PAMAP

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PAMAP System Software Report and Documentation

		Name (company)	Date
Approved	Work Package 5 Leader	Ilias Lamprinos (ICOM)	**31 August 2010**
	Hierarchical responsible	Nicos Ioannidis (ICOM)	**31 August 2010**
Verified	WP5 Leader	Ilias Lamprinos (ICOM)	**31 August 2010**
Released	Coordinator	Didier Stricker (DFKI)	**31 August 2010**

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Author(s):	Lamprinos Ilias (ICOM)
Contributors list:	Michalis Chouchoulis, Kostas Tsakalos (ICOM) Daniel Steffen, Gabriele Bleser & Gustaf Hendeby (DFKI)

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PAMAP project aims at developing a system that enables the accurate monitoring of the physical activities of aging people. This deliverable provides the reader with an overview of the first software prototypes of the web based Electronic Health Record (Chapter 1), the web based Electronic Health Record Administration Tool (Chapter 2), the interactive TV based Personal Health Record (Chapter 3) and the Measurements Visualization Application (Chapter 4). It also describes the mechanisms used for the integration of the first PAMAP system prototype, namely the web services for the communication of the Measurements Advanced Processing Application and the Measurements Visualization Application with the Electronic Health Record Application. It should be noted that the Measurements Advanced Processing Application software is described in a separate deliverable (D4.2).

1.1. Introduction

The development environment, consist basically of the Application Server, which is Glassfish and the Database server, which is an Oracle server. The Application Server is running under JVM version 5 or higher, supporting java server pages and web or enterprise applications based on J2EE. The development tools which are used include the Integrated Development Environment NetBeans and Database Monitor applications, such as Oracle Developer and TOAD for Oracle.

1.2. Supported functionality of the first prototype

The PAMAP EHR application enables clinicians and paramedical personnel to edit/review health related information of the monitored subjects. More specifically, the following information fields will be available for editing:

- ***General Health Profile of the Monitored Subject***; family health history, habits & social history (e.g. smoking, alcohol consumption), allergies, vaccinations
- ***Visits;*** organ system findings, manual entry of symptoms & measurements
- ***Medical Tests;*** test orders, manual entry of test results, test results overview and graphic representation
- ***Diagnosis Management;*** insert new diagnoses, using the ICD-10 nomenclature, search for past diagnoses
- ***Treatment Management;*** surgeries, medication

In addition to the above, an Overview tab provides the user with a quick and printable outline of selected information (e.g. diagnoses, medications, surgeries, specific measurements, related to the subject).

1.2.1. Entering the web-based EHR

Figure 1 depicts the entry point of the PAMAP system. The user has the ability to select the appropriate application from a list including the Electronic Health Record, the Personal Health Record, the Patient Relationship Management and the Administrative Tool.

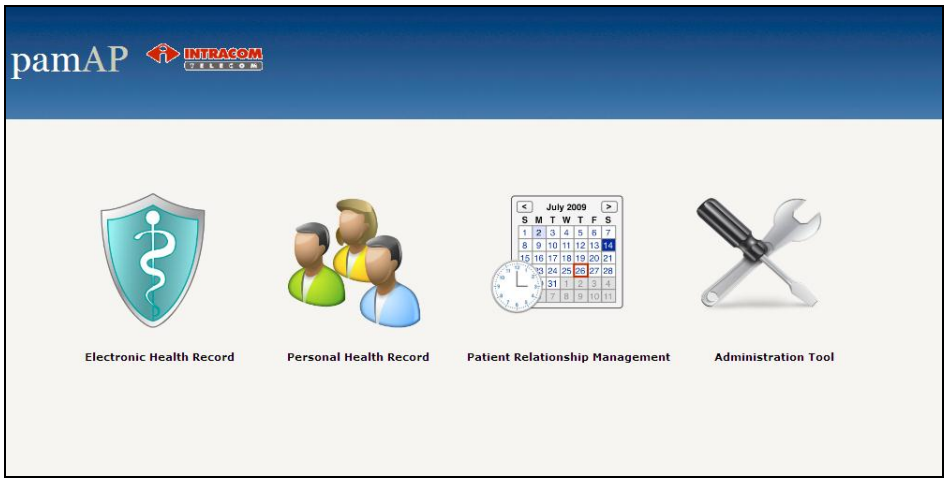

Figure 1: The PAMAP system entry page

1.2.2. Searching for a Patient in the EHR database

Figure 2 presents the screen where a user can select or search for a patient available in the EHR database in order to retrieve his/her EHR related information and use the rest of the functionality supported by the EHR application.

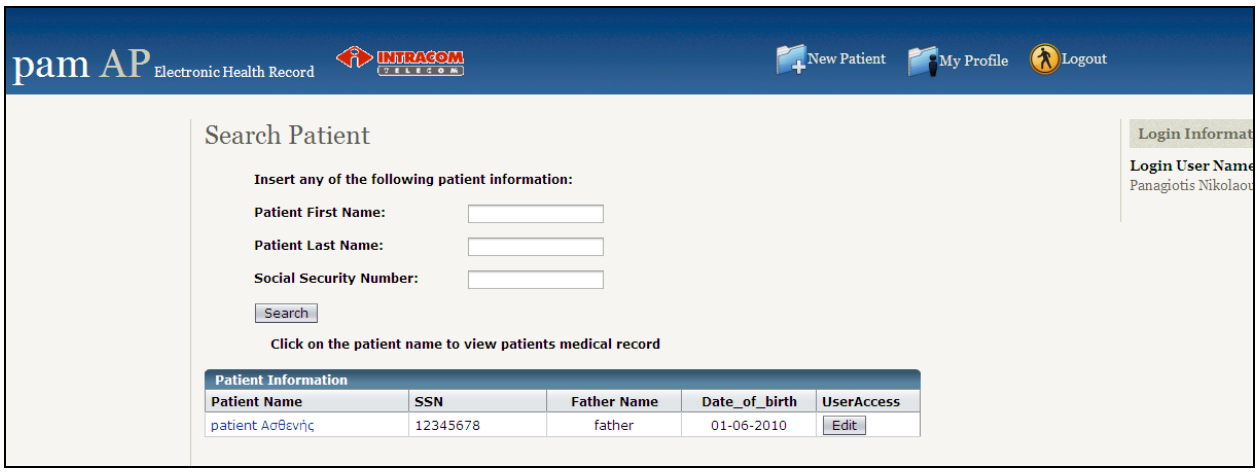

Figure 2: Searching for a patient in the EHR database

1.2.3. Patient Personal Details

Figure 3 presents the screen where the user can edit and review the patient's personal details.

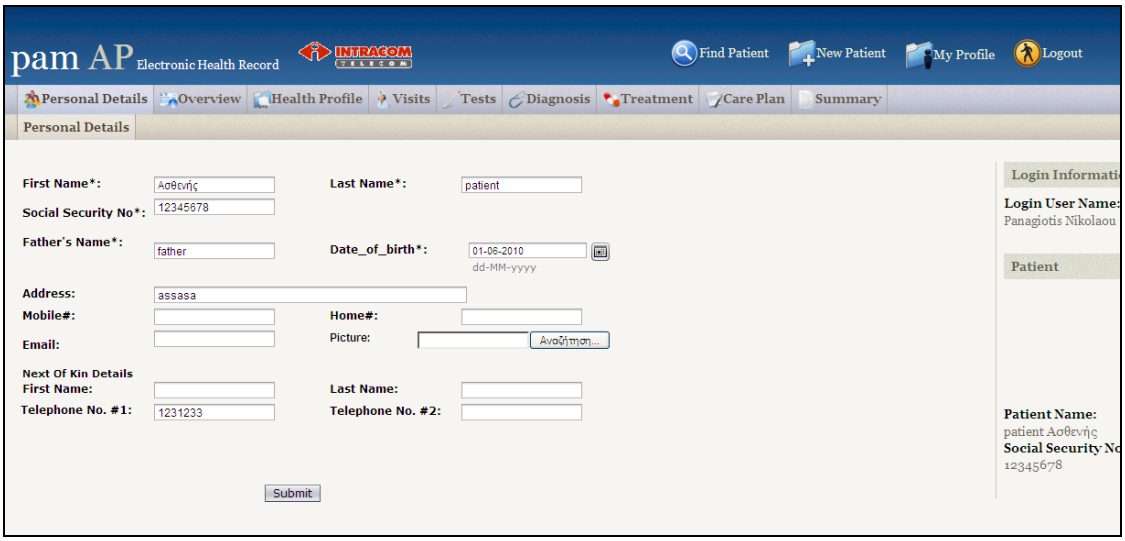

Figure 3: Editing - Reviewing patient personal details

1.2.4. Patient's Health Profile: Family History

Figure 4 presents the screen where the user can edit and review the patient's family health history. The user is able to insert a new item including info about any of the patient's family members. The ability of editing is allowed only to users having the clinician role.

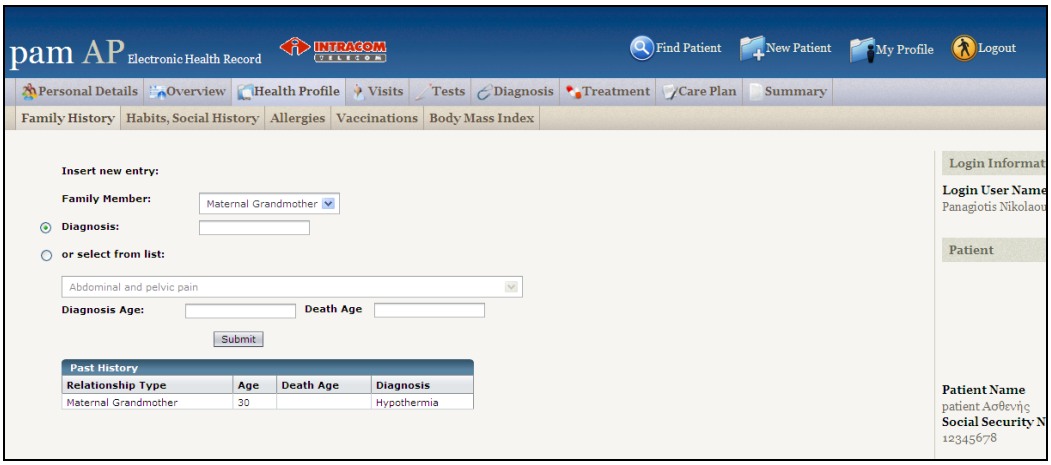

Figure 4: Patient's Family Health History

1.2.5. Patient's Health Profile: Health Related Habits of Living

Figure 5 presents the screen where the user can edit and review the health related habits of living. The ability of editing is allowed only to users having the clinician role.

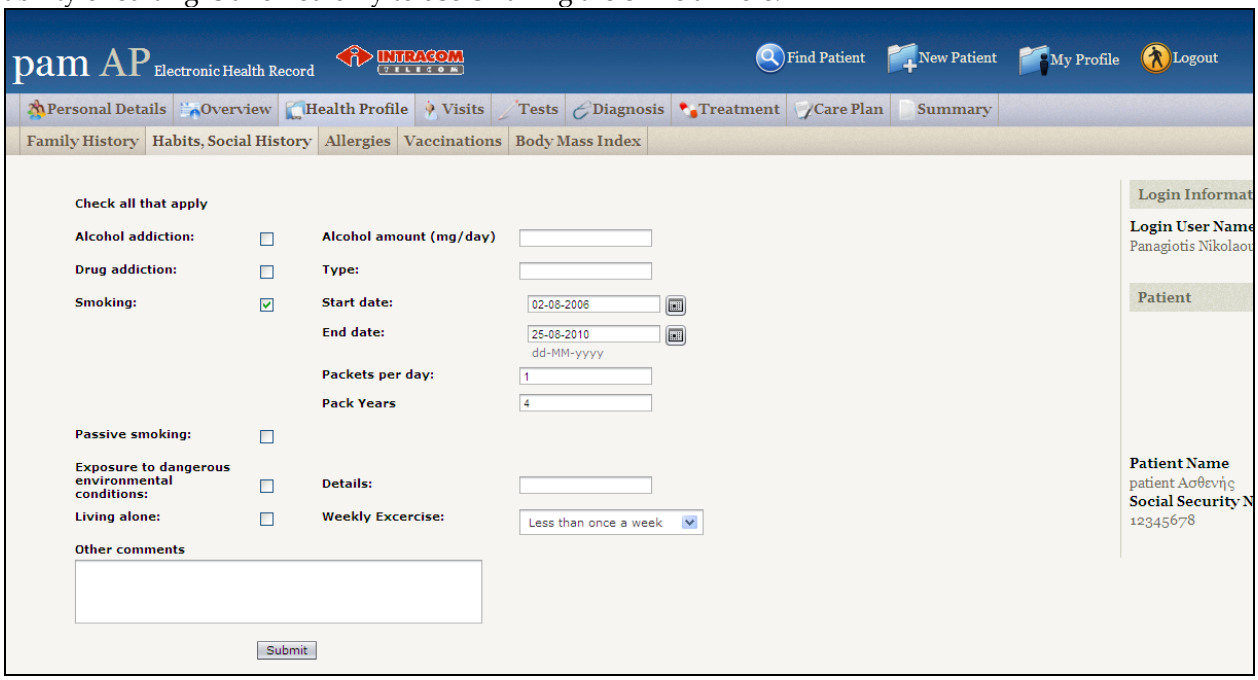

Figure 5: Health Related Habits of Living

1.2.6. Patient's Health Profile: Allergies

Figure 6 presents the screen where the user can edit and review patient's allergies. The ability of editing is allowed only to users having the clinician role.

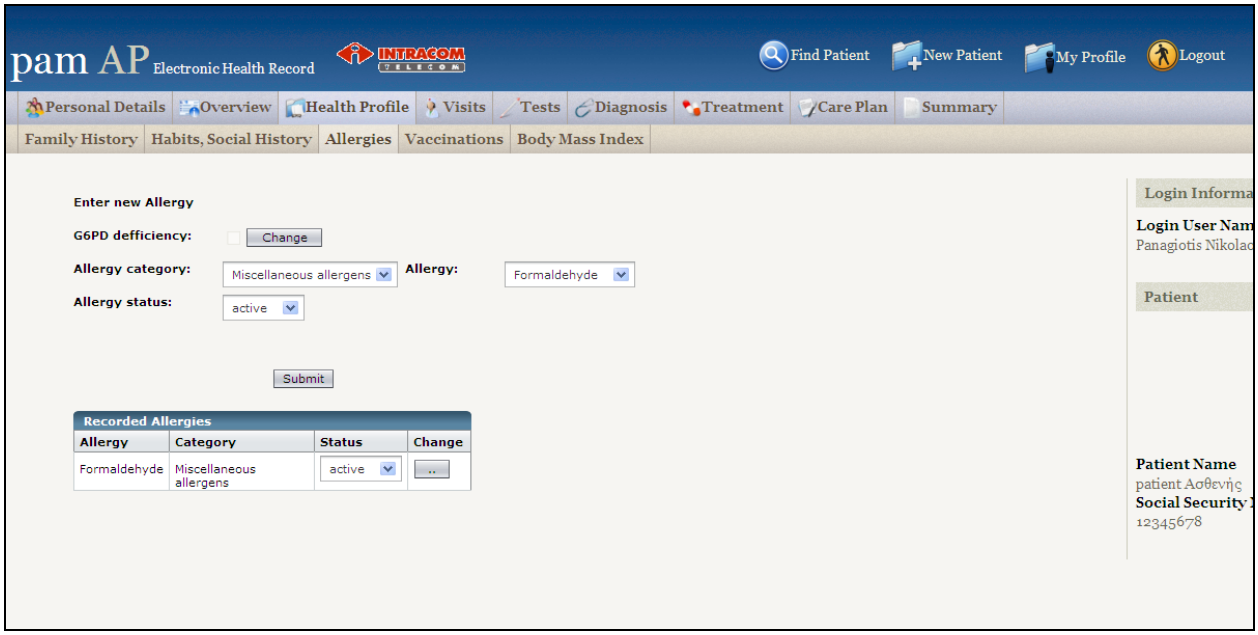

Figure 6: Patient's allergies

1.2.7. Patient's Health Profile: Vaccinations

Figure 7 presents the screen where the user can edit and review patient's vaccinations. The ability of editing is allowed only to users having the clinician role.

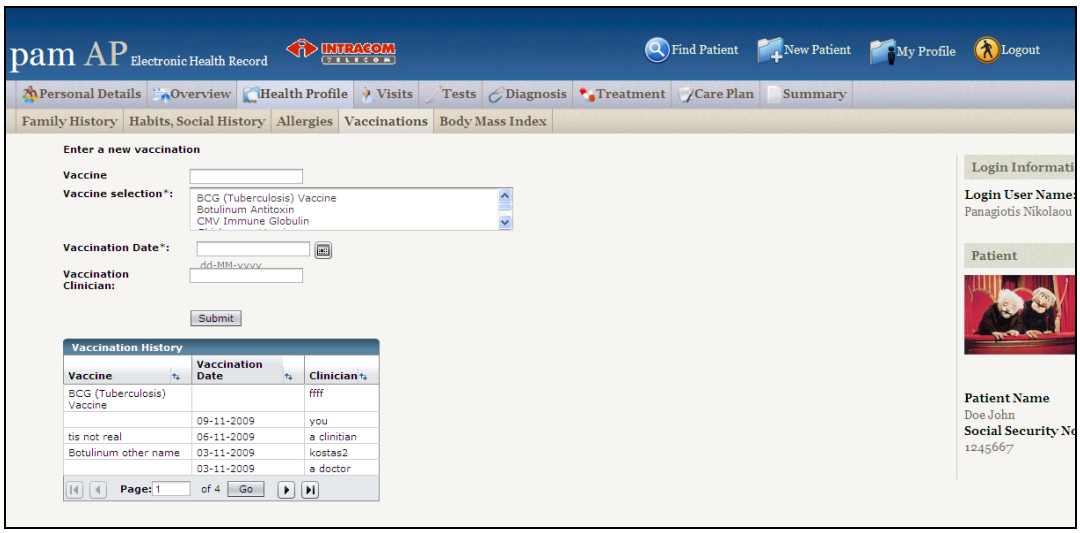

Figure 7: Patient's vaccinations

1.2.8. Patient's EHR Overview

Patient's EHR overview includes information related to diagnoses, medication and surgeries, as presented in Figure 8, Figure 9 and Figure 10 respectively. Appropriate links may drive the user to editing an existing or inserting a new entry, in each of the corresponding pages. The ability of editing is allowed only to users having the clinician role.

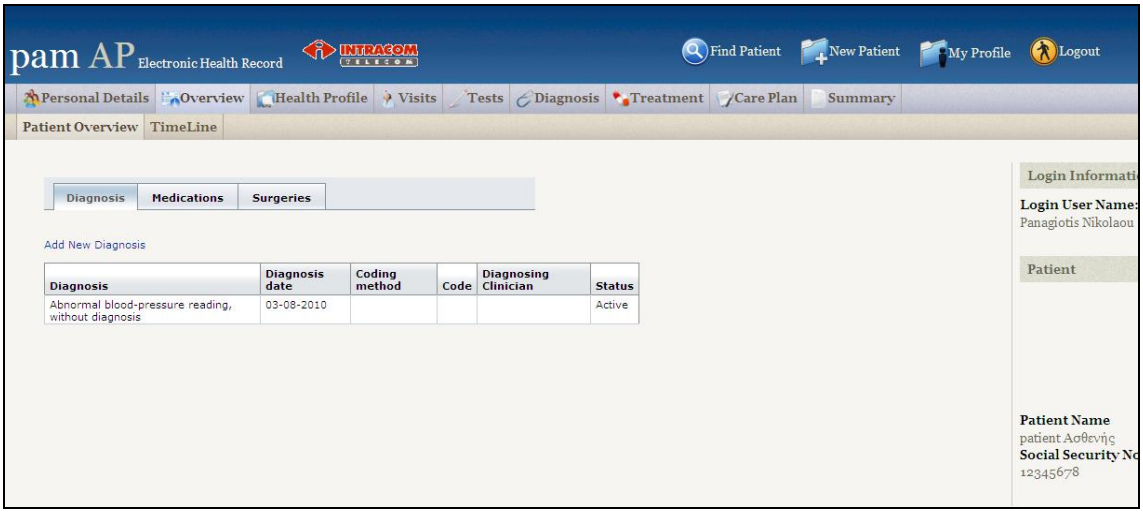

Figure 8: Patient EHR Overview: Diagnoses

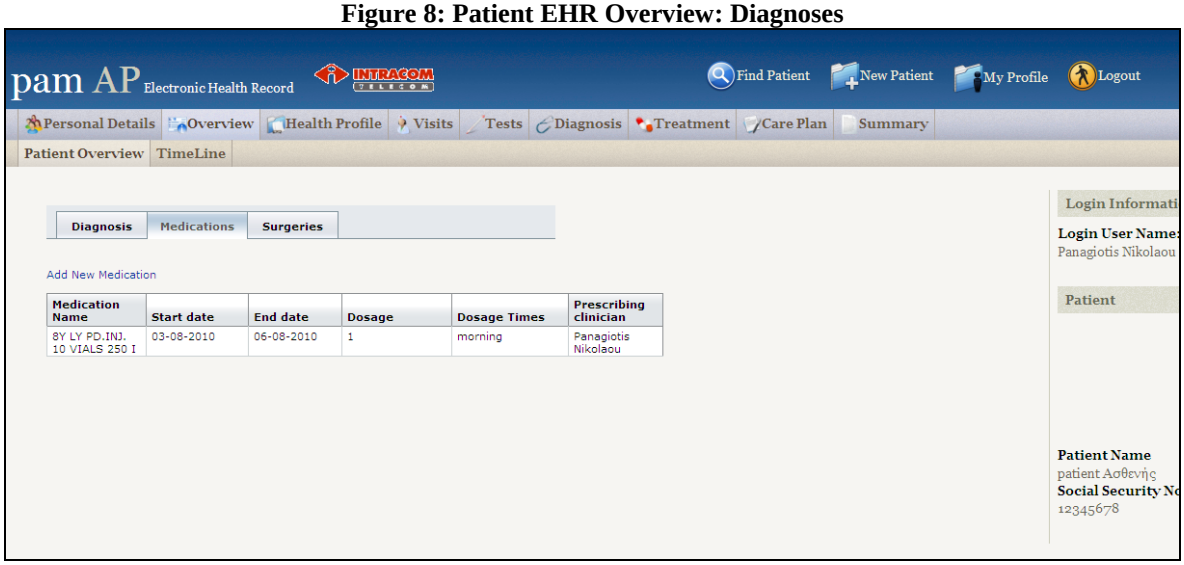

Figure 9: Patient's EHR Overview: Medications

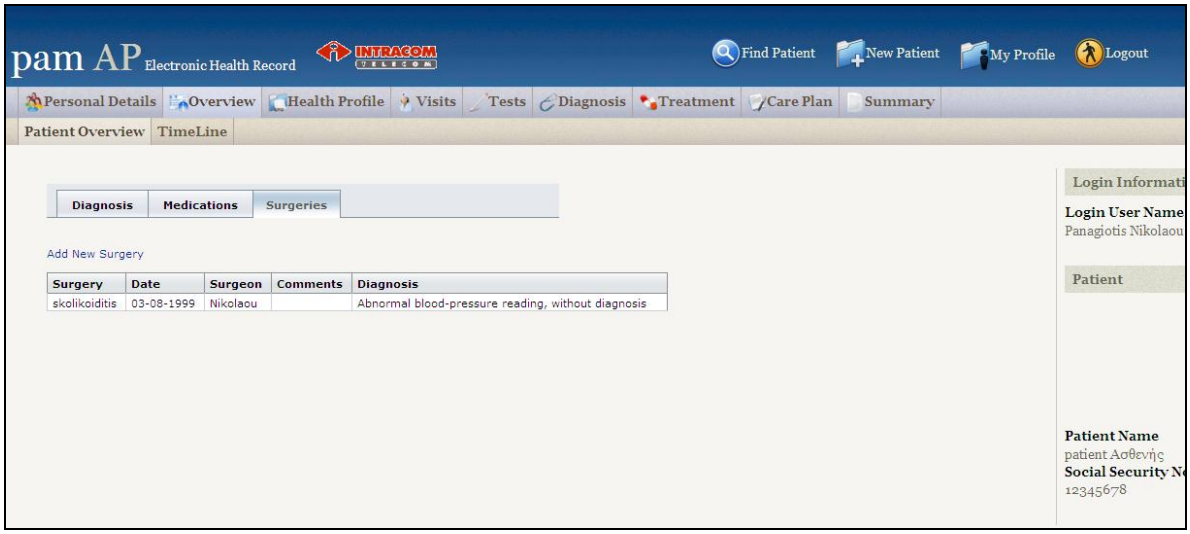

Figure 10: Patient's EHR Overview: Surgeries

Patient's Overview also includes a timeline including brief info (date, label) about vaccinations, medications, visits, surgeries, diagnosis concerning with the selected patient. The user is able to click on the brief info item and navigate to the appropriate web page including the detail info. Moreover, he/she is able to change the query criteria, in order to refresh the displayed info.

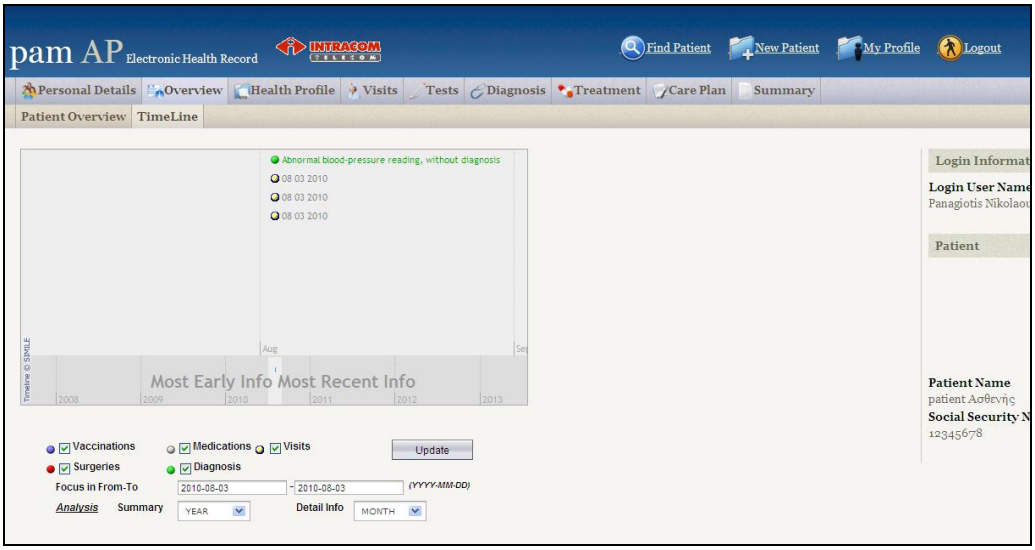

Figure 11: Patient's Overview: Timeline presentation

1.2.9. Patient's Tests

Figure 12 shows the page where the user can order a clinical laboratory test or other tests related to the patient, e.g. a self-test or a rehabilitation exercise. After doing so, the Pending Test Results is updated accordingly (Figure 13), and, upon execution of the test and automatic or manual entry of the test results, the Test Results page is updated accordingly (Figure 14). The user is also given the ability to insert attachment files related to a specific test (e.g. documents, pictures, etc.), as presented in Figure 15.

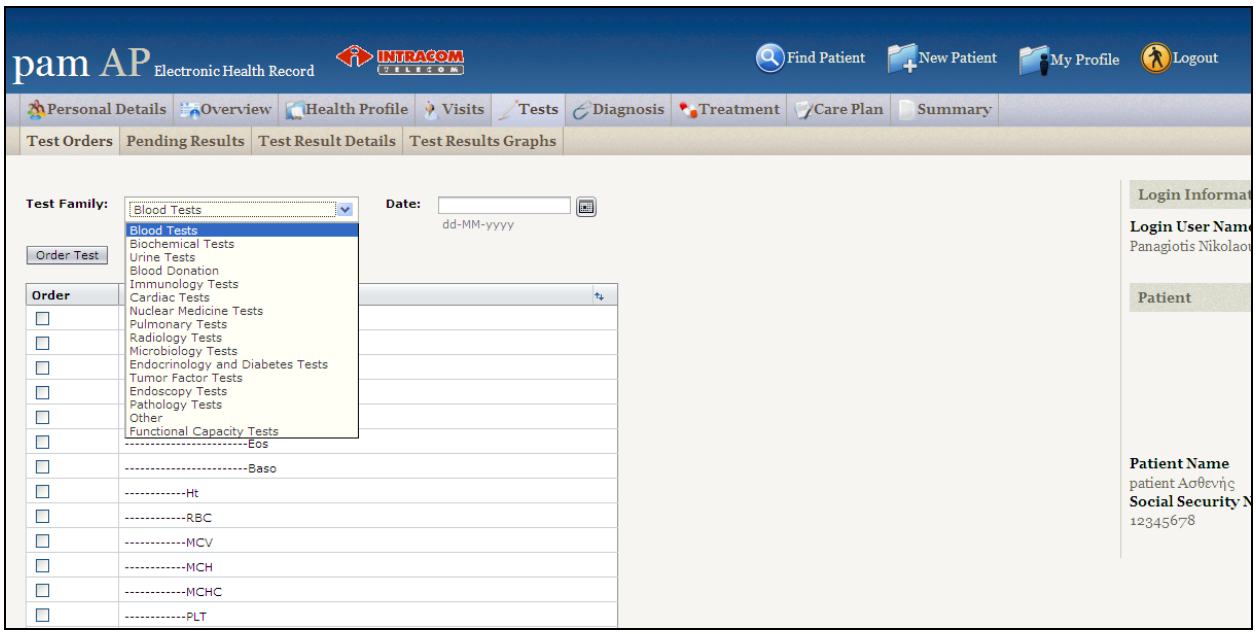

Figure 12: Clinical Laboratory and other Tests

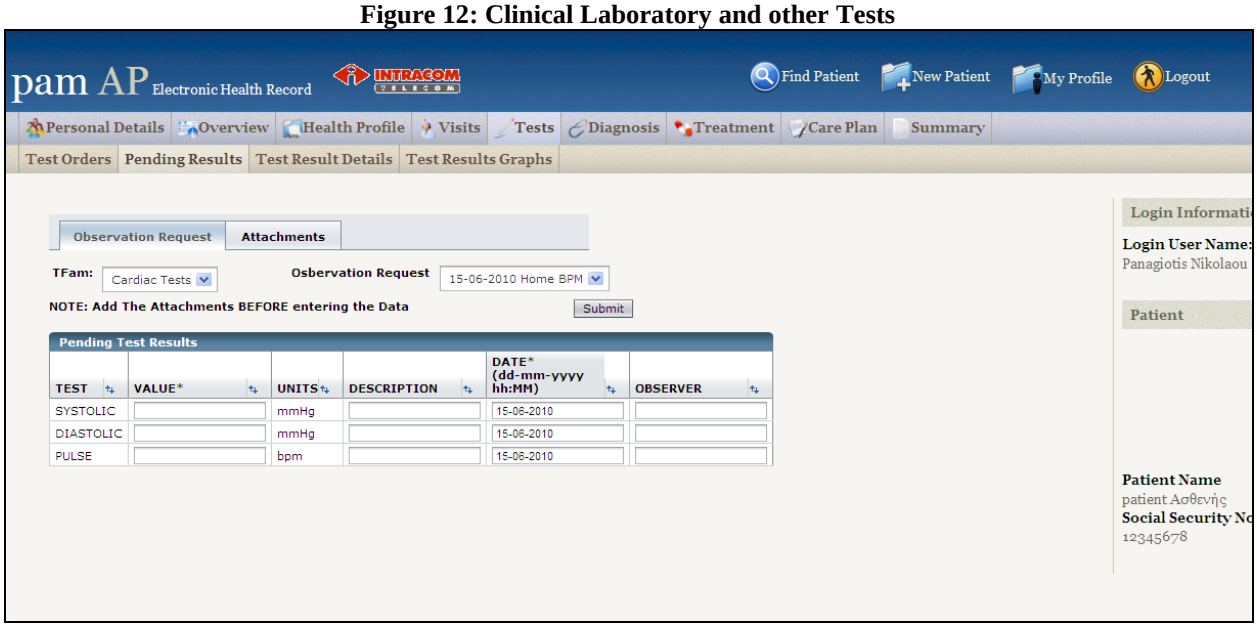

Figure 13: Test's with pending results page

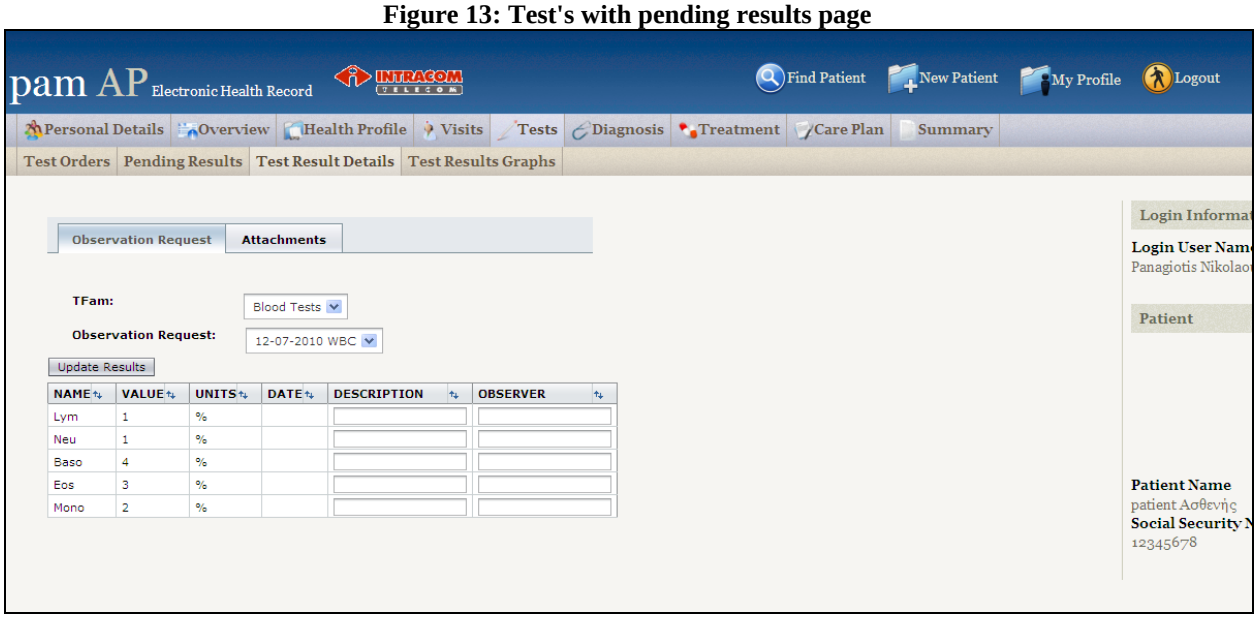

Figure 14: Test Results

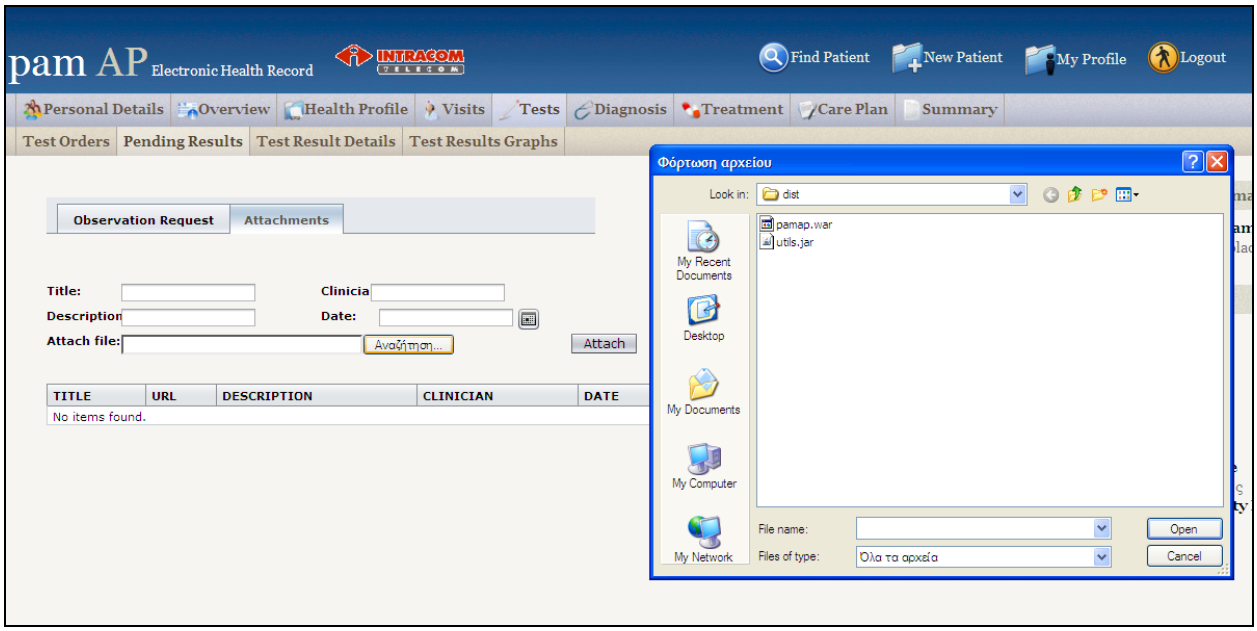

Figure 15: Attachments in the Test Results

1.3. Personal Rehabilitation Plans

We discriminate between the *Overall Rehabilitation Plan*, i.e. the list of activities that are prescribed by the Medical Doctor/Attending Nurse during the set up of the rehabilitation plan of a patient; and, the *Daily Rehabilitation Plan*, i.e. the list of activities that the patient should carry out each day, as derived from the Rehabilitation Plan.

Overall Rehabilitation Plan is a single xml file, containing information on what the user has to do during the rehabilitation period. The application software is responsible for parsing this file and appropriately generating the information that is required when the viewer switches to the Overall Rehabilitation Plan screen.

1.3.1. Care Plan Definition

Figure 16 shows the page where the user can define a new care plan for the selected patient.

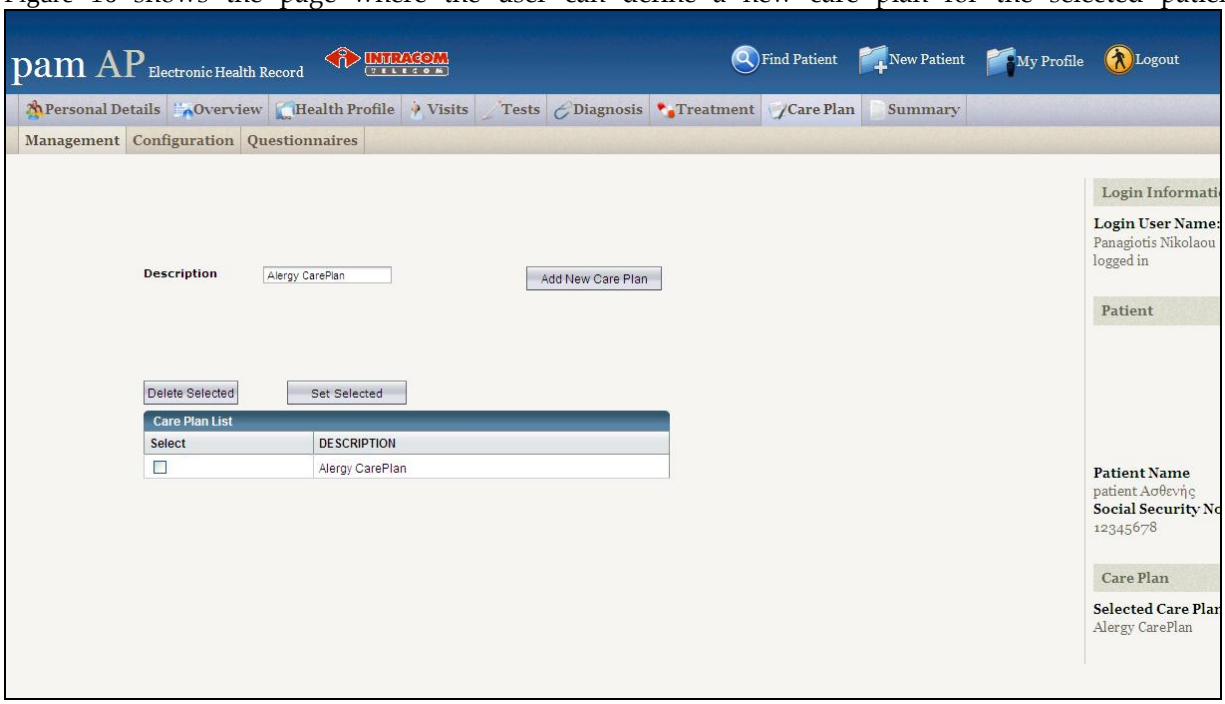

Figure 16: Care Plan Definition

Following the care plan definition step the user is provided with the functionality to configure this care plan by selecting measurements, education material and questionnaires for it (Figure 17). The name of the selected Care Plan appears down and right on the screen. In order to insert a new measurement, the user has to select the appropriate measurement category from a list of predefined categories. Next action is to define the time period in between the patient has to get the measurements. The periodicity is a parameter which defines the amount of measurements during the defined time unit. The time unit has to be selected from the user from a list of predefined units like 'day', month' etc. If the user owns the role of clinician he has the ability to insert the complete measurement info into the system. After the insertion, the system offers a useful API as a set of services, in order to get in XML format all the measurements which are necessary to complete from the patient, during a given time period.

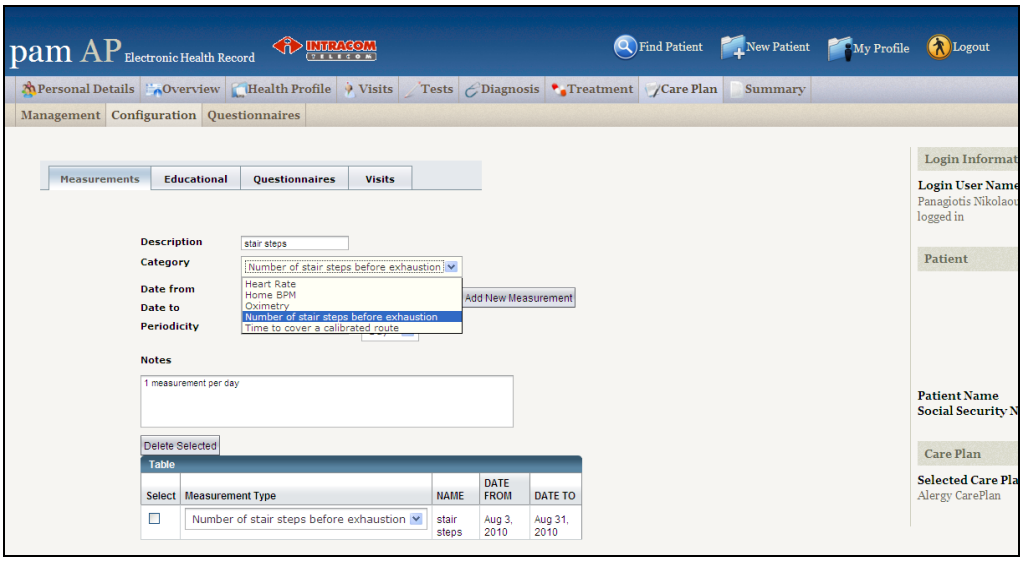

Figure 17: Care Plan Configuration

For the configuration of the Educational Material to be assigned in a specific Care Plan a separate tab is available (Figure 18). The name of the selected Care Plan appears down and right on the screen. In order to insert a new session, the user has to select the appropriate session category from a list of predefined categories. Next action is to define the time period in between the patient has to join the session. The periodicity is a parameter which defines the amount of session to join, during the defined day of week. If the user owns the role of clinician, he has the ability to insert the complete session info into the system. After the insertion, the system offers a useful API as a set of services, in order to get in XML format all the sessions which the patient has to join to, during a given time period.

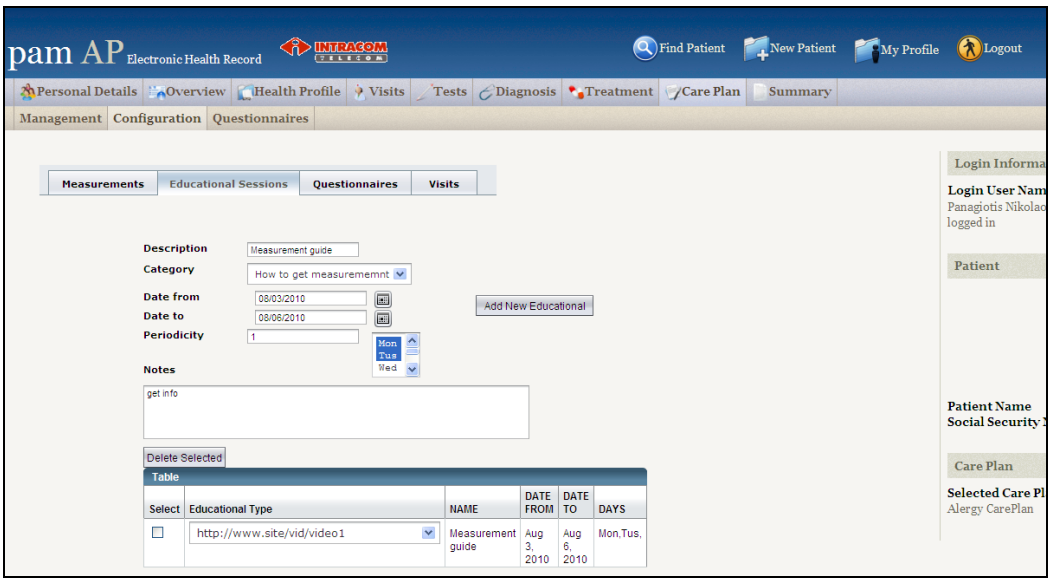

Figure 18: Configuration of Educational Sessions related to a Care Plan

For the configuration of patient visits to his/her clinician related to a specific Care Plan another tab should be used, as presented in Figure 19. The name of the selected Care Plan appears down and right on the screen. Next action is to define the date, when the patient has to do the visit to the clinician. If the user owns the role of clinician he has the ability to insert the complete visit info into the system. After the insertion, the system offers a useful API as a set of services, in order to get in XML format all the visits which the patient has to do, during a given time period

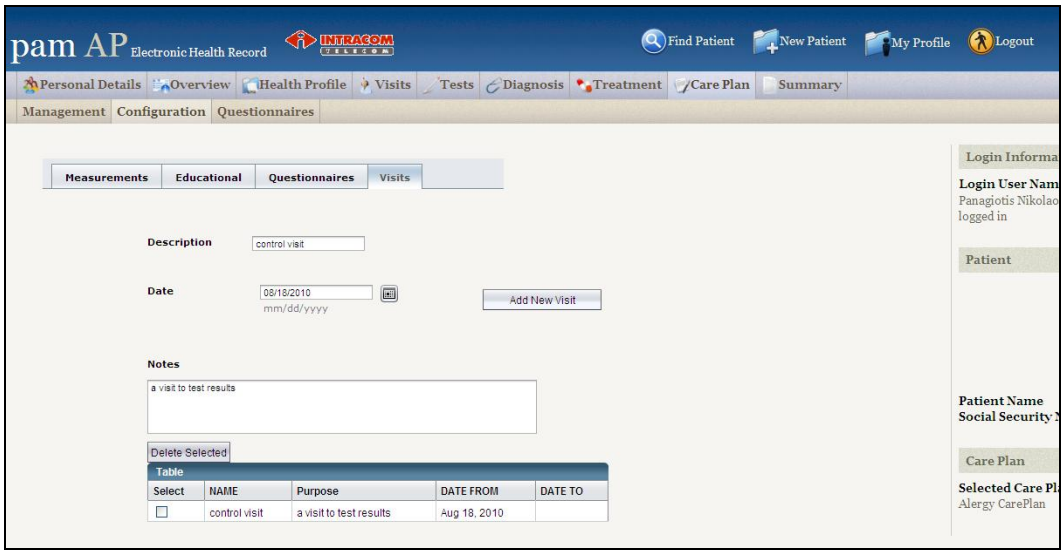

Figure 19: Configuration of Visits related to a Care Plan

Finally, the user uses the tab presented in Figure 20 to select the questionnaires that should be answered by the patient in the context of a Care Plan. The name of the selected Care Plan appears down and right on the screen. In order to insert a new session, the user has to select the appropriate questionnaire category from a list of predefined categories. Next action is to define the time period when the patient has to answer the questionnaire. The periodicity is a parameter which defines the amount of sessions to join during the defined day of week. If the user owns the role of clinician he has the ability to insert the complete questionnaire info into the system. After the insertion, the system offers a useful API as a set of services, in order to get in XML format all the questionnaires which the patient has to answer, during a given time period.

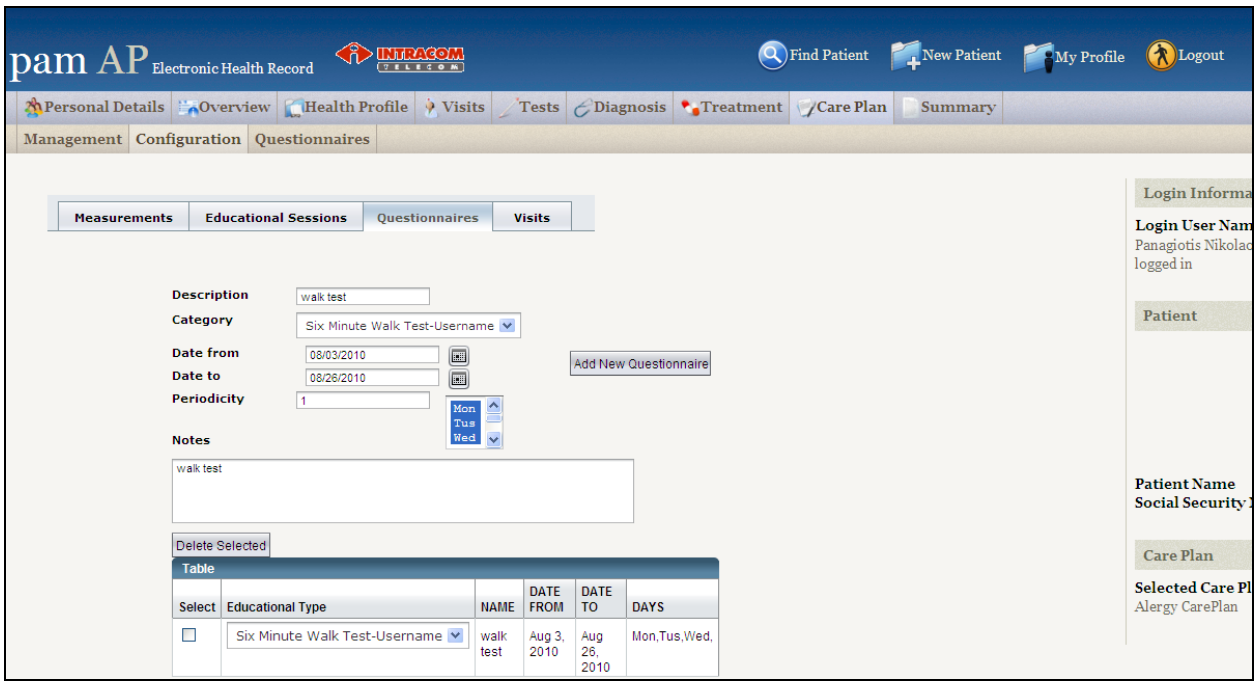

Figure 20: Configuration of Questionnaires to be answered in the context of a Care Plan

A PAMAP Administrator Web Interface enables the PAMAP System administrator to have access to a set of administrative tools. A log in page (Figure 21) is available for the user to authenticate himself.

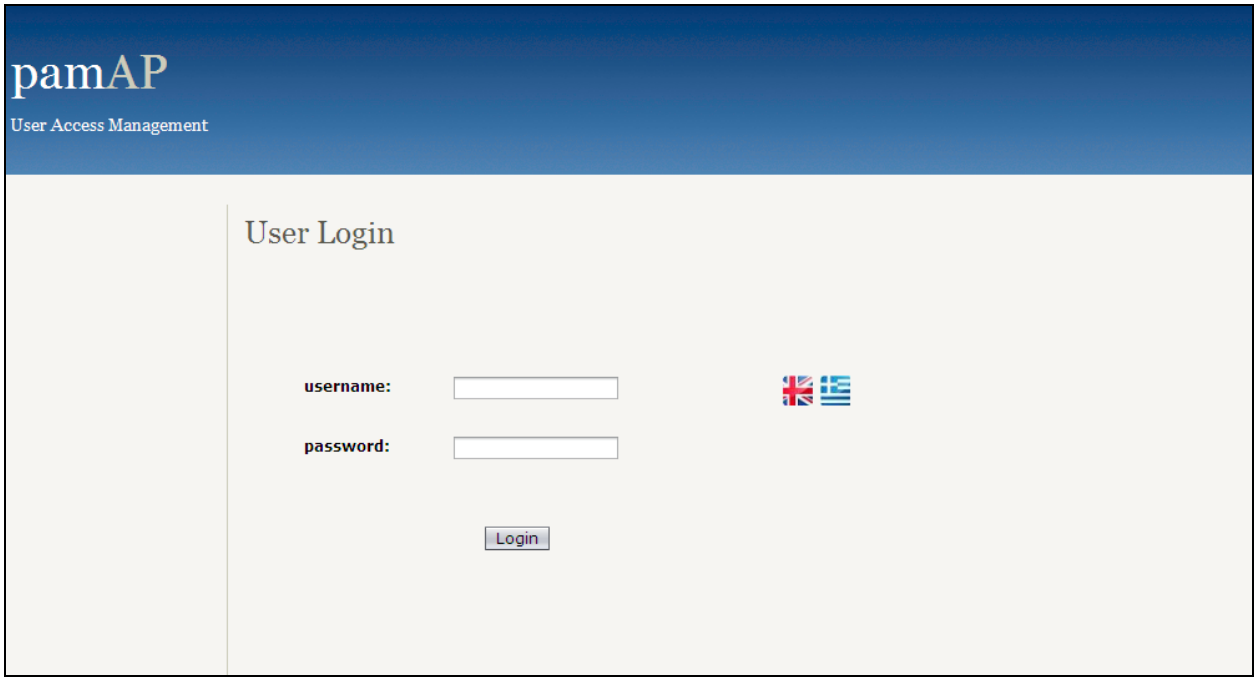

Figure 21: Log in to the PAMAP Administration Tool

If the authentication is successful, the necessary user interface functionalities are activated and access to the PAMAP system database is granted (Figure 22). The functionality includes edit of the profile of the PAMAP system users, configuration of their access right and credentials, etc.

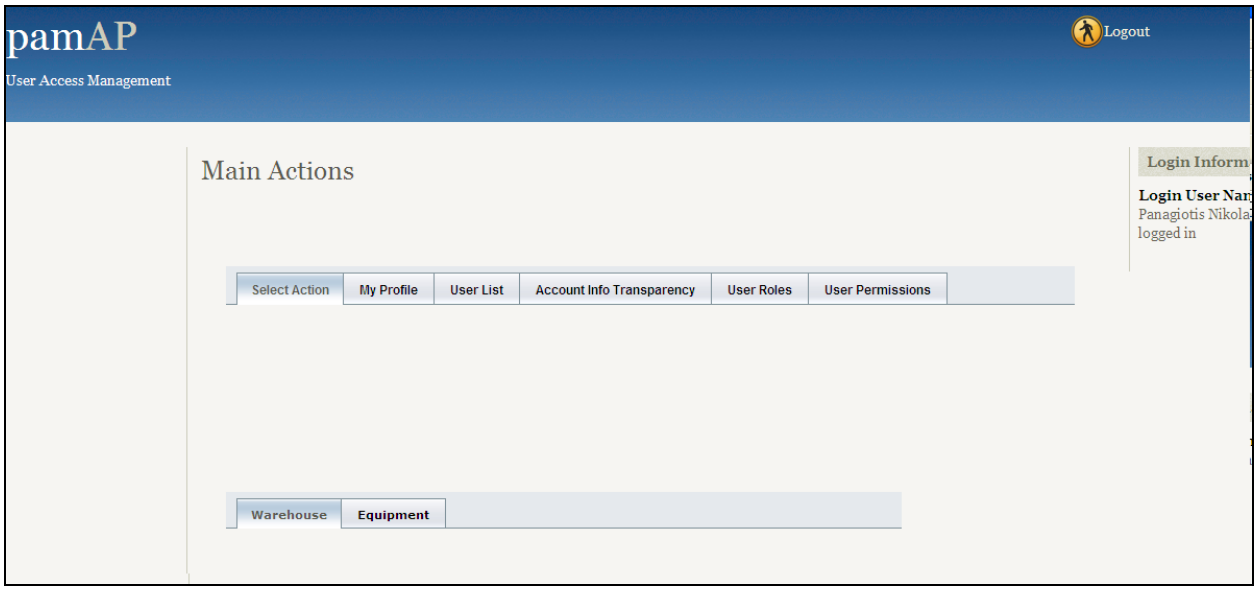

Figure 22: PAMAP Administration Tool Environment

Of special interest is the tab that enables the administrator to manage PAMAP equipment (Figure 23), i.e. it is a device manager that associates medical devices, STBs and other terminal equipment to physical or logical entities (patients/healthcare professionals or network nodes, respectively).

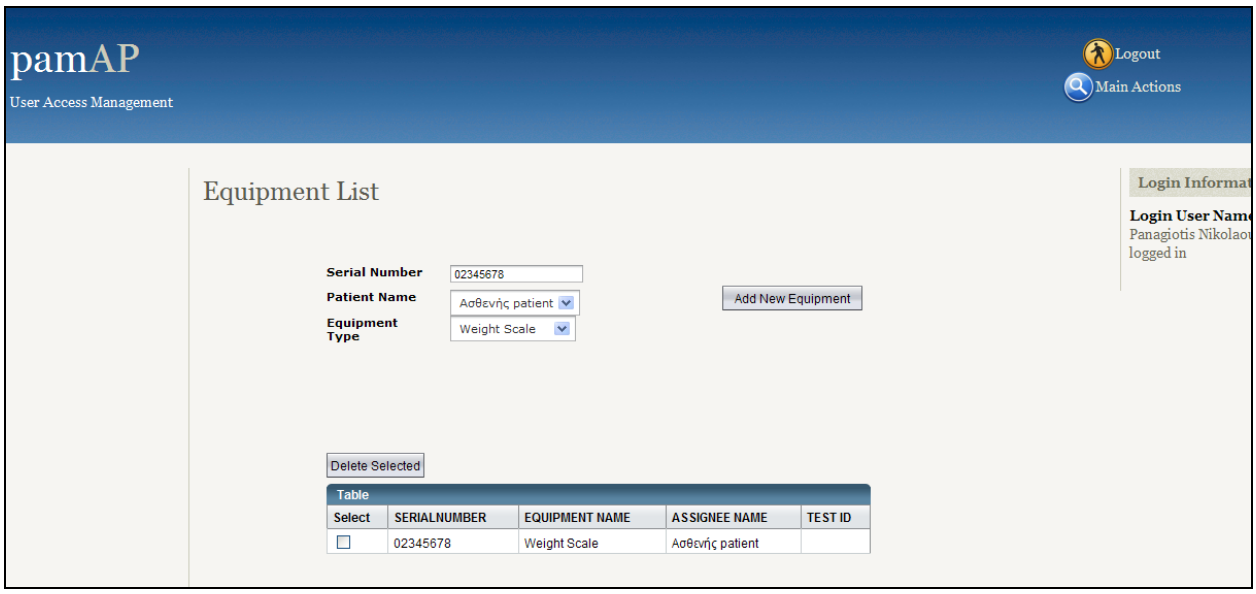

Figure 23: Equipment management tab

3.1. Introduction

The development environment consists basically of the Application Server, which is GlashFish and the Database server, which is an Oracle server. The Application Server is running under JVM version 5 or higher, supporting java server pages and java web servlets. The development tools, include the Integrated Development Environment NetBeans and Database Monitor applications, such as Oracle Developer and TOAD for Oracle. A Linux open source DHCP server is used in order to supply IP address to the STBs.

3.2. Supported functionality of the first prototype

The *Personal Health Record* application provides an i-TV interface to the intLIFE EHR. The sitemap of the PHR site presented in the TV monitor of the patient is the following

- Sitemap:
- Login
    - Personal Health Record
        - Overview
        - Laboratory Test Results Details
        - Laboratory Test Results Graphs
    - Day Issues
        - Measurements
        - Questionnaires
    - Personal Messages
        - User Name
        - Message
    - Personal Reminders
        - User Name
        - Task
    - Educational Material
        - Educational Sessions
    - Videoconference
    - Rehabilitation Plan :
        - Measurements
        - Educational Sessions
        - Questionnaires
        - Hospital Visits
        - Laboratory Tests

In the following set of figures indicative pages of the i-TV based PHR site are presented.

Figure 24: Log in to the i-TV PHR application

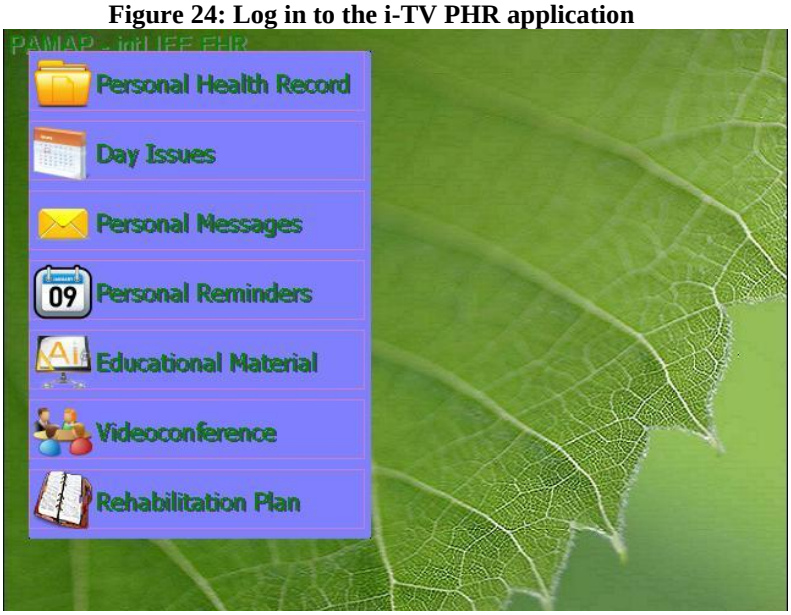

Figure 25: i-TV based PHR user menu

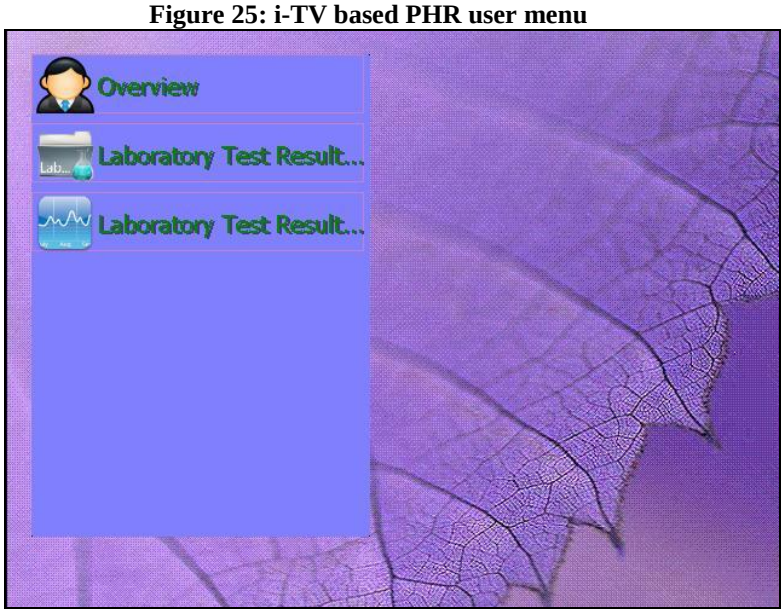

Figure 26: Daily issues according to the patient's Care Plan

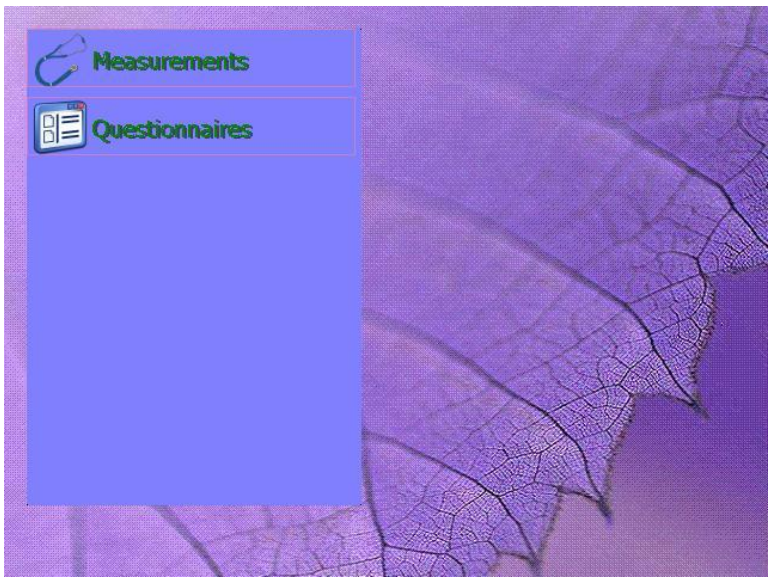

Figure 27: Daily issues according to the patient's Care Plan

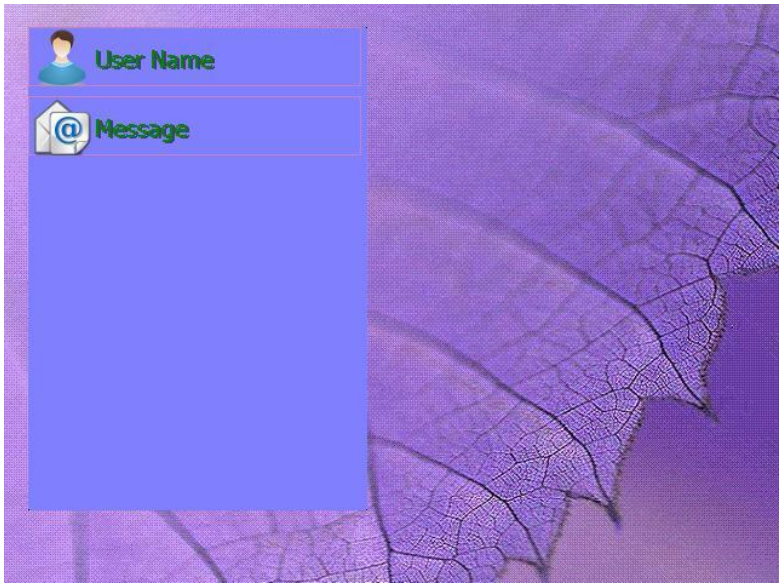

Figure 28: Personal Messages List

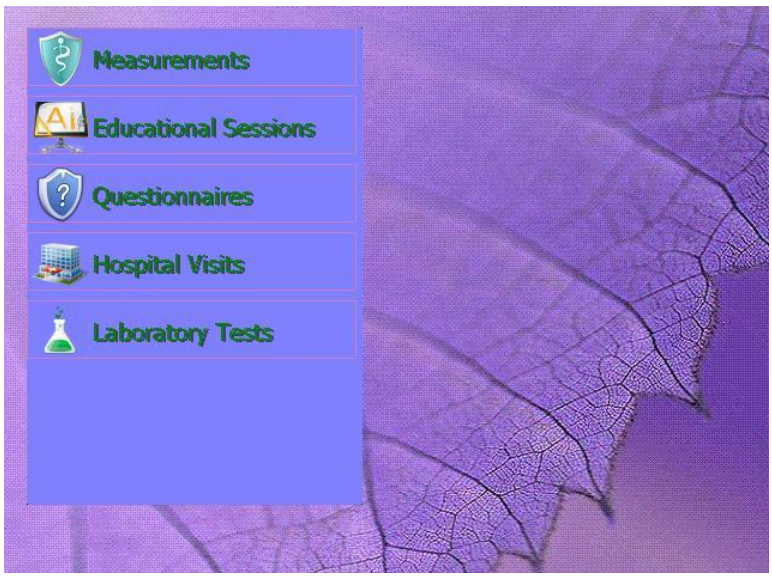

Figure 29: Rehabilitation plan as presented in the i-TV PHR interface

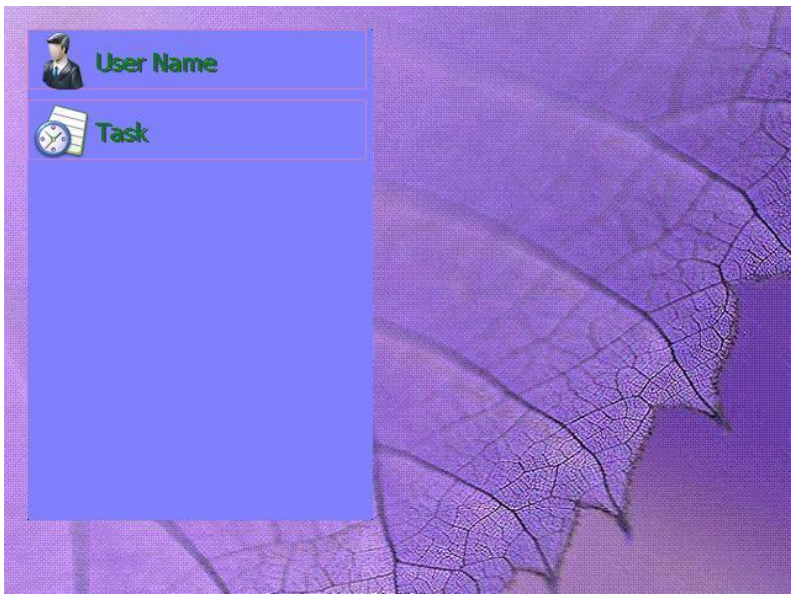

Figure 30: Personal Reminders List

NAME	DATE	METHOD	CODE	CLINICIAN	STATUS
Abnormal blood-pressure reading, without	01-11-2009				Active
othertest	13-10-2009				Ongoing
testtest	05-10-2009				Active
A	12-07-2009			test	Inactive
e	05-04-2009			me	Ongoing
Persistent delusional disorders	18-07-2008	ICD10	F22	Panagiotis	Ongoing
test free text diagnosis	12-07-2008			Panagiotis	Active
sdsa	08-07-2008			FGHGFH	Ongoing
Inhalation and ingestion of other objects	08-07-2008	ICD10	W80	jkhk	Ongoing
ghjghj	29-06-2008			Panagiotis	Active
Personality and behavioral disorders due to brain disease, damage and dysfunction	29-06-2008	ICD10	F07	Panagiotis Nikolaou	Active
ghjghj	29-06-2008			Panagiotis	Active
test diagnosis	29-06-2008			Panagiotis	Ongoing
Other mood (affective) disorders	20-07-2005	ICD10	F38	Panagiotis	Inactive

Figure 31: PHR Overview as presented in the i-TV (Diagnoses tab)

NAME	START	END	DOSAGE	TIMES	CLINICIAN
Abnormal blood-pressure reading,					
othertest					
testtest					
A					test
e					me
Persistent delusional disorders					Panagiotis
test free text diagnosis					Panagiotis
sdsa					FGHGFH
Inhalation and ingestion of other objects causing obstruction of					jkhk
ghjghj					Panagiotis
Personality and behavioral disorders due to brain disease,					Panagiotis Nikolaou
ghjghj					Panagiotis
test diagnosis					Panagiotis

Figure 32: PHR Overview as presented in the i-TV (Medication tab)

Figure 33: PHR Overview as presented in the i-TV (Surgeries tab)

Figure 34: Test Results as presented in the i-TV based PHR

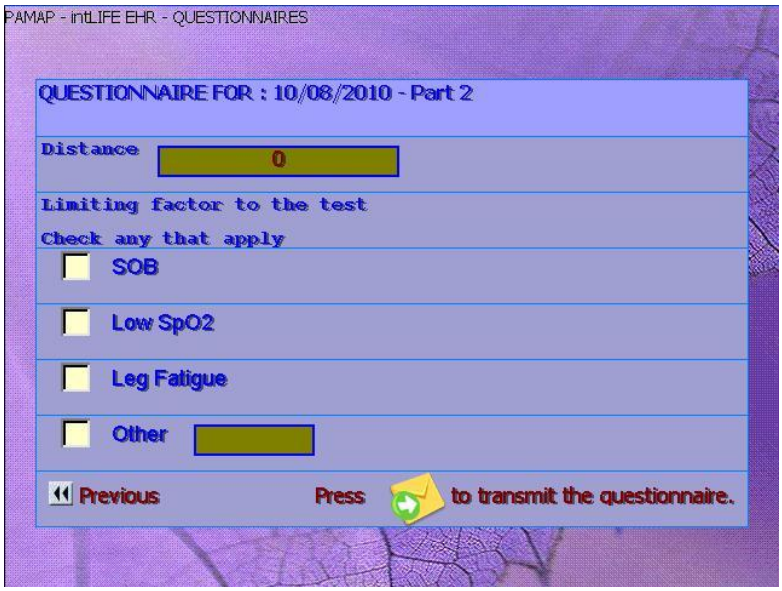

Figure 35: Questionnaires as presented in the i-TV interface

4.1. Introduction

The Measurements Visualization Application is a Java application. Independency, architectural neutrality and portability are besides others the main reasons why this language has been chosen. Furthermore, the visualization uses the Java3D rendering framework.

Supporting different kinds of integrated development environments like Eclipse or NetBeans, the framework of the Measurements Visualization Application was designed as a Java Web Start application. The Web Start features include the ability to automatically download and install a Java Runtime Environment in the case where the user does not have Java installed, and for programmers to specify which JRE version a given program needs in order to execute. Thus, allowing an easy and automatic installation of the Measurement Visualization Application. No expert or any technical skills are necessary. Any user can use the application by simply installing a JNLP client (most commonly Java Web Start). The installation can occur automatically such that the end user sees the client launcher downloading and installing the Java application when first executed. Furthermore, the user does not have to remain connected to the Internet to execute the downloaded programs, because they execute from a locally-maintained cache. Updates of the software download from the Web become available when the user has a connection to the Internet, thus easing the burden of deployment.

In order to provide an easy development process for all partners of PAMAP the Measurement Visualization Application utilizes Apache Maven. Maven describes the Measurement Visualization software project being built, its dependencies on other external modules and components, and the build order.

4.2. Supported functionality of the first prototype

The Measurements Visualization Application provides the functionality to visualize the measurements generated by the Measurements Advanced Processing application and the Measurements Preprocessing application. The visualization might be graphs showing the heart rate or a virtual avatar animated with the body poses of the patient during the rehabilitation exercises. The Measurements Visualization application receives the data to be visualized either directly from the MAPA or from the PAMAP server, whereat the data to be visualized might be either real-time (i.e. currently streamed from the MAPA) or offline (i.e., a database record).

For the development of the Measurement Visualization Application a user-centered design process has been chosen. As described in the scenarios different user groups (e.g. patient, physician, etc.) with different skills and experience levels will use the measurement visualization interface.

The first Measurement Visualization Application prototype focuses on the visualization and interaction regarding elderly people. Here, different viewpoints have to be considered: Visibility, Accessibility, Legibility, and Language.

Figure 36 shows an example of the Measurement Visualization interface: the start screen of the application. The representation is easy and simple. Currently, the user is able to select among four modes. These modes can be expanded as needed. For the ease of interaction for elderly the size of the buttons as well as the font size is comparably large. The developer mode in the lower right corner is used for the test and evaluation process and will be explained later. All available modes could be used either by the patient while exercising or by the physician for analyzing the collected data.

Moreover, depending on the origin of the user the application has to support different languages. As shown in Figure 36 the Measurement Visualization Application supports different languages; among others: French, English, and German. The application could be easily extended to support further

languages. In case some of the chosen terms/definitions are not suitable a simple exchange is possible. Finally, for colour-blind users one can change the colour scheme of the user interface.

Figure 36 Example of the start screen of the Measurement Visualization Application for German (left) and English (right) users. Depending on the origin of the user the appropriate language is selected

Pressing the "Training" button the user enters the "Training" mode shown in Figure 37. This mode is used to display the user's movement; the most important mode for the patient. While the user is performing his exercises an abstract puppet moves according to the user's movement in real-time. Depending on the exercise additional information is displayed. Figure 37 shows an example exercise. Here, the user did one out of five repetitions. In addition, the user interface allows displaying warnings that a movement is not executed correctly or information on how to do it correctly. Using the training plan from the EHR the patient / user is guided through the whole exercise step by step. This also includes breaks to protect against over-exertion.

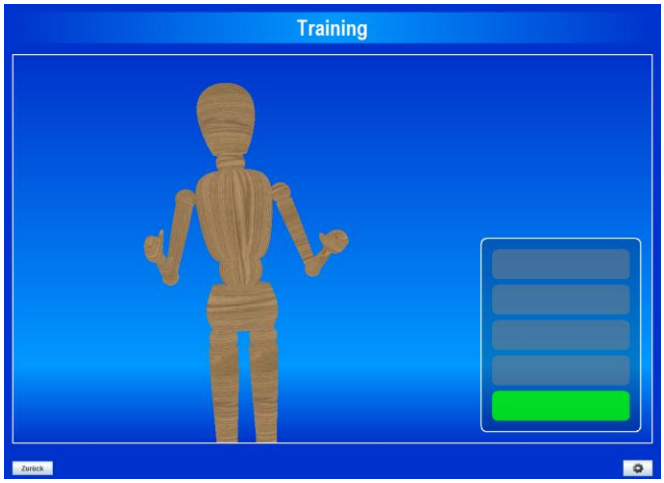

Figure 37: The training mode visualizes the movement of the user. According to the movement of the user (real-time or play back) an abstract puppet moves. Furthermore, the interface shows the number of repetitions that have been executed by the user.

The "Statistics" mode shown in Figure 38 is able to display the exercise intensity for different time intervals. In the upper chart the level computed for one minute is displayed. The following chart summarizes the level of a day. The bottom chart displays the level for one week. Using this mode one is able to examine the activity of the user for one minute up to one week.

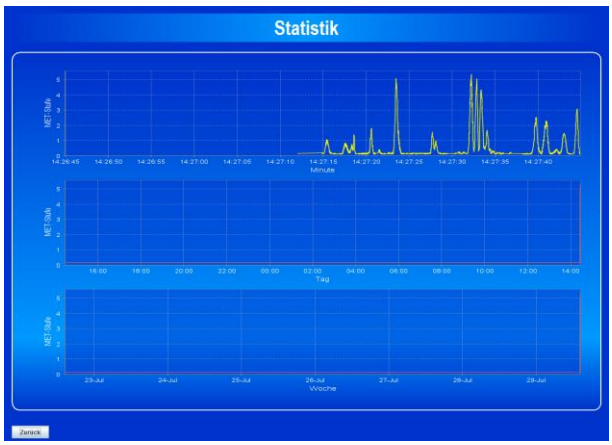

Figure 38: **The statistics page displays the 1-minute (top), daily (middle), and weekly (bottom) exercise intensity of the user's activity**

In order to cover leisure activities like Nordic walking, etc. the additional mode "Map" has been developed (Figure 39). For displaying maps an interface has been implemented to utilize the web service of OpenStreetMap. The map mode combines GPS related data and additional sensor data. For example the user's heart rate can be displayed. Thus, the user as well as the physician is able to examine places at which activity was too tiring. Next time the user can take care and protect himself from over-exertion.

Figure 39: **The map (Landkarte) page presents the combination of GPS and additional sensor data (e.g. heart rate) of the user.**

For development, test and evaluation an additional interface has been implemented (Figure 40). Currently, the interface allows switching between different sources for the measurement stream. The different possibilities represent the various scenarios in which the measurement visualization application will be used. Firstly, the application developer is able to select the "online" mode for the real-time visualization of the users' movement. Additionally, this mode allows recording the real-time stream and saving it in a file. This file can be used in the "offline" mode for play back of the recorded motion data. The "webservice" section allows a connection to the EHR to get the recorded exercise. The last two options cover the scenario of analyzing the recorded exercise data to improve the rehabilitation.

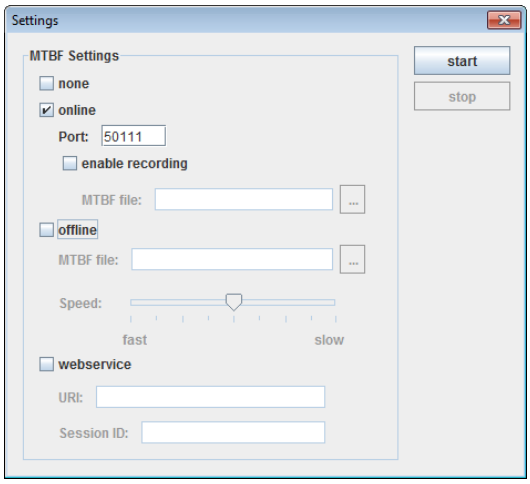

Figure 40: **An interface implemented for the development team. The user is able to switch between online, offline and web service as source for the measurement stream**

PC client - PAMAP Server communication link; the uplink from the PC client to the PAMAP is used to push the (pre)processed information to the PAMAP EHR database of the subject. The downlink is used to receive subject-related settings that are required for data (pre)processing, in the Control Unit, or advanced processing in the MAPA (e.g. min/max allowed heart rate, weight/age of the patient, etc.). Client-server communication is performed using **Web Services**. The web service that supports the client-server communication is the ICOM_EHR_Service (see Appendix). The interface that is used to resolve the above web service from the pc client (c++ client) is specified in the icomapi.h file (see Appendix).

The following documents provide additional information as well as technical details:

- Specification of the web service that supports the client-server communication **(ICOM_EHR_Service Web Service WSDL file)**
- Specification of the Motion Tracker Binary Format (MTBF.doc)
- Specification of API for communication with PAMAP server (icomapi.h)