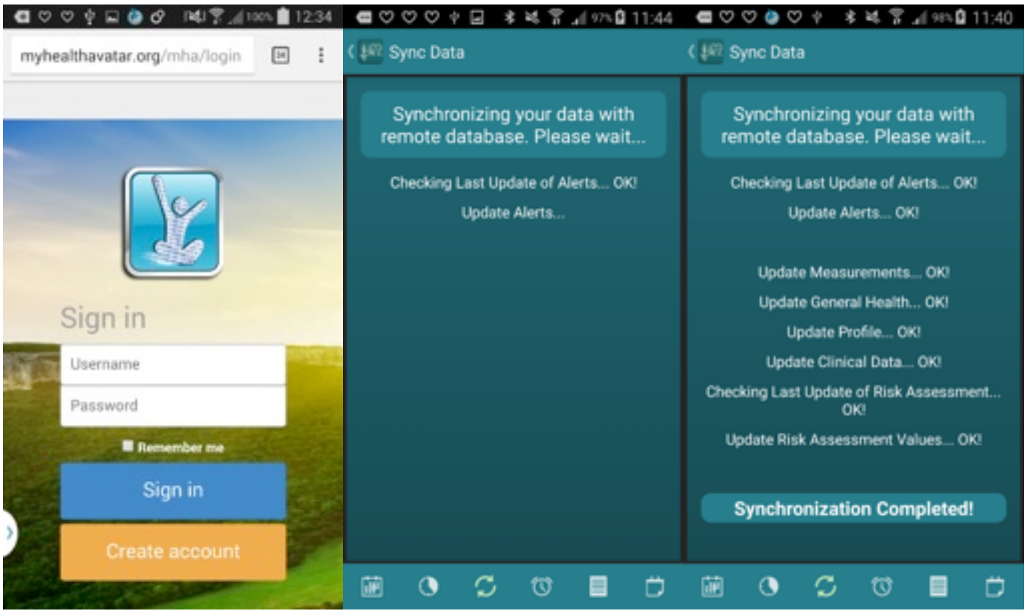


Figure 3.2.3: Synchronize data with MyHealthAvatar platform

In addition to the real-time monitoring, the *CHF Risk Assessment application* provides to the patient self-health status assessment services based on validated risk evaluation algorithms (Figure 3.2.4). In particular, three risk assessment models have been implemented providing longer (3-, 4-year) and shorter (1-, 2- year) heart failure risk assessment. Figure 3.2.4 to Figure 3.2.6 display the algorithms' questionnaires with the respective results' screens, whereas Figure 3.2.7 shows the list of all the calculated risk scores. The bellow color conventions are followed: *green* for "low risk", *yellow* for "slight risk" and *orange* for "considerable risk". Data can be retrieved from the MyHealthAvatar platform upon the request of the user/ patient so as to be used in the algorithms, such as measurements, general health, profile and clinical data. Moreover, the list of risk scores is sent to MyHealthAvatar.

Figure 3.2.4: Risk Assessment Algorithms, Framingham CHF risk assesment (picture on the right)

Figure3.2. 5: Framingham Hypertension

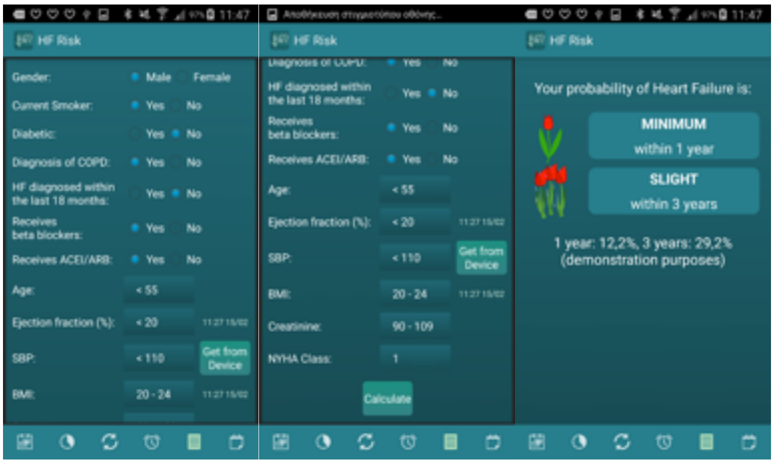


Figure 3.2.6: MAGGIC HF

Figure 3.2.7: List of calculated risk scores

3.3 Osteoarthritis Demo (OST)

High end clinical demo (HECD): OST

	UAC	3DS	DB	VC	DCU	TOOL	HIS	CHF	OST	DIAB	NEPH	EME
CHF(FORTH)												
OST(FORTH)	x	x	x	x	x	x	x		x			
DIAB-EME (BED)												
NEPH (ICCS / USAAR)												

Table 4 Use cases (column) vs OST

Demonstration for the Osteoarthritis

1. Introduction

Osteoarthritis (OA) is a disabling degenerative joint condition leading to joint pain, stiffness and loss of function predominantly in the knees, hips, hands, and spine. The major histological finding in osteoarthritis is degeneration and loss of the articular cartilage that acts as a protective cushion between bones within a joint. An estimated 75% of adults over the age of 65 years have osteoarthritis resulting to impaired quality of life, and considerable healthcare costs. Moreover, about 100% of adults over the age of 80 years old have osteoarthritis.

Factors that may increase the risk of osteoarthritis include:

- *Older age*. The risk of osteoarthritis increases with age.
- *Sex*. Women are more likely to develop osteoarthritis, though it isn't clear why.
- *Obesity*. Carrying extra body weight contributes to osteoarthritis in several ways. It puts added stress on weight-bearing joints, such as your hips and knees. In addition, fat tissue produces proteins that may cause harmful inflammation in and around your joints.
- *Joint injuries*. Injuries, such as those that occur when playing sports or from an accident, may increase the risk of osteoarthritis.
- *Certain occupations*. If your job includes tasks that place repetitive stress on a particular joint, that joint may eventually develop osteoarthritis.
- *Genetics*. Some people inherit a tendency to develop osteoarthritis.
- *Bone deformities*. Some people are born with malformed joints or defective cartilage, which can increase the risk of osteoarthritis.
- *Other diseases*. Having diabetes or other rheumatic diseases such as gout and rheumatoid arthritis can increase your risk of osteoarthritis.

Osteoarthritis often gradually worsens, and no cure exists. Although, there is no cure, patients/citizens can manage this chronic condition with the medical professionals' help. The principal action that can be taken in order to slow down the progression of the condition and help τo improve pain and joint function is to adopt a healthier lifestyle, i.e. follow a balanced diet combined with a good balance of rest and activity each day. Exercise, in conjunction with medication/supplements, can reduce the pain of arthritis and improve patients' overall condition. However, these healthy behaviours are not achieved in practice by patients, despite their value understood by both patients and medical professional. Moreover, medical professionals cannot usually ascertain if the patients follow the guidelines for a healthier lifestyle defined by them, parameters that would be helpful for better follow-up. This demonstration will be designed for empower both doctors and citizens (patients and healthy with high risk of developing osteoarthritis) for the long-term management of osteoarthritis condition utilizing the MHA platform.

MHA offers a one-stop service for citizens for data collection and self-management such as monitor, record and education. Precisely, the system will support the storage of behaviours and daily activities of citizen. It will function as a supportive environment to empower normal citizens in looking after their own health, raising their self-awareness of any potential risk of developing diseases while encouraging their healthy lifestyles in terms of doing routine daily exercises, stopping smoking and controlling their diet. Therefore, naturally many existing functionalities in MHA can be directly used for the needs of osteoarthritis use case. In addition, we will incorporate genetic predisposition evaluation services for examining if an increased risk of developing osteoarthritis exists, which will be used by the citizens in order to understand their personal risk of developing osteoarthritis, and the impact of their behaviour and lifestyles towards the risk.

2. Descriptions and design

Objectives

The objective of this demo is two-fold; to empower both patients/citizens and medical professionals by providing a supportive environment for the long-term management of osteoarthritis condition. Medical professionals (such as GPs) will be able to review together with patients a plethora of clinical and personal health information regarding the health status of patients/citizens through MHA platform. The related data (medical history, clinical examination, imaging data, evaluation metrics for measuring knee pain range of motion of the knee joint) will be properly visualized and presented using interactive multi-scale visualization techniques. This blend of medical imaging metrics and personal activity information, will give a better insight of the condition regarding OA diagnosis or progress and will allow the clinician to assess the situation in a more personalised fashion. In case where a GP is reviewing this information, it may also act as a baseline for better assessing if a referral to an expert is needed. In the suggested scenario, advanced personalized healthcare will also be enhanced by genomic predisposition evaluation for developing osteoarthritis. Although this might not be applicable at present, it is important to include it in the scenario in order to emphasise the vision on how MHA can really influence decision support in the future.

Patients/Citizens will be able to access a platform that will monitor their daily dietary and ambulatory activity and warn them, if they do not meet the recommendations that have been given to them (e.g. target activity, supplements etc.). Moreover, semi quantitative metrics, regarding knee pain and range of motion of the knee joint, will be collected periodically. The monitoring will rely on techniques of self-life logging for enhancing the patient engagement. Also, the platform will function as a supportive environment to the patients by means of offering advice and assistance. It is expected that a good knowledge of the condition will lead to enhanced patient behaviour. Thus, the demonstration will focus on how the users can play a key role in monitoring and managing their own health and become co-producers of their OA health management together with their GP.

The functionalities implemented in terms of the osteoarthritis use-case are:

1. MyHealthAvatar will be enriched by a visualization toolbox providing proper interactive, multi-scale visualization techniques of the data related to osteoarthritis disease (e.g., medical history,

clinical examination, imaging data, evaluation metrics). These techniques will offer a useful input to medical professionals in order to carry out personalized medicine and for better follow-up. Visual analytics will also be used to display aggregated lifestyle data aiming to easy interpretation by both citizens (patients and healthy) and medical professionals.

2. For the needs of the osteoarthritis use case, we are going to use already the following existing functionalities in MyHealthAvatar platform.

   2.1 Data collection: The users will be able to easily upload their own health data (e.g. activities, movements, step counts, diet etc.) into the platform using their mobiles. Part of this data are also related and will be used by the osteoarthritis use case (e.g. activities, movements, diet). Evaluation metrics, strongly related with the osteoarthritis condition, will also be collected periodically. These metrics include a number with regard to a certain pain-scale and a number with regard to the range of motion of knee joint (in degrees).

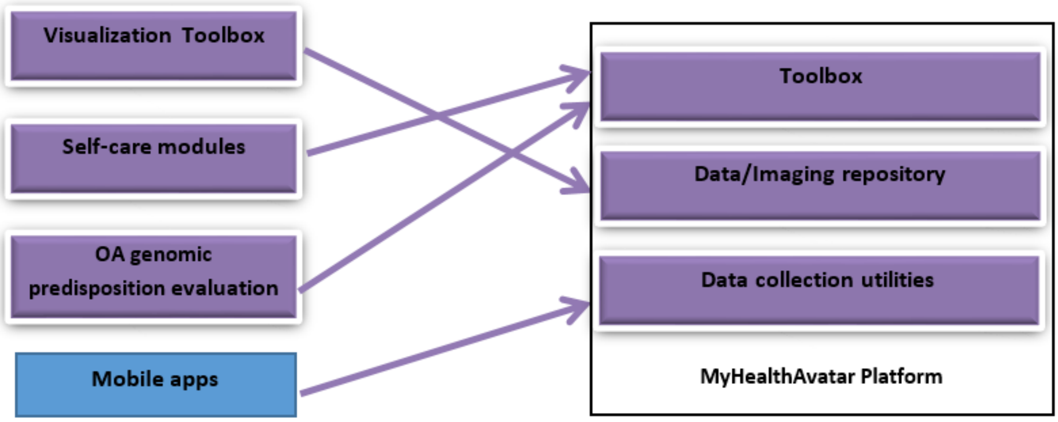
   2.2 Personal Diary: This diary presents and manage the patients/citizens' health status and behaviours, including diet, movement, environment, mood, smoking, symptoms etc. Visual analytics will be used in order to display individual or aggregated data for easy interpretation from the patients/citizens. The personal diary will be used by the self-care module described below.

3. The MyHealthAvatar platform will incorporate personal self-care module that allow planning and reminding for daily physical exercises, diet and medication where necessary.

   3.1 After clinical examination and diagnosis, the patient is guided properly by the medical professional. These guidelines include a set of targets in terms of daily activities, dietary etc., which are also valid for the healthy citizens with a high risk of developing osteoarthritis. Osteoarthritis service will review the progress of the patient/citizen by comparing the data originated from the patient diary module with the guidelines given to patient/citizen by the medical professional. If the patient/citizen did not manage to reach these special, periodic targets, a reminder service we warn the patient.

   3.2 Education: The general recommendation for the osteoarthritis condition will be delivered to the patients/citizens in needs, as it is expected that a good knowledge of the condition will lead to enhanced patient behaviours.

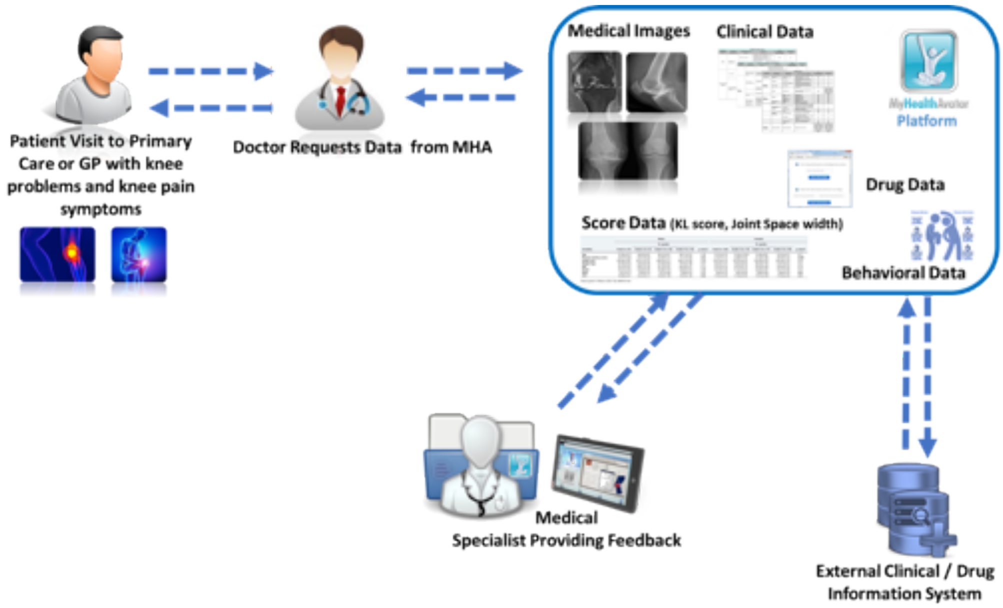
4. MyHealthAvatar will incorporate genomic predisposition evaluation for estimating the risk of developing osteoarthritis for a patient/citizen. When a high risk of developing osteoarthritis is revealed for a healthy patient, he will be informed and guided for modifying and adopting a healthier lifestyle.



Implementation of Osteoarthritis case (left) and the MyHealthAvatar Platform

The figure above is a diagram that shows the implementation of the Osteoarthritis case and its relationship with the MyHealthAvatar platform. Figure 2 shows the interactions between MyHealthAvatar platform, external resources and the users regarding the use case that was described (patient and GP reviewing the blended information for a more personalised assessment of OA risk or progression).

It should be stresssed that the implementation of the scenario will be closely coupled with the implementation of the MyHealthAvatar platform. Many functionalities that will be utilised by the targeted end-users of the Osteoarthritis case will be implemented directly as inherent components of the platform.



Osteoarthritis case (left) the link with MyHealthAvatar Platform

Targeted end-users

This demonstration will target medical professionals, patients and healthy citizens with high risk of developing osteoarthritis in order to provide a complete, long-term management of the condition through lifestyle monitoring. Focus will also be on the genomic predisposition evaluation for developing osteoarthritis and lifestyle management for reducing the risk.

Added values of MyHealthAvatar

MyHealthAvatar provides a novel platform that empowers both citizens (patients and healthy) and medical professionals for the long-term management of OA. It will function as a supportive environment to empower citizens in looking after their own health, raising their self-awareness of any potential risk of developing OA while encouraging their healthy lifestyles in terms of doing routine daily exercise and controlling their diet according to the clinical recommendation (e.g. in cases of high risk of developing OA the clinician might suggest mild exercise and Calcium, vitamin D supplements). It offers a one-stop service for citizens in terms of data collection and self-management services such as record, monitor and education. Citizens will be able to upload periodically their own health data, e.g. evaluation metrics, using mobile apps. The avatar system will also monitor patients' daily dietary and ambulatory activity and warn patients if they are not compliant with the guidelines issued by the medical professionals. The avatar system will also promote citizens' education on the knowledge of OA. It is expected that a good knowledge of the disease parameters will lead to consistent citizen behavior.

In addition, medical professionals will be provided by a useful input regarding the health status of patients/citizens as the related data will be properly visualized and presented using interactive multi-scale visualization techniques. This will be a novel, enhanced clinical decision support tool that will blend medical imaging information with personal health information such as activity and nutrition trends which allow a more holistic assessment of the citizen's status regarding OA. In essence, this will give a better insight of the condition and its progress for carrying out personalized medicine and for better follow-up. Advanced personalized healthcare will also be enhanced by genomic predisposition evaluation for developing osteoarthritis.

3. Implementation

Osteoarthritis is the most common form of arthritis, affecting millions of people worldwide. It is a degenerative condition of joints and is characterized by loss of the articular cartilage that acts as a protective cushion between bones within a joint and by growth of a new bone in affected joints, causing stiffness and pain. Osteoarthritis affects mainly the knee, hip, hand, spine and less often, the feet. Its symptoms often develop slowly and worsen over time. Osteoarthritis usually affects more women than men, and tends to turn up as people get older but is also common amongst people of working age. Other common factors that may increase the risk of developing osteoarthritis are obesity, previous joint injuries, certain occupations, genetics, bone deformities and other diseases.

A patient visits Primary Care or GP complaining for knee problems and knee pain symptoms. The clinician proceeds with the diagnosis of the osteoarthritis condition by physical exam in conjunction with imaging test (radiographs and MRIs) and lab tests (blood tests and joint fluid analysis). As there is no known cure for osteoarthritis, clinician advices the patient for lifestyle interventions i.e., mild daily exercise, reduction of body weight and proper medication for reducing the pain and improving the patient's overall condition. If these conservative treatments don't help, other procedures may be applied (e.g. surgical, lubrication injections etc.).

However, these healthy behaviors are difficult to be achieved in practice despite the fact that their value is understood by patients. Moreover, medical professionals cannot usually ascertain if the patients follow their guidelines for a healthier lifestyle, which would be helpful for better follow-up. The OAcare app was designed for empowering both clinicians and patients for the long-term management of the knee osteoarthritis condition utilizing the functionalities of the MyHealthAvatar platform. The design of the app is responsive i.e., it can be seamlessly displayed in different screen resolutions from smartphones to tablets and personal computers. The OAcare app delivers two different versions satisfying the patients and clinicians requirements and needs.

OAcare for patients

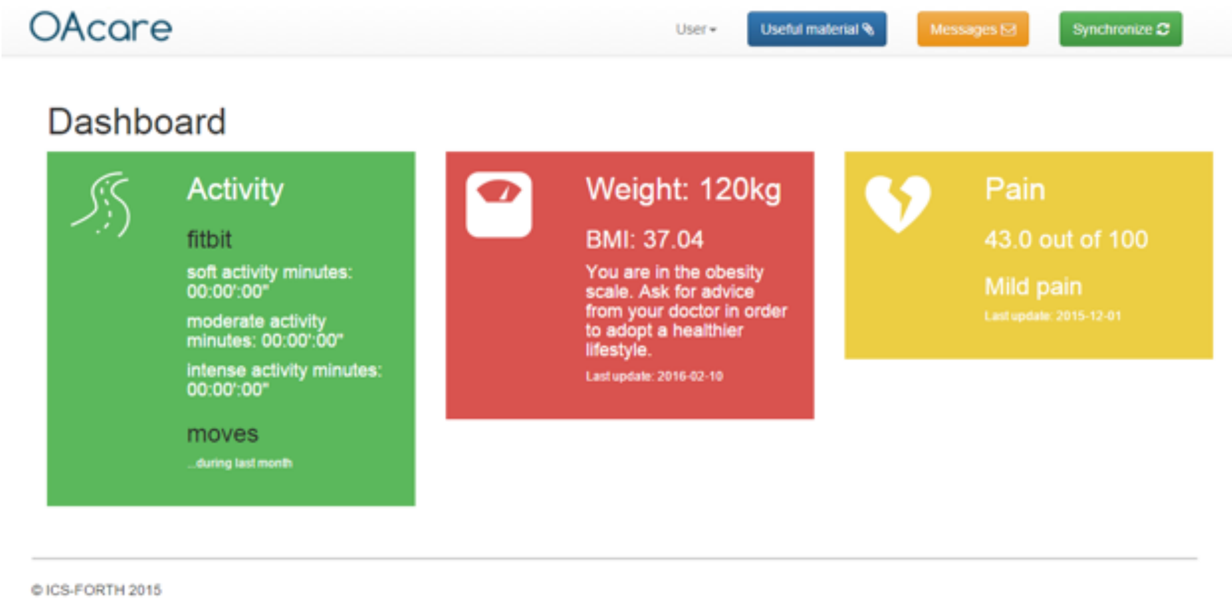


Figure 3.3.1: Through the dashboard of the OAcare app, the patient has an overview of his activity, weight and pain data.

The patients' version offers a supportive environment for empowering patients in looking after their own health, raising their self-awareness of the osteoarthritis risk factors while encouraging for a healthier lifestyle. The app presents (Figure 3.3.1) and utilizes activity, weight and pain data and is able to advise the patient properly if he does not manage to meet the special medical guidelines issued by the care plan that was previously set up by his physician. Through the app, the patient can also update his profile data, such as allergies, medications, weight (Figure 3.3.2) and fill out questionnaires for extracting pain and quality of life (QoL) information (Figure 3.3.3).

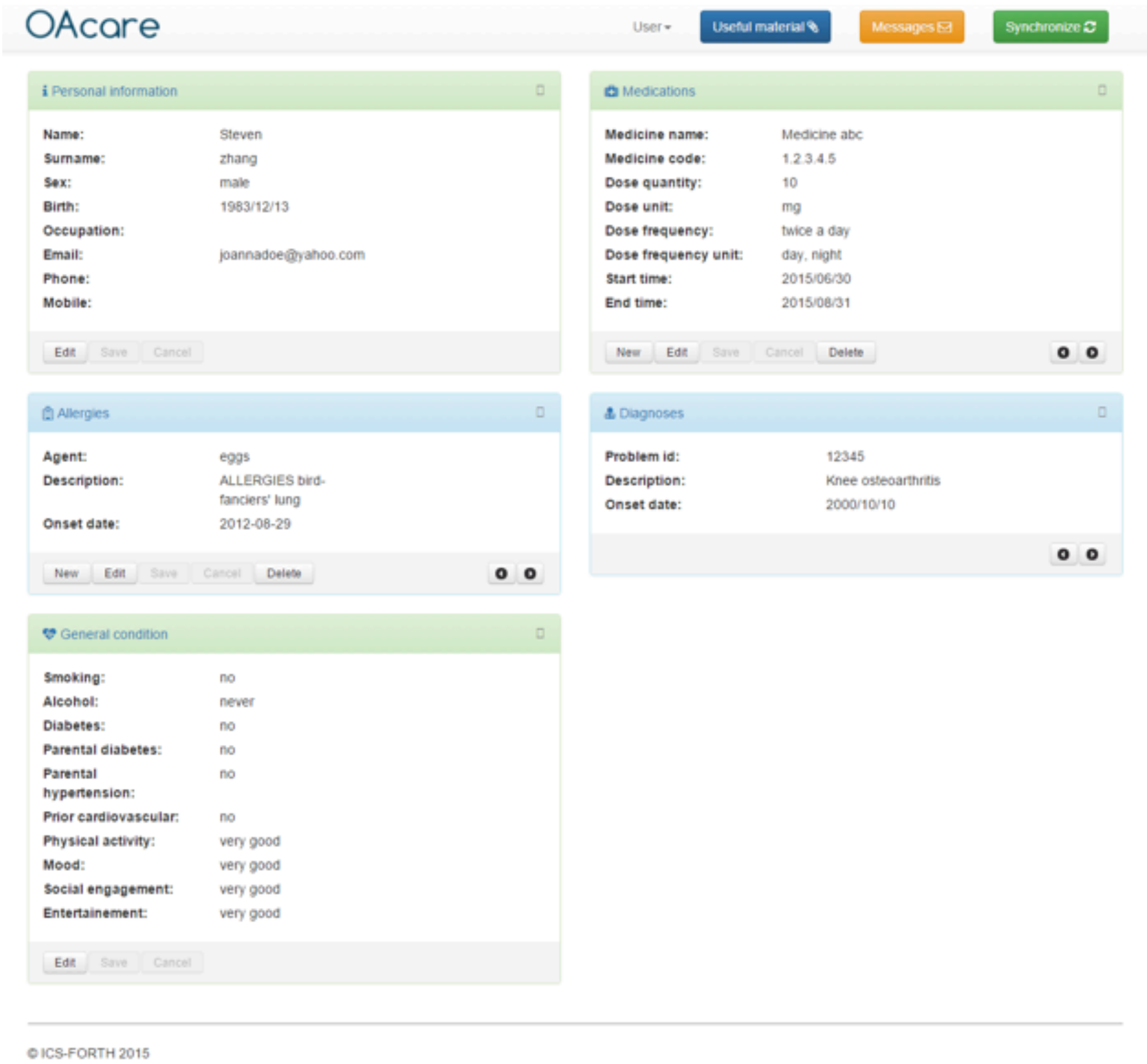
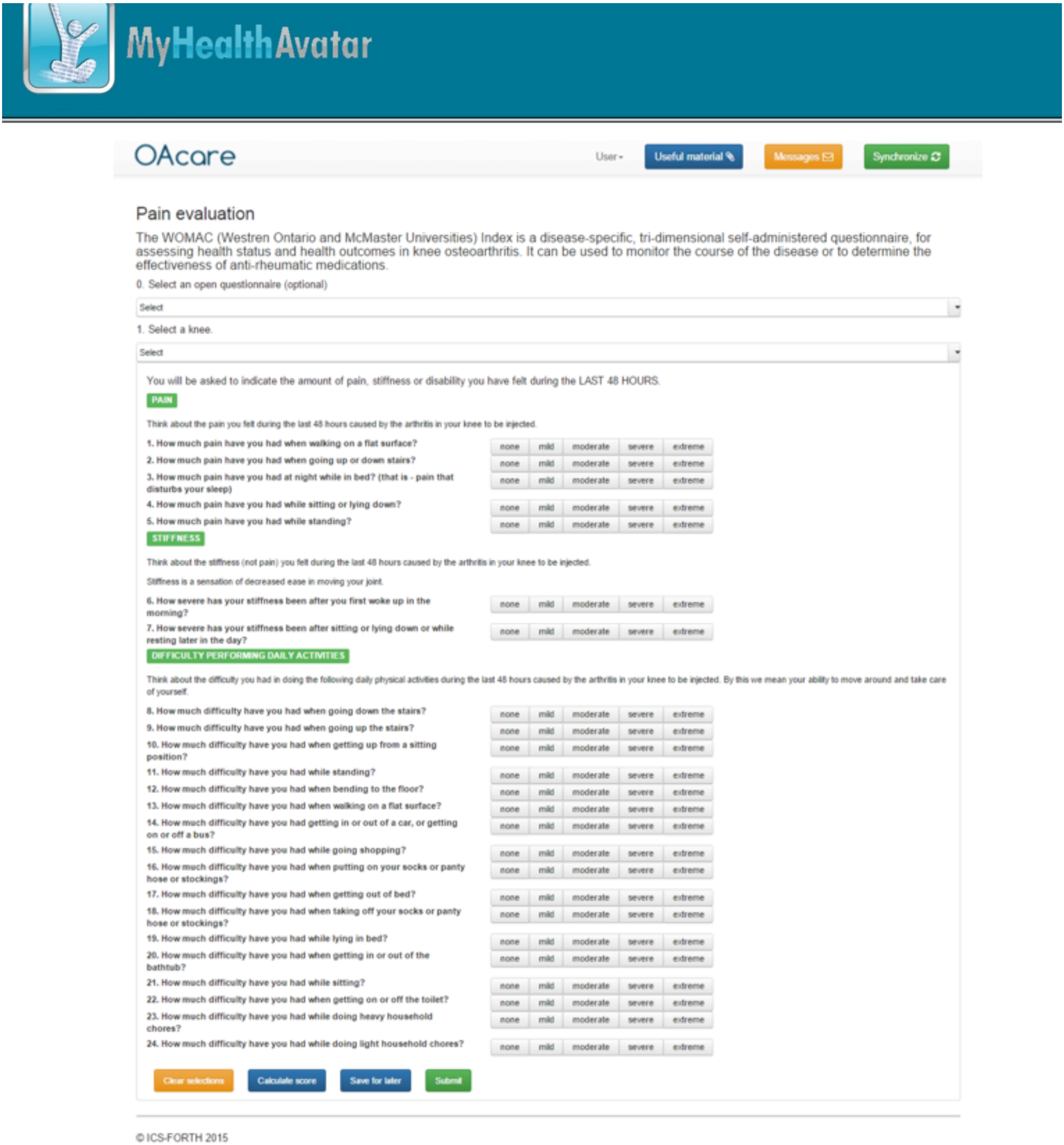


Figure 3.3.2: Patient's profile data


MyHealthAvatar

OAcare User ▾ Useful material Messages Synchronize

Pain evaluation

The WOMAC (Westren Ontario and McMaster Universities) Index is a disease-specific, tri-dimensional self-administered questionnaire, for assessing health status and health outcomes in knee osteoarthritis. It can be used to monitor the course of the disease or to determine the effectiveness of anti-rheumatic medications.

0. Select an open questionnaire (optional)

Select

1. Select a knee.

Select

You will be asked to indicate the amount of pain, stiffness or disability you have felt during the LAST 48 HOURS.

PAIN

Think about the pain you felt during the last 48 hours caused by the arthritis in your knee to be injected.

1. How much pain have you had when walking on a flat surface?	none	mild	moderate	severe	extreme
2. How much pain have you had when going up or down stairs?	none	mild	moderate	severe	extreme
3. How much pain have you had at night while in bed? (that is - pain that disturbs your sleep)	none	mild	moderate	severe	extreme
4. How much pain have you had while sitting or lying down?	none	mild	moderate	severe	extreme
5. How much pain have you had while standing?	none	mild	moderate	severe	extreme

STIFFNESS

Think about the stiffness (not pain) you felt during the last 48 hours caused by the arthritis in your knee to be injected.

Stiffness is a sensation of decreased ease in moving your joint.

6. How severe has your stiffness been after you first woke up in the morning?	none	mild	moderate	severe	extreme
7. How severe has your stiffness been after sitting or lying down or while resting later in the day?	none	mild	moderate	severe	extreme

DIFFICULTY PERFORMING DAILY ACTIVITIES

Think about the difficulty you had in doing the following daily physical activities during the last 48 hours caused by the arthritis in your knee to be injected. By this we mean your ability to move around and take care of yourself.

8. How much difficulty have you had when going down the stairs?	none	mild	moderate	severe	extreme
9. How much difficulty have you had when going up the stairs?	none	mild	moderate	severe	extreme
10. How much difficulty have you had when getting up from a sitting position?	none	mild	moderate	severe	extreme
11. How much difficulty have you had while standing?	none	mild	moderate	severe	extreme
12. How much difficulty have you had when bending to the floor?	none	mild	moderate	severe	extreme
13. How much difficulty have you had when walking on a flat surface?	none	mild	moderate	severe	extreme
14. How much difficulty have you had getting in or out of a car, or getting on or off a bus?	none	mild	moderate	severe	extreme
15. How much difficulty have you had while going shopping?	none	mild	moderate	severe	extreme
16. How much difficulty have you had when putting on your socks or panty hose or stockings?	none	mild	moderate	severe	extreme
17. How much difficulty have you had when getting out of bed?	none	mild	moderate	severe	extreme
18. How much difficulty have you had when taking off your socks or panty hose or stockings?	none	mild	moderate	severe	extreme
19. How much difficulty have you had while lying in bed?	none	mild	moderate	severe	extreme
20. How much difficulty have you had when getting in or out of the bathtub?	none	mild	moderate	severe	extreme
21. How much difficulty have you had while sitting?	none	mild	moderate	severe	extreme
22. How much difficulty have you had when getting on or off the toilet?	none	mild	moderate	severe	extreme
23. How much difficulty have you had while doing heavy household chores?	none	mild	moderate	severe	extreme
24. How much difficulty have you had while doing light household chores?	none	mild	moderate	severe	extreme

Clear selections Calculate score Save for later Submit

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Figure 3.3.3: Pain evaluation questionnaire

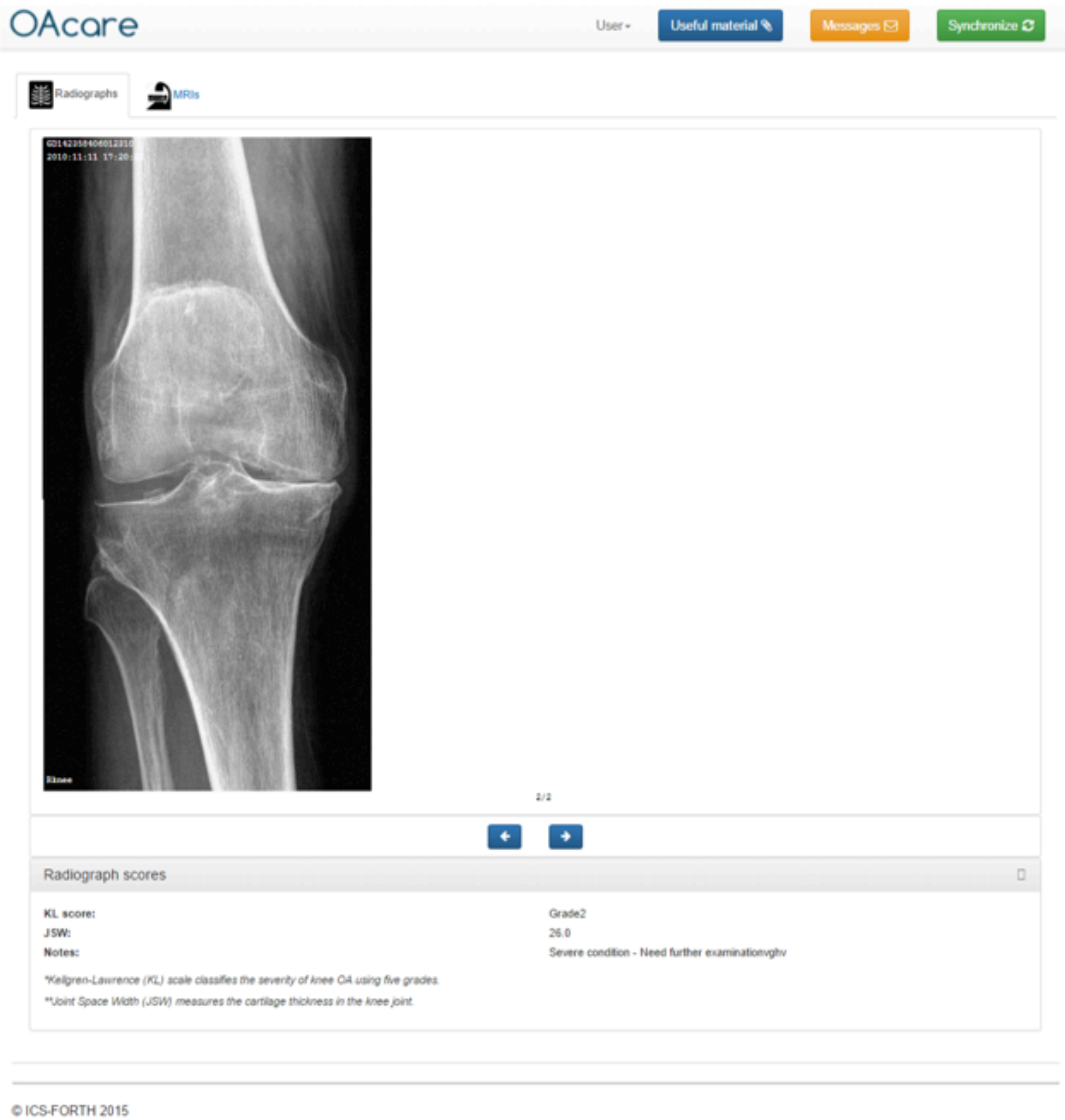


Figure 3.3.4: Patient's imaging data and radiographic scores

Furthermore, the patient can view his imaging data (ragiographs and MRIs), the radiographic scores entered by the clinician after examining the radiographic data (Figure 3.3.4), and some useful charts regarding the variances of activity, weight and pain data over the time (Figure 3.3.5). In addition, the patient can view his current care plan that is set up by the physician (Figure 3.3.6), as well as view and update his weight and height (Figure 3.3.7).

The patient can also use the app in order to directly communicate with his physician (Figure 3.3.8). Moreover, the patient can search over the educational material for the osteoarthritis condition and may be informed about the nature of the condition, the symptoms, the causes, the risk factors, the treatments and drugs, the lifestyle remedies etc (Figure 3.3.9). It is expected that a good knowledge of the condition will lead to enhanced patient behavior, allowing him to play a key role in managing his own health. Finally, OAcare app provides synchronization with MyHealthAvatar platform retrieving data from the patient's account at his request (Figure 3.3.10).

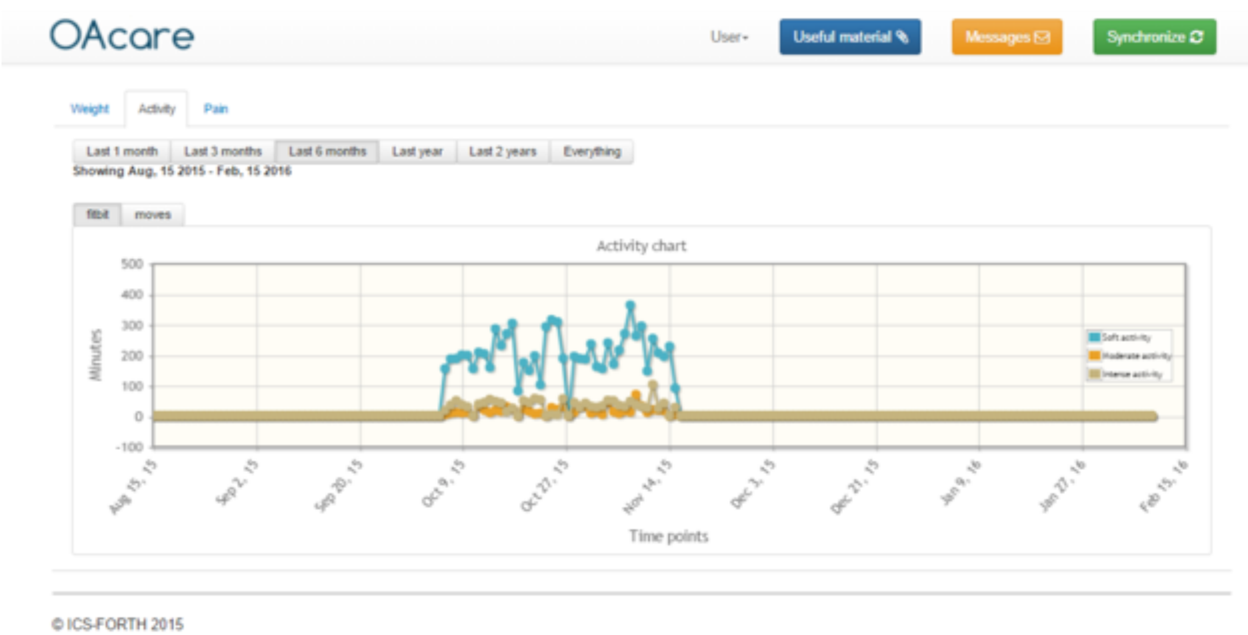


Figure 3.3.5: Activity, weight and pain data charts

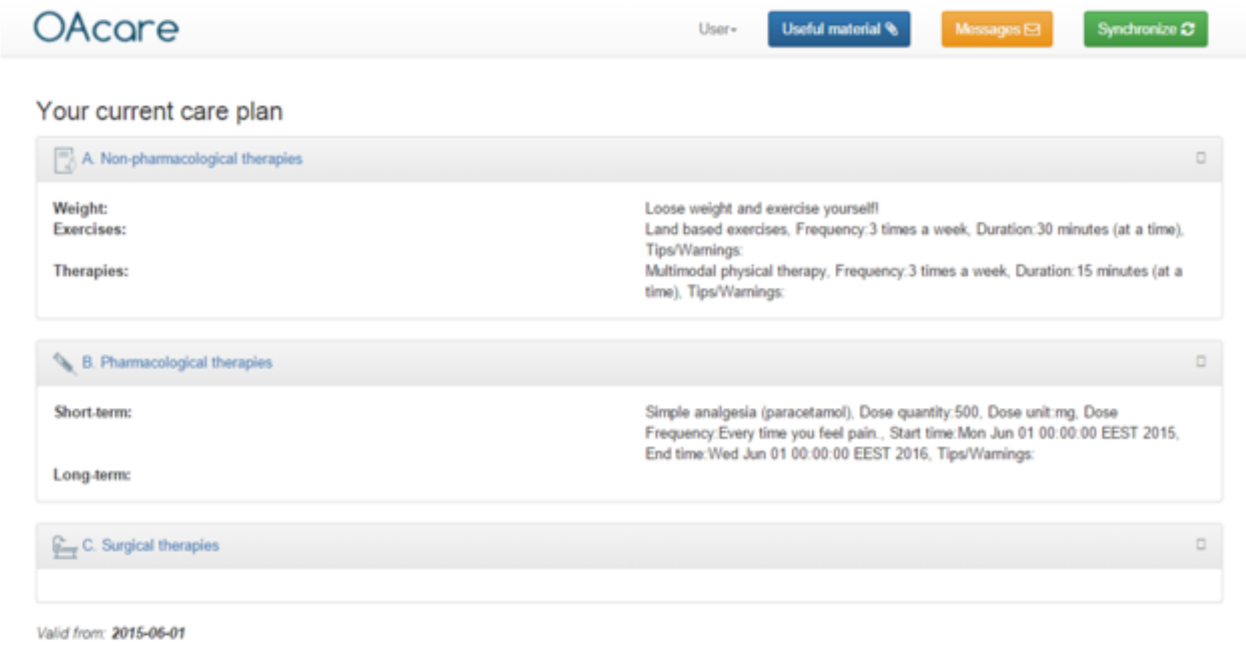


Figure 3.3.6: Patient's care plan

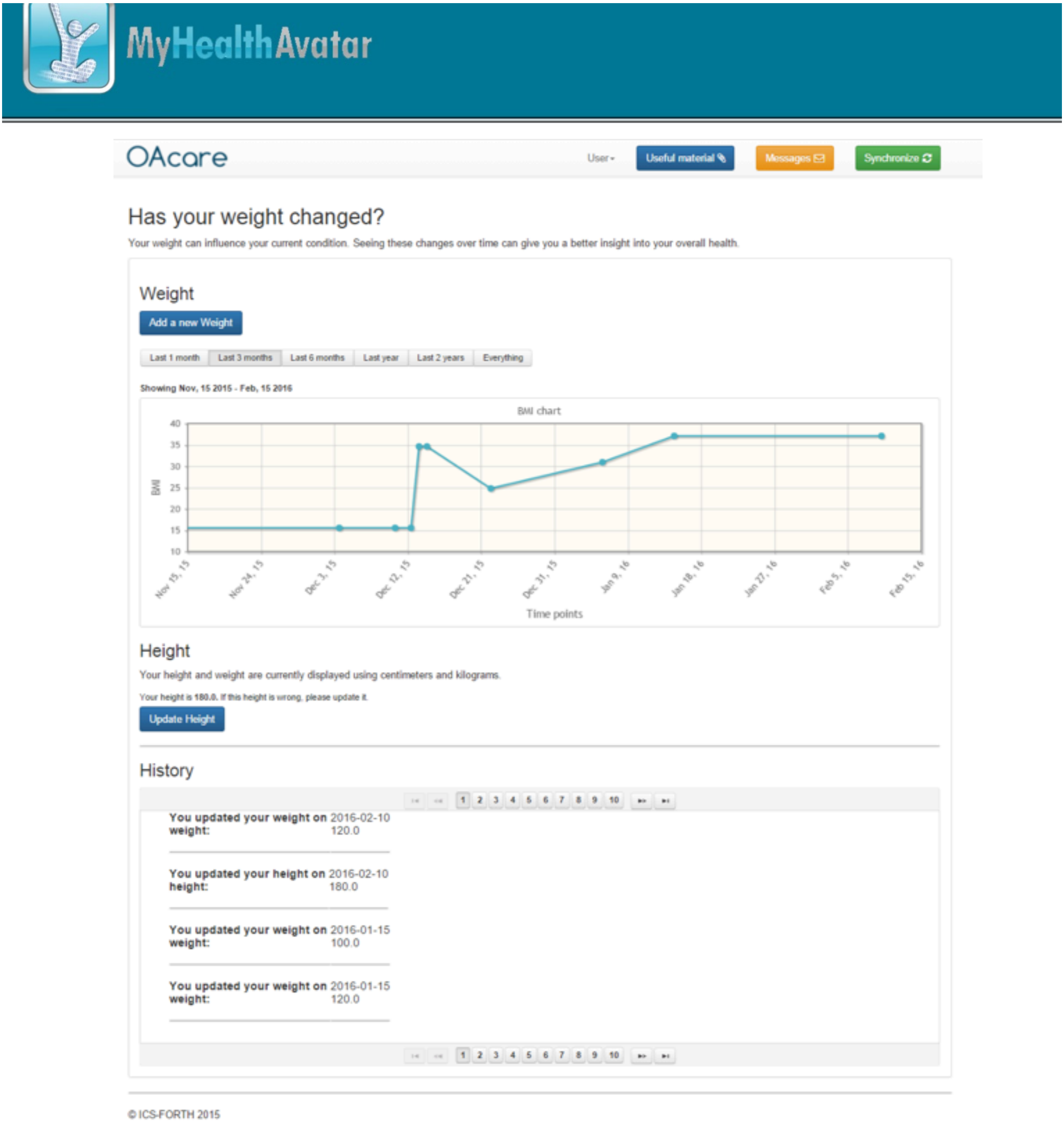


Figure3.3.7: Update weight and height

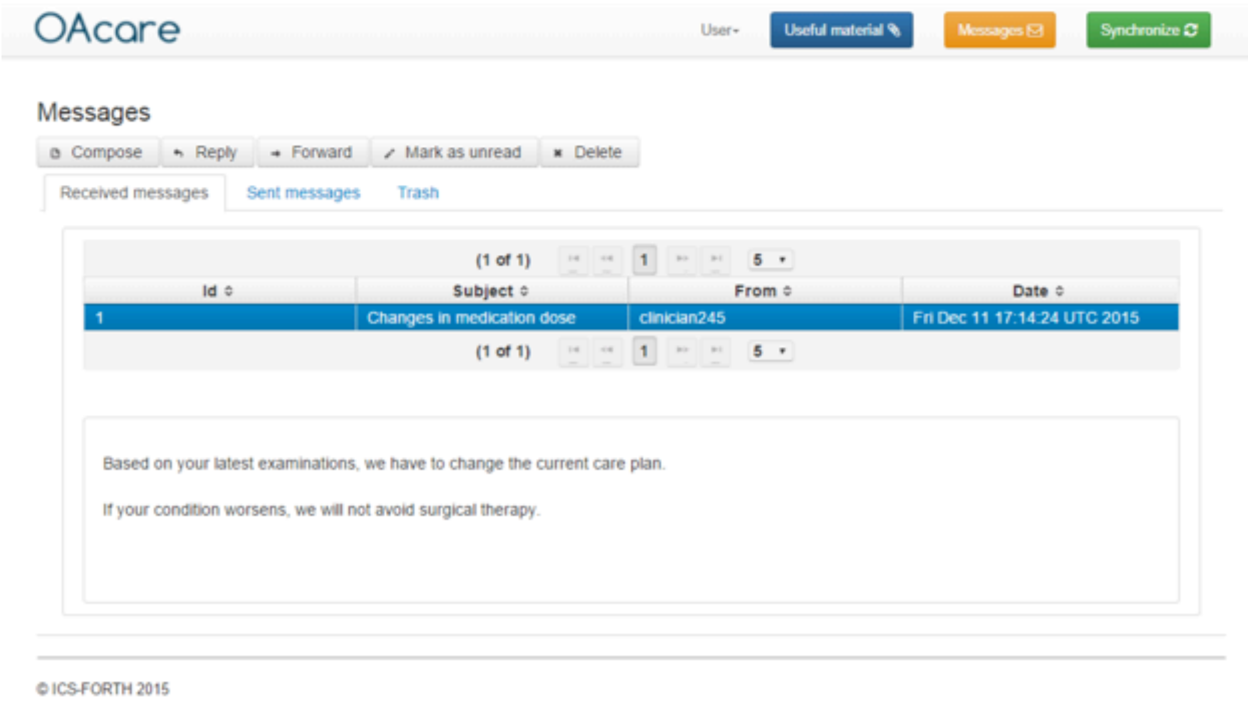


Figure 3.3.8: Patient can exchange messages with his physician directly

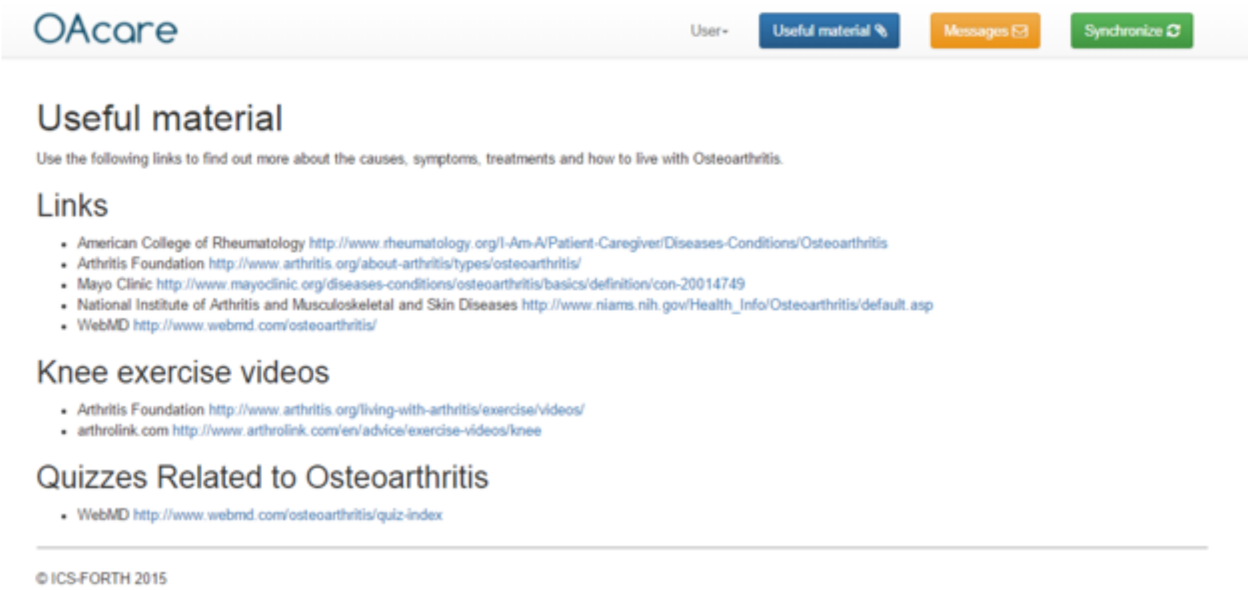


Figure3.3.9: Educational material for the osteoarthritis condition

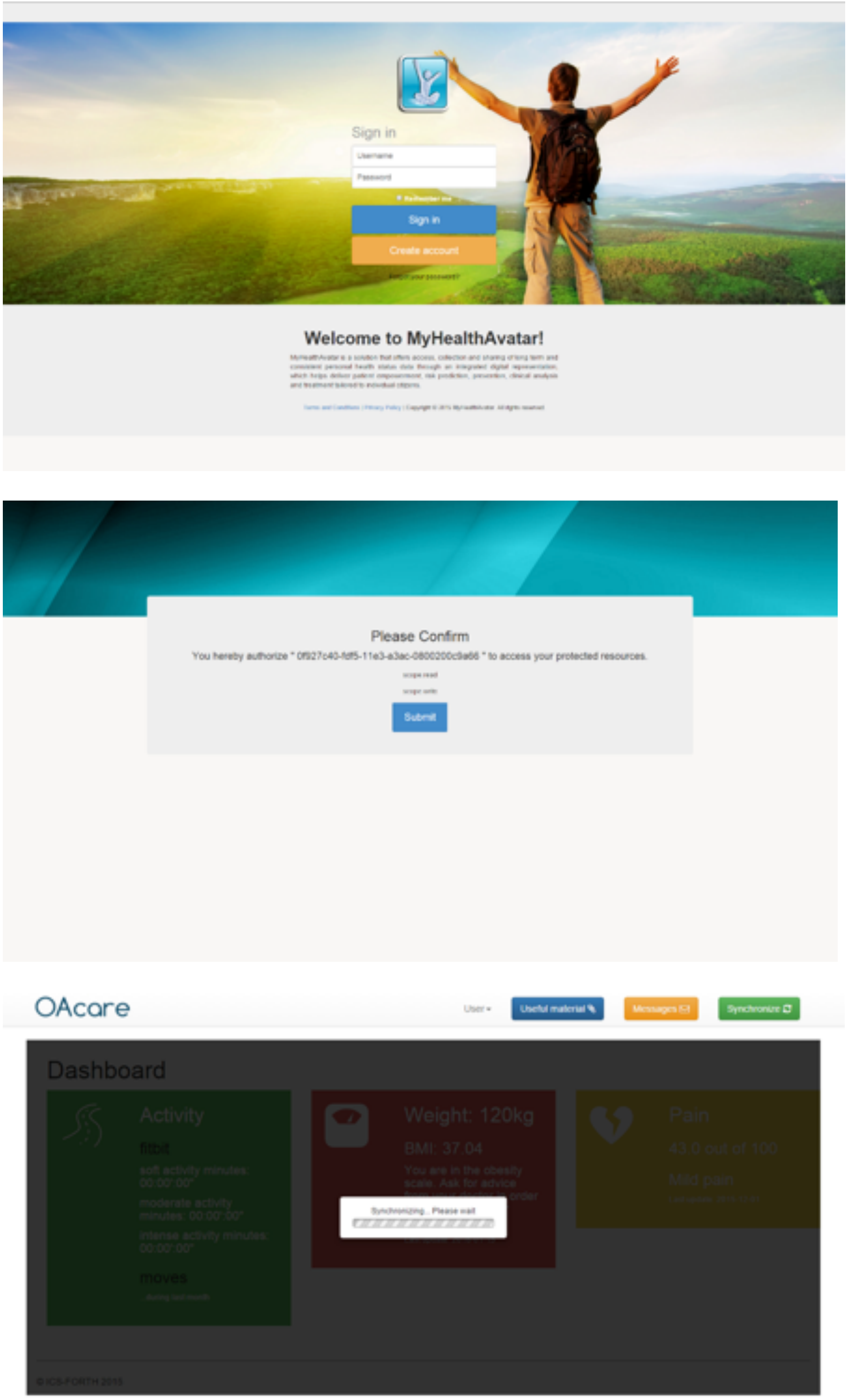


Figure 3.3.10: Synchronizing data with MyHealthAvatar platform

OAcare for the clinicians (OAcare+)

The clinicians' view has been developed in order to provide a useful input to clinicians regarding the current patient's health status, as the related data will be properly visualized and presented.

At first, the clinician selects a patient to view their data (Figure 3.3.11) and then the app provides the main menu for easy navigation (Figure 3.3.12). The clinician can view the patient's imaging data (radiographs and MRIs) and up-date or edit the two radiographic scoring metrics (Figure 3.3.13). Moreover, the clinician can examine patient's lifestyle and pain data (Figure 3.3.14), as well as their profile (Figure 3.3.15) and update or send advice messages to patients (Figure 3.3.16).

Furthermore the clinician can set up a new care plan (Figure 3.3.17) and view the history of previously set up plans and their level of "success" based on the corresponding pain data. In addition, the clinician can upload educational material (links or files) that may be helpful for patients for better understanding the nature of their condition, or for further learning about recent advances in osteoarthritis management.

To summarize, the scope of the OAcare app is to provide patients an easy-to-use way of managing and monitoring their medical data related to the knee osteoarthritis, from the emerging of the condition until today, with the goal to enhance patients' engagement. On the other side, the OAcare app will benefit clinicians as they will be able to view the patient's medical data over the time, assisting them to better understand the patients' current health status and the progression of the condition. Next releases of the app may contain a genetic evaluation service for examining if an increased risk of developing osteoarthritis exists.

Figure 3.3.11: List of Patients

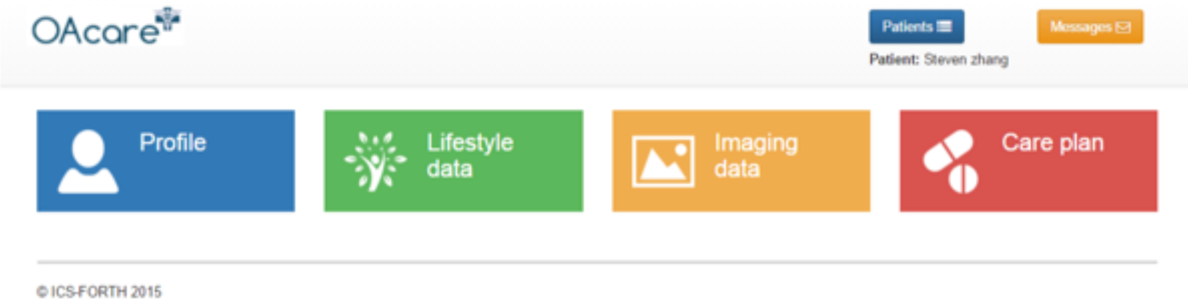


Figure 3.3.12: Main menu of OAcare+ app

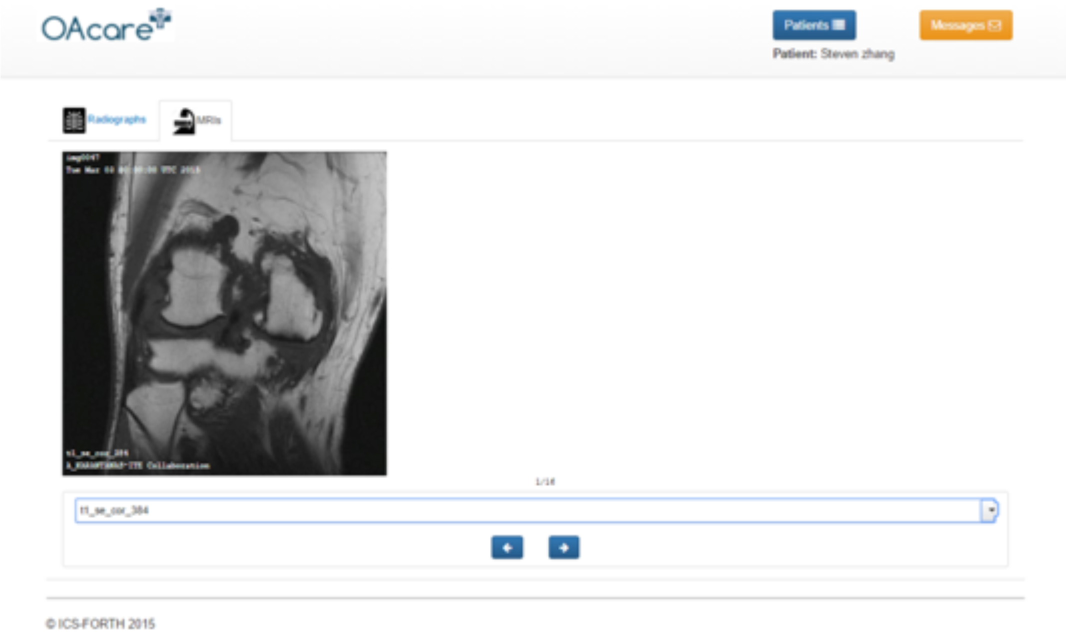


Figure3.3.13: View the patient's imaging data and/or edit the two radiographic scoring metrics

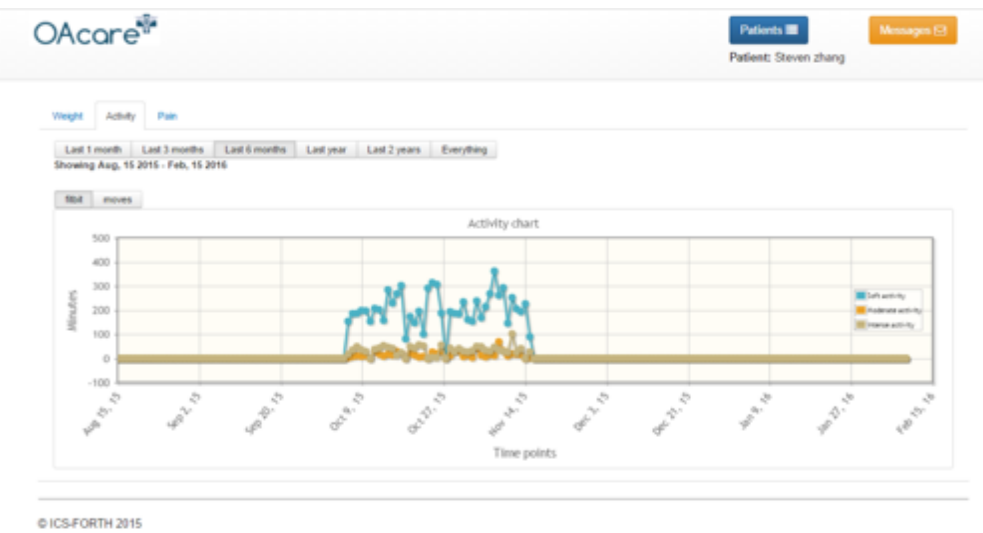


Figure3.3.14: Patient's lifestyle and pain data

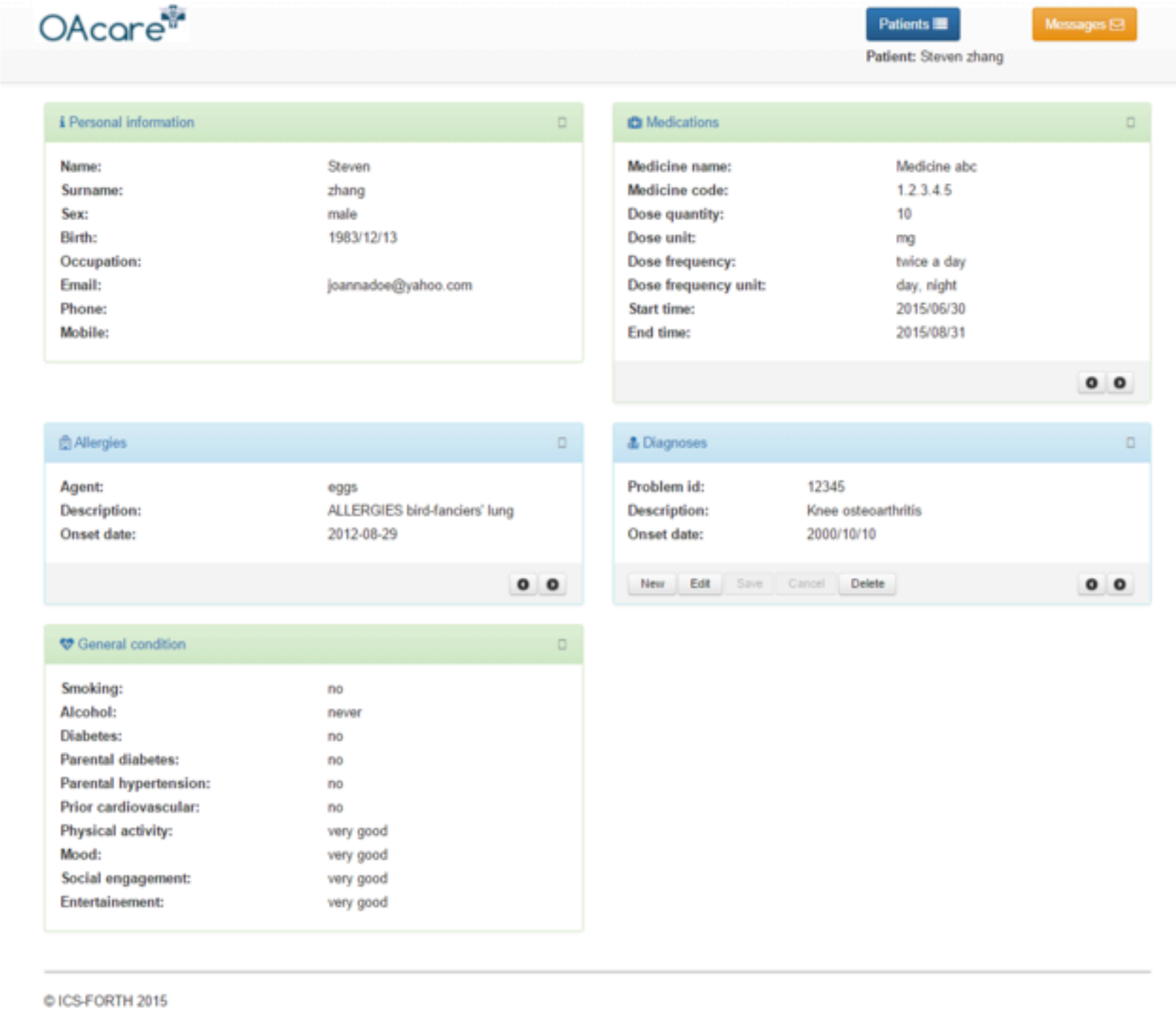


Figure3.3.15: Patient's profile data

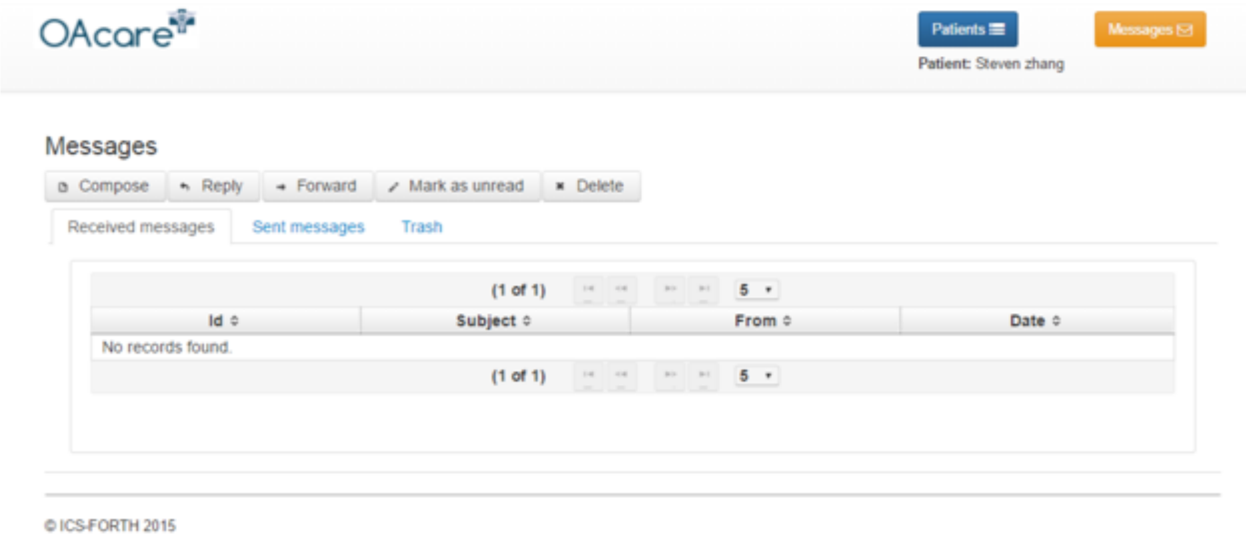


Figure 3.3.16: Sending advice messages to patients

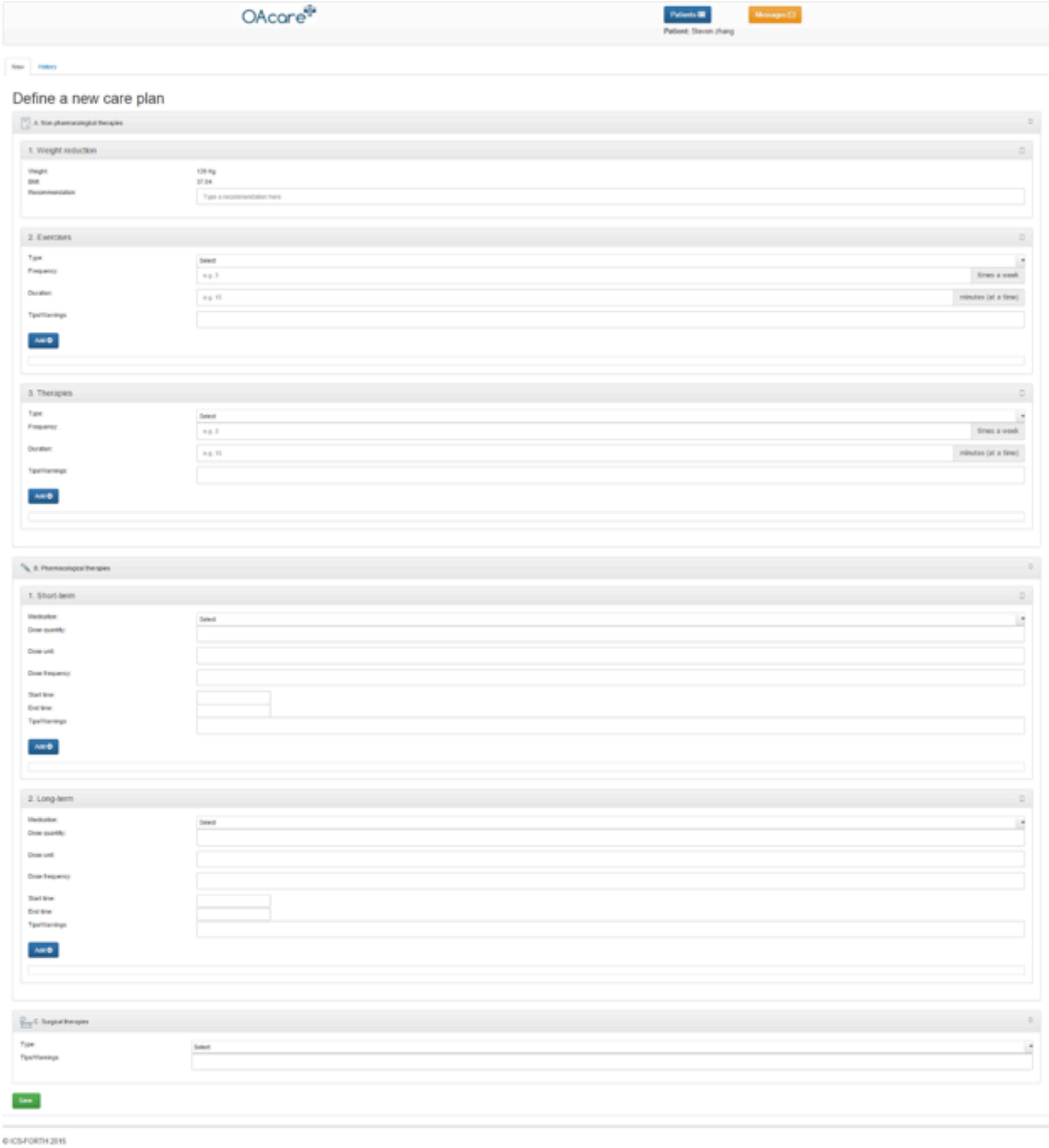


Figure3.3.17: The clinician can set up a new care plan (Figure 17) and view the history of previously set up plans

3.4 *Nephroblastoma (Wilms Tumour) Simulation Model and Clinical Trial (UC-NEPH): In-silico Profiling of Patients and Predictions*

High end clinical demo (HECD): UC-NEPH

	UAC	3DS	DB	VC	DCU	TOOL	HIS	CHF	OST	DIAB	NEPH	EME
CHF(FORTH)												
OST(FORTH)												
DIAB-EME (BED)												
NEPH (ICCS / USAAR)	x	x	x	x		x	x				x	

Table 5 Use cases (column) vs UC-NEPH

Demonstration for the UC-NEPH

1. Introduction

1.1 Nephroblastoma - Wilms Tumour

Wilms tumour is the most common malignant renal tumour in children. Dramatic improvements in survival have occurred over the last 40 years. Today treatments are based on several multicenter trials and studies conducted by the SIOP in Europe and COG in North America. The main objectives of these trials and studies are to treat patients according to well-defined risk groups in order to achieve the highest possible cure rates, to decrease the frequency and intensity of acute and late toxicities and to minimize the cost of therapy. In that way the SIOP trials and studies largely focus on the issue of preoperative therapy. The concept of neoadjuvant chemotherapy plays an important role in the treatment for most paediatric solid tumours today. The complete surgical removal of a shrunken tumour is facilitated, mutilation caused by surgical procedures is minimized or avoided and micrometastases, not visible at diagnosis, are treated as early as possible. Besides that, response to treatment can be measured individually by tumour volume reduction and / or percentage of therapy induced necrosis in the histological specimen.

The International Society of Paediatric Oncology (SIOP) enrolled children with Wilms tumour into 6 studies up to now (SIOP 1, SIOP 2, SIOP 5, SIOP 6, SIOP 9, SIOP 93-01). Graf et al give a review of these studies[7]. Since 1994 more than 2000 patients with a kidney tumour are enrolled in the SIOP / GPOH studies and trials. The 7th trial and study (SIOP 2001) started in 2002 (Figure 7). The randomized question of this trial was stopped in December 2009 after reaching the proposed number of patients. Results did show that anthracyclines are not needed to treat patients with stage II or III intermediate risk and localized nephroblastoma.

[7] Graf N, Tournade MF, de Kraker J: The Role of Preoperative Chemotherapy in the Management of Wilms Tumour - The SIOP Studies. Urologic Clinics of North America, 27:443-454, 2000

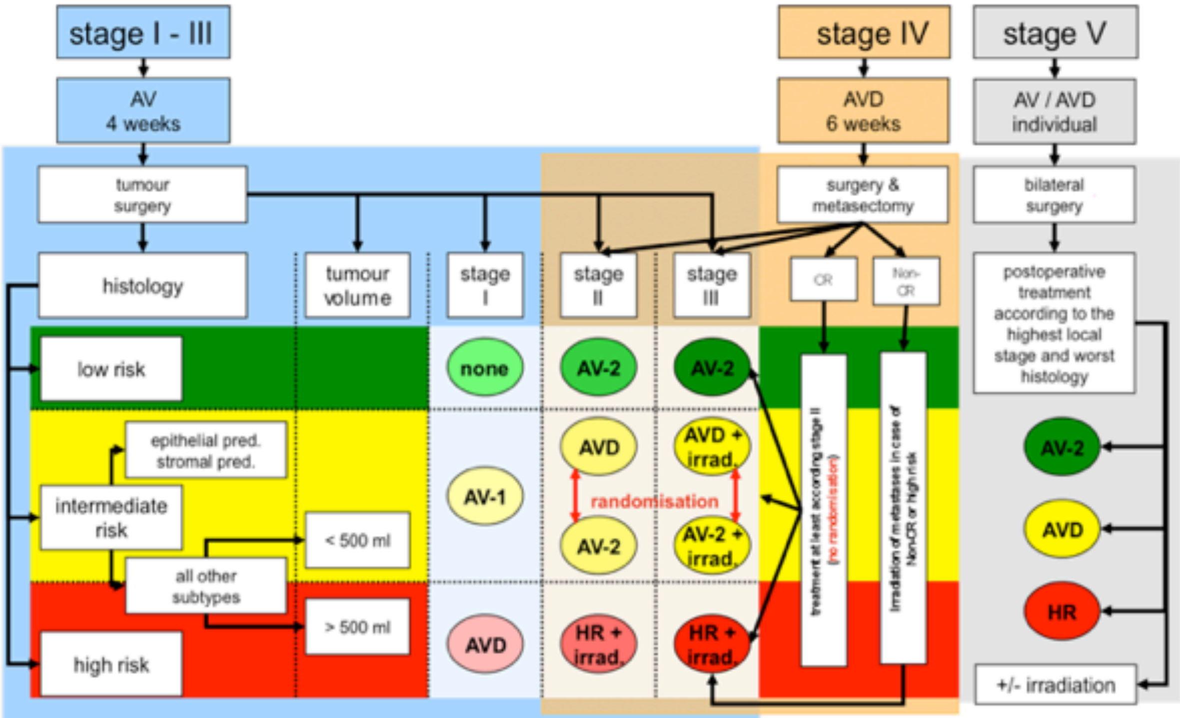


Figure 3.4.1. Outline of the nephroblastoma trial and study SIOP 2001/GPOH. CR: Chemotherapy. A: Actinomycin. V: Vincristine. D: Doxorubicin. 1,2: Different treatment schemas. HR: High Risk.

The main mission of the International Paediatric Oncology Society (SIOP) Renal Tumour Study Group (RTSG) is to increase survival and to reduce treatment toxicity in all children diagnosed with any renal tumour, aiming to offer them the same standardized high quality in diagnostics and treatment, independent of the tumour type, the socio-economic status or the geographic region.

Renal tumours include nephroblastoma or Wilms tumours (WT) in around 90% of the cases. The other tumours consist of rare subgroups including Clear Cell Sarcoma of the Kidney (CCSK), Renal Cell Carcinoma (RCC), Malignant Rhabdoid Tumours of the Kidney (MRTK), Congenital Mesoblastic Nephroma (CMN), and few others, even rarer tumours. This high-end scenario is dealing solely with nephroblastoma.

Given the relative rarity of paediatric renal tumours and in particular rare subgroups, it is necessary to recruit as many patients as possible. Over the last decades nearly 10.000 children are prospectively enrolled in SIOP Wilms Tumour studies and trials. Since SIOP 93-01 SIOP RTSG registered nearly 7.000 patients from 261 centres out of 28 countries with a renal tumour. All of them have been treated according to harmonised European trials. This has resulted in more standardised diagnostic procedures, improved risk stratification, and adjusted treatment recommendations for nephroblastoma.

The hallmark of the SIOP RTSG approach is the preoperative chemotherapy with Vincristine and Actinomycin-D without preceding mandatory histological assessment. This has the clear evidence-based benefit of down staging tumours, thereby sparing survivors the late effects of doxorubicin or radiotherapy by around 20%[8]. Nevertheless, this approach carries the risk of misdiagnosis (< 5%), as currently the so-called non-Wilms tumours cannot be identified by standard radiology or biomarker assessment.

Although the overall and event-free survival of most renal tumours is excellent, further improvements are needed to find better risk stratifications and corresponding treatments, as some patients still have a poor clinical outcome despite intensive treatments. An example is the blastemal type nephroblastoma representing a subtype of post chemotherapy resistant blastema, which has already shown to benefit from intensive treatment in SIOP 2001. [9] [10] Nevertheless the definition of blastemal type WT is subjective and not taking the absolute blastemal volume into account. Therefore a better subtyping of WT and other renal tumours is mandatory. Such developments can only be achieved with the design of biological driven approaches.

The efforts made by the biology committee of the SIOP-RTSG allow now to set up a protocol for the whole spectrum of childhood renal tumours in Europe. In addition, the recent SIOP 2001 study has shown the importance of complete data collection, which will be guaranteed by real time online data collection in collaboration with the experienced data management of the international SIOP office in Amsterdam.

1.2 Nephroblastoma clinical trial management system (ObTiMA)

The current high-end scenario aims to provide a harmonised platform, which will test therapeutic preoperative approaches for nephroblastoma.

Data regarding radiology, histology, biological markers on blood and urine tests and genetic counselling will be recorded. In addition, the study aims to provide biomaterial for molecular and genetic research to find new biomarkers and targets for new compounds in the future. This will be done by storing and analysing biomaterial by a wide range of molecular and proteomic technologies from patients enrolled in the new nephroblastoma protocol and having given consent for this research. Together with radiological innovations this strategy will demonstrate early response to preoperative chemotherapy in 'in silico'.

Data used in this high-end scenario will be managed with ObTiMA that is an ontology-based clinical trial management system. The design phase of a trial is facilitated by the Trial Builder of ObTiMA in which all aspects of a clinical trial can be specified: A trial chairman can define the outline and metadata of a trial in a master protocol to describe, e.g., trial goals or administrative data. The ontology-based creation of CRFs is one of ObTiMA major functionalities. A graphical user interface

[8] Mitchell, C., et al., Immediate nephrectomy versus preoperative chemotherapy in the management of non-metastatic Wilms' tumour: results of a randomised trial (UKW3) by the UK Children's Cancer Study Group. Eur J Cancer, 2006. 42(15): p. 2554-62.

[9] Vujanic, G.M., et al., Central pathology review in multicenter trials and studies: lessons from the nephroblastoma trials. Cancer, 2009. 115(9): p. 1977-83.

[10] Marry M. van den Heuvel-Eibrink, Harm van Tinteren, Christophe Bergeron, et al. Outcome of localised blastemal type Wilms tumour patients treated according to intensified treatment in the SIOP WT 2001 protocol, a report of the SIOP renal tumour study group (SIOP-RTSG). EJC submitted [Under revision]

allows defining content, navigation, and layout of CRFs to capture all patient data during a trial, e.g., medical findings or diagnostic data. Since many trials collect similar or equal data, it is possible to store components of or complete CRFs in a repository as templates. When setting-up a clinical trial, appropriate CRFs' template can either be directly reused or can be quickly created by composing them from existing CRF components. This in turn fosters the CRF standardization since CRFs can then readily be compared on the level of single items (through ontological concepts) and also on component level or in their entirety.

ObTiMA itself is composed of different modules and fulfils all GCP criteria, including an Audit Trail. Data safety and security are guaranteed as pseudonymization of private data is implemented according to roles and rights assigned to users of ObTiMA.

ObTiMA provides the following features

1. eCRFs
2. Access to biobanking
3. Access to a DICOM server
4. SAE and SUSAR reporting

The ObTiMA data are stored in a central database that is located in a militarized zone at the Saarland University Hospital to ensure data safety and data protection (Figure 3.4.2).

Via the Internet remote data entry is possible. To get access to ObTiMA and the eCRFs each participating centre needs to register for getting member of the SIOP-RTSG and the SIOP nephroblastoma study. After registration and signing a contract for participation in the UMBRELLA or any other study or trial credentials to use ObTiMA will be provided.

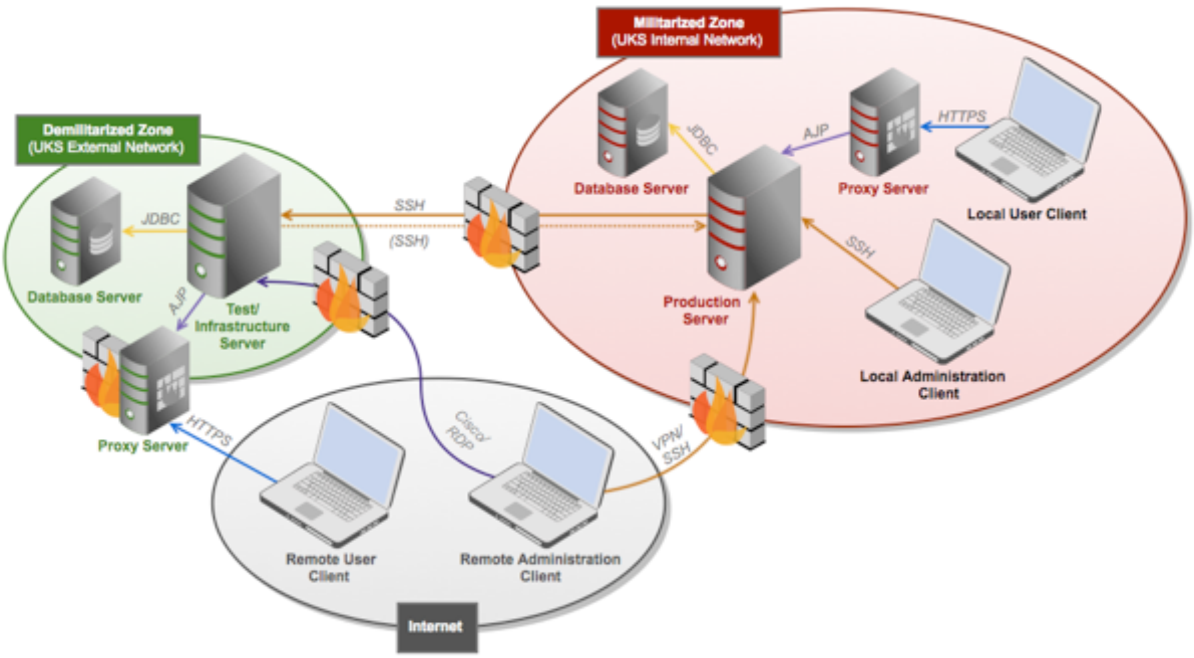


Figure 3.4.2. Infrastructure for ObTiMA

All data within ObTiMA will be encrypted and in addition personal data are pseudonymized. Only treating physicians can see real names and have only access to their patients.

1.3 Nephroblastoma Oncosimulator

The Oncosimulator for nephroblastoma is synoptically depicted in Figure 3.4.3.

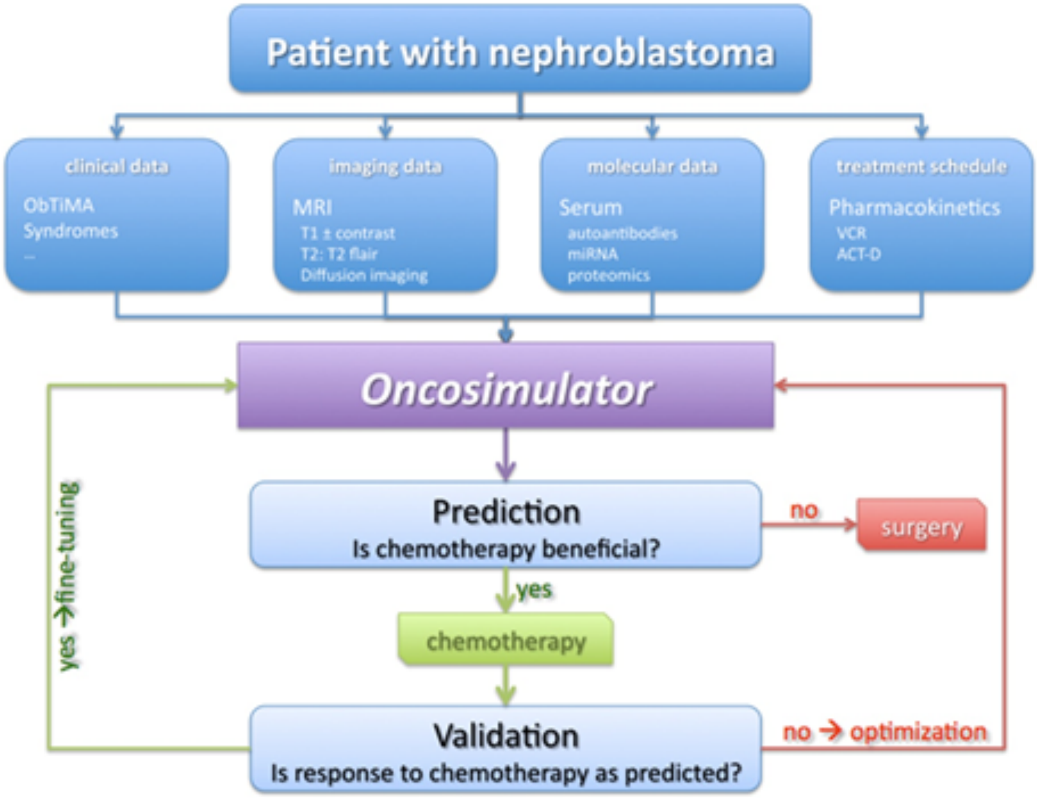


Figure 3.4.3. The workflow of the Oncosimulator for nephroblastoma

In this section a brief description of the basics of the Oncosimulator multiscale models is provided[11] . The models start from the macroscopic high biocomplexity level (imaging data) and proceed towards lower biocomplexity levels. The macroscopic anatomic region of interest is either manually or semi-automatically annotated by the clinicians on MRI imaging sets acquired at time of diagnosis. A virtual cubic mesh is used for the discretization of the area of interest (tumour) of which the elementary cube is termed geometrical cell. A hypermatrix i.e. a mathematical matrix of (matrices of (matrices…of (matrices or vectors or scalars))) corresponding to the anatomic region of interest is subsequently defined. The latter describes explicitly or implicitly the local biological, physical and chemical dynamics of the region. The following (sets of) parameters are used to identify a cluster of

[11] G Stamatakos, Memeber , IEEE , D Dionysiou, A Lunzer, R Belleman, E Kolokotroni, E Georgiadi, M Erdt, J Pukacki, S Rueping, S Giatili, A d`Onofrio, S Sfakianakis, K Marias, Member , IEEE , C Desmedt, M Tsiknakis, Member , IEEE , and N Graf, Member , IEEE "The Technologically Integrated Oncosimulator: Combining Multiscale Cancer Modeling with Information Technology in the In Silico Oncology Context" DOI:10.1109/JBHI.2013.2284276 IEEE J Biomedical and Health Informatics vol.18, No. 3, pp.840-854 2014

biological cells belonging to a given equivalence class within a geometrical cell of the mesh at a given time point:

I. The spatial coordinates of the discrete points of the discretization mesh with spatial indices i, j, k respectively. It is noted that each discrete spatial point lies at the center of a geometrical cell of the discretization mesh.

II. The temporal coordinate of the discrete time point with temporal index l.

III. The mitotic potential category (i.e. stem or progenitor or terminally differentiated) of the biological cells with mitotic potential category index m.

IV. The cell phase (within or out of the cell cycle) of the biological cells with cell phase index n. The following phases are considered: {G1, S, G2, M, G0, A, N, D}, where G1 denotes the G1 cell cycle phase; S denotes the DNA synthesis phase; G2 denotes the G2 cell cycle phase; M denotes mitosis; G0 denotes the quiescent (dormant) G0 phase; A denotes the apoptotic phase; N denotes the necrotic phase and D denotes the remnants of dead cells.

For the biological cells belonging to a given mitotic potential category AND residing in a given cell phase AND being accommodated within the geometrical cell whose center lies at a given spatial point AND being considered at a given time point; in other words for the biological cells clustered in the same equivalence class denoted by the index combination ijklmn, the following state parameters are provided:

i. local oxygen and nutrient provision level
ii. number of biological cells
iii. average time spent by the biological cells in the given phase,
iv. inumber of biological cells hit by treatment,
v. number of biological cells not hit by treatment.

The initial constitution of the tumour has to be estimated based on the available medical data through the application of pertinent algorithms. This state corresponds to the instant just before the start of the treatment course to be simulated. The entire simulation can be viewed as the periodic and sequential application of a number of algorithms (operators) on the hypermatrix of the anatomic region of interest which takes place in the following order: a) time updating i.e. increasing time by a time unit (e.g. 1h), b) estimation of the local oxygen and nutrient provision level. c) estimation of the effect of treatment referring mainly to cell hit by the treatment, cell killing and cell survival. Available molecular and/or histological information is integrated primarily at this point. d) application of cell cycling, possibly perturbed by treatment. Transition between mitotic potential cell categories such as transition of the offspring of a terminally divided progenitor cell into the terminally differentiated cell category is also tackled by this algorithm set. e) handling of differential tumour expansion/ shrinkage or more generally spatial geometry and tumour mechanical dynamics. f) updating the local oxygen and nutrient provision level at each time step. It is worth noting that stochastic perturbations about the mean values of several model parameters are considered (hybridization with the Monte Carlo technique). A generic tumour cell cytokinetic model is depicted in Figure 3.4.4.

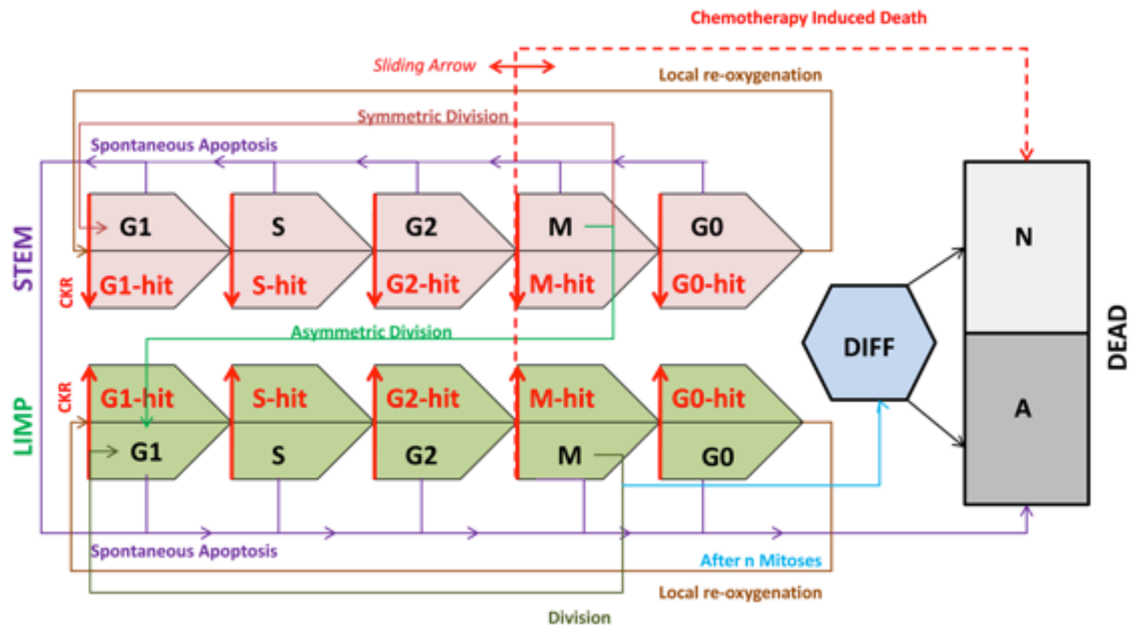


Figure 3.4.4. Generic cytokinetic model used. LIMP: LImited Mitotic Potential cells. DIFF: terminally differentiated cells. G1: Gap 1 phase. S: DNA synthesis phase. G2: Gap 2 phase. M: Mitosis. G0: dormant phase. N: necrosis. A: apoptosis. Hit: cells lethally hit by chemotherapy. CKR: Cell Kill Rate. The arrow indicating chemotherapy-induced death is a sliding arrow, with position dependent on drug pharmacodynamics.

2. Descriptions and Design

2.1 Objectives

The outcome of this high-end scenario is to provide a tool that demonstrates response of nephroblastoma to a given preoperative chemotherapy. This can be used in a fourfold way:

- To demonstrate to patients and/or parents of patients how a given tumour will respond to preoperative chemotherapy. This will help in explaining diagnosis and treatment of nephroblastoma to patients and/or parents of patients. Such a demo will not use the actual data of the given patient.

- To give physicians treating a patient with a nephroblastoma the ability to check how this specific nephroblastoma will respond to preoperative treatment with vincristine and actinomycin-D.
- To provide clinical researchers and modelers a powerful tool to define an in silico patient profile and further exploit it in other modelling approaches and VPH projects. Moreover, it could serve as a statistical tool to categorize patients (by associating their clinical and in silico profiles) and define ranges of model parameter values to guide the process of model adaptation for new patient cases.

- To demonstrate to citizen what 'in silico' models/tools can do today. This can serve as a learning environment for 'in silico' models and will help to disseminate the importance of 'in silico' models in medicine to the public, to medical stakeholders, industry and funding agencies. It is pointed out that the purpose of the in silico experimentation functionality is currently limited to the
- education of the public so that they can be prepared for the future translation of thoroughly clinically validated models to clinical practice.

2.2 Targeted end-users

The high-end scenario will target patients and parents of patients, paediatric oncologists, researchers and the public as given by the 4 different objectives.

2.3 Nephroblastoma Educational Scenario.

The Nephroblastoma Use case is developed and demonstrated as an external application with respect to the MyHealth Avatar platform. This is done because of the nature of the disease and the psychological effects its existence could cause on the patients and/or their parents. Therefore, the Use case was implemented to facilitate the patient/patient parent – doctor interaction, which is the only way that sensitive patient data and the model execution outputs can be viewed and implemented, while at the same time, the oncology expert's result interpretation, guidance and advisory are present.

However, since MyHealthAvatar is directed a great deal to citizens as well, it should be beneficial to let the general public know what VPH multiscale models are capable of and how can they contribute to the battle against severe diseases such as cancer. This ought to be done by registering within the MyHealthAvatar platform a separate version of the Nephroblastoma Use case, named "Nephroblastoma Educational scenario". It contains the Nephroblastoma Oncosimulator, which operates on synthetic data acquired by literature, and produces a simple set of results.

2.4 Added value for the MyHealthAvatar platform.

Through the Nephroblastoma Use Case and its educational model, the MyHealthAvatar platform has the opportunity to demonstrate its capabilities for assisting a third party application, by providing its own collected data and/or access to external data sources, in order to either train, adapt and validate simulation models in development, or feed already clinically used models and provide actual

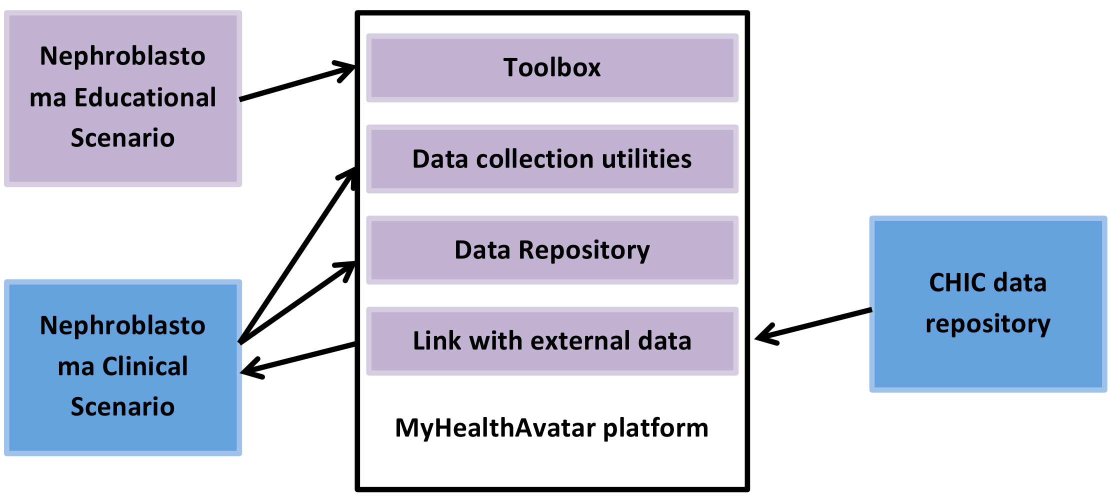
results for patients, whose data can be outside the MyHealthAvatar platform. At the same time, the storage of the execution results back to the MyHealthAvatar platform by using its API, indicates that the platform itself can further add to its collected data by incorporating outputs from simulation model executions, which in turn can offer to the work of other modules within the platform or other models inside or outside the platform, etc. It is a mutual benefit, which stems from the potential role of MyHealthAvatar as a data and authentication"transit center" and acts as a positive feedback loop for facilitating the work of both the platform and the applications connected to it.
Education-wise, partially validated models, simulating a hypothetical patient's disease progress (based on data acquired from literature), running through a platform such as MyHealthAvatar are suitable for general public education. The Nephroblastoma educational scenario (as part of the MHA toolbox), through its triple form of results (table of numerical values explaining the tumor's evolution, graph of tumor volume evolution over time, 3D reconstruction of initial and final tumor volumes), can be used to notify the patient and/or their parents of the new methods that are used to specify the treatment scheme. Extending this notion, the general public can be informed that such tool do exist for a variety of diseases (with cancer being an indicative example, given through the MHA platform), and show the basic biological mechanisms, disease progression, and response to treatments, (health literacy).

3. Implementation

The main part of the use case (hereinafter referred to as "Nephroblastoma Clinical Scenario") is implemented and demonstrated through IAPETUS, which is a prototype web application build by the In Silico Oncology and In Silico Medicine Group, ICCS-NTUA. It is composed of two major modules. A Tool/Model Repository capable of storing simulation models and pertinent/assisting tools, as well as their individual attributes in separate tables, and a user interface to setup and carry out model executions and handle the outcoming results. It is built to handle all kinds of simulation models, including the various Oncosimulator branches, developed at ICCS. The "Nephroblastoma Clinical Scenario" provides the user the ability to model real patients. In order to demonstrate this usability in the framework of MHA, a connection with the CHIC data repository has been established.

The educational scenario is integrated within the MHA platform and called by the user after they log in, via the toolbox menu.

The following figure gives the implementation overview of the Nephroblastoma Use Case with respect to the MyHealthAvatar platform



To use IAPETUS, a user is first met by the initial screen:

IAPETUS home screen

If they do not have an account within the application, they can sign up for one:

IAPETUS sign up page

After creating their account, or if they already have one, they can login:

IAPETUS login page

Upon successful login, they see the home screen, where they can choose between the model repository module and the Oncosimulator Module:

IAPETUS successful login

IAPETUS main page

If they choose the Oncosimulator Module, they have the choices of giving input and running an execution, or viewing a report on past executions:

IAPETUS Oncosimulator main page

If they choose to run a new execution, first they must choose the cancer type:

IAPETUS cancer choice page

Then, they must choose one of the contained models which pertain to the chosen cancer type:

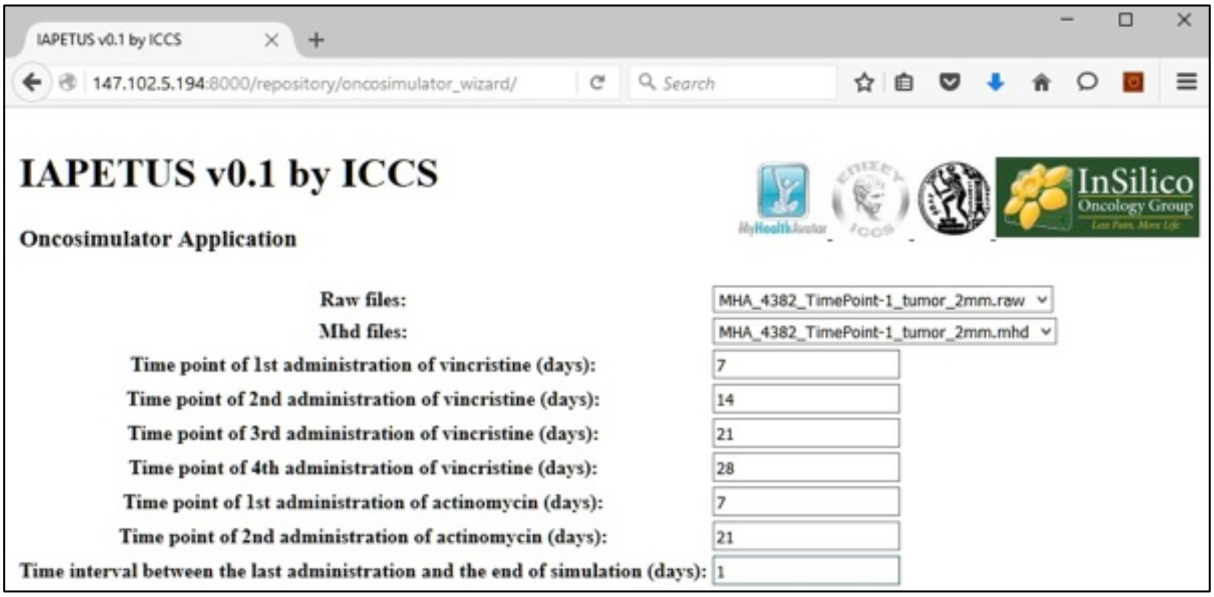
IAPETUS model choice page

After that, they select a patient:

IAPETUS patient choice page

By selecting the patient the IAPETUS connects to the CHIC data repository and retrieves the corresponding files (imaging) of the patient chosen in the appropriate format to serve as input to the oncosimulator model.

Finally, they provide the input parameters for the schema. At the same time, the pertinent input files will be fetched from the CHIC repository and brought up to the user. It should be noted that this screen is always different for every model included in the application's repository:

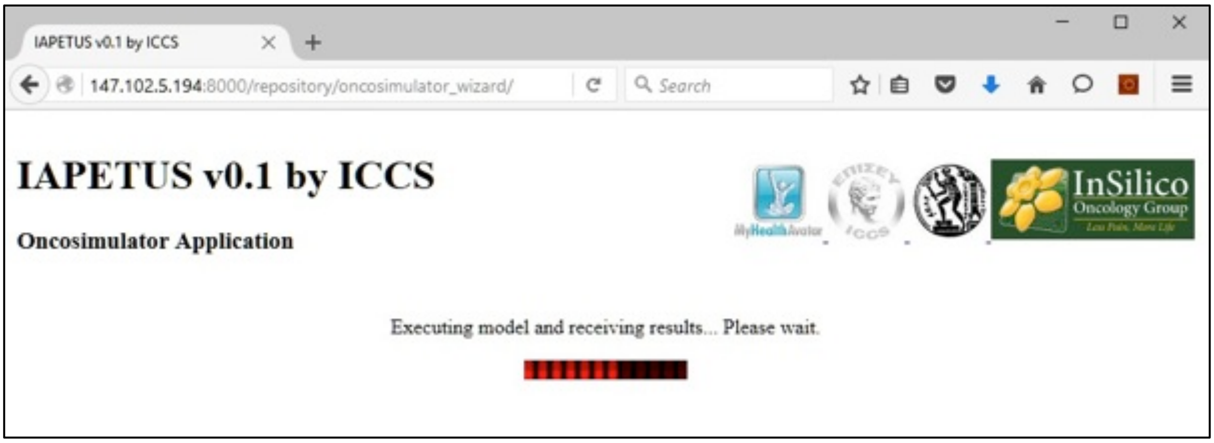


IAPETUS values input page

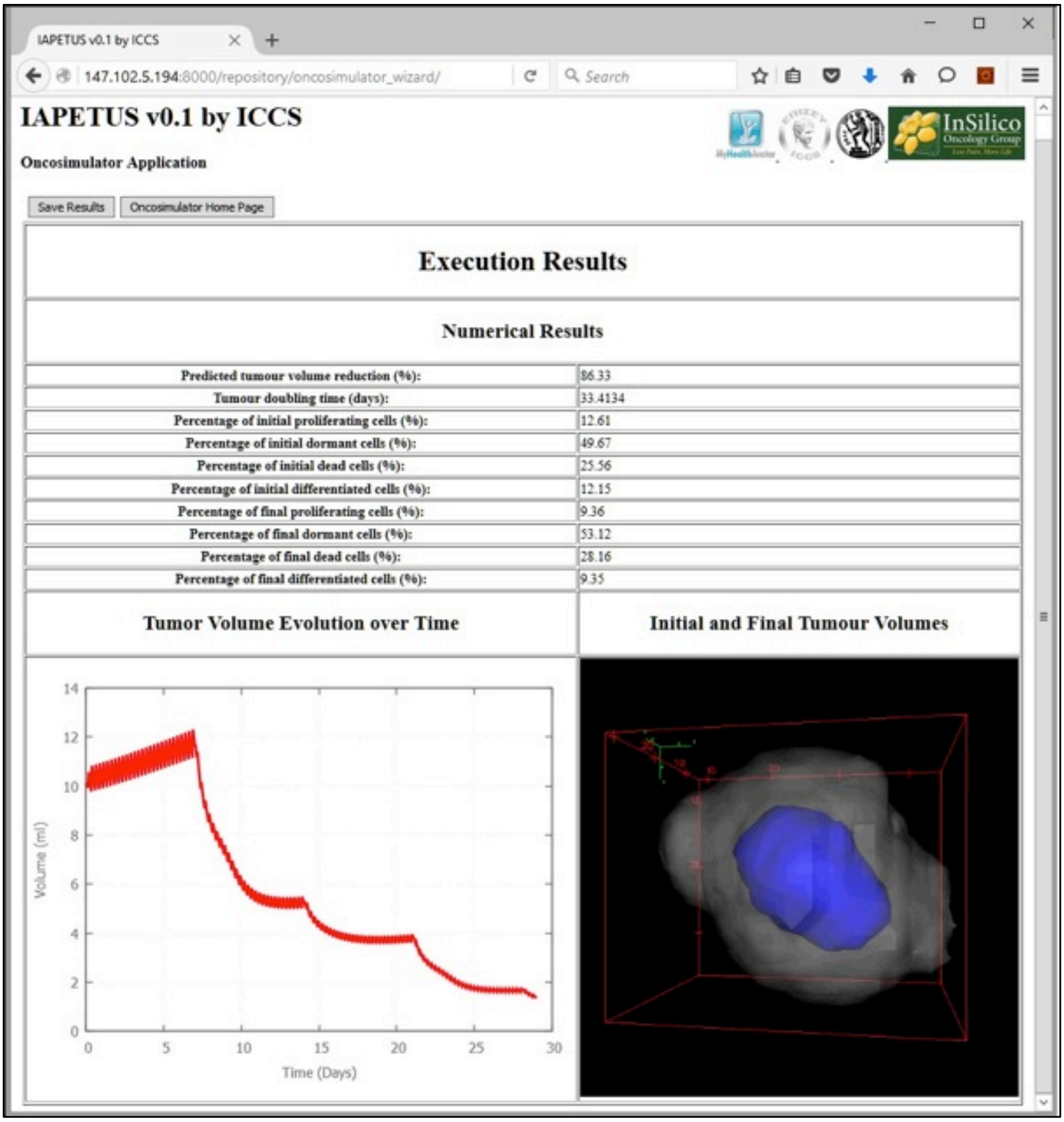
Finally, they are given one last chance to confirm their inputs. If they are certain about what they have entered, they may click on Run execution:

IAPETUS confirmation page

Results are calculated and presented to the user:

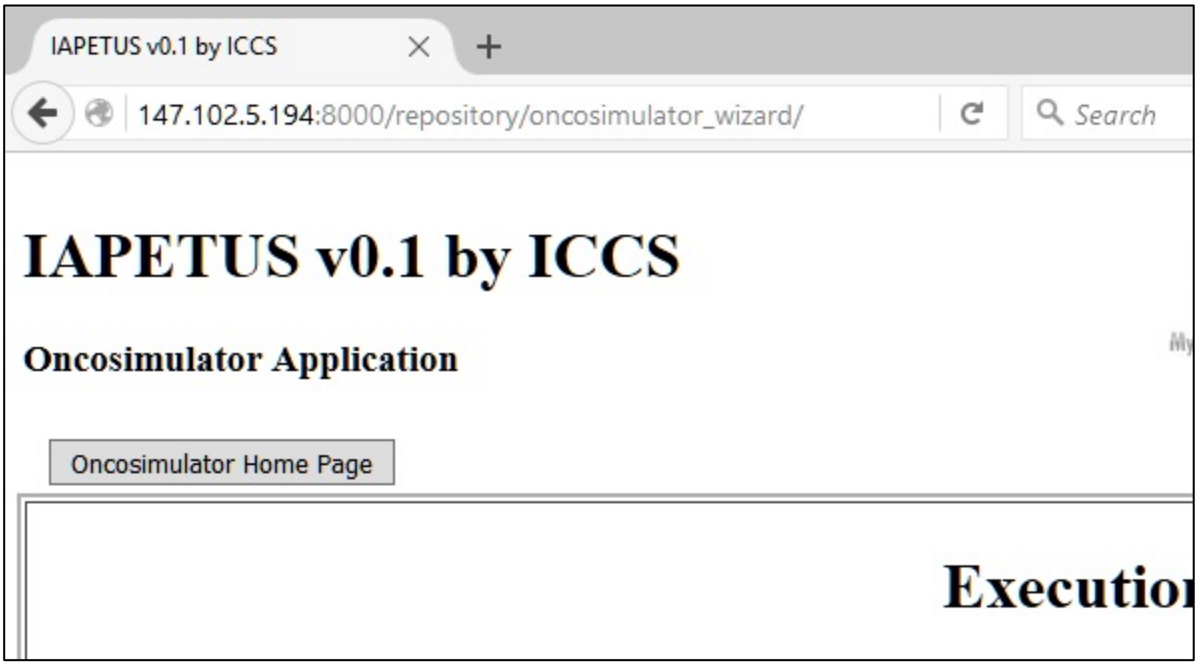


IAPETUS execution screen



IAPETUS results page

The user can save the results by pressing the corresponding button. A report in pdf format will be produced and saved in MHA through an API (data collection utility). Then the user could click the "Oncosimulator Home page" button to return to the module home page:



prompt to return to oncosimulator home page

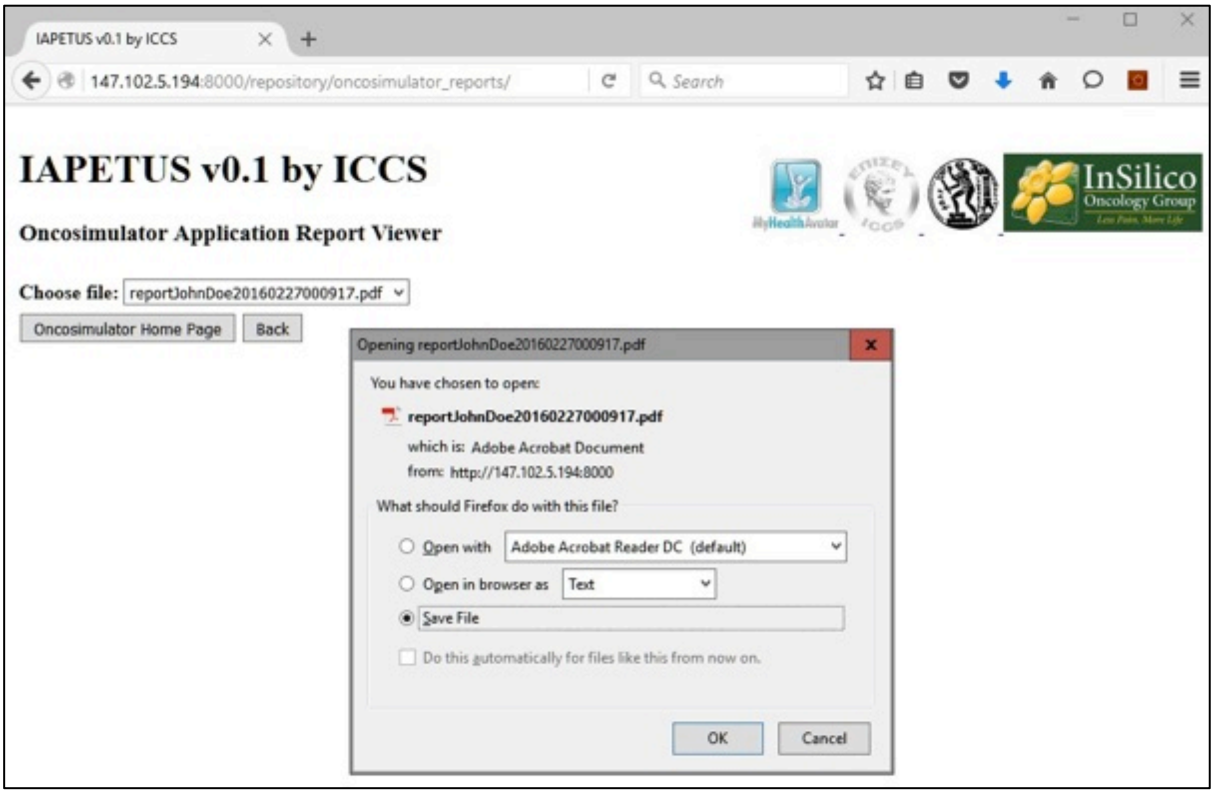
To view a report, they must click on the button “View a previous simulation’s report” and then chose a patient:

IAPETUS patient choice page for retrieving reports

Then choose a report from a list of reports pertaining to that person:

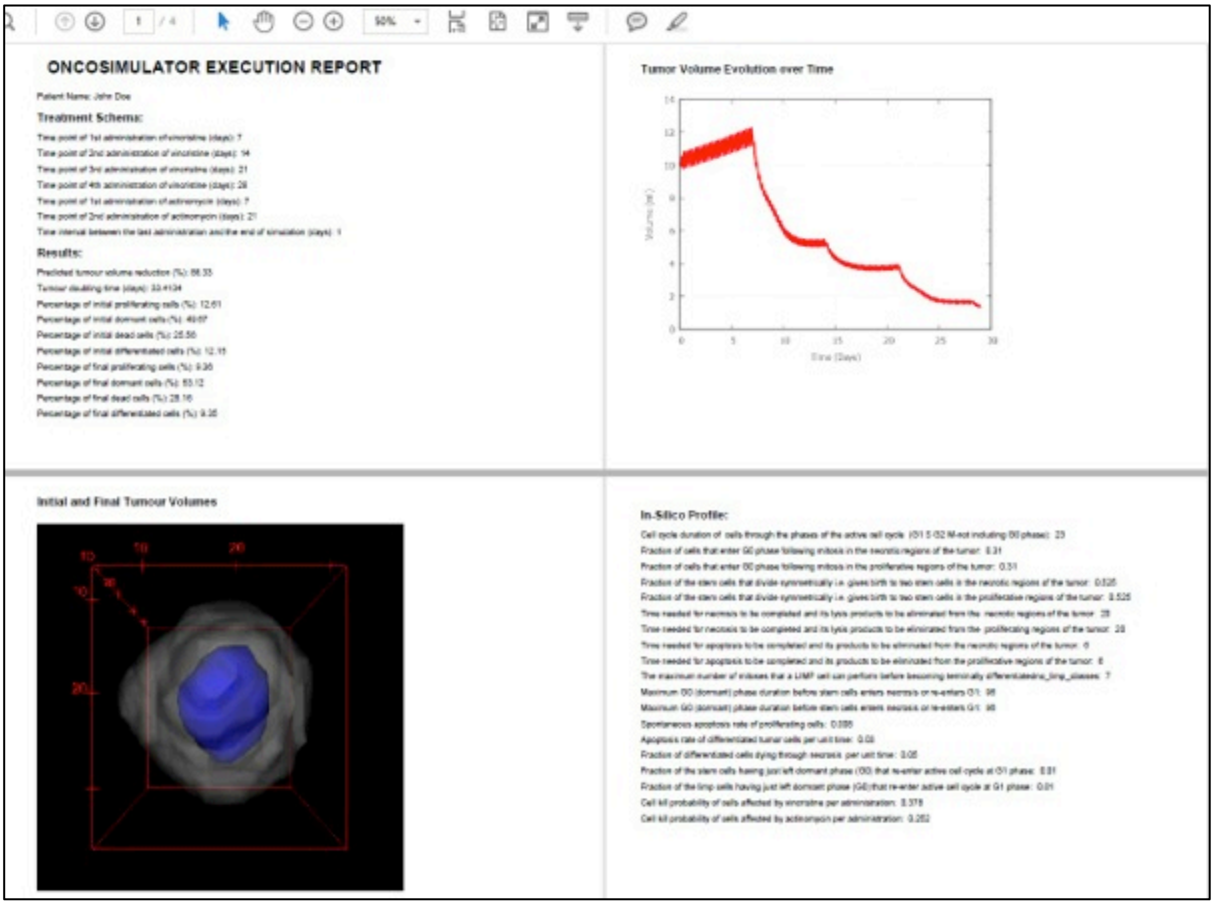
IAPETUS report choice page

Download the file (pdf format):



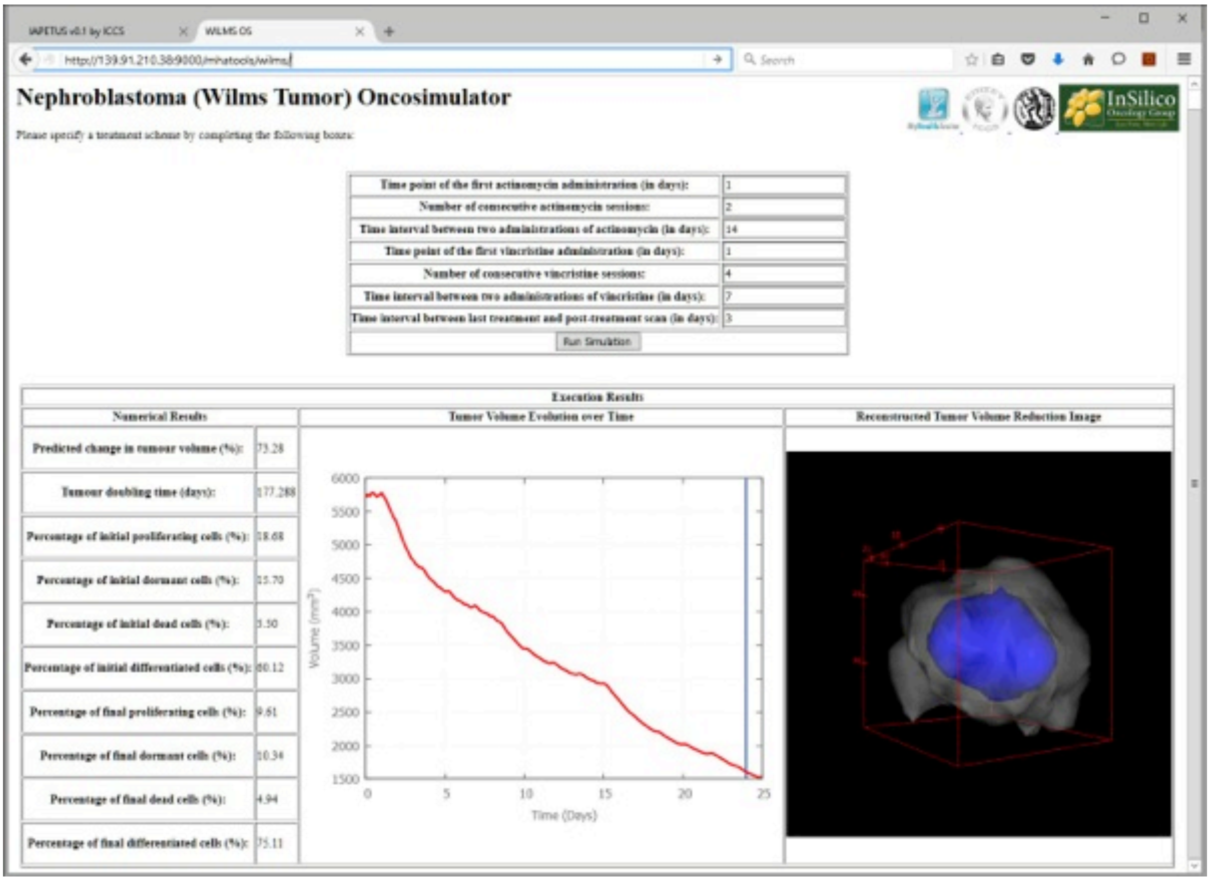
Downloading requested report file

And open it with their pdf viewer:



Report PDF file

The Nephroblastoma Educational Scenario is accessed by the "Toolbox" menu inside MyHeathAvatar platform. The user is directly presented with a table, in which they are required to give their own values and formulate a treatment schema. Then they click on the "Run simulation" button. The results are presented below the initial table. The next figure demonstrates the final screen of the tool.



Nephroblastoma Educational Tool final result screen. The first table is what the user sees when they enter the tool. The “Execution Results” table is formulated on-the-fly by the outputs of the oncosimulator’s execution.

4 Conclusions

This document presents in details MHA demos selected. All demos are close related to the prioritised and final set of Use Cases / Scenarios reported in WP7 and WP9.

The general Demonstrator is defined as a way to demonstrate the prototype of MyHealthAvatar, with the primary purpose of showcasing its idea, performance, method or features.

MyHealthAvatar is a non-profit research project to study how technologies are able to help patients and citizens look after their own health and wellbeing. It offers you a place to keep records of your medical information as well as your daily activities and lifestyles. It promotes self-care of patients and citizens for healthy lifestyle and wellbeing.

MyHealthAvatar is a lifetime companion for your daily life and health. It can:

- Remember your activities of daily living, including your movements, locations, food intake, mood, sleep quality and photos
- Record your health status such as heart rate, blood pressure and glucose can also be logged.
- Identify and highlight important events in your life.
- Summarise your lifestyle and assess the quality of your life
- Help you enter your health records (e.g. conditions, medication, immunization, allergy)
- Indicate your risks of developing diseases, such as cardiovascular, diabetes, hypertension and stroke.
- Allow you to share information among friends through social media.

MyHealthAvatar offers a range of smart tools to facilitate data input and revisit, and to discover significant information for your health and wellbeing. It has:

- Tools to automatically collect your steps count, calories consumption, active minutes, locations and movements.
- A chat interface for you to log your food consumption, mood and other health-related information using text, photo, icon and voice through a chat with MyHealthAvatar. The MyHealthAvatar app asks for this information at appropriate time and places, for example, while you are waiting for bus. It also delivers you tips and reminders for healthy behaviours, for example, breakfast recommendations, suggestions for a walk if you have been sitting for too long.
- Map, calendar and clock for you to review your daily activities, movements, step counts and travel distance on any given day. The MyHealthAvtar app allows you to view your daily activities via animation. Especially, the app makes easier for you to access your activities on the same day last week. With these features, you can revisit old times for past experiences, bring to mind cherished moments, and jog your memory about the details of past events.
- A timeline for you to view the change of your step counts, travel distance, active minutes, calories, etc.
- A health profile page presented in a professionally designed layout and graphical illustration for you to edit and view your health information, such as name, address, DoB, contact details,

care providers, immunisation, allergies, medical history, medication history, and lab test results (e.g. blood test). You can print off this page in the event of vising a new doctor.
- Tools to predict your risks of developing cardiovascular, diabetes, hypertension and stroke.

MHA provides a unique platform that empowers normal citizens in terms of supporting their life management and healthy lifestyles. Whereas in the past, the so-called 'grey area' patients with prediabetes were not looked after by the health care system. As a citizen oriented platform, the MHA platform provides services to the general public that help them identify and mange their risk of developing diabetes. It is a perfect complement to the health care system. It offers a one-stop service for citizens in terms of data collection, and self-management services, such as monitor, record, and education. The system supports the storage the behaviours and daily activities of citizen. It functions as a supportive environment to empower normal citizens in looking after their own health, raising their self-awareness of any potential risk of developing diseases while encouraging their healthy lifestyles in terms of doing routine daily exercise, stopping smoking and controlling their diet. Therefore, naturally many existing functionalities in MHA can be directly used for the needs of pre-diabetic care. In addition, we have incorporated tailored services, such as diabetes risk assessment models for pre-diabetic care, which is used by the users to understand their personal risk of developing diabetes, and the impact of their behaviour and lifestyles towards the risk.

As a citizen oriented platform, the MyHealthAvatar platform provides services to the general public that help them identify and manage CHF related risks. It offers an easy to use service for citizens in terms of data collection, and real time self-management services, such as monitor, record, and alarm. The system will function as a supportive environment to empower citizens and patients in looking after their own health through self-awareness of potential risks of developing diseases. Therefore, many existing functionalities in MyHealthAvatar will be used for the needs of personalized CHF risk profile assessment and real-time monitoring.

MyHealthAvatar provides a novel platform that empowers both citizens (patients and healthy) and medical professionals for the long-term management of OA. It will function as a supportive environment to empower citizens in looking after their own health, raising their self-awareness of any potential risk of developing OA while encouraging their healthy lifestyles in terms of doing routine daily exercise and controlling their diet according to the clinical recommendation (e.g. in cases of high risk of developing OA the clinician might suggest mild exercise and Calcium, vitamin D supplements). It offers a one-stop service for citizens in terms of data collection and self-management services such as record, monitor and education. Citizens will be able to upload periodically their own health data, e.g. evaluation metrics, using mobile apps. The avatar system will also monitor patients' daily dietary and ambulatory activity and warn patients if they are not compliant with the guidelines issued by the medical professionals. The avatar system will also promote citizens' education on the knowledge of OA. It is expected that a good knowledge of the disease parameters will lead to consistent citizen behavior. In addition, medical professionals will be provided by a useful input regarding the health status of patients/citizens as the related data will be properly visualized and presented using interactive multi-scale visualization techniques. This will be a novel, enhanced clinical decision support tool that will blend medical imaging information with personal health information such as activity and nutrition trends which allow a more holistic assessment of the citizen's status regarding OA. In essence, this will give a better insight of the condition and its progress for carrying out personalized medicine and for better follow-up. Advanced personalized healthcare will also be enhanced by genomic predisposition evaluation for developing osteoarthritis.

Through the Nephroblastoma Use Case and its educational model, the MyHealthAvatar platform has the opportunity to demonstrate its capabilities for assisting a third party application, by providing its own collected data and/or access to external data sources, in order to either train, adapt and validate simulation models in development, or feed already clinically used models and provide actual results for patients, whose data can be outside the MyHealthAvatar platform. At the same time, the storage of the execution results back to the MyHealthAvatar platform by using its API, indicates that the platform itself can further add to its collected data by incorporating outputs from simulation model executions, which in turn can offer to the work of other modules within the platform or other models inside or outside the platform, etc. It is a mutual benefit, which stems from the potential role of MyHealthAvatar as a data and authentication”transit center” and acts as a positive feedback loop for facilitating the work of both the platform and the applications connected to it.
Education-wise, partially validated models, simulating a hypothetical patient’s disease progress (based on data acquired from literature), running through a platform such as MyHealthAvatar are suitable for general public education. The Nephroblastoma educational scenario (as part of the MHA toolbox), through its triple form of results (table of numerical values explaining the tumor’s evolution, graph of tumor volume evolution over time, 3D reconstruction of initial and final tumor volumes), can be used to notify the patient and/or their parents of the new methods that are used to specify the treatment scheme. Extending this notion, the general public can be informed that such tool do exist for a variety of diseases (with cancer being an indicative example, given through the MHA platform), and show the basic biological mechanisms, disease progression, and response to treatments, (health literacy).

Appendix 1 – Abbreviations and Acronyms

CHF	Congestive Heart Failure
DoW	Description of Work
EHR	Electronic Health Record
ICT	Information and Communications Technology
MHA	MyHealthAvatar
PHR	Personal Health Record

Appendix 2 – The Final Set of MHA Scenarios / Use Cases

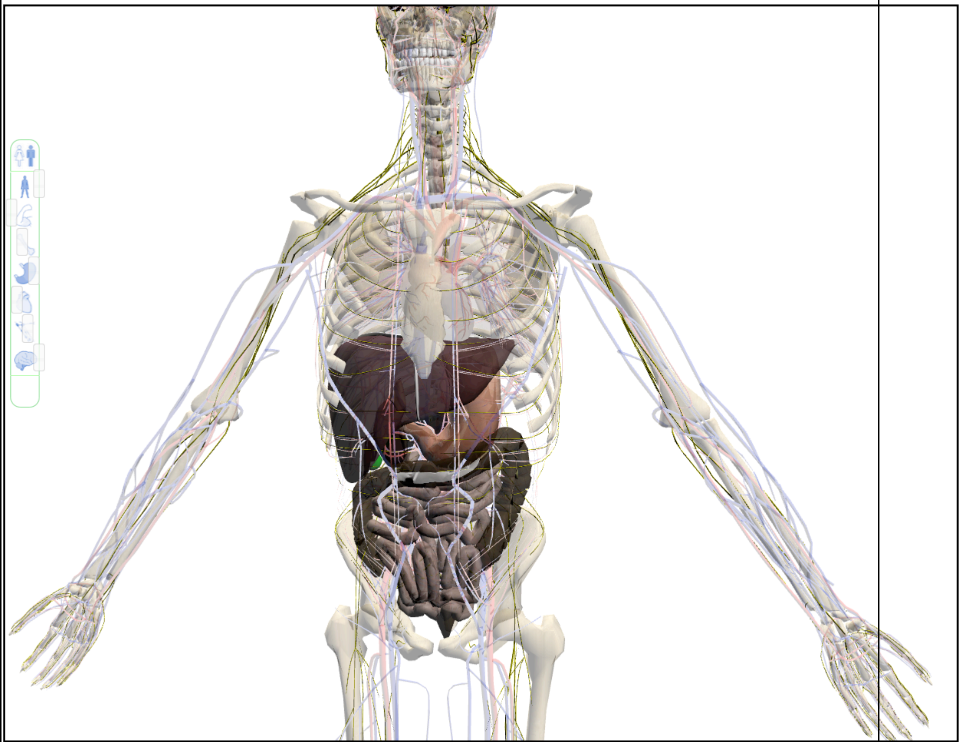
MHA User Accounts (UC-UAC)

Use Case ID:	UC-UAC		
Use Case Name:	MHA User Accounts		
Technical Collaborators:	BED, FORTH, ICCS	**Clinical Collaborator:**	USAAR
Description:	Users (citizens) will be able to log onto the system using their username and password. New users will be able to sign up to the system by creating basic personal information including security questions. Informed consent and privacy: Users will need to accept the privacy policy and the "terms and conditions" of using the MyHealthAvatar platform. Upon log into the system, users will be able to enter, browse their data, explore medical information, communicate with other fellow patients. Users will be able to view and interact with an avatar - a 3D representation of the human body. It will allow the End User to click with the computer mouse on a particular part of the avatar "body" to trigger a search of medical records to retrieve relevant information MyHealthAvatar is a platform for End-Users who want to share their health information to create collective knowledge about disease, health, and treatments. In order to achieve this goal advanced Informed Consent and Privacy Policy Scenario / Use Case should be implemented. End User has the GUIs, functionalities and tools in the frames of MyHealthAvatar platform to accept, reject, print or revise at any time the Privacy and Informed Consent settings. There will be two types of users, the first type includes patients and citizens for their life time data collection, the second type includes doctors who will be linked to the avatars from citizens/patients for clinical practices and medical research purpose		
Actors:	*Two types of users: Type 1: Patients/citizens* *Type 2: doctors/medical researchers*		
Trigger:	*n/a*		
Preconditions:	*n/a*		
Successful End condition	*n/a*		
Fail End condition	*n/a*		
Basic Flow:	Sign up and log in 1. After press a sign up button, new users will provide basic information (user name, age, gender etc.) and some security questions. They will also have to accept the privacy policy and the "terms and conditions" of using the MyHealthAvatar platform.		

	2. Upon log in, users will be able to access the system 3. Users will be able to perform the system operations (e.g. data browsing, sharing etc.) Privacy policy setting 1. Successful Log-In (or New account creation) by using Username or Email and Password 2. Click Accept/Revise link named "Privacy and Informed Consent" of your Avatar 3. The Privacy and Informed Consent description with checkboxes is shown. 4. End User has the option to select any checkbox according his/her preferences 5. End User has the option to "Edit", "Save" and "Print" the Accepted "Privacy and Informed Consent" preferences. Note: the sign up interface for patients and doctors will be slightly different.	
Alternate Flows:	*n/a*	
Postconditions:	*N/a*	
Dependencies:	*n/a*	
Required External Resources:	[ ] Data, please specify:	n/a
	[ ] Tools, please specify:	n/a
	[ ] Services, please specify:	n/a
	[ ] Models, please specify:	n/a
	[ ] Other, please specify:	n/a
How this use-case is going to be validated?		
Frequency of Use:		
Who are the users?	*Two types of users: Type 1: Patients/citizens* *Type 2: doctors/medical researchers*	
Special Requirements:		
Assumptions:		
Questions:		

Avatar Visualization (UC-3DS)

Use Case ID:	UC-3DS		
Use Case Name:	3D Avatar Visualization		
Technical Collaborators:	BED	**Clinical Collaborator:**	USAAR
Description:	MyHealthAvatar platform would propose an avatar - a 3D representation of the human body - to allow End Users (e.g. patients, doctors) to visualize patient medical records in a new way. The avatar will be used as a means for presenting general medical knowledge		

	to the citizen users. Users will be able to select individual parts and see related medical information such as anatomy. The information may also include medicine and food. Some individualization of the 3D model is desirable.  **3D Avatar View** *Centre for Computer Graphics & Visualisation University of Bedfordshire, UK* *(18-19 February 2014, Luton Meeting)*
Actors:	*This will be mainly for citizens/patients to view their own data* *The doctors can also load the avatars from their patients to see patient data*
Trigger:	*n/a*
Preconditions:	*n/a*
Successful End condition	*n/a*
Fail End condition	*n/a*
Basic Flow:	The basic steps are: 1. Successful Log-In (or New account creation) by using Username or Email and Password 2. Select your Avatar 3. Click on different parts of the 3-D Avatar of the human body (e.g. kidney) 4. See all the available medical history and information related to that patient's parts of the human body (e.g. text entries, EHR, lab results and/or medical images). 5. Browse the available information with ability to Add, Edit, Save, Change the Privacy Settings, or Delete the existing entries. 6. End messages (e.g. "Success", "Error") in case of any of the above performed actions. 7. Log-Out option with related message

Alternate Flows:	*n/a*	
Postconditions:	*N/a*	
Dependencies:	*n/a*	
Required External Resources:	[ ] Data, please specify:	n/a
	[ ] Tools, please specify:	n/a
	[ ] Services, please specify:	n/a
	[ ] Models, please specify:	n/a
	[ ] Other, please specify:	n/a
How this use-case is going to be validated?		
Frequency of Use:		
Who are the users?	*This will be mainly for citizens/patients to view their own data* *The doctors can also load the avatars from their patients to see patient data*	
Special Requirements:		
Assumptions:		
Questions:		

MHA Data Browse (UC-DB)

Use Case ID:	UC-DB		
Use Case Name:	MHA Data Browse		
Technical Collaborators:	BED, LIN, FORTH, ICCS	**Clinical Collaborator:**	USAAR
Description:	Upon log in to their own account, users will be able to browse their own data, including all the personal health status data collected through the avatar system, plus medical records and clinical data from the hospitals The avatar system will need to offer tools that support effective data query and search, such as filtering. The 4D avatar will play an important role in presenting the data. Users will be able to select individual parts of the avatar body to view the data associated to the selected parts. Different colours or textures will be assigned to individual parts of the 4D avatar to represent their health status. For example, if the heart has a serious problem it will be highlighted using a unique colour or texture Patients/citizens will use the data browser to view their own data; Doctors will be able to view data from all his/her patients connected to the avatar. The avatar system will also need tools which will help users to analyze medical images		
Actors:	*Patients/citizens will use the data browser to view their own data* *Doctors will be able to view data from all his/her patients connected to the avatar.*		
Trigger:	*n/a*		

Preconditions:	*n/a*
Successful End condition	*n/a*
Fail End condition	*n/a*
Basic Flow:	The basic steps are: 1. Successful Log-In (or New account creation) by using Username and Password 2. Use user interface (menus, dialog boxes etc) to view data 3. Allow to use filters for data selection 4. Allow data presentation at different level of details (e.g. use small text box, large textbox, or even open a new page) 5. View health status through the colours/textures of the 4D avatar 6. Click on individual parts of the avatar to view relevant data 7. For image data browsing: • Select a set of medical images within the avatar • Load and Browse the selected images • Allow zoom in/out at particular areas of the images • Indicate the images at corresponding part of the avatar body • Perform basic image processing, such as Image filtering, and enhancement, etc. • Perform segmentation of region of interests (lesions or anatomies) on selected images
Alternate Flows:	*n/a*
Postconditions:	*N/a*
Dependencies:	*n/a*
Required External Resources:	[ ] Data, please specify: n/a [ ] Tools, please specify: n/a [ ] Services, please specify: n/a [ ] Models, please specify: n/a [ ] Other, please specify: n/a
How this use-case is going to be validated?	
Frequency of Use:	
Who are the users?	*Patients/citizens will use the data browser to view their own data* *Doctors will be able to view data from all his/her patients connected to the avatar.*
Special Requirements:	
Assumptions:	
Questions:	

MHA Virtual Community (UC-VC)

Use Case ID:	UC-VC		
Use Case Name:	MHA Virtual Community		
Technical Collaborators:	BED, FORTH	**Clinical Collaborator:**	USAAR

Description:	This case describes the search framework from end-users' perspective and it is focused on listing all MHA registered end-users with ability to apply advanced search filters: • Age • Gender • Votes (Likes) • Treatment • Symptom • Interests • Country • City • etc. It is important to mention that every end-user should confirm the possibility to visualize his/her profile publically or privately. Only public profiles should be visible in search results. Additionally, the search function is suggested to be accessible only for end-users with public profiles. This case also provides a social media that allows patients to build up a virtual community by sharing their daily activities (e.g. how many exercises they have done), exchanging their experiences. It should also provide a link to Facebook/Twitter. The social media service will be used to allow the interconnection of end users. This social media service, accessible by smart phones, will be used in a dual mode allowing the users to insert information about themselves (like they do in common social media technologies) but also will be a mean of supporting personalized services to them from the system in the form of alerts and guidance (i.e. post therapy monitoring of user's behaviours after orthopaedics operation, cancer patients reaction to treatment, etc.). More specifically, patients will be able to 1) Find patients with similar condition, symptom and treatments 2) Find out symptoms and treatment for their conditions by looking at other fellow patients 3) Find out possible conditions for their symptoms by looking at other fellow patients *4)* Find out possible treatments for their conditions by looking at other fellow patients *5)* Find out "friends" and allow "followers" as in Facebook/Twitter *6*) Share activities, exercise experiences etc with friends and followers. End User has the related tools in the frames of MyHealthAvatar platform to collect, save and share data from third party social networks (Facebook, Twitter, etc.). The interface allows the End Users to attach to his/her own Avatar his/her own Facebook and/or Twitter account. The End-User's Avatar will have the frames to show the last updates, status messages or short texts from the related Facebook and/or Twitter accounts. The Avatar (End-User) has the option to share data to the added (only own!) Twitter and/or Facebook channels
Actors:	*Patients/citizens will use this to build patient communities* *Doctors can also have the option to join in the patient communities*
Trigger:	*n/a*

Preconditions:	*n/a*	
Successful End condition	*n/a*	
Fail End condition	*n/a*	
Basic Flow:	*Upon* successful Log-In (or New account creation) by using Username and Password, users will be able to carry out search among all the users of the avatar system for the following purposes: 8. Search for patients with specific conditions, symptoms and treatments 9. Find out symptoms and treatments for specific conditions 10. Find out conditions from specific symptoms. 11. Search for treatments for specific conditions 12. Find out "friends" and allow "followers" as in Facebook/Twitter 13. Share activities, exercise experiences etc with friends and followers.	
Alternate Flows:	*n/a*	
Postconditions:	*n/a*	
Dependencies:	*n/a*	
Required External Resources:	[ ] Data, please specify:	n/a
	[ ] Tools, please specify:	n/a
	[ ] Services, please specify:	n/a
	[ ] Models, please specify:	n/a
	[ ] Other, please specify:	n/a
How this use-case is going to be validated?		
Frequency of Use:		
Who are the users?	*Patients/citizens will use this to build patient communities* *Doctors can also have the option to join in the patient communities*	
Special Requirements:		
Assumptions:		
Questions:		

Self Data Collection (UC-DCU)

Use Case ID:	UC-DCU		
Use Case Name:	Self Data Collection		
Technical Collaborators:	BED, FORTH	**Clinical Collaborator:**	USAAR
Description:	This case seeks new solutions for increasing the quality and sustainability of future healthcare systems by actively engaging citizens in monitoring their own health through self collection of lifelogging data. The development and treatment of many diseases are affected by our life styles and environment. A long term monitoring of these factors, especially through the self-involvement of patients, is extremely valuable in supporting individualised health prediction and treatment. Many studies have shown compelling needs in self-lifelogging and self monitoring of		

	patients, which has great potential in leading to preventive medicine, cost saving and enhanced quality in future healthcare. We aim to create a symbiotic relationship of available technology today and MyHealthAvatar platform. The goal is to respond to the fast growing demand for developing new technologies and services for self monitoring for supporting wellness, fitness and prevention of the most common chronic diseases (i.e. cardio-vascular and stroke, diabetes, rheumatic problems, respiratory problems and COPD, etc.). Mobile applications will monitor user's "health-status", "lifestyle" and "wellness" and upload data to the MyHealthAvatar system for close monitoring of health conditions and prevention of many diseases. The system then will be able to analyse user's lifestyle and medical data. Special "alerts" will be applied to support end users with feedback supporting and assisting their daily activities and well-being. An interface for patients writing a diary is very helpful to collect patient specific data related to their disease. This can be partly structured: e.g. body weight, heart rate, blood pressure, temperature, medicine taken, etc. It can also include structured data of scoring systems, e.g. physical and/or psychological and/or emotional status. In addition free text entry needs to be allowed. More specifically, we explores various ways for the data collection in the avatar to monitor users' health-status, lifestyle and wellness. These include: • Web interface for data entry • Sensors (e.g. blood glucose, blood pressure, heart rate, locations, steps, sleep) • Mobile apps For example, users uses a glucose meter and MyHealthAvatar platform to monitor his/her blood sugar levels. The data is saved that maintains the Avatar's long-term history and looks for possible abnormal events. If the saved data is unusual, or the End-User skips a test, the MyHealthAvatar platform automatically generates an alert message Mobile apps will be used to monitor the health status of the users (e.g. mood, food). We will also explore the possibility to extract health related information from electronic cards (e.g. purchase of food and drink, daily exercises in gyms), as well as from social network. We will also look into the possibility of implementing an advanced Patient Devices Software Development Kit (SDK or "devkit"). A SDK will represent a set of software development tools that will allow healthcare it professionals the creation of applications for MHA able to access and strore data from any patient monitoring device. Patient Devices SDK may be something as simple as an application programming interface (API) in the form of some files to interface to a particular programming language or include sophisticated hardware to communicate with MHA platform. SDK may also include sample code and supporting technical notes or other supporting documentation to help clarify points from the primary reference material.
Actors:	*Patients/citizens*
Trigger:	*n/a*
Preconditions:	*n/a*
Successful End condition	*n/a*
Fail End condition	*n/a*

Basic Flow:	The basic steps are: For manual data entry: • Successful Log-In (or New account creation) by using Username and Password • Click relevant section from your Avatar • The interface is shown with ability to enter and or visualize data by date, week, month, year. • End User has the option to select any date or any diary entry with possibility to update it (in case of updates the update date is shown) • Some diary entries could be in linkage with avatar appearance. • End User has the option to "Edit", "Save", "Print" or "Share" the Diary info. For automatic data collection 1. Login in and select "remote monitoring devices" 2. End-User has the option to "Add" the monitoring device, at the initial stage only a glucose meter could be added 3. The monitoring devices parameters (Bluetooth or USB) are settled. 4. Users should be able to switch on/off the automatic data collection 5. User has the option to visualize the collected data 6. Collected data could change the appearance of the Avatar and/or alert messages are sent if the End-User skipped a test
Alternate Flows:	*n/a*
Postconditions:	*N/a*
Dependencies:	*n/a*
Required External Resources:	[ ] Data, please specify: n/a [ ] Tools, please specify: n/a [ ] Services, please specify: n/a [ ] Models, please specify: n/a [ ] Other, please specify: n/a
How this use-case is going to be validated?	
Frequency of Use:	
Who are the users?	*Citizens/patients*
Special Requirements:	
Assumptions:	
Questions:	

MHA Toolbox (UC-TOOL)

Use Case ID:	UC-TOOL		
Use Case Name:	MyHealthAvatar Toolbox		
Technical Collaborators:	ICCS, FORTH	**Clinical Collaborator:**	USSAR
Description:	**Remote Monitoring**		

	The Remote Monitoring tool/frame collects and processes patient care information from supported healthcare devices that conform to standards (preferably selected by the Continua Health Alliance). End User uses a glucose meter and MyHealthAvatar platform to monitor his/her blood sugar levels. The MyHealthAvatar platform reminds to check the blood sugar regularly during the day, and the glucose meter should be able seamlessly to transmit the measurements to the Avatar after each use. The data is saved that maintains the Avatar's long-term history and looks for possible abnormal events. If the saved data is unusual, or the End-User skips a test, the MyHealthAvatar platform automatically generates an alert message. The monitoring data will be made available through the citizen self-monitoring case (which is another use case). To allow for remote monitoring from the doctors using the avatar system, we need to link the avatar system to the hospital information system (which is again another use case). This will subsequently allow the transfer of the avatar data into the hospital records. **Simulation** End-User has the GUIs, functionalities and tools in the frames of MyHealthAvatar platform to create and execute a biological simulation scenario. End-User selects one of the biological simulation models available in the Model Repository and one of the sets of clinical data available in the Clinical Data Repository (or uploads a set from his computer). Afterwards he/she executes a biological simulation. Finally he/she retrieves the results of the simulation and proceeds to their evaluation. **Knowledge discovery** Patients are interested in the most recent and personalized information about their disease, treatment and prognosis. MHA platform could contain a ontology-based Knowledge Discovery (KD) module able to connects highly heterogeneous data and textual information. The semantic framework could be based on gene, tissue, disease and compound ontologies (important for drugs and clinical research frames). This framework could contain information from different organisms, platforms, data types and research areas that is integrated into and correlated within a single searchable environment using search algorithms. It could provide a unified interface for all MHA users to formulate, explore and identify new information (according to specific preferences and needs) across vast collections of available experimental and research data. KD module could combine classical keyword-based search with text-mining and ontologies to navigate large results sets (internal & external) and facilitate information and/or knowledge discovery. End users could be provided with an advanced ontology based (Gene Ontology (GO) and Medical Subject Headings (MeSH)) 'Table of Contents' in order to access, explore, structure (quickly) the millions of available resources (PubMed abstracts, news, clinical trials info) according to the predefined topics of interest (Allergy, Cancer, etc.).
Actors:	*Remote consultation: doctors (GPs) and patients*

	Simulation: researchers, clinicians, patients *Knowledge discovery: medical researchers, doctors*
Trigger:	**Simulation:** • User accesses the section "Simulation Interface". • User "clicks" on a specific area of the 3-D avatar of the human body, for example the kidney, is directly or indirectly (by a menu) redirected to the "Simulation Interface" and is guided to the proper biological simulation model/-s (for example the kidney simulation model/-s
Preconditions:	**Simulation:** • The User has to Log-in or to create a New Account (New Avatar). • The option to "perform simulations using biological models" must be enabled in the user's profile. • The user must have the proper access rights in order to use a biological simulation model from the Model Repository. • The biological simulation model must be already imported to the Model Repository. • The user must have the proper access rights in order to use a set of clinical data from the Clinical Data Repository. • The clinical data that the biological simulation model needs in order to run must be already imported into the Clinical Data Repository or it must be provided (uploaded) by the user just before the start of the simulation. • The clinical data must be compatible, in terms of format and content, with the selected biological simulation model. • The user must have the proper access rights to a computational platform. • The computational platform must have enough available resources in order for the simulation to be performed successfully
Successful End condition	*n/a*
Fail End condition	*n/a*
Basic Flow:	The basic steps in case of **simulation** are: 1. Successful Log-In (or New account creation) by using Username or Email and Password. 2. Select the Avatar. 3. The flow ends here if the End-User doesn't have the option "Perform simulations using biological models" enabled. 4. The flow continues if the End-User has the option "Perform simulations using biological models" enabled. 5. End-User creates a biological simulation scenario, by selecting a simulation model from the Model Repository and a set of data from the Clinical Data Repository. 6. End-User starts the simulation process. 7. When the simulation is completed, the proper ending code is displayed, either a success message or an erroneous message. 8. End-User user has the possibility to download the results of the simulation to his computer, either the simulation ended successful or with errors".
Alternate Flows:	The alternative flows in case of **simulation** are: 1. In step 5 of the basic flow, the selection of the simulation model can be guided by narrowing the available simulation models to only the ones related to a specific part of the human body, by clicking on the 3-D representation of human body. *2.* In step 6 of basic flow, End-User can upload a set of data from his

<table>
<tr><td></td><td colspan="2">computer instead of using a set of data provided by the Clinical Data Repository</td></tr>
<tr><td>Postconditions:</td><td colspan="2">N/a</td></tr>
<tr><td>Dependencies:</td><td colspan="2">Simulation:
• The option to perform simulations using biological models must be enabled in the user's profile.
• The user must have the proper access rights to the Model Repository.
• The user must have the proper access rights to the Clinical data repository.
• The user must have the proper access rights to a Computational Platform.</td></tr>
<tr><td rowspan="5">Required External Resources:</td><td>[ ] Data, please specify:</td><td>Clinical data (already preprocessed), ready to be used by the simulation models</td></tr>
<tr><td>[ ] Tools, please specify:</td><td>• Model Repository
• Clinical Data Repository (related to simulation models)</td></tr>
<tr><td>[ ] Services, please specify:</td><td>• Query the Model Repository for available models.
• Query the Clinical Data Repository (related to biological simulation models).
• Copy a selected model to the computational platform.
• Copy a set of selected preprocessed data to the computational platform.
• Execute the simulation scenario (by sending a computational job to the computational platform).
• Retrieve the result of the execution of a simulation model.</td></tr>
<tr><td>[ ] Models, please specify:</td><td>Simulation Models</td></tr>
<tr><td>[ ] Other, please specify:</td><td>Computational Platform: Can be either a personal computer, a cloud virtual machine, a High Performance Computer (HPC) or any other system able to perform computational simulations.</td></tr>
<tr><td>How this use-case is going to be validated?</td><td colspan="2"></td></tr>
<tr><td>Frequency of Use:</td><td colspan="2">Medium</td></tr>
<tr><td>Who are the users?</td><td colspan="2">Remote consultation: doctors (GPs) and patients
Simulation: researchers, clinicians, patients
Knowledge discovery: medical researchers, doctors</td></tr>
</table>

Special Requirements:	
Assumptions:	**Simulation:** • The biological simulation model is already imported in the model repository. • A set of clinical data compatible with the aforementioned biological simulation model is already imported in the clinical data repository. • Appropriate computational resources are available for running the simulation. • The security framework is responsible for controlling the access to the model repository, the clinical data repository and the computational platform.
Questions:	Although the biological simulation model (nephroblastoma) planned to be used in the MyHealthAvatar demonstrator doesn't use proprietary software, what if a model uses proprietary software, like a model developed in Matlab (licensing issues)?

Link MHA to HIS and CTMS (UC-HIS)

Use Case ID:	UC-HIS		
Use Case Name:	Link MHA to HIS (Hospital Management System) and CTMS (Clinical Trials Management System)		
Technical Collaborators:	FORTH, ICCS	**Clinical Collaborator:**	USAAR
Description:	End User has the GUIs, functionalities and tools in the frames of MyHealthAvatar platform to enter, import, store and export personal medical data with hospital information systems. One option is to use ObTiMA as a dummy system to mimic external hospital system. ObTiMA, an ontology-based clinical trial management system, has been developed as a proof-of-concept application to highlight the possibilities of ontology based creation and managing of clinical trials within the ACGT (Advancing Clinico-Genomic Trials on Cancer) project. ObTiMA has a modular architecture with a core basic module for data management of clinical trials. Different other modules are under development in the frames of p-medicine project. The data stored in ObTiMA are relevant for the Health Avatar to enhance the system with relevant clinical trial data. On the other hand the info stored in MHA might be of relevance for a clinical trial. As result, the bidirectional data upload from MHA to ObTiMA is needed. This Scenario / Use Case describes the bilateral linkage between ObTiMA and MHA by being focused on the Operational Data Model (ODM). There are also a few other dummy systems available at FORTH, which can be used to mimic the external hospital system.		
Actors:	*Patients/citizens will see their own health records from the hospitals* *Doctors will be able to see patient data in their avatars*		
Trigger:	*n/a*		
Preconditions:	*n/a*		
Successful End condition	*n/a*		

Fail End condition	*n/a*	
Basic Flow:	The basic steps are: • Access the data export/import interface • Specify data export/import from ObTiMA (or other dummy systems) • Specify data export/import from MHA • Confirmation message of data/export	
Alternate Flows:	*n/a*	
Postconditions:	*N/a*	
Dependencies:	*n/a*	
Required External Resources:	[ ] Data, please specify:	eCRF with filed in data from ObTiMA Health Avatar with clinical trial related data (i.e. laboratory results, pre-operative state, etc.)
	[ ] Tools, please specify:	ObTiMA platform
	[ ] Services, please specify:	n/a
	[ ] Models, please specify:	The Operational Data Model (ODM) is designed to facilitate the archive and interchange of the metadata and data for clinical research, its power being fully unleashed when data are collected from multiple sources.
	[ ] Other, please specify:	n/a
How this use-case is going to be validated?		
Frequency of Use:		
Who are the users?	*Patients/citizens will see their own health records from the hospitals* *Doctors will be able to see patient data in their avatars*	
Special Requirements:		
Assumptions:		
Questions:		

Personalized CHF Related Risk Profiles and "Real-Time Monitoring" Services (UC-CHF)

Use Case ID:	UC-CHF		
Use Case Name:	Personalized CHF Related Risk Profiles and "Real-Time Monitoring" Services		
Technical Collaborators:	FORTH	**Clinical Collaborator:**	University of Crete, Faculty of Medicine
Description:	A major challenge related to caring for patients with chronic conditions is the early detection of exacerbations of the disease that may be of great		

	significance. In this scenario we focus on methodologies that would facilitate the prevention, monitoring, and treatment of heart disease on a daily basis. Generally, cardiovascular disorders as chronic diseases require a continuous everyday record for patient's status. The proposed scenario is built on the following pillars: *1) Real-time patient monitoring* In addition to the above the dedicated clinical personnel should be contacted immediately and possibly intervene in time before an acute state is reached, by changing medication, or any other interventions, in order to ensure patient safety. There is a need to support real-time remote monitoring of patients diagnosed with congestive heart failure and MHA, enhanced with semantic technologies, may host personalized, accurate and up-to-date clinical information. To this end we built a real-time patient/ doctor alarming will be built according to rule-based alarms enabling intelligent alerting of the dedicated physician in case of an emergency. The alarming process will be based on vital signs monitoring and specifically Heart Rate (HR), Pulse Oximetry, and Blood Pressure acquisition, adapted according each specific patient's medical history and age, and even risk predictor's outcome (described below). *2) CHF Risk Assessment* In order to tailor the proposed system to the patient's profile and assist physicians in selecting people who are predisposed by coronary disease, hypertension, or valvular heart disease; we build a CHF related risk profile based on a risk appraisal function that is based on the diagnostic criteria [i.e. the Framingham Heart Study (486 heart failure cases during 38 years of follow-up)]. The predictors used are based on Age, Coronary heart disease and Valve disease status provided by the patient Electronic Health Record (EHR), as well as on HR, on blood pressure and on Body Mass Index (BMI) provided by the pulse oximeter, the blood pressure monitor and the weight scale, respectively. The calculated risk probability may be used to alter the default threshold values (higher risk probability adds more constraint on the physiological patterns). Furthermore, we present what else data regarding patients' health status could be embed into the platform towards the creation of a profile with necessary information for both patient and treating physicians. To this respect an approach of presenting data regarding demographic, physiology, diagnostic test results and disease management (i.e. prescribed drugs) is provided. *3) Comorbidities and Drug Interaction* There are many cases where more than one medications are prescribed due to disease progression or due to the wide appearance of both cardiac and non-cardiac co-morbidities (respiratory comorbidities, renal dysfunction, cognitive dysfunction, depression and in some cases arthritis). To this respect, there is an urgent need for providing information in both the treating physicians, but also the patient him/ herself regarding negative drug interactions.
Actors:	Avatar1 (Doctor), Avatar2 (Patient)
Trigger:	Patient is diagnosed with CHF according to: • Patient's physiological, imaging, blood test results data and past diagnoses, uploaded in patient's electronic health record or during creation of patient's Avatar in MHA platform. • Patient physical examination and confirmation with differentiating diagnostic tests (i.e. echocardiography)

Preconditions:	The major precursor of all cardiovascular diseases is attributed in congenital or acquired factors that lead to atherosclerosis disorders and in some cases to complications from diabetes, kidney disease and hypercholesterolaemia. Heart failure is caused by any condition, which reduces the efficiency of the myocardium, or heart muscle, through damage or overloading. As such, it can be caused by a diverse array of conditions, including myocardial infarction (in which the heart muscle is starved of oxygen and dies), hypertension (which increases the force of contraction needed to pump blood) and amyloidosis (in which protein is deposited in the heart muscle, causing it to stiffen).

Basic Flow:	Basic steps
	1. Generation of patient's avatar
	    o Register life style factors (i.e. diet habit, alcohol, smoking)
	    o Register of physiology, pathology, genetic information (i.e. pharmacogenomics) regarding patient's health
	        ▪ Age
	        ▪ Height
	        ▪ Weight
	        ▪ Body Mass Index(BMI)/Body Surface Area (BSA)
	        ▪ Blood pressure
	        ▪ Pulse (possible need for creating time graphs)
	    o Register life style factors (i.e. diet habit, alcohol, smoking physical activity)
	2. Embed in Avatar platform of patient's examination results
	    o Update of patient's basic examination outputs regarding cardiovascular system (blood test results, blood pressure, EEG results, imaging and physical exam)
	3. Diagnosis of the heart failure and classification of patient according to one (or if possible more) categories (i.e. Framingham and or NYHA)
	    o Matching of possible co-morbidities or setting alarms for possible complications due to disease progression (i.e. kidney function)
	4. Record of patient's drug prescription (dose regiments) provided by the treating physician
	5. Record of patient's compliance regarding provided treatment
	    o Update avatar during last drug prescription for other diseases and alarm for possible interactions between medications (i.e. antibiotic medicines that could interact with cardiovascular treatments)
	6. Real-time patient vital signs and data updates (if available) and processing to detect possible deviations from normal values

Alternate Flows:	Alternative flows will be followed if patient data are not provided in full.
Postconditions:	• Remote monitoring of patient health status after diagnosis. • Risk assessment and update data in MHA platform. o Creation of graphs with data values in time (i.e. BP, pulse, time of drug administration etc.) • Basic information for patient regarding health status during treatment. • Information regarding administration of other medications prescribed regarding drug-drug interactions and also in cases of over-the-counter medication that can be taken from the patient etc.
Dependencies:	This case tries to integrate information from the potential architecture of the platform including data from ontologies (linking of information regarding disease progression, side effects, drug interactions, genomic data,

<table>
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<td></td>
<td colspan="2">environmental factors, regulatory organizations guidance etc.)
This use case includes or is part of the following use cases:

Utilization of personal genomic information for the individualization of MHA platform
Decision making tools regarding emergency situations in clinical practice. The example of anti-platelet & anticoagulation therapy in the pre-operative patients

To achieve a good functionality as proposed in this set the following device and technologies should also be available:

Wireless or wearable medical devices and sensors acquiring patient's vital signs. In our reference implementation the supported measurements are:
Heart Rate (HR), SpO2, body weight and real time ECG monitoring.
Monitoring application recording the aforementioned bio signals and hosting risk assessment algorithms to enable the alerting process.
Ontology-driven application intelligence capable of reasoning on the patient's and drug data.
</td>
</tr>
<tr>
<td rowspan="2">Required External Resources:</td>
<td>[ ] Data, please specify:</td>
<td>
Patient's data

Demographic
Gender
Age
Height
Weight
BMI/BSA
Genetic
CHF related genome data
Pharmacogenomic data
Physiology- Pathology
Blood pressure
Cardiac flow (BP and pulse)
Kidney function
Blood test results
Coagulation factors
Atherosclerosis level

Differentiating tests
Associated diseases
Physical examination
Imaging
Electrocardiography
Echocardiogram
Protocols/References regarding disease diagnosis/treatment

Available regimens for prescription and potential alternatives
Medline references
Patients hand out from regulatory organizations for disease management

</td>
</tr>
<tr>
<td>[ ] Tools, please specify:</td>
<td>For Physician

PC hosting MHA platform with access to EHR
Links of Avatar's internal
</td>
</tr>
</table>

		organs with diagnostic tools (i.e. linking of heart with ultra-sound image of the patient or ECG) • Medline references o i.e. drug interactions • Availability to store part of the data as case study For Patient • PC hosting MHA platform with access to EHR • Smartphone with MHA interface capable of updating necessary data (i.e. daily diet) • Wireless vital signs monitoring devices Information on disease progression with/without compliance (i.e. visualization of heart function)
	[ ] Services, please specify:	Links with EHR and PACS Links with external databases (i.e. DrugBank)
	[ ] Models, please specify:	1. Risk Assessment model 2. Real Time Alarming model 3. Visualization models 4. Disease progression models
	[ ] Other, please specify:	
Frequency of Use:	The proposed application can be used even in real time or selected time intervals, depending on the patient's initial diagnosis. Frequency of use can be categorized in two parts: 1) Patient's information regarding health status, disease progression, improvement etc. 2) Any treating physician which is going to prescribe a specific treatment for the patient and has access to MHA platform	
Special Requirements:	Familiarity of doctors and generally of the medical staff with MHA technologies Linking of MHA data between research and medical organizations and personnel applying MHA technological tools and services.	
Assumptions:	Some basic assumptions are: • Necessary physiological and clinical data to run the model. • Detailed patient's health history record • Linking of MHA platform with hospitals as well as research institutions that contribute in the health care system • Linking of the platform with external resources for providing information regarding CHF diagnosis and treatment • Monitoring Devices/ Sensors, if available • Patient's compliance in keeping update information in MHA platform • Doctor's compliance in updating patient's examination info in MHA platform • Full and detailed patient's health history record.	
Questions:		

Osteoarthritis (UC-OST)

Use Case ID:	*UC-OST*		
Use Case Name:	Osteoarthritis		
Technical Collaborators:	FORTH	**Clinical Collaborator:**	University of Crete, Faculty of Medicine
Description:	Osteoarthritis (OA) is a disabling degenerative joint disease leading to joint pain, stiffness and loss of function predominantly in the knees, hips, hands, and spine. The major histological finding in OA is degeneration and loss of the articular cartilage that acts as a protective cushion between bones within a joint. Imaging methods including weight bearing radiographs and in selected cases Magnetic Resonance Imaging (MRI,) may be used to study morphological and inflammatory changes occurring in the articular cartilage, menisci, extra-articular soft tissues and the subchondral bone marrow. Health care professionals support assessment and management of patients with OA in order to modify their nutrition and exercise lifestyle behaviour. Hereditary factors (genetic) increase the risk for developing OA. It is worth pointing out that an estimated 75% of adults over the age of 65 years have OA resulting to impaired quality of life, and considerable healthcare costs. Moreover, about 100% of adults over the age of 80 years old have OA. The avatar system will monitor patient's daily diary and ambulatory activity and warn the patient, if she/he does not meet the special medical guidelines. The monitoring will rely on techniques of self-life logging, enhancing the patient engagement. Also, the platform will function as a supportive system to the patients by means of offering advice and assistance. Moreover, the avatar system will offer a useful input to doctors, as the related heterogeneous data (i.e. imaging and semi-quantitative data) will be properly visualized and presented using interactive, multi-scale visualization techniques. This will help doctors for data reasoning and for carrying out personalized healthcare. Advanced personalized healthcare will also be enhanced by existing genomic predisposition evaluation and health risk estimation. Thus, this use case is strongly related with the UC-09 (MHA Personal Genomic Information).		
Actors:	*Doctors and citizens/patients*		
Trigger:	1. *A citizen is diagnosed with Osteoarthritis* 2. *Avatar platform reveals for a citizen an increased risk of developing OA*		
Preconditions:	*n/a*		
Successful End condition	*n/a*		
Fail End condition	*n/a*		
Basic Flow:	1. The patient visits the doctor complaining for knee joint pain,		

	stiffness, particularly after rest, crepitus, and swelling (soft from joint effusion or hard from osteophyte formation). The diagnosis of OA is based on the: a. History including pre-existing disorders such as previous serious injury, b. Clinical examination, c. Imaging studies, primarily radiographs and in some cases MRI, d. Additional semi-quantitative metrics are collected for diagnosis and follow up: • A number recorded with regard to a certain pain-scale • Range of motion of the knee joint (in degrees), e. Genetic predisposition evaluation for examining if an increased risk of developing OA exists (according to available genomic data). The above data, imaging and evaluation metrics, are collected and stored through the avatar system, which has novel ways for representing this multi-scale and heterogeneous information to medical professionals. **Self-care:** The treatment includes drugs and in more severe cases local injections, use of knee braces and knee replacement surgery. In addition, the doctor advices patient to modify or change the lifestyle. This includes weight reduction, exercise (quadriceps muscle strengthening, resistance training, aerobic exercise-walking, and flexibility exercise) and aquatic exercise. Too little movement can lead to stiffness and weak joints, whereas strong muscles protect joints. An OA management plan also involves following a healthy diet, managing stress and depression, and getting a good balance of rest and activity each day. **Monitoring:** The avatar system will monitor patient's daily dietary and ambulatory activity (using activity trackers) and warn the patient, if he does not meet the special medical guidelines (e.g. losing weight, exercise etc.). The monitoring will rely on techniques of self-life logging, which will monitor a wide range of daily activities and behaviours of the patients, including their locations, movements, diet, quality of life, environment, and other symptoms, etc. Visual analytics will be used to display individual/aggregated data items to allow easy interpretation of the data from the patients. With the search bar of the system, the users can easily send queries about their activities, movements, diet, etc. **Patient education:** The avatar system will also allow patient education on the knowledge of the diseases. It will also test the knowledge of the patients. It is expected that a good knowledge of the disease will lead to enhanced patient behaviours. 2. The patient visits the doctor again complaining for recurrence and deterioration of symptoms.

	a. The semi-quantitative metrics are collected again and compared with the previous ones stored through the avatar system. b. A new weight baring radiograph is taken. c. The doctor examines if the patient was compliant with the treatment guidelines. If the radiograph reveals severe structural changes, the doctor will discuss the surgical replacement of the joint. If the radiographic findings do not explain the clinical symptoms, a new MRI is required to explore other than internal derangement causes, such as insufficiency fracture of the subchondral bone. Due to the temporal nature of the data the representation is obtained by “animating” the visualization over time. Each frame will display the value of each parameter at a given time point.	
Alternate Flows:	*1. Avatar system reveals for a citizen an increased risk of developing OA through comparison to existing genomic predisposition data and warns the patient.* *2. Avatar system advices citizen to modify or change his lifestyle. This includes weight reduction, exercise (quadriceps muscle strengthening, resistance training, aerobic exercise-walking, and flexibility exercise) and aquatic exercise.*	
Postconditions:	-	
Dependencies:		
Required External Resources:	[ ] Data, please specify:	• Patients' data from MyHealthAvatar, including patient’s history, imaging data, genomic data, semi-quantitative metrics, daily activities, exercises, diet over the time
	[ ] Tools, please specify:	• Multi-scale visualization & visual analytics tools for the visual representation of the multi-scale, heterogeneous data related to OA • Genomic analysis tools for evaluating the genomic predispo-sition and health risk
	[ ] Services, please specify:	• Links to data repository for retrieving the patients’ clinical data
	[ ] Models, please specify:	•
	[ ] Other, please specify:	• Visualization server for performing the multi-scale data representation: can be either a personal computer or a high performance computer
How this use-case is going to be validated?	*By citizens with OA and medical experts*	
Frequency of Use:	*When a citizen is diagnosed with OA or has an increased risk of developing OA*	

Who are the users?	*Doctors and citizens/patients*
Special Requirements:	-
Assumptions:	-
Questions:	-

Pre-Diabetes (UC-DIAB)

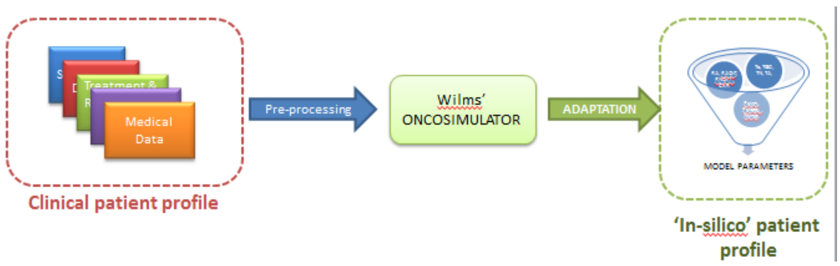
Use Case ID:	UC-DIAB		
Use Case Name:	Pre-Diabetes		
Technical Collaborators:	BED	**Clinical Collaborator:**	
Description:	Diabetes is the world's fastest growing disease with substantial costs at individual and social economic level. It is estimated diabetes affect more than 32 million EU citizens (nearly 10% of the total EU population), and an additional 32 million citizens have not yet been diagnosed, or with pre-diabetes. Globally, the main risk factors for chronic disease, such as diabetes, are hypertension, tobacco use, high cholesterol, low fruit and vegetable intake, overweight and obesity, sedentary lifestyle and alcohol abuse. Strategies for tracking chronic disease include prevention and early detection; people with high risk of developing diabetes are suggested to carry out many self-care behaviours. These include dietary change, exercise, regular self-medication , and regular attendance at clinic and for screening programmes. If diagnosed with diabetes, additional care, such as insulin injection, self-manage of blood glucose, and insulin dose adjustment are needed. Self-management means that people can take a more active role in decisions about their own treatment and about healthy lifestyle. It is a shared responsibility between individuals and service provider. Service providers recognise the individual's role in managing their health and well-being. MyHealthAvatar provides a unique citizen/patient empowered system that can be used, in particular for pre-diabetes care where the citizens with high risk of diabetes but not yet been diagnosed, and therefore not yet been known to the health care system. The functionalities of MyHealthAvatar provides a one-stop service for citizens in terms of data collection, and self-management services, such as monitor, record, and education. The avatar system will support the storage the behaviours and daily activities of citizen. The platform will function as a supportive environment from healthcare providers to the individual by means of offering advice, assistance and assessments; and by means of allowing for health promotion.		
Actors:	Doctors and citizen/patient		
Trigger:	Citizen takes risk analysis, and has been predicted with high risk		
Preconditions:			
Successful End condition			
Fail End condition	-		
Basic Flow:	The avatar system will include: • **Personal Diary:** Storage and management of the health status of the individual and their behaviours. This will rely on techniques of self-lifelogging, which will monitor a wide range of daily activities and behaviours of the citizen/patient, including their locations, movements, diet, quality of life, environment, mood, blood		

	pressure, glucose, alcohol, smoking, and other symptoms, etc. Visual analytics will be used to display individual/aggregated data items to allow easy interpretation of the data from the patients. With the search bar of the system, the users can easily send queries about their activities, movements, diet, etc. • **Intervention:** allowing for multi-modal intervention of lifestyle in a shared decision manner between the doctor and citizens/patients. In the case of pre-diabetes, MyHealthAvatar will be able to demonstrate to the citizens/patients the relations between the outcomes of the self-management/treatment using prediction models. . “Behaviour prescription” will be issued based on clinical guidelines and trusted sources (such as NICE), which is expected to include a set of targets in terms of daily activities, calorie intake and energy consumption, etc. • **Monitoring:** allowing for the progress review of the individual by comparing the personal diary with the behaviour prescription as mentioned above. • **Warning:** The avatar system will send reminder messages at various priorities in one of the following occasions: medication reminder, due hospital visit (for screening etc.), sign of change of conditions, early sign of one of developing diabetes with constant scored as high risk. • **Complication:** The avatar system will have patients’ clinical records and history, which will facilitate the management of complications from other possible conditions. The long term records will also help define personalised care plan.	
Alternate Flows:	-	
Postconditions:	-	
Dependencies:	-	
Required External Resources:	[x] Data, please specify:	Citizen/Patients' data from MyHealthAvatar, including daily activities, exercises, diet, mood, etc.
	[x] Tools, please specify:	Visual analytics tools for data visualization & analysis Statistical tools for computing standard indexes & charts (e.g. BMI, SAD) Prediction tolls for ‘good’ or ‘bad’ behaviours.
	[ ] Services, please specify:	
	[x] Models, please specify:	Statistical tools for computing standard indexes & charts(e.g. BMI, SAD)
	[ ] Other, please specify:	
How this use-case is going to be validated?		
Frequency of Use:		
Who are the users?	Citizen/patients	
Special Requirements:		
Assumptions:		
Questions:		

Nephroblastoma (Wilms Tumour) Simulation Model and Clinical Trial (UC-NEPH)

<table>
<tr><td>Use Case ID:</td><td colspan="3">UC-NEPH</td></tr>
<tr><td>Use Case Name:</td><td colspan="3">Nephroblastoma (Wilms tumour) Simulation Model and Clinical Trial:
In-silico profiling of patients and prediction simulations</td></tr>
<tr><td>Technical Collaborators:</td><td>ICCS</td><td>Clinical Collaborator:</td><td>USAAR</td></tr>
<tr><td>Description:</td><td colspan="3">Nephroblastoma diagnosis is based on a variety of multiscale data. These data can be used in the creation of a clinical multiscale profile of the tumour. After the necessary pre-processing of the available data, the data are fed into a nephroblastoma simulation model.
The nephroblastoma simulation model is a predominantly discrete, clinically-oriented multiscale model of solid tumour response to treatment. Preoperative chemotherapy is the simulated form of treatment. A ''top-down'' simulation approach is adopted. The simulation method starts from the macroscopic imaging data, representing a high biocomplexity level, and proceeds towards lower biocomplexity levels.
Clinical orientation of the model has been a fundamental guiding principle throughout its development. Available medical data (imaging, histopathological, molecular) can be exploited, in order to strengthen patient individualized modeling.

Stage 1 (in-silico profile of patients):
Semi-automatic adaptation of the model parameters could be conducted in case of efficient availability of clinical data (many data sets at different time points). The determined model parameters serve as a patient record for in silico tumor characteristics and form the 'in-silico profile' of the patient.



Stage 2 (prediction simulatations):
The paediatric oncologist using the 'in-silico profile' of the patient runs a number of experiments in silico (= on the computer), to simulate the most likely response of the tumour to the most relevant candidate chemotherapeutic schemas. The outcomes of the simulations (predictions) help the oncologist decide the appropriate treatment plan.
The 'in-silico profile' could be further used from clinicians as a tool to provide insight into individualized biological characteristics of the tumor, an input for future model use and an input for the use of other models. It could also serve as a statistical tool to categorize the patients (by associating their clinical and in silico profiles) and define a range for model parameters to lead adaptations of new patients.</td></tr>
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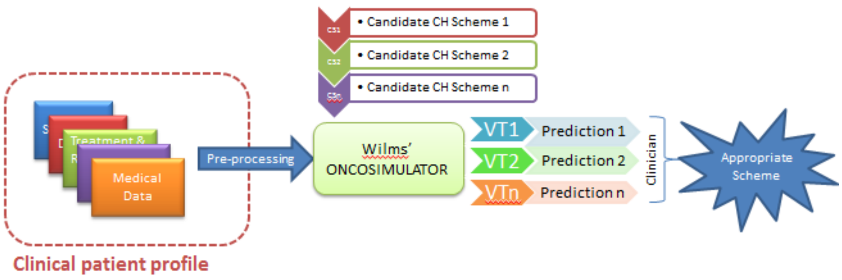

References:

G.S.Stamatakos, E.Ch.Georgiadi, N.Graf, E.A.Kolokotroni, and D.D.Dionysiou., Exploiting Clinical Trial Data Drastically Narrows the Window of Possible Solutions to the Problem of Clinical Adaptation of a Multiscale Cancer Model. 2011, PLOS ONE
Georgiadi EC, Stamatakos GS, Graf NM, Kolokotroni EA, Dionysiou DD et al., Multilevel Cancer Modeling in the Clinical Environment: Simulating the Behaviour of Wilms Tumour in the Context of the SIOP 2001/GPOH Clinical Trial and the ACGT Project. in. : Proceedings of the 8th IEEE International Conference on Bioinformatics and Bioengineering. 8-10 Oct 2008. Athens, Greece. CFP08266, ISBN: 978-1-4244-2845-8, Library of Congress: 2008907441, Paper No. BE-2.1.2.
Graf N, Hoppe A, Georgiadi E, Belleman R, Desmedt C et al., In Silico Oncology for Clinical Decision Making in the Context of Nephroblastoma. Klinische Paediatrie , Vol. 221, pp. 141-149.

</td></tr>
<tr><td>Actors:</td><td>End User & MyHealthAvatar platform</td></tr>
<tr><td>Trigger:</td><td>Stage1: Enrich the patient record with an “in silico” profile
Stage2: Prognosis is needed for nephroblastoma response to treatment.</td></tr>
<tr><td>Preconditions:</td><td>
The availability of clinical data that is compatible, in terms of format and content, with the nephroblastoma simulation model.
The availability of sufficient computational resources in order for the simulation to be performed.
</td></tr>
<tr><td>Successful End condition</td><td>-</td></tr>
<tr><td>Fail End condition</td><td>-</td></tr>
<tr><td></td><td>The basic steps for stage 1 are:

The End-User places the already preprocessed data to the location where the model expects to find them.
The Technical partner adapts the model parameters according to the available clinical data
The End-User starts the simulation process.
When the simulation is completed, the End-Users use the appropriate
</td></tr>
</table>

	tools in order to read or/and visualize the outcome of the simulation. 5. The End-Users evaluate the adaptation by comparing simulation results with clinical reality. 6. In case of a succesful adaptation, the defined model parameters are recorded by the End Users and form the "in-silico patient profile" 7. In case of not satisfying adaptation, steps 2-5 are repeated. The basic steps for stage 2 are: 1. The End-User places the already preprocessed data to the location where the model expects to find them. 2. The End-User starts the simulation process. 3. When the simulation is completed, the End-User uses the appropriate tools in order to read or/and visualize the outcome of the simulation.		
Alternate Flows:	-		
Postconditions:	Stage 1: The in-silico profile of the patient is recorded. Stage 2: A treatment plan is drawn.		
Dependencies:	This use case will be used as test case for UC-TOOL (MHA Toolbox).		
Required External Resources:	[x] Data, please specify:	Clinical data (already preprocessed), ready to be used by the simulation model. The SIOP 2001/GPOH clinical trial, including microRNA data, if available, will be used.	
	[x] Tools, please specify:	Open source tools (e.g. ImageJ) can be used for visualization purposes.	
	[ ] Services, please specify:		
	[ ] Models, please specify:		
	[ ] Other, please specify:		
How this use-case is going to be validated?	Technical validation of the use case will be performed by the responsible technical partner.		
Frequency of Use:	When a prognosis in needed for nephroblastoma patients.		
Who are the users?	Clinicians, Researchers		
Special Requirements:	-		
Assumptions:	-		
Questions:	-		

Emergency Contact (UC-EME)

Use Case ID:	UC-EME		
Use Case Name:	MHA Emergency Contact		
Technical Collaborators:	BED, USAAR	**Clinical Collaborator:**	USAAR

Description:	This use case describes the situation where a patient is unconscious in Accident and Emergency Units in hospitals. The patient is not able to authorize the doctors to access his data in the avatar. However, some of the information within the avatar can be crucial for the clinical decisions by the doctors. For example, the doctor needs to know a health profile of the patient, including his previous medical history, etc. We envisage a Europe-wide MHA service centre is needed to offer a solution to this case. Each avatar user will have the option to sign an agreement to authorize the data access to doctors, who may treat him/her under a future emergency circumstance. For the signed users, doctors can contact the MHA service centre to obtain their data in the MHA for the treatment purpose under an emergency situation.	
Actors:	Doctors at emergency units in hospitals Patients Worker in the MHA service centre	
Trigger:	n/a	
Preconditions:	n/a	
Successful End condition:		
Fail End condition:		
Basic Flow:	Users 1. New users will grant access to the doctors for emergency data access during the sign up process. 2. The users can also log in the existing account first and then to grant the access 3. The users can change their decisions at anytime 4. The users will be informed about their legal rights and risks for giving or not giving the access In an emergency situation where 1. The doctors will contact the MHA service centre 2. The IDs of the doctors and the hospital will be checked 3. The service centre will search for the patient information in the MHA system according to the patient information provided by the doctors 4. The patient information will be provided to the doctors by either direct download, or granting access to the account	
Alternate Flows:	n/a	
Postconditions:	n/a.	
Dependencies:	n/a	
Required External Resources:	[ ] Data, please specify:	n/a
	[ ] Tools, please specify:	n/a
	[ ] Services, please specify:	n/a
	[ ] Models, please specify:	n/a
	[ ] Other, please specify:	
How this use-case is going to be validated?	We will create a virtual citizen who will provide the authorization during his MHA amount, and will simulate the case where a doctor contact the MHA service centre and will be checked and granted access to the patient data by the service centre.	
Frequency of Use:	Only in medical emergency	
Who are the users?	Patients who give authorization through their user account Doctors from emergency units The MHA service center staff	

Special Requirements:	no
Assumptions:	The authorization from the users will be given
Questions:	n/a