

Institut für Parallele und verteilte Systeme

Universität Stuttgart  
Universitätsstraße 38  
D - 70569 Stuttgart

Fachstudie Nr. 196

## **Vergleich von Gesundheitsdatenmodellen**

Georgios Balatzis, Tim Borner, Oliver Röhrdanz

<b>Studiengang:</b>	Softwaretechnik
<b>Prüfer:</b>	Prof. Dr.-Ing. habil. Bernhard Mitschang
<b>Betreuer:</b>	Dr. rer. nat. Matthias Wieland
<b>begonnen am:</b>	16.03.2014
<b>beendet am:</b>	16.09.2014
<b>CR-Klassifikation:</b>	J.3 LIFE AND MEDICAL SCIENCES

## Contents

Contents.....	5
1. Introduction .....	6
2. Definitions.....	7
2.1 EHR, EMR .....	7
2.2 ASC X12 .....	7
2.3 CEN/TC 251 .....	8
2.4 DICOM.....	8
2.5 ISO TC 215 .....	8
2.6 xDT .....	9
2.7 HL7 Standard (Health Level 7 Standard).....	9
3. OpenMRS .....	11
4. Caisis .....	19
5. NOSH.....	25
4.1 Provider Account.....	25
4.2 Assistant Account.....	32
4.3 Patient Account.....	33
6. Microsoft HealthVault.....	35
7. OpenEMR .....	40
6.1 Doctor Account .....	40
6.2 Patient Account.....	47
8. The Carrot .....	49
9. Mirth Connect / DHIS2.....	56
10. Comparison.....	58
11. Conclusion.....	60
Table of Figures.....	61

## 1. Introduction

According to researches done by the WHO, asthma is a common disease all around the world. Asthma is characterized by recurring symptoms such as coughing, chest tightness, reduced oxygen saturation and shortness of breath. Sometimes it requires even an emergency admission. Supervising and taking care of these patients can dramatically reduce the time needed for convalescence. Therefore it is recommended by the ECHO-Project to supervise asthma patients using online systems and modern smartphones or web browsers. To keep track of the patient's data it needs an electronic health system to manage these data.

The goal of this study is to evaluate several existing platforms and systems to store and manage health care data. The final platform should be able to keep track of current and past data sets. Furthermore it shall offer a dedicated doctor account which can make recommendations to the patients and dedicated patient's account in which they can enter measured data and vitals on their own.

## 2. Definitions

### 2.1 EHR, EMR

A electronic health record (EHR) also called electronic medical record (EMR) is a general and abstract description of electronic saved data containing patients demographics, medical history, medications, allergies, immunization status, laboratory test results , radiology images, vital signs and personal statistics. It is thought of as one 'file' that contains all the data so it is easily updatable, so it contains always the most recent data and it is possible to exchange the data between health care systems.

[This brings a lot of positive aspects against paper-based data on the on hand as it needs less space to save all the data and it is easily shared and saved at multiply locations and can improve the quality in health care. It makes it easy for a consistent standard of documents and offers the possibility to trigger warnings or reminders. But on the other hand there is the possibility to 'hack' into the systems and steal the data or damage the systems.]

For the technical implementation of the transfer of this data there are several standards that will be presented briefly in here.

### 2.2 ASC X12

The ASCX12 (Accredited Standards Committee) is an organization which develops xml standards for the electronic data exchange and is chartered by the American National Standards Institute (ANSI). The standards are mainly used in the USA.

### 2.3 CEN/TC 251

Cent/TC 251 is a European workgroup working on standardization of health information and communication technology. They made for example the *EN 13606* which is a standard for interoperability between health care systems, it defines a stable standard for EMR exchange between different systems. Also they made the *EN 13940* which is a system of concepts to support continuity of care. A third standard is *EN 12967*, the Health Informatics Service Architecture, it should define an architecture enabling openness, integration and interoperability amongst healthcare information systems and also a methodology to describe healthcare systems through a language, notation and paradigm suitable to facilitate the planning, design and comparison of systems.

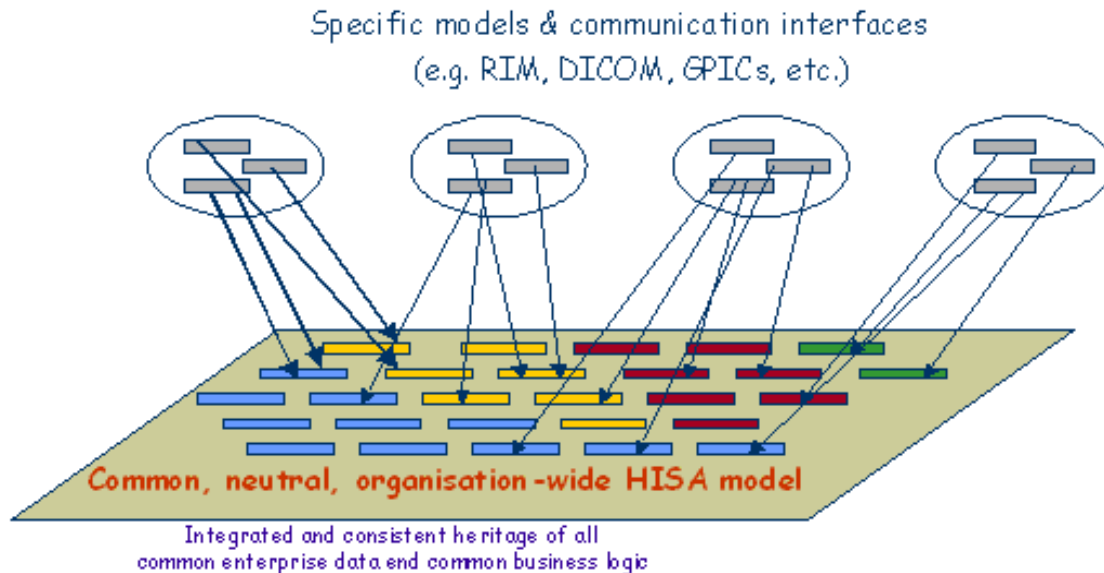


Figure 1. Specific models and communication interfaces  
<http://www.consortioedith.it/public/immagineDocHisa.bmp>

### 2.4 DICOM

DICOM or ISO 12052 is an international standard for interchanging medical images. It defines the formats of medical images and is implemented in almost every radiology, cardiology imaging and radiotherapy device.

### 2.5 ISO TC 215

This ISO contains technical specifications for EHRs, this contains also the HL7 data exchange standard that is described in more detail below.

For example ISO 18308 defines requirements for the architecture of a system that processes, manages and communicates EHR information.

## 2.6 xDT

xDT is a group of data exchange formats used in the German health care, there are different formats e.g. the ADT format for transferring billing data, the BDT format for exchange of complete EHRs, the GDT format to transfer data among medical devices and software systems and the LDT format to transfer orders to laboratory tests and results.

## 2.7 HL7 Standard (Health Level 7 Standard)

A lot of Hospitals and Organizations that provide Healthcare, use an enormous variety of computers and devices to track a patient's Health, to bill and organize the clinic. This variety of computers and devices need somehow a way to communicate through Interfaces. Rising problem is that not all devices and computers, are able to communicate per default with each other. Health Level 7 provides some standard guidelines, standards and methodologies, which allows the devices to exchange data. It can be viewed as a Framework for exchange, integration, sharing and retrieval of Medical Information, as it defines how Data should be packed and communicated between the peers, setting up the language, the Data Structure and the Data Types. The guidelines set from the Health Level 7 standard are supposed to force the Developers of various platforms and health care programs that are going to be used, to not export various types of Data or Data Formats, but to use a uniform Data type. The resulting export should be easily shareable Information between Health Organizations using the standard. This ability to exchange information should help to minimize the tendency for medical care to be geographically isolated and highly variable. Management, evaluation of Health services, delivery and clinical practice are supported, as it is the most commonly used in the whole world Standard. The Health Level 7 Organization was founded in 1987, when in the United States of America, the Organization announced to public a set of Norms. The name HL7 comes from the seven levels of the Open Systems Interconnection (OSI) model. Level Seven is the Application Level. This Norm set was thought to set a standard for data processing of administrative and medical Data. Vision of the Organization is to create the best and most widely used standards in healthcare. Nowadays the Health Care 7 Organization, has Affiliates Organizations in over 30 Countries, with the first affiliate Organization founded 1993 in Germany. The standards of Health Level 7 can be easily found on the official Website [1] of the Organization. Selected products and standards are provided by no cost Licenses. Standards of Health Level 7 can also be found under the ANSI/ ISO/ HISTP standards, as it provides the whole life cycle from development, adoption and market recognition until the utilization and adherence of the products. Those Standards are grouped into seven categories by reference:

1. Group Primary Standards: Most frequently used and asked Standards in this are to be found in this Group. System Integrations, inter - operability and compliance.
2. Group Foundational standards: Technology infrastructure that must be implemented by the developers of Health Level 7 Standards. Also the Fundamental tools and building blocks, used to build the Standards themselves.
3. Group Clinical and Administrative Domains: Messaging and Document Standards (Format) for clinical specialties are described in this Section. This Group is taken use of usually after Group 1 (Primary Standards) is implemented.
4. Group EHR Profiles: The Standards that provide profiles and functional models for electronic health records and management.

5. Implementation Guides: Guides and Support Documents for the use of conduction with an existing standard (Supplemental and supportive Documents and Documentation for parent standards, parent components)
6. Rules Section: The technical Specifications, programming structures and guidelines for software and standard Development.
7. Education and Awareness: (DSTU's) Draft Standards for Trial Use and current projects are found here. Tools helping to understand and adopt the Heath Level 7 Standard.

The Members themselves are also organized into workgroups. There are Meetings of those workgroups three times per year at various locations, where the members meet each other and work together on the standards and educate themselves and the IT Community. Those Meetings are open for everyone to join and most of the working groups recruit developers through them, as HL7 is a volunteer organization. Every Member is encouraged to be participate in all Work Groups, as the Work groups are responsible for defining the standards. Also every Work Group has two or more head chairmen. There are three kinds of membership. Individual membership in which the member is personally interested in the Standard, the affiliate membership and the organizational membership for members who want to use the standards as part of their business plan.

### 3. OpenMRS

OpenMRS is a worldwide community of volunteers from many different backgrounds. Some of them are involved in the health-care system directly, other have a technological backgrounds. Together they aim to create one of the most flexible and largest technology platforms for medical health-care. The project itself is mainly written in Java with some JavaScript and Ruby which is typical for a web based application. The full source code and project are released under its own license which builds on the existing Mozilla Public License 1.1.

There exist some OpenMRS demos to give the user a taste of the Software based on different point-of-views.

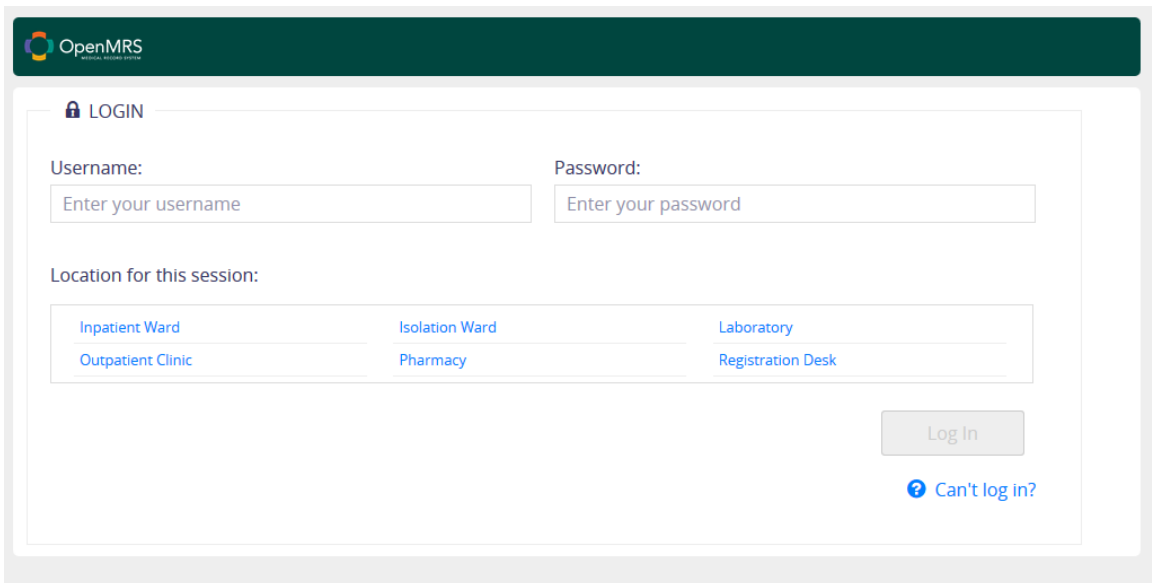


Figure 2. Login screen for the OpenMRS Platform

As early as the user visits the page, he has the ability to choose the location for his session. The user needs to provide his username, a password and the starting location for his current session to login and continue.



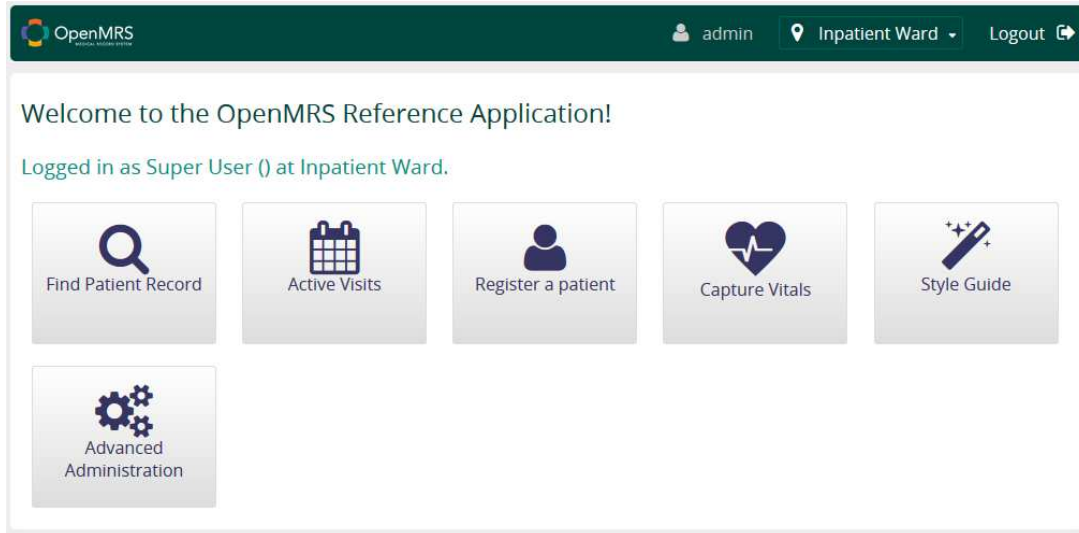


Figure 3. Welcome Page, logged in the Inpatient Ward

After logging in the user is greeted by a clear arranged and neatly looking menu which provides him the main functions of the application. On the top right hand side the user can see his name as well as the current location he is logged in at, and of course he can log himself out there. For the user it is also possible to change his location directly in the main menu without the need to log out first and later log in again. He just needs to click onto his current location and is prompted with all the possibilities where he can choose his new location from. Available are, as already seen on the login screen, the Inpatient Ward, Laboratory, Outpatient Clinic, Pharmacy and the Registration Desk.

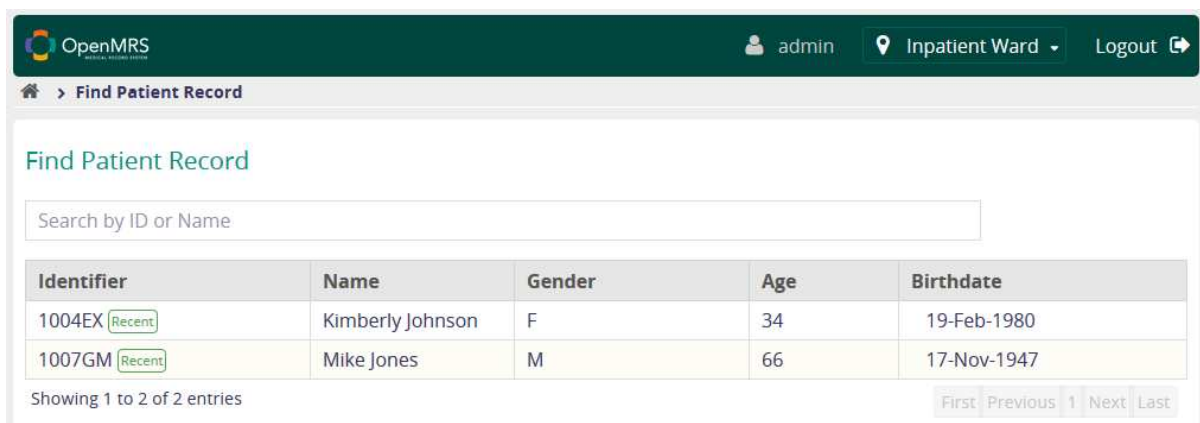


Figure 4. Patient record overview

In the main menu the user has the ability to find a patient record in the database. By selecting this option the user has the ability to find a record on a patient. Per default the recent patients are listed there, in our example this are two people. In case the user wants to search for any non-recent patients one can do so by just clicking into the search bar and entering either the name of the person or the unique Identifier. To gain more information about a specific patient one just need to click onto a patient's name.

The screenshot displays the OpenMRS interface for a patient named Kimberly Johnson. The header shows the user 'admin' and the location 'Inpatient Ward'. The patient's details include 'Johnson, Kimberly', 'Female', '34 years (19.Feb.1980)', and 'Patient ID 1004EX'. A status indicator shows 'Active Visit'.

**DIAGNOSIS**

- Viral conjunctivitis
- Retained placenta or membranes, without Hemorrhage
- Perineal laceration during delivery
- Jaundice
- Other Noninfectious Disorders of Lymphatic Channels
- hookworm disease
- Sexually Transmitted Disease

**VISITS**

Today	Active - Outpatient
<a href="#">23.Oct.2013</a>	Outpatient
<a href="#">02.Apr.2013</a>	Outpatient
<a href="#">13.Mar.2013 - 16.Mar.2013</a>	Inpatient
<a href="#">27.Sep.2012</a>	Outpatient

[Show more info >](#)

**VITALS**

**Last Vitals: 23.Oct.2013 04:22 PM**

- Height (cm) 127.0cm
- Weight (kg) 170.0kg
- (Calculated) BMI **105.4**
- Temperature (C) 36.0°C
- Pulse 172/min
- Respiratory rate 11/min
- Blood Pressure 192 / 28
- Blood oxygen saturation 71%

**Current Visit Actions**

- End Visit
- Visit Note
- Admit to Inpatient
- Capture Vitals

**General Actions**

- Add Past Visit
- Merge Visits

Figure 5. Private patient's record note

This private patient's record note presents all required information, in this case about "Kimberly Johnson". We can see all the diagnosis made, as well as the recorded vitals, which consists of the height, weight, BMI, Temperature, Pulse, Respiratory rate, blood pressure and blood oxygen saturation. We can also view the patient's latest visits and their statuses.

The screenshot displays the OpenMRS interface for a patient named Kimberly Johnson. The top navigation bar includes the OpenMRS logo, the user 'admin', the location 'Inpatient Ward', and a 'Logout' button. The breadcrumb trail shows 'Johnson, Kimberly > Visits'. The patient's name 'Johnson, Kimberly' is displayed with 'Female 34 years (19.Feb.1980)' and an 'Edit' link. The patient ID is '1004EX'. A green dot indicates an 'Active Visit'. Below this, there are two tabs: 'Visits' (selected) and 'Contact Information'. An 'Actions' dropdown menu is visible. The main content area shows a list of visits on the left and a detailed view of the active visit on the right. The active visit started on 08 May 2014 at 07:48 AM and has no diagnosis yet. The actions for this visit are 'End Visit', 'Visit Note', 'Admit to Inpatient', and 'Capture Vitals'. The list of past visits includes: 'Viral conjunctivitis' (23 Oct 2013 - 23 Oct 2013), 'Perineal laceration during delivery' (02 Apr 2013 - 02 Apr 2013), 'Jaundice' (13 Mar 2013 - 16 Mar 2013), and 'hookworm disease' (27 Sep 2012 - 27 Sep 2012).

Figure 6. Overview of the last patient's visits

By clicking on one of the visits the user can edit the visit note, admit the patient to the inpatient ward, capture vitals or when the visit is over mark it ended.

On the left hand side the doctor has also the ability to see all of the past visits and happenings.

The screenshot shows the OpenMRS interface for editing a visit note. At the top, the header includes the OpenMRS logo, the user 'admin', the location 'Pharmacy', and a 'Logout' button. The breadcrumb trail is 'Home > Susana, Bibi > Visit Note'. The patient information section displays 'Susana, Bibi' with 'Female 31 years (23.Apr.1983)' and 'Patient ID 1007GM'. Below this is an 'Active Visit' indicator. The 'Visit Note' section contains several fields: 'Provider' (dropdown menu with 'Super User' selected), 'Location' (dropdown menu with 'Pharmacy' selected), and 'Date' (text input with '08/05/2014' and '(dd/mm/yyyy)' format). To the right of these fields are 'Primary Diagnosis:' and 'Secondary Diagnoses:' sections, both currently showing 'Not chosen' and 'None' respectively. A 'Clinical Note' text area is located below the provider and location fields. At the bottom, there are 'Cancel' and 'Save' buttons.

Figure 7. Editing a visit note

The user has also the ability to take notes on the current visit. He can enter the primary diagnosis and the secondary diagnosis. Furthermore the provider of the note can be edited, as well as the location and the date.

The screenshot shows the OpenMRS interface for a patient named Kimberly Johnson. The header includes the OpenMRS logo, the user 'admin', the location 'Inpatient Ward', and a 'Logout' button. The patient's name 'Johnson, Kimberly' and ID '1004EX' are displayed. A list of visits is shown on the left, with the most recent visit selected. The main area displays details for the visit on March 13, 2013, including a warning that actions are for a past visit, a list of encounters (Discharge, Admission, Visit Note), and a Vitals record.

Figure 8. Another overview of the past visits

By clicking onto one of these visits the user can see a summary of the last visit, previous diagnosis and possible admissions and discharges. The user is also warned, that the current visit happened in the past and shall likely not be edited afterwards, which should prevent the user from unintended changes onto these records.

One can also view the private contact information for the specific patient by clicking on this tab in the upper part of the screen, which will then display the name, age, location and phone number and other contact details in case they are available.

OpenMRS

admin Inpatient Ward Logout

Active Visits

Search

Patient ID	Name	Check-In	Last Seen
OpenMRS ID: 1007HK	<a href="#">Prashant Suvarna</a>		Visit Note Outpatient Clinic @ 08.May.2014, 08:30:43
OpenMRS ID: 1004EX	<a href="#">Kimberly Johnson</a>		
OpenMRS ID: 1007GM	<a href="#">Mike Jones</a>		

Showing 1 to 3 of 3 entries

First Previous Next Last

Figure 9. Active visits listed

Back on the main menu the user can also view active visits directly without searching for a patient before. There, as assumed, are all currently happening visits listed with the patient ID, name and check-in date as well as “last seen” information which is composed of a location and a date to track this information unique. By clicking on the patients the name user is again directed to the patient record note.

Other options on the main menu are to register a new patient into the database, data fields such as name and family name as well as the gender and the birthdate are required. The option to enter an estimated age might come in useful for persons without any records. These information can later be edited on the patient’s record note.

OpenMRS

admin Inpatient Ward Logout

Register a patient

Register a patient

**Demographics**

Name

Gender

Birthdate

**Contact Info**

**Confirm**

What's the patient's name?

Given (required) Family Name (required)

Figure 10. Registering a new patient

Back on the main screen, a third option is to register a new patient into the database. Data fields such as the name and family name as well as the gender and the birthdate are required. The option to enter an estimated age might come in useful for person without records.

One can also enter contact information to allow the easy contact to these patients.

The fourth option on the main menu is to capture the vitals of a patient, which can only be done once the patient is checked in. These vitals consists of, as previously seen, the patients pulse, weight,

temperature, height, respiratory rate, and blood oxygen saturation, systolic and diastolic blood pressure. Once entered, this information can also be accessed from the patient's record note.

The Style Guide options is probably no benefit for later use, this is probably a section for developers or admins and may not be available to default users. Colors, navigation element and the design might be changed there.

As well as the style guide the administrative center may not be available to users on final use. The administrator has the ability to change various settings regarding HL7 Messages, the Maintenance, Visits, the Users and their roles as well as an automatic ID Generation and Exchange Modules there.

All these information are stored on the server the web service is running on and can so be accessed from any computer all around the world. The User Interface is really slick and neat and provides all the needed information. By testing the service it felt fluid and intuitive and was easy to handle and navigate in. One drawback might definitely that the user interface seems not support multiple languages, at least not yet since all fields are English. But there's another big one patients cannot log themselves into this system and update their current vital signs, their doctor has to do that for them – so in situations where patients also need to be able to have a user account this system might not be the ideal choice.

### Web Links

Webpage: <http://openmrs.org/>

Demo: <http://demo.openmrs.org/openmrs/login.htm>

## 4. Caisis

Caisis is an open source, web-based cancer management system that integrates patient care with research. Caisis is a derivative of the Italian word, Casus, which means "opportunity" or "event." Because that word was already trademarked, the creators decided to change the spelling slightly to Caisis, which carries the same meaning. This name also resembles an acronym for Cancer Information System.

Been downloaded by a lot of Institutions worldwide, the system promotes standards and collaborative research. Thanks to the Community that has been receiving constant Feedback, for over a decade, from collaborating Health centers, the Caisis Platform has been formed. The Community aims at high usability, and a clean vision when creating large datasets for researching cancer and patient care. The system is freely distributed and released under an Open Source License.

The Healthcare System Platform is written in ASP.NET/C# and uses Microsoft SQL Server. It is entirely web based, making it cross platform usable from the Users point of view. As an administrator it is possible to run the Platform on a Unix System (Linux or Mac Server), as long as the Mono Project is installed and configured for this use.

As in Open MRS demonstrated, there is also on the Web-Page of Caisis a Demo that can be used to get a glance at the Platform and its functions. Unfortunately the point of views, available in this Demo, are lesser than in Open MRS.

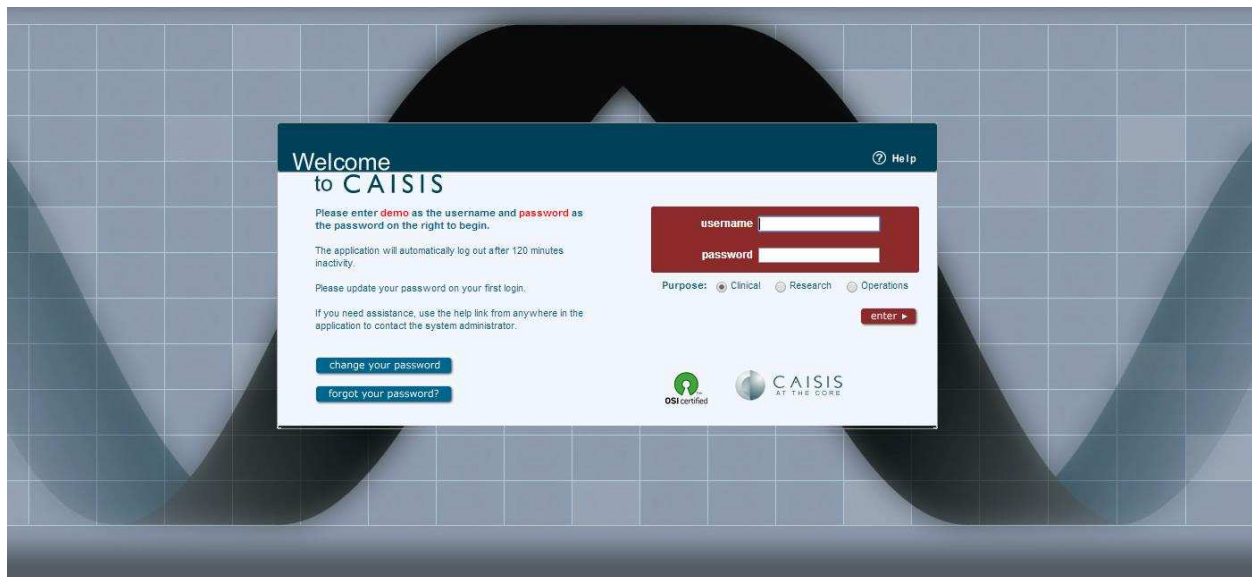


Figure 11. Caisis Login Screen

To be able to enter and use the Platform, the User has to authenticate with his username and password, also choose which session type (listed as Purpose here) he wants to use.

In this footage we will be logging in as Clinical Purpose because of the Administrative rights, but on the Demo Page there are no Options for Developers/Admins.



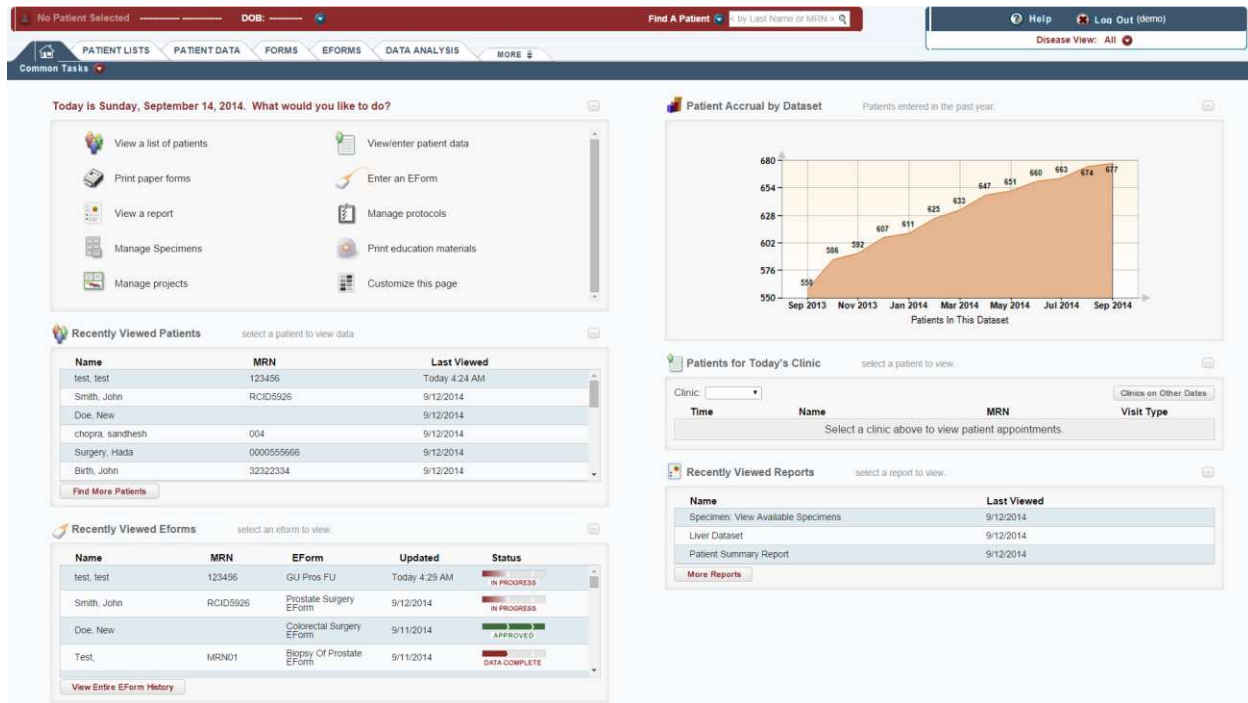


Figure 12. Welcome Page in Caisis

First of all the User is logged into the „Home Page“, where he has an Overview of his activities, meetings and a lot of other Information. On this page the User can make use of the listed common Tasks or navigate through the tabs, and filter out the actions he wants to use. On the „Home Page“ the Main Window the actual Date is displayed to the User and fast access to Viewed Patients, Viewed Eforms, Pending Eforms, today's patients, viewed report, patients accrual by datasets, and a lot of other common tasks. For example he can view a list of patients, enter patient data, print paper forms, enter an EForm, view a report, manage protocols, manage specimens, print education materials, manage projects and at last customize the Start Page. On the top right corner the User can see his name, use the Help-Button and Log-out. Other actions can be performed like Filtering the entire Database search Results to a Disease. On top in the mid task bar the User always gets the Name-lastname of the Selected Patient and a DOB rate. Also its search function can be used like a search Engine with the „Find A Patient - Filter“ giving the user a lot of opportunities to manipulate the search results.

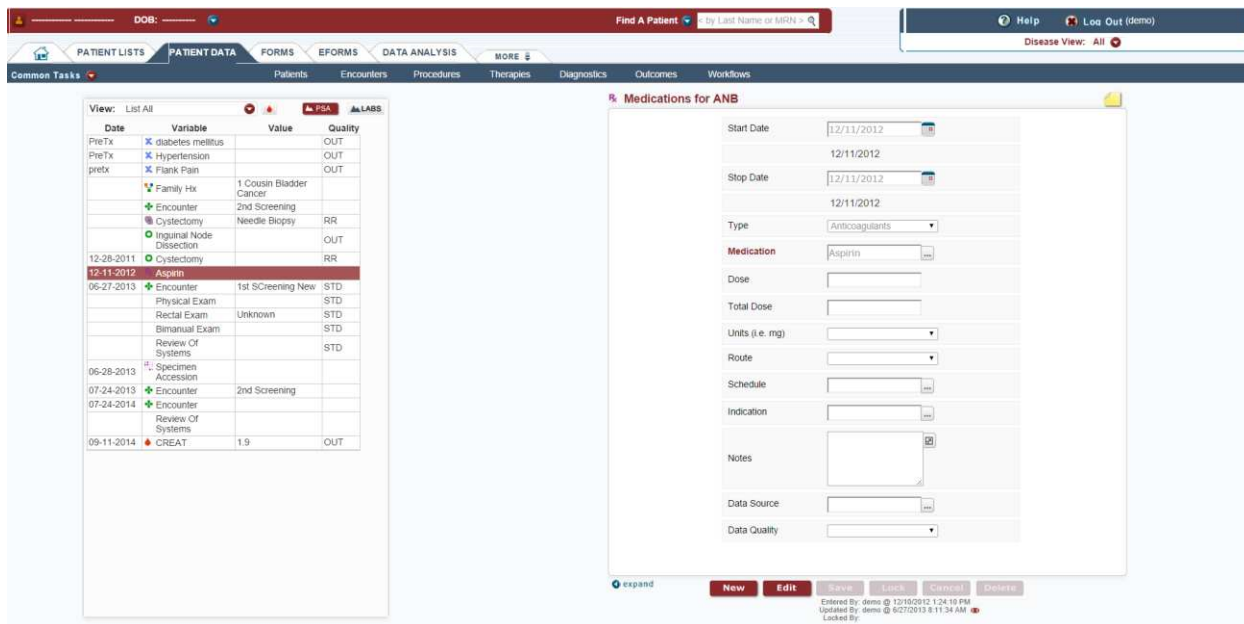


Figure 13. Overview of the patient's data

Highlighting the Patients Data Tab we can see various vital Information about the Patient that might be very interesting for the User. On the left panel a Table with valuable Information about Exams and Health Checkups, Results as upcoming Exams, exists. The Exams, Results and notes are listed from previously taken to upcoming. Information about the Illness, the Date encounters occurred, the Date medication was taken and the amount of it, Date and Name of surgery, etc. is given. If the User wants to edit this Information, or maybe export it, he has to highlight an Event (ex. 12-11-2012 Aspirin) and then he can manipulate the Information in the right Tab. If the User clicks on the Exam or Checkup he can visit the Node and edit the Attributes of the Node. For example Medication can be edited for the Doses that has to be taken by the User, or the Units he has to consume. The Schedule and the start and end date. Highlighting an Exam the editable attributes if the Node are more. A Date can be inserted, a type, the name of the Physician, Nurse and the Status. Also many results and valuable Information like the Height, BMI and Weight of the patient can be edited.

Figure 14. Registering a new patient in Caisis

New Patients can easily be added to the Database by clicking the „Common Tasks“ drop-down Menu and highlighting the „Add new patient“ Option. As in the Picture seen there are a lot of Options available, to enter Information about the Patient. Only Last Name and MRN are required Information, as for the Developer those two values are vital and important, for the Database. Values as First-, Middle-name, Date of Birth, Gender, Race, Contact Status, Addresses and Notes are not required for making a record.

Of course we did some testing and came to the conclusion that the MRN is a value that has to be unique. If not so, the Platform prompts the User that a recorded Patient already exists with the given MRN. The other way, the Last name has to be a value unlike null. It appears that there can be more „PatientsFachstudie“ in the Database with different MRNs, but different „PatientsFachstudie1“ and „PatientsFachstudie2“ with the same MRN cannot exist. Searching for the Patients can be done through the „Find a Patient“ text field on top of the Site, or on clicking the „Patients List “ Tab.

All Patients



Click a record below to view data for that patient. Displaying 0 to 200 of 677 patients [Next](#) ▶

Name	D.O.B.	MRN	Comments
			PROTOCOL-PATIENT
a			
AA			
ali			
ANB			
Datpatient			
Reza			
s			
test			Protocol-Patient   Participant ID: 100017
#1# #1#		#1#	Protocol-Patient   Participant ID: 100024
#2# #2#		#2#	Protocol-Patient   Participant ID: 100025
???? ?????	14042013	9100	
??? ??????	1361	?????	
????? ??????		89767263	
????? ??????		100537	
????? ?apasta?????	05/11/1988	1452369852145	?sd asdsaasdas asdasdsad asdsad sadsadasdad asd sadasd asd d dsd asddsasadsad asdasdad asdasdad asd asd asdasd asd asd asd asd asd sd asd s sadasddas dsa dasd asd asd das
121212 1121212		1121212	
12		fgh567	
John 123	11/16/1970	AK47	none   Participant ID: 100030
1925 Tu St 1925 Tu St	1925 Tu St	Unit #290	

Figure 15. Overview of all patients

At this time the only available Display Language on the Caisis Platform is english, but as it is a Open Source Project (GPL General Public License) there shouldn't be a Problem to install Language Packs manually. The Official Statement of Caisis Developers is that Language expansions will come with time, as the project matures.

**Minimum Requirements for the Web Server Are:**

**Web Server**

- Windows Server 2000 and above
- IIS 6 and above
- Microsoft .NET Framework 3.5/4.0

**Database**

- Microsoft's SQL Server 2008++
- To estimate DB size, the following formula may be used:

- $[(24.7 \times \# \text{ Patients})/1024] + 10\text{MB} = \text{Total Database Size (MB)}$
- Computed Average: 24.7 KB/Patient
- Empty Database Size: 10.0 MB
- 1MB = 1024 KB
- 10 % of MDF file (equals the size of the log file)

### Web Links

Webpage: <http://www.caisis.org/>

Demo: <http://caisis.org/demo/Login.aspx>

## 5. NOSH

Nosh (New Open Source Health) is another Open Source Health Charting System released under the GNU AFFERO GENERAL PUBLIC LICENSE which aims to let medical providers have access to an “intuitive, world-class electronic health record for minimal cost”. The project is developed by Michael Chen, a family physician from Portland, Oregon. The project is mainly written in PHP with JavaScript.

The Live Demonstration offers four abilities to log into the system either as provider, assistant, billing and patient, so we can actually use the system as patient as well which might be a huge advantage.



Figure 16. Login Screen for the Nosh Platform

The login screen is minimalistic but still offers a modern design, where the user can enter his username, password and the organization he wants to log into.

### 4.1 Provider Account

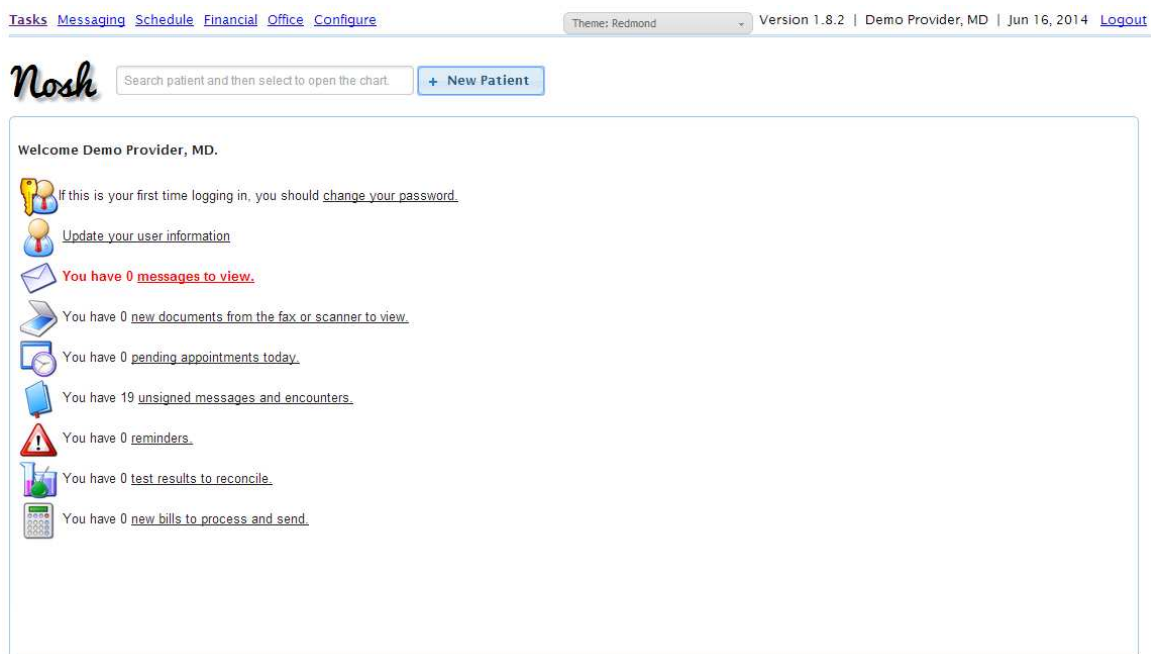


Figure 17. Welcome Screen for a provider in NOSH

As we are logged in as a provider we are greeted by a welcome page which shows us new unread messages, new documents, appointments or reminders.

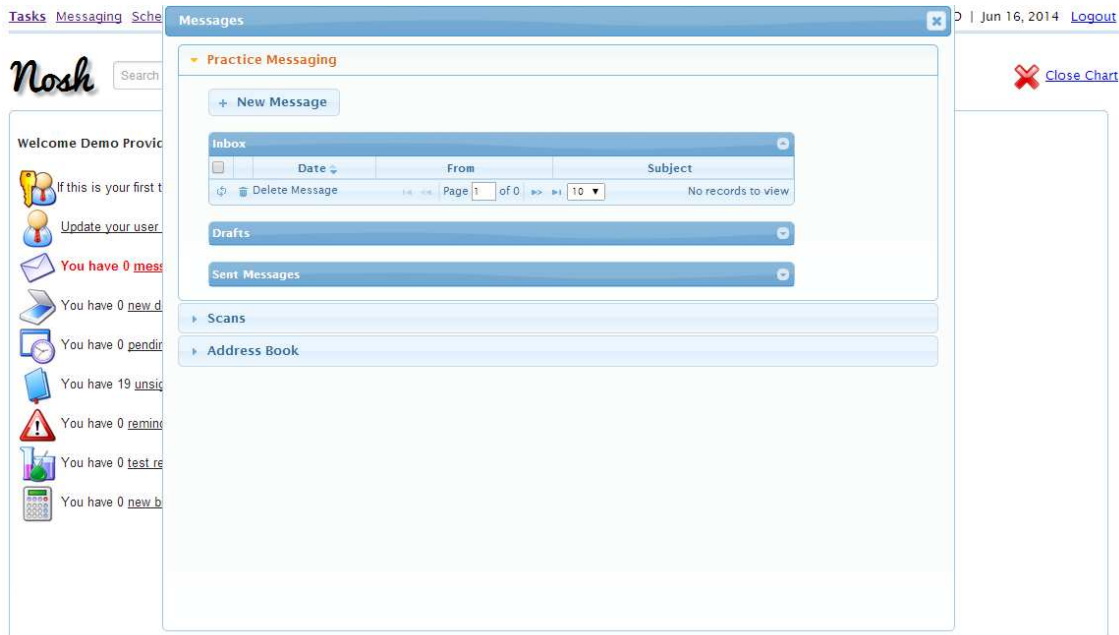


Figure 18. Message Overview in NOSH

By clicking the message item on the top content bar we access the message menu, which is not opened as a new webpage or tab but instead as window on top of the welcome screen. Here we can send messages; import done scans or one can manage the address book. By clicking onto the new message item another window appears which looks similar to mail clients, there we have the ability to enter a subject the receiver of the message or copies of it, additionally to mails we have the ability to enter the concerning patient which is optional as a second subject.

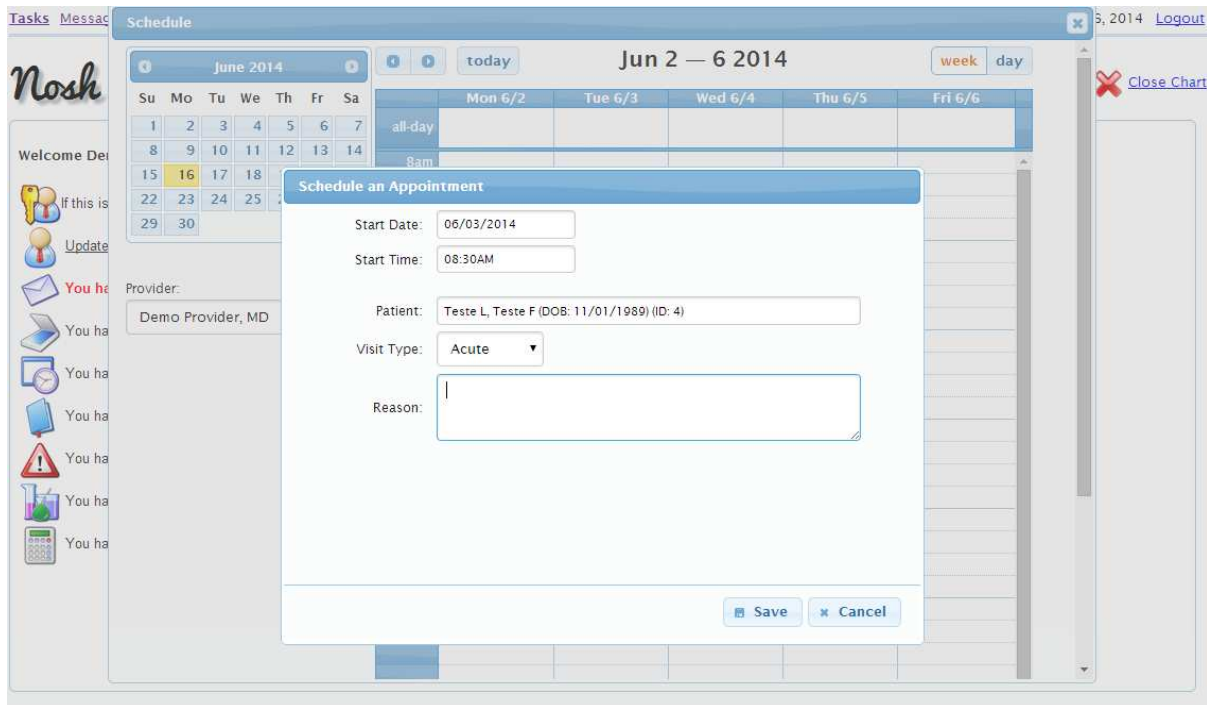


Figure 19. Calendar and schedule option for appointments

The option schedule opens a calendar; by clicking onto any of the free slots we can schedule a new appointment. By default there are five visit types available: acute, followup, surgical, reser and FOC. The patient field has some sort of auto complete so the user does not need to keep all the patients and their data in his mind. On the first sight there might be no option to change the duration of such an appointment, but after creating it one can drag the end to the field the user desires to. The system allows the user to have multiple appointments at the same time. The single appointments can be dragged and dropped from one time or day to another one.



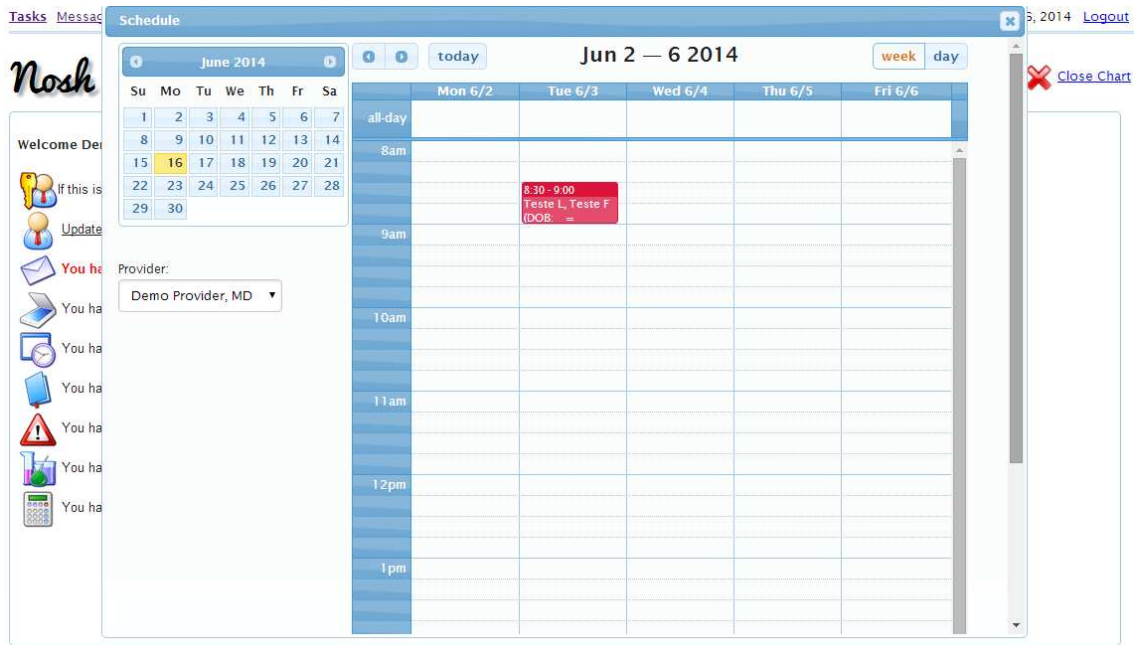


Figure 20. Example appointment in the calendar

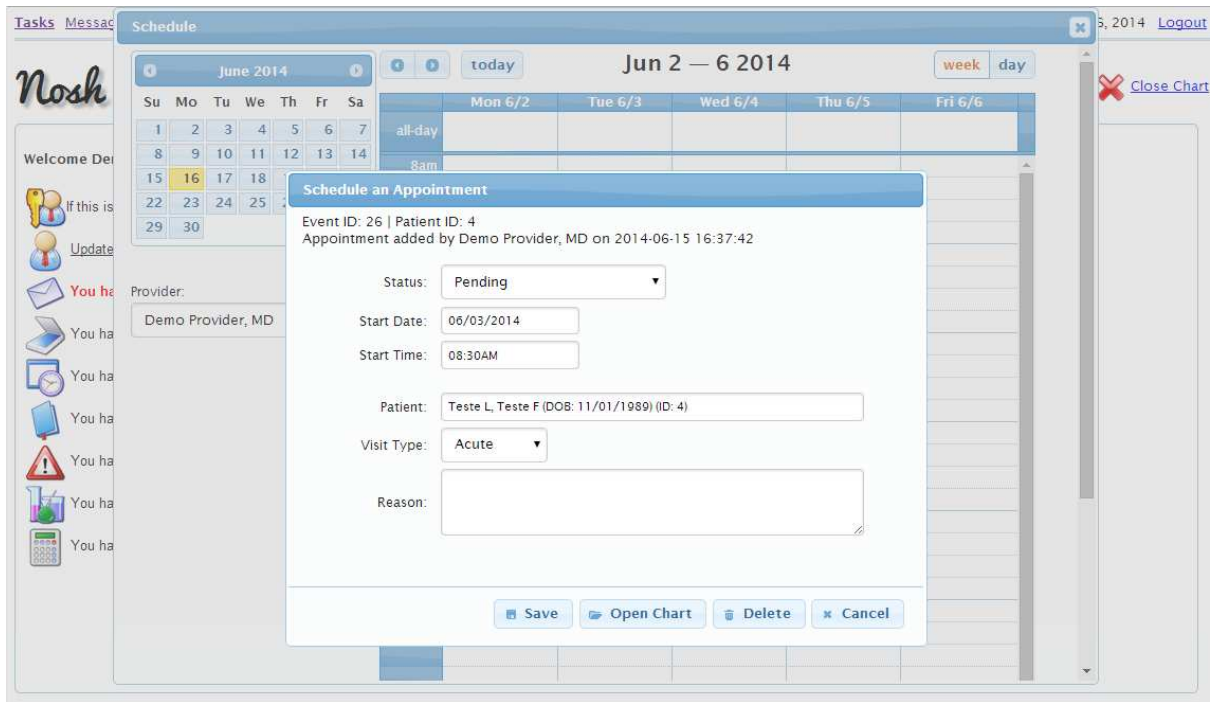


Figure 21. Scheduling an appointment

By clicking back onto the appointment we have now the possibility to delete it or open the chart.

Tasks Messaging Schedule Financial Office Configure Theme: Redmond Version 1.8.2 | Demo Provider, MD | Jun 16, 2014 Logout

Nosh Search patient and then select to open the chart. + New Patient [Active Patient Chart: Teste F Teste L] Close Chart

Chart for (ID: 4)  
 Nickname:  
 Date of Birth: November 1st, 1989  
 Age:  
 Gender:  
 Last Encounter: No previous visits.  
 Next Appointment: None.  
 Prevention Orders  
 Growth Charts

Demographics  
 Save Save and Close Cancel Insurance Register for Patient Portal

Name and Identity  
 Last Name: Teste L First Name: Teste F Nickname:  
 Middle Name: Title: Date of Birth: 11/01/1989  
 Gender: SSN: Race:  
 Marital Status: Spouse/Partner Name: Employer:  
 Ethnicity: Caregiver(s): Status: Active  
 Referred By: Preferred Language:

Contact  
 Guardian  
 Other

Figure 22. Demographics overview and edit option

This gives us a lot of information about the patient, there may be even more information or fields that needed but fortunately they do not need to be filled. On the left hand side we have also the ability to view the demographics, issues, medications, supplements and so one. This allows us either to view or to update information on the patient record note.

Tasks Messaging Schedule Financial Office Configure Theme: Redmond Version 1.8.2 | Demo Provider, MD | Jun 16, 2014 Logout

Nosh Search patient and then select to open the chart. + New Patient [Active Patient Chart: Teste F Teste L] Close Chart

Chart for (ID: 4)  
 Edit Demographics  
 Edit Issues  
 Edit Medications  
 Edit and View Details  
 Edit Supplements  
 Edit Immunizations  
 Edit Allergies  
 Edit Alerts

Medications  
 Medications - Click on the Date Active column to get past prescriptions for the medication.  
 Date Active Due Date Medication Dosage Unit SIG Frequency

Add Medication  
 Medication: Dosage: Unit:  
 Sig: Route: PO Frequency:  
 Special Instructions: Reason:  
 Date Active: 06/16/2014  
 Save Cancel

Figure 23. Medications handling in NOSH

This can be done by e.g. clicking onto medications, then edit and view details and add medication. So we have to enter the medication the signature, the dosage and unit, as well as special instructions of the frequency the patient needs to take his medication.

Back on the welcome page we can register and add a new patient to the database by clicking the new patient button and then enter the last, first name, date of birth and the gender of the patient. These fields are required, the other ones, listed in the chart section are optional and might be filled there.

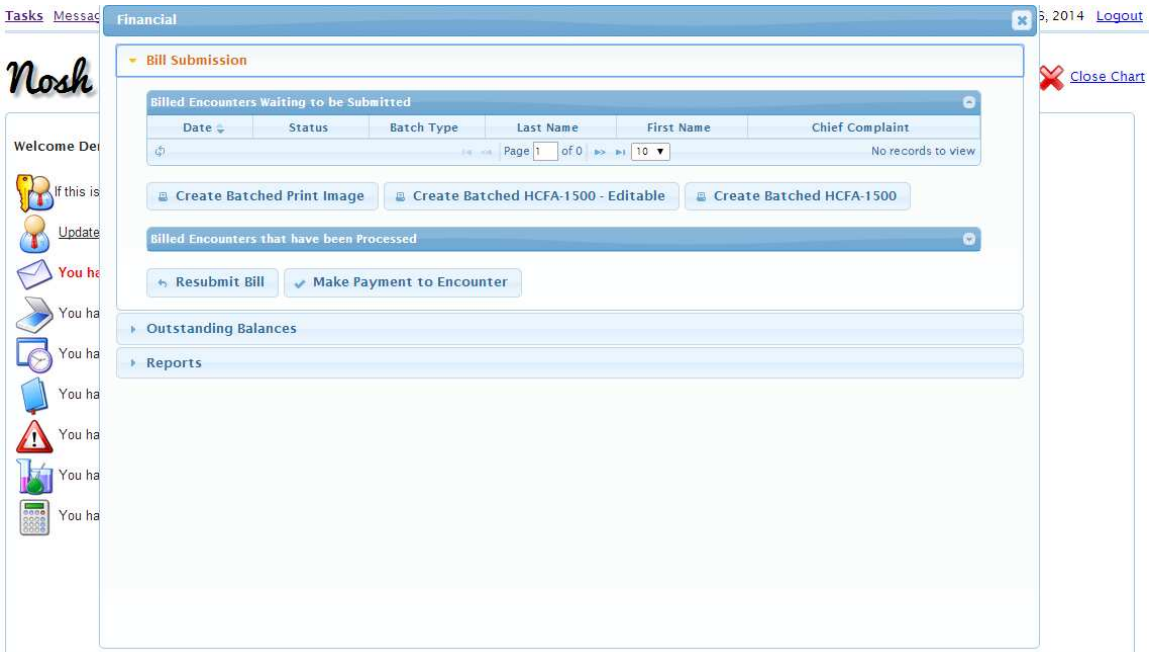


Figure 24. Financial section in NOSH

By choosing the financial section we have the ability to create bills, add outstanding balances or reports.



Figure 25. Office Tools to handle the inventory and import and exports of files in NOSH

By choosing the Office item, we have different options to edit the vaccine inventory or the temperature. One can also see queries and reports or export the office data.

The configure section allows us to set divers settings for the HPI Forms, Situation Forms and different orders.

## 4.2 Assistant Account

Despite logging into the system as the provider nosh also offers the ability to login as a assistant. The start page nearly looks the same. We have a welcome message and the start page with notifications about received but not yet read messages, documents or reminders. In comparison to the provider account there is only the appointments field missing.

On the top we have also the menu bar which includes tasks, messaging, scheduling and so on.

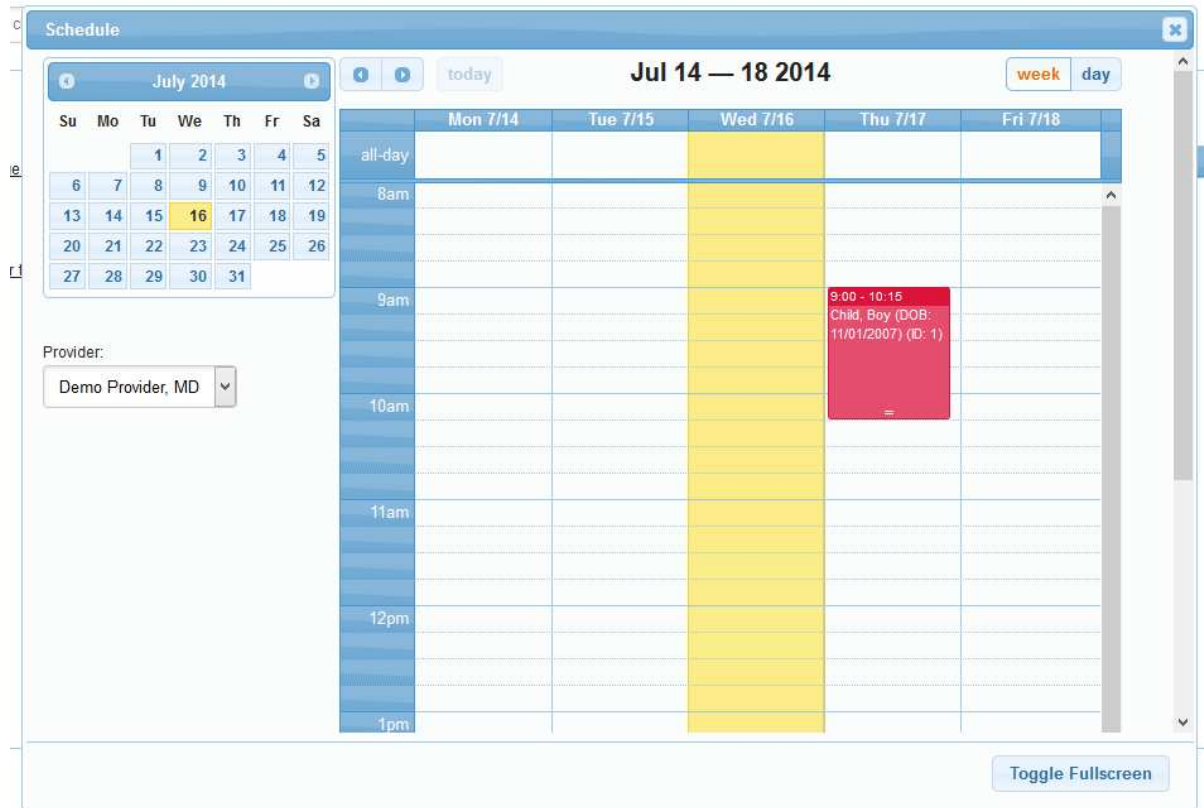


Figure 26. An appointment in the view of an assistant

The scheduling calendar looks the same as being logged in as provider, the assistant can choose the provider on the bottom left hand side and see the corresponding calendar and reschedule his appointments.

### 4.3 Patient Account

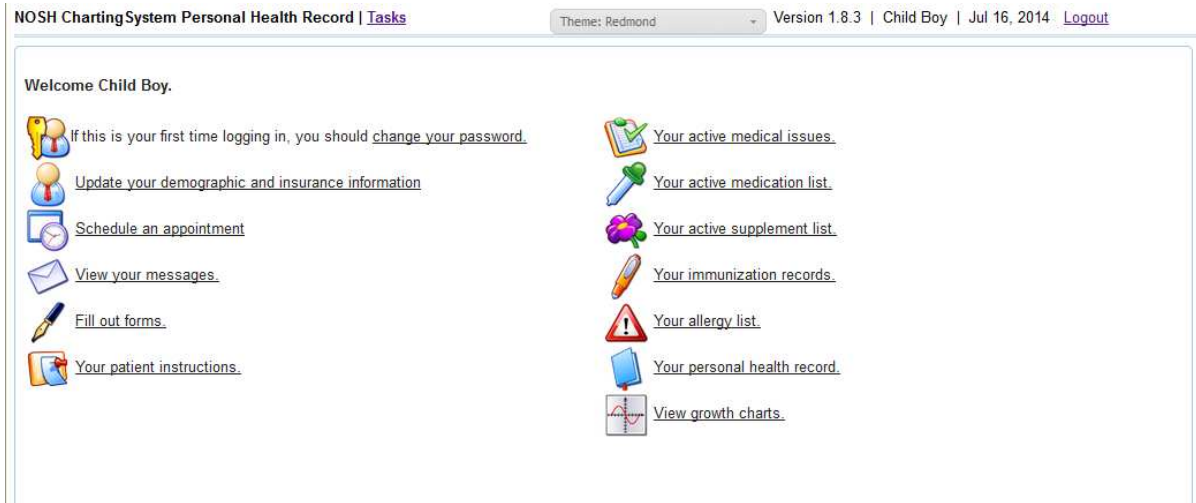


Figure 27. Welcome Page as patient (here: Child Boy)

Another option is to log in as a patient, which can come in quite handy. The start page finally looks really different compared to what we saw from the providers and assistants point of view. On the start page we can update our demographic and insurance information or schedule an appointment. We have also the ability to view our messages, find patient instructions or fill out forms. We can also have a look at our active medical issues as well as medication and supplement list. Also we can see our immunization records and an allergy list as well as our personal health record and a growth charts.

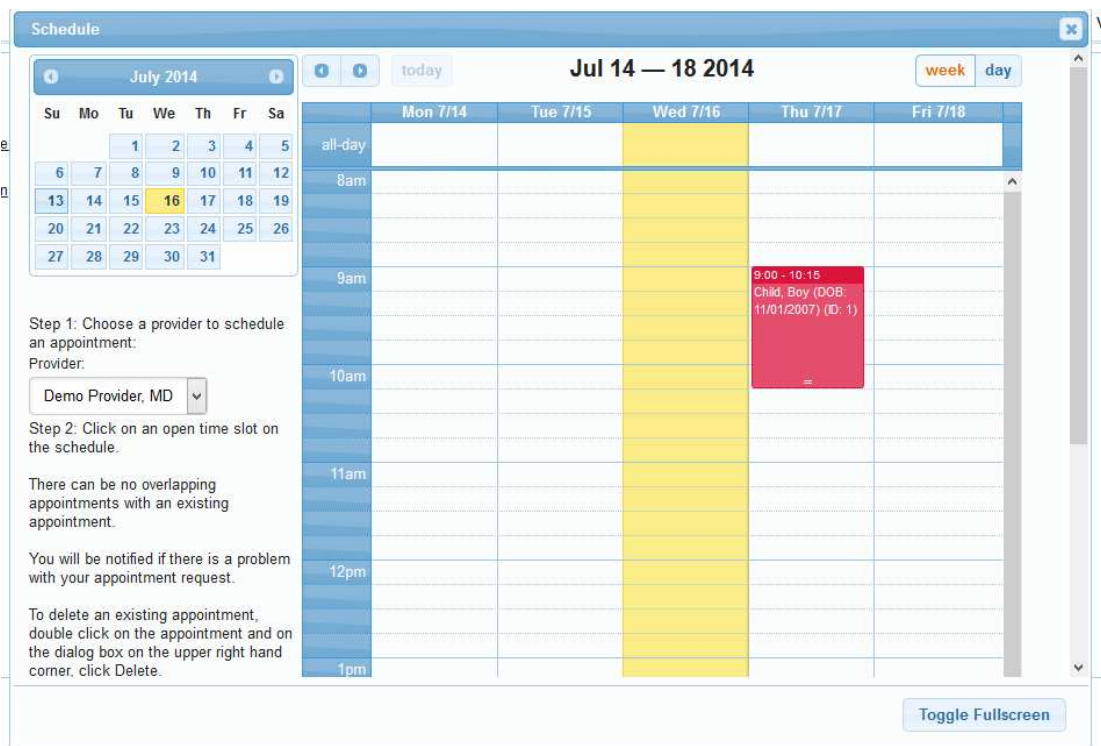


Figure 28. An appointment in the view of the patient

Scheduling an appointment as patient works the same as scheduling an appointment as provider or assistant. On the left hand side the patient can choose the provider and can read the instructions on how to reschedule an appointment on their own. Nosh will notify the patient if there is a problem with the appointment in case it cannot be rescheduled according to the patient wishes.

Forms and instructions cannot be added as patient instead viewed only. Once the provider has added a form the patient should be able to fill out this form from his account.

Date Active	Issue
2014-05-19	ADHD, anxiety

Page 1 of 1 View 1 - 1 of 1

Inactive Issues

Figure 29. Listed issues

By choosing the issue field these are displayed to the user, issues can also not be added as user but only viewed. The same applies to the other fields, where the user can keep track of his medical history and view past events, but he is not able to edit or change any of these entries.

#### Web Links

Webpage: <http://www.noshchartingsystem.com/>

Demo: <http://demo.noshchartingsystem.com:444/nosh>

## 6. Microsoft HealthVault

Microsoft HealthVault is in comparison to the previous clinic management systems no open source platform but we can still test it by creating a Microsoft account.

On the first page HealthVault advertises itself with the features it provides, it can give us the ability to organize our family’s health information and be better prepared for doctor visits and unexpected emergencies. Furthermore we can create a more complete picture of our health, with us ourselves at the center and last but not least achieve our fitness goals. [http://goo.gl/CO3FTm, 2014-07-15] Access to the health data can be shared so that one can change the entered values.

After login in we are welcome by the start page and a brief introduction.

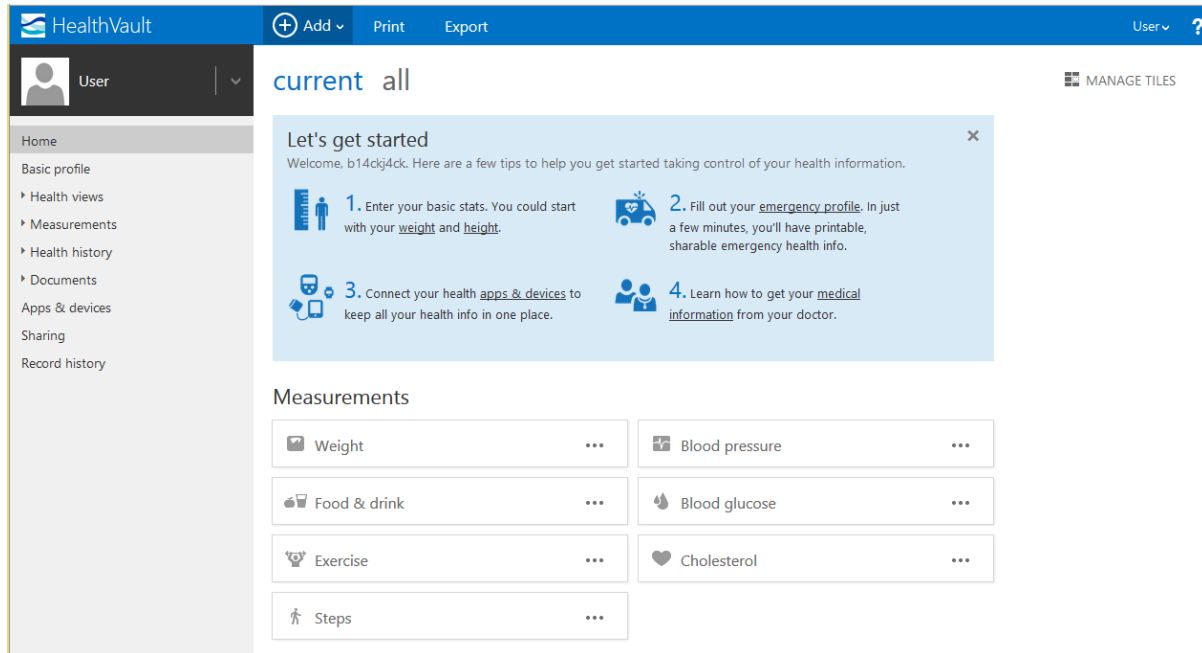


Figure 30. MS HealtVault after logging in

The first steps are quite simple we can enter our weight either in “lbs” or in “kg”. Furthermore one needs to enter the date of the record, so we can keep track of our possible weight fluctuations. After entering our weight we shall enter our height, either in feet and inch or in, as we use it, centimeters. As seen on the weight page we need to enter a date as well, to keep track of changes which might not be needed for full-grown patients. The Import buttons gives one the ability to upload a comma separated spreadsheet file containing the suitable data.

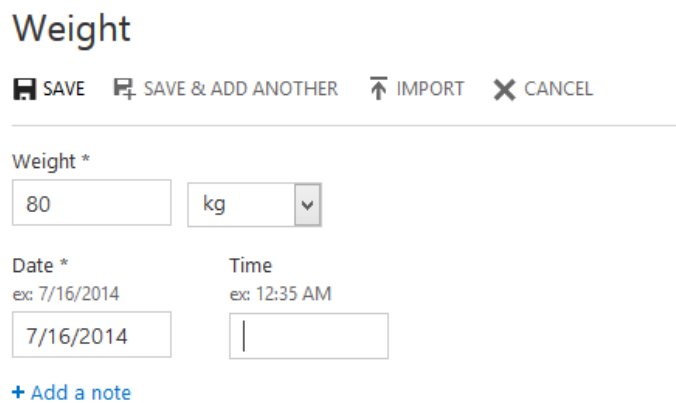


Figure 31. Editing a person’s weight in MS HealthVault



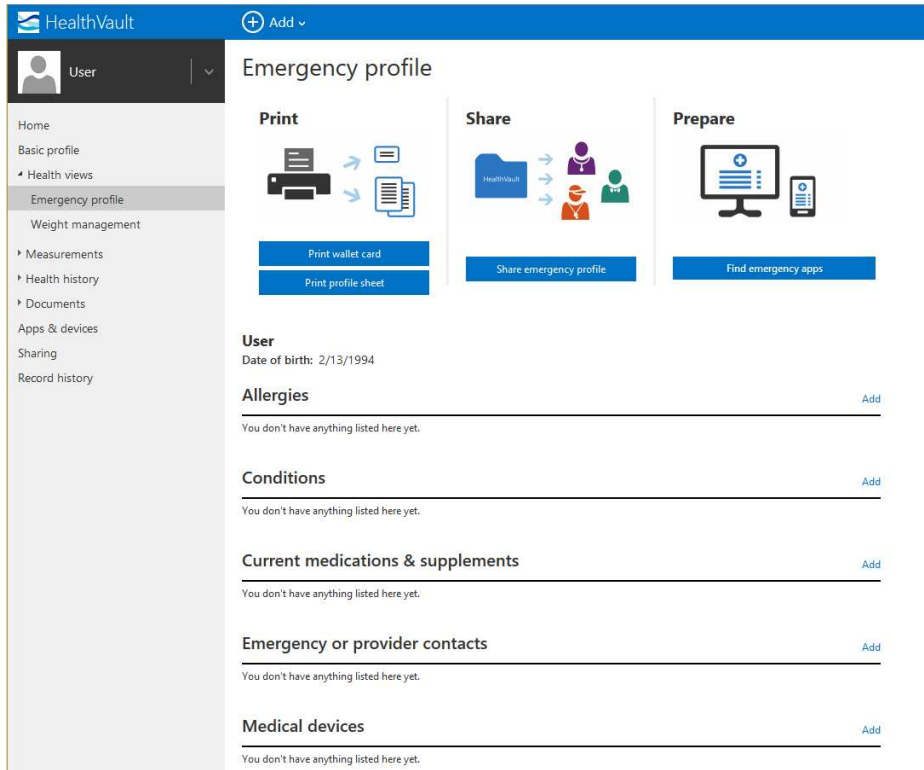


Figure 32. Emergency profile in MS HealthVault

After entering our height and weight the “Let’s get started” guide advises us to complete our emergency profile. Several allergies, conditions or medical devices can be listed here. By choosing to add a new allergy we have a lot of options to customize the record. We, of course, have to enter the name of our allergy and can also enter the reaction where we can choose from a lot of different options (approx. 80 Values) containing blood infection, cough, diarrhea, fatigue, fast breathing and many many more. Type does not offer that much options, we can choose from environmental, animal, food, medication or plant. We can but do not have to enter some treatment info, we can enter the treatment provider including his full contact info, we also enter the treatment and have to answer the question whether the treatment did stop the reaction, we can choose from yes, no or don’t know. One can also enter an allergen code and a note to even further describe this allergy.

Similar to the allergt record we can enter a new condition give it a name and select a status, the options are “Comes and goes”, “is gone” and “currently has this”. The user can also enter the start and end date and how it ended (ex: recoverd) and of course enter even more notes.

**Allergy**

SAVE SAVE & ADD ANOTHER CANCEL

Name \*  
Asthma

Reaction  
blood infection

Type  
environmental

First observed  
ex: 7/16/2014  
7/31/2014

Hide treatment info

Treatment provider  
Doctor

Show contact info

Treatment

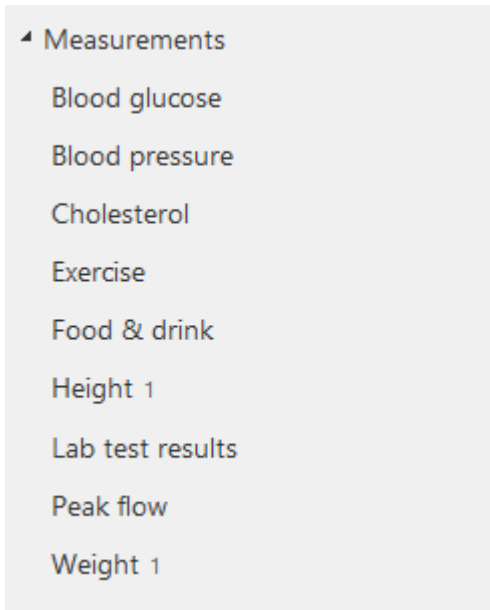
Does treatment stop the reaction? \*  
Don't know

Allergen code  
A10DFS

Note

Figure 33. Editing Allergy information in MS HealthVault

We can enter current medications and supplementes as well as emergency or prociver contacts and medcial devices as we entered the allergies and the conditions. The doctor entered in the allergies section is automatically added in the section “emergency or provider contacts”.



Our emergency profile also provides the options to print a wallet card the profile sheet or to share our emergency profile. Another option is to find emergency apps.

On the left hand side we have a brief overview of our previous measurements. We can enter new data for the blood glucose, our blood pressure the cholesterol value. We can also add exercises we are currently doing such as swimming or walking. We can enter our food & drinks, our height and different lab test results. We can also add a peak flow and keep track of our height history which offers us also a nice chart overview containing our past data.

Figure 34. List of several provided measurements

Below our measurements we have a brief health history

overview which consist of different values such as allergies, appointment and conditions we entered before. By cklicking on the corresponding field we see the history over our past data with

Last there are some options in the document section to import different HL7 file types into the system. Microsoft HealthVault currently supports the Continuity of Care Document (CCD) and Continuity of Care Record (CCR).

We can also enter apps and devices which keep track of our health values. We can also look at a the record history and can we changes made in a specified period of time.

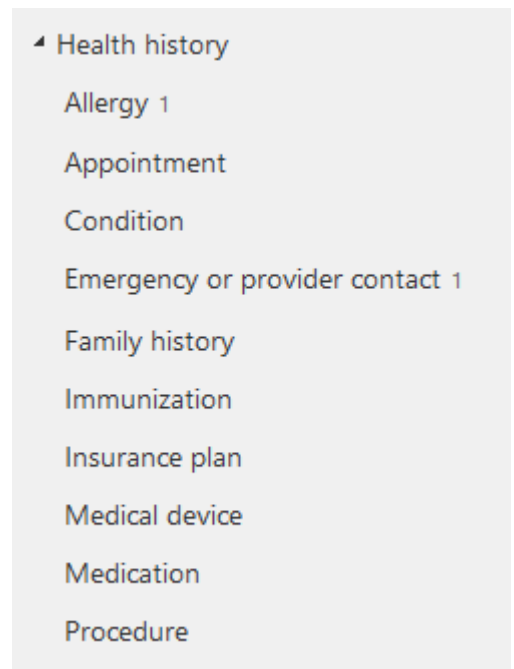


Figure 35. Health History in MS HealthVault

Date	Action	Type	Changed by	App	Summary	Details
7/16/2014 1:05:31 AM	Changed	Application-Specific Information	b14ckj4ck ...	Microsoft HealthVault	HealthVault Homepage Tile Settings	⌵
7/16/2014 12:51:06 AM	Created new entry	Emergency or Provider Contact	b14ckj4ck ...	Microsoft HealthVault	Doctor (Provider)	⌵
7/16/2014 12:51:05 AM	Created new entry	Allergy	b14ckj4ck ...	Microsoft HealthVault	Asthma	⌵
7/16/2014 12:38:52 AM	Created new entry	Height Measurement	b14ckj4ck ...	Microsoft HealthVault	193 cm	⌵
7/16/2014 12:38:43 AM	Created new entry	Weight Measurement	b14ckj4ck ...	Microsoft HealthVault	80 kg	⌵
7/16/2014 12:31:44 AM	Created new entry	Application-Specific Information	b14ckj4ck ...	Microsoft HealthVault	HealthVault Homepage Tile Settings	⌵
7/16/2014 12:31:44 AM	Created new entry	Basic Demographic Information	b14ckj4ck ...	Microsoft HealthVault	male; Born 1994	⌵
7/16/2014 12:31:43 AM	Created new entry	Personal Demographic Information	b14ckj4ck ...	Microsoft HealthVault	b14ckj4ck ...	⌵
7/16/2014 12:31:43 AM	Created new entry	Personal Contact Information	b14ckj4ck ...	Microsoft HealthVault	b14ckj4ck@hotmail.de (Primary)	⌵

Figure 36. Look at the records history

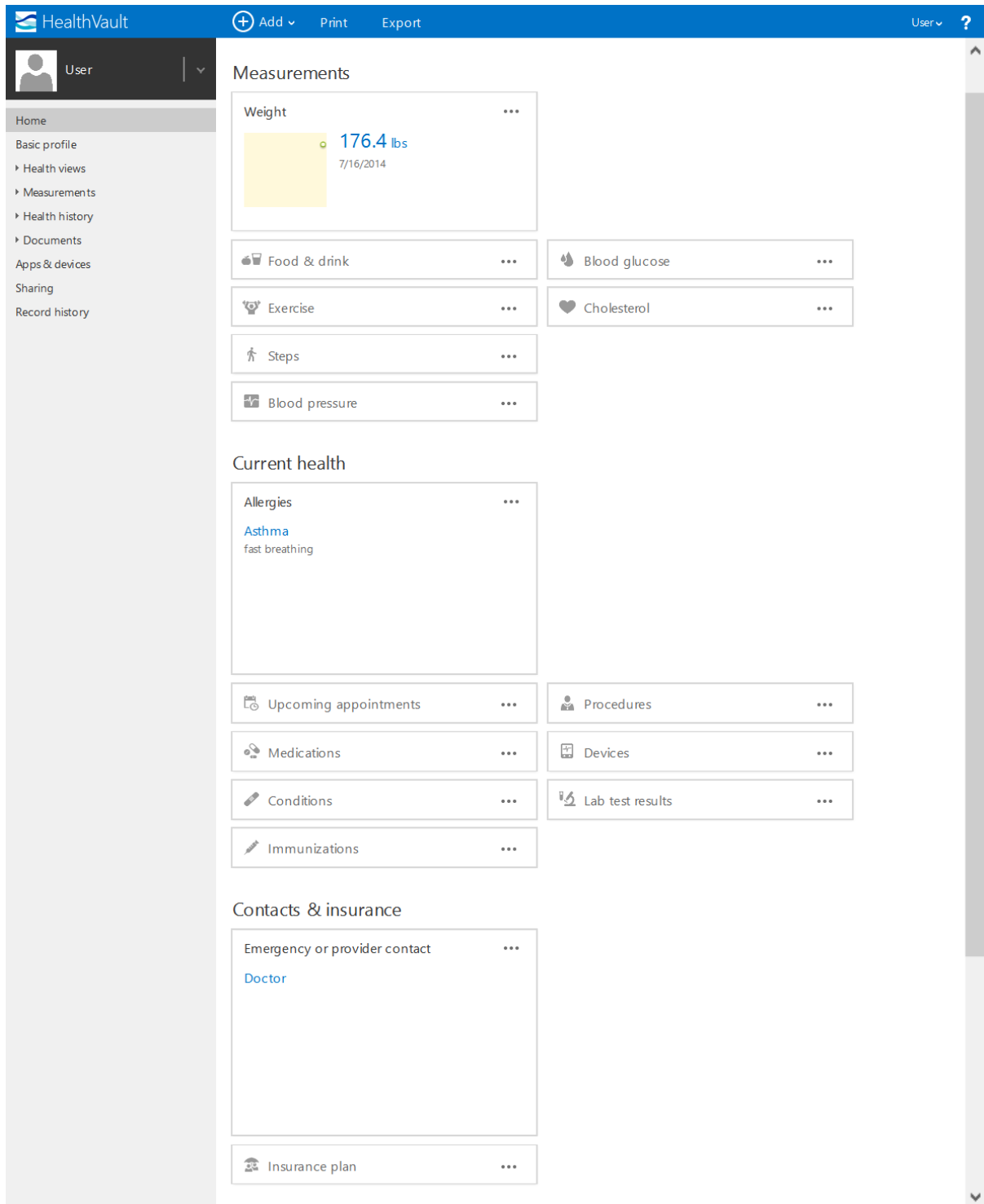


Figure 37. The User's home page in MS HealthVault

Back on the main and start page we have a brief overview of either all or the current data, containing our weight and much more of our entered data.

As of our knowledge there is nothing like a special doctor or physician account, the data must be shared with him, so he can check our entered data. The advantage might be that we are actually in control after deciding to change our doctor our old one can no longer access our data (in case we remove his authorization), on the other hand these must be entered manually what might be confusing for many users. We would prefer dedicated doctor or physician accounts and believe this would make the platform easier to use and understand.

Despite being not a HL7 standard Microsoft HealthVault can still import HL7 file types, therefore we added and tested it here. This platform is neatly arranged and fits well with all the other Microsoft services. This can either be an advantage or a huge disadvantage. A large problem might be that the data is stored on the Microsoft servers all around the world, due to the latest NSA scandals this might not be ideal. Different people working and supporting the HL7-Standard claim the “The Crisis in E-Health Standards” needs to be stopped and this should not be done by “quasi-governmental committees” [<http://goo.gl/7HEZuY>, 2014-07-15]. Microsoft HealthVault provides some good ideas such as adding devices which keep automatically track of the patient’s vital signs and the ability to always look at the vital signs of older related persons or of one’s kids but in the end might not be used due to a limited access, since it is not an open-source project, and the fact we do not have control over the data. HealthVault interacts strongly with the corresponding API which might be regarded as another disadvantage since this is a proprietary Microsoft API it might be available across many devices but be rather Microsoft specific. On the other hand by using these APIs keeping track, changing or adding information has been made really easy.

#### Web Links

Webpage: <https://www.healthvault.com/>

## 7. OpenEMR

OpenEMR is an electronic health record (EMR) and medical practice management software. It is written in PHP which makes it more or less platform independent as many platforms (Windows, Linux, Max OS X, ...) run PHP. The Project was created with the aim to give the users of EMR software a free and feature rich software where they have the complete control over the system and the patient's data. It is licensed under the GNU General Public License and therefore freely available for everyone. It also has an ONC Complete Ambulatory EHR Certification.

### 6.1 Doctor Account

The first thing to see when opening the web frontend to OpenEMR is a login box where the user has to provide a user name and a password, he can also choose from about 20 languages, any other language can be added and translated with a google docs spreadsheet maintained by the community. The OpenEMR demo gives the opportunity to login as an admin, a physician, a clinician, an accountant

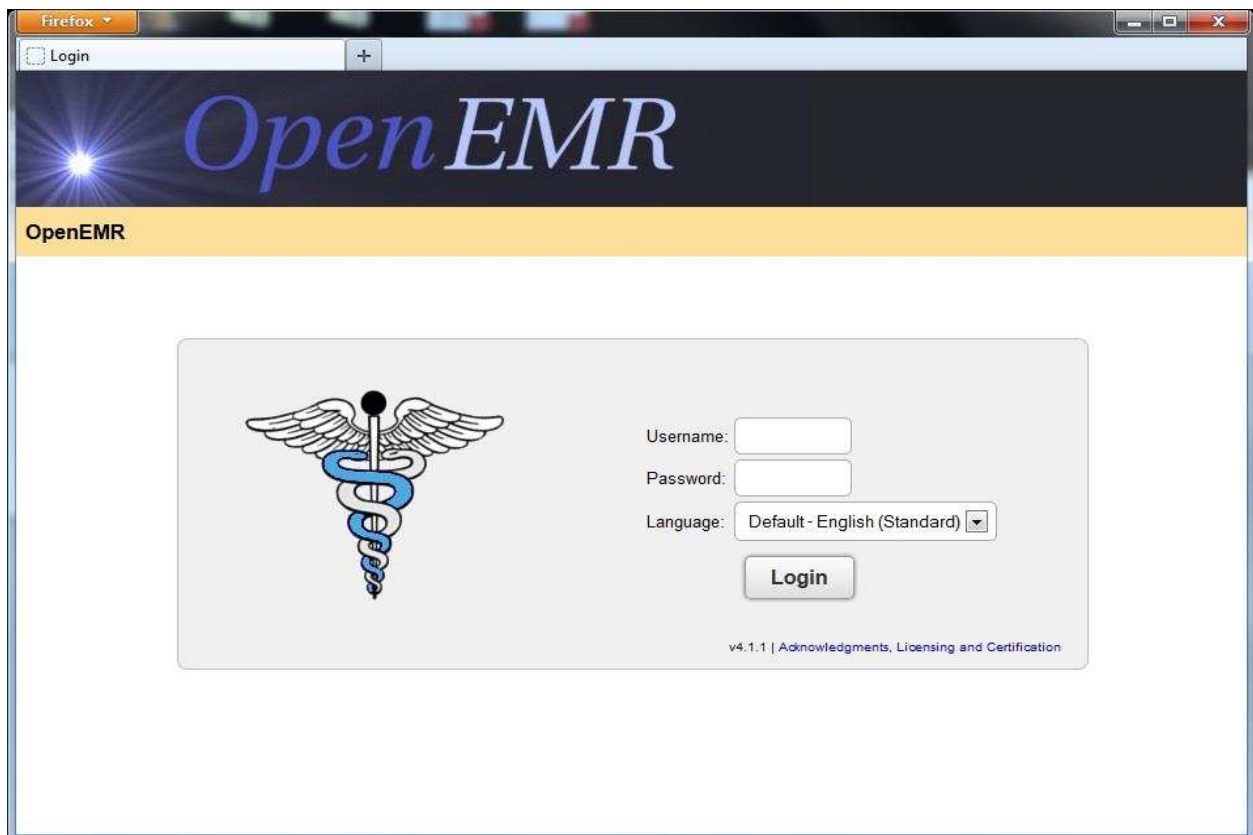


Figure 38. Login Screen in OpenEMR

[http://www.open-emr.org/wiki/images/thumb/5/57/OpenEMR-Login\\_4\\_1\\_1.png/800px-OpenEMR-Login\\_4\\_1\\_1.png](http://www.open-emr.org/wiki/images/thumb/5/57/OpenEMR-Login_4_1_1.png/800px-OpenEMR-Login_4_1_1.png)

and a receptionist, where a physician has more access than a clinician. There is also a Login for patients but that is on an own subpage and is covered later.

After the login you are normally on the calendar view and have a main menu on the left. The style looks a bit old for the systems of today but it seems to be easy enough to find what you are looking for.

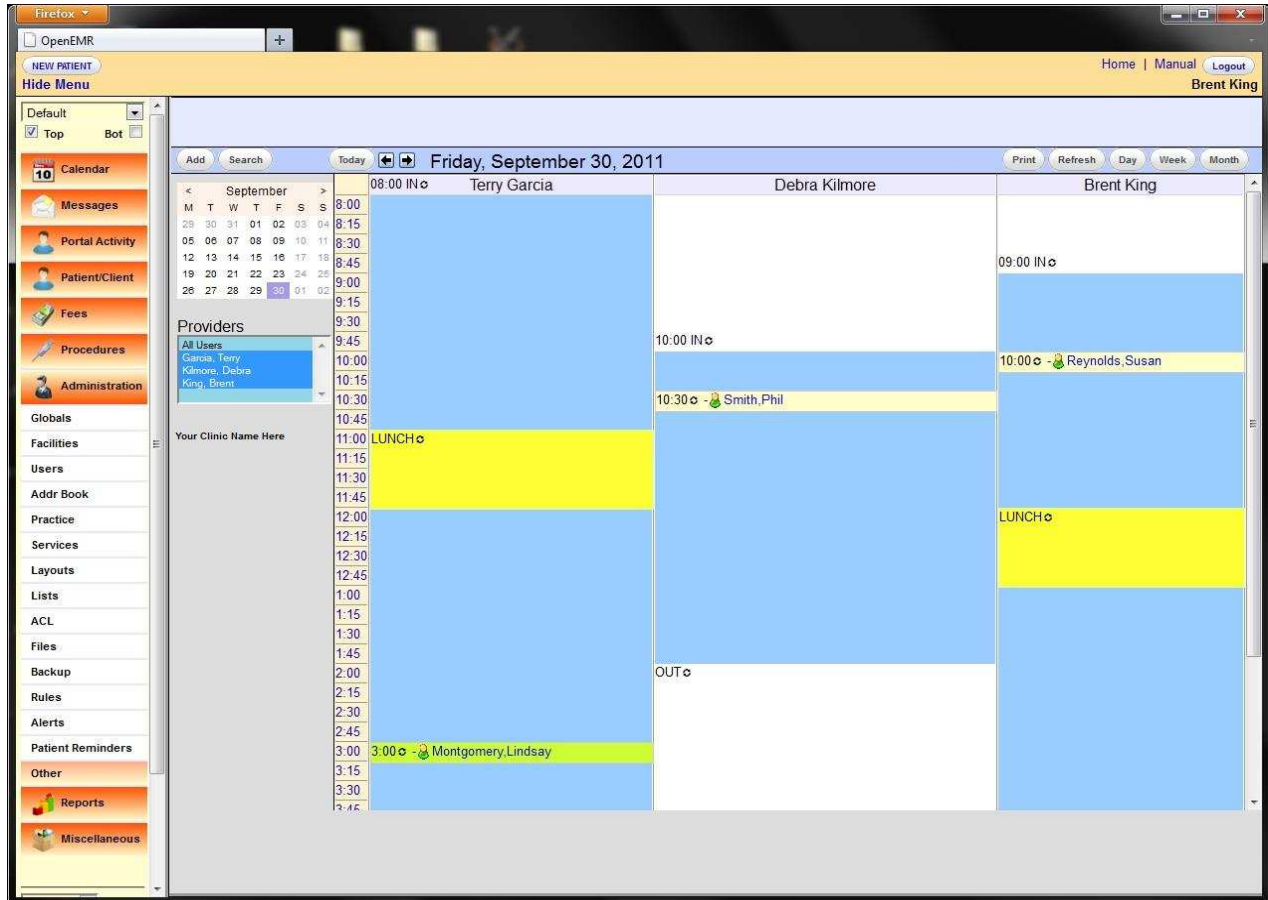


Figure 39. Schedule

[http://www.open-emr.org/wiki/images/thumb/4/40/OpenEMR-Calendar\\_4\\_1.jpg/800px-OpenEMR-Calendar\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/thumb/4/40/OpenEMR-Calendar_4_1.jpg/800px-OpenEMR-Calendar_4_1.jpg)

The calendar supports finding of open appointment slots, categories for appointment types which then can have different colors and restrictions. It also supports notification via email and SMS.

For the patient data OpenEMR supports patient demographics which contain primary information (such as name, date of birth, sex and identification), marital status, contact information of patient and patient's employer, primary provider, HIPAA information, language and ethnicity, insurance coverage, deceased tracking and is fully customizable.

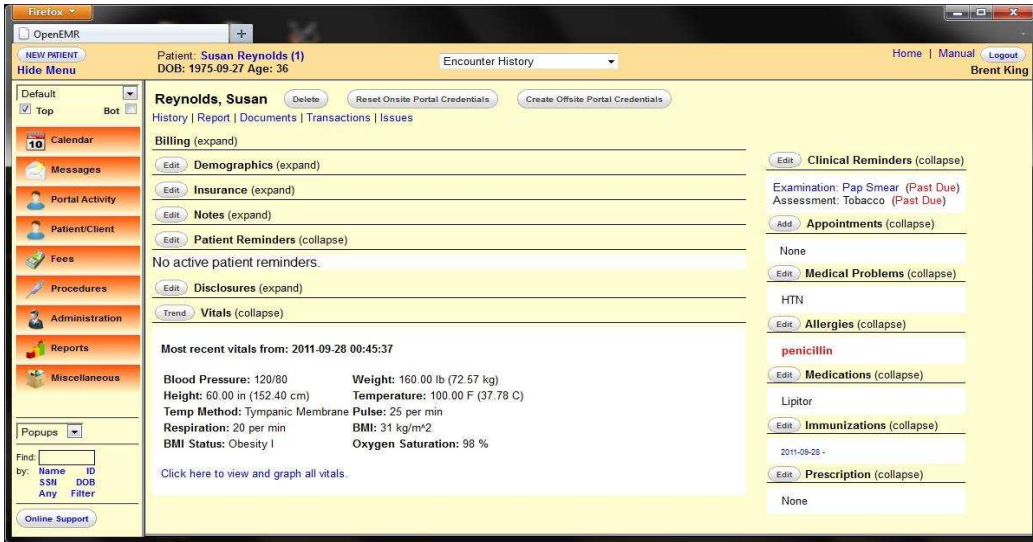


Figure 40. Patient overview  
[http://www.open-emr.org/wiki/images/thumb/b/b1/OpenEMR-Patient\\_Summary\\_4\\_1.jpg/800px-OpenEMR-Patient\\_Summary\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/thumb/b/b1/OpenEMR-Patient_Summary_4_1.jpg/800px-OpenEMR-Patient_Summary_4_1.jpg)

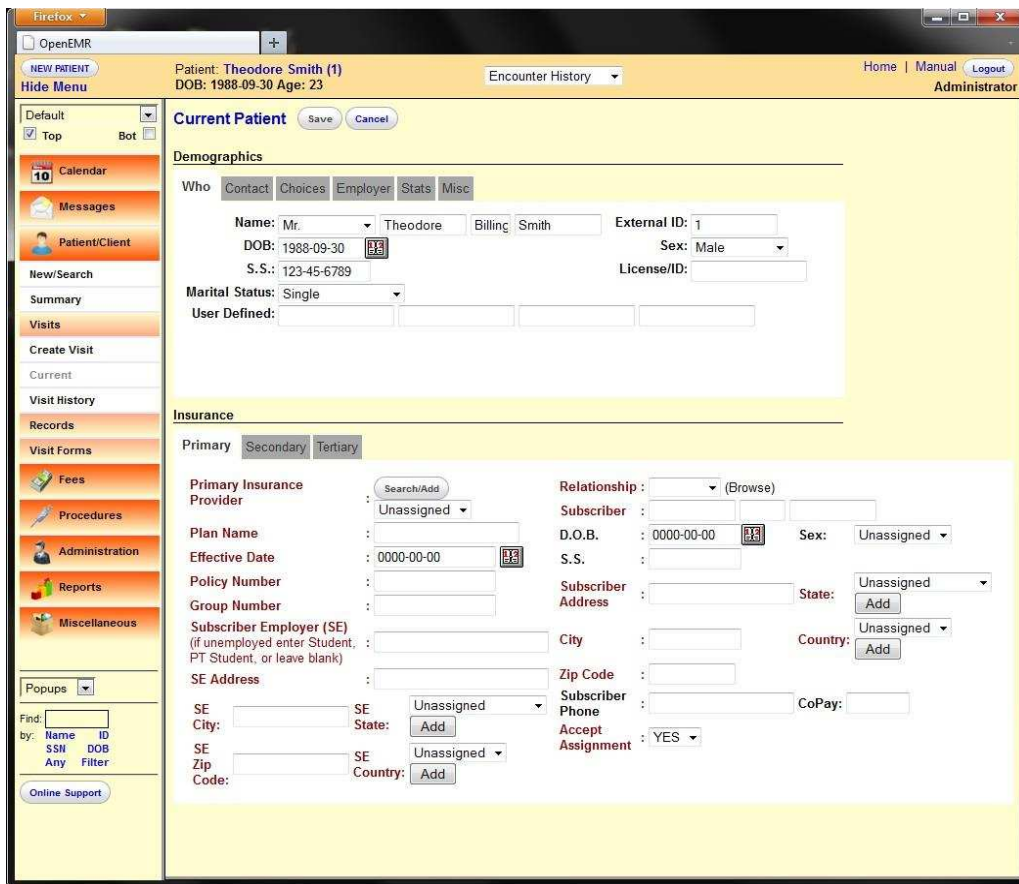


Figure 41. Patient's demographic  
[http://www.open-emr.org/wiki/images/thumb/7/7f/OpenEMR-Demographics\\_4\\_1.jpg/689px-OpenEMR-Demographics\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/thumb/7/7f/OpenEMR-Demographics_4_1.jpg/689px-OpenEMR-Demographics_4_1.jpg)



As mentioned before it is an EMR management system and therefore can handle all the data contained in an electronic medical record such as medical issues, medications, immunizations, vitals, laboratory data, reports and notes. It has also the possibility of graphical charting, voice recognition and even creating and customizing the forms for the data input.

NEW PATIENT Patient: John Kerry (6) Encounter History Home | Manual Logout  
 Hide Menu DOB: 0000-00-00 Age: 2011 Selected Encounter: 2011-09-30 (17) Brent King

Default Top Bot

Calendar Messages Portal Activity Patient/Client Fees Procedures Administration Reports Miscellaneous

Popups Find: by: Name ID SSN DOB Any Filter Online Support

Encounter Summary Administrative Clinical Layout Based

### Vitals

Name	Unit	09/30/2011 18:06:01	09/30/2011 18:05:50
Weight	lbs	140	140.00
Weight	kg	63.50	63.50
Height	in	62	62.00
Height	cm	157.48	157.48
BP Systolic	mmHg	150	120
BP Diastolic	mmHg	90	80
Pulse	per min	95	80
Respiration	per min	16	20
Temperature	F	98	100.00
Temperature	C	36.67	37.78
Temp Location		Oral	Oral
Oxygen Saturation	%	97	97
Head Circumference	in		
Head Circumference	cm		
Waist Circumference	in		
Waist Circumference	cm		
BMI	kg/m <sup>2</sup>	25.6	25.6
BMI Status	Type		Normal BL
Other Notes			

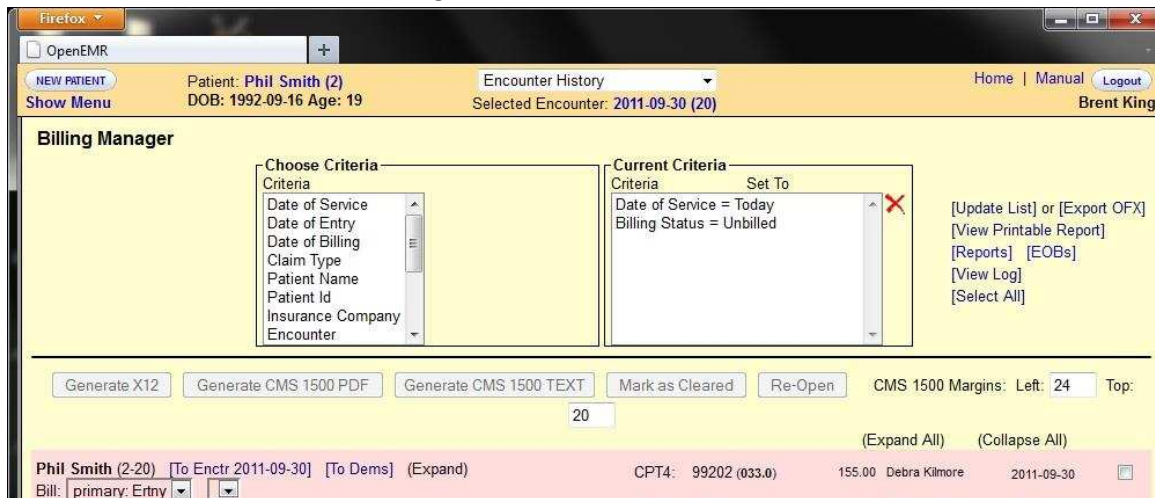
Save Form Don't Save

Figure 42. Patient's vitals

[http://www.open-emr.org/wiki/images/thumb/4/47/OpenEMR-Vitals\\_4\\_1.jpg/613px-OpenEMR-Vitals\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/thumb/4/47/OpenEMR-Vitals_4_1.jpg/613px-OpenEMR-Vitals_4_1.jpg)



There is also a form for medical billing:



A user also can easily use the

Figure 43. Billing system

[http://www.open-emr.org/wiki/images/thumb/d/d4/OpenEMR-Billing\\_4\\_1.jpg/800px-OpenEMR-Billing\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/thumb/d/d4/OpenEMR-Billing_4_1.jpg/800px-OpenEMR-Billing_4_1.jpg)

online drug search, track patients prescriptions and medications and create new as E-Prescribe, print, fax or email. There are also options for DEA, NPI and state license numbers. And support for In-house pharmacy dispensary.

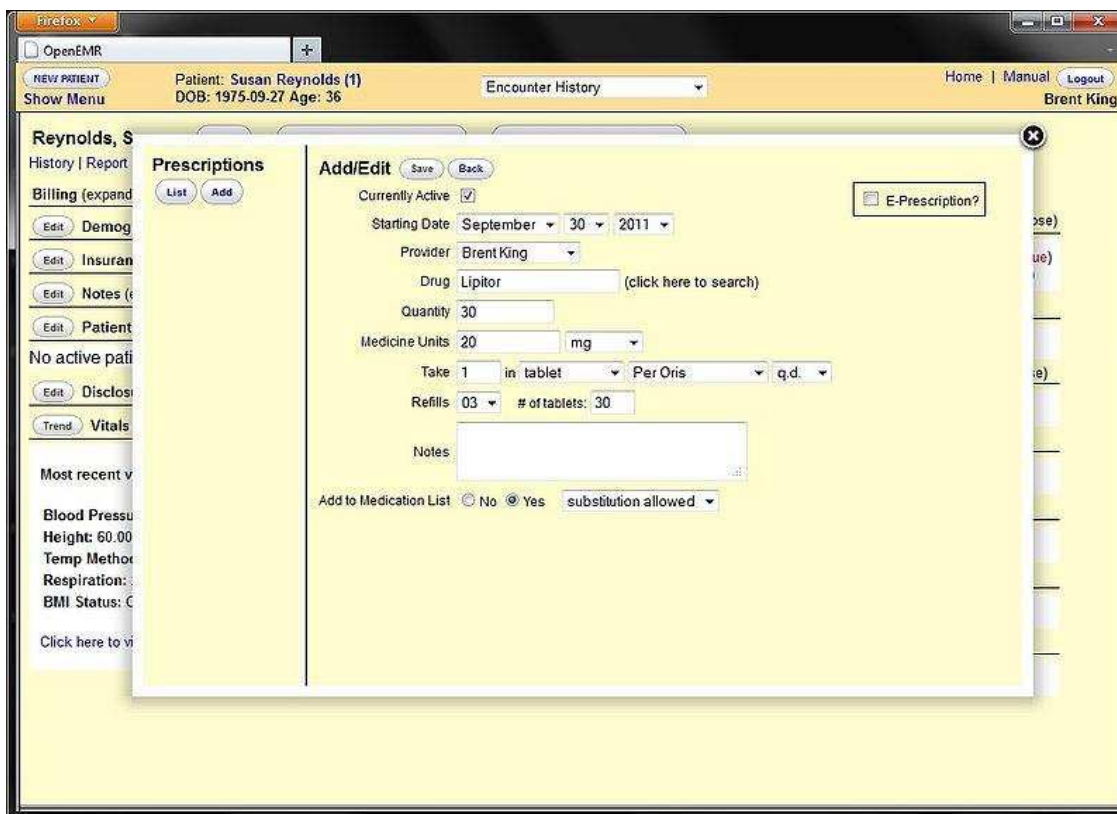


Figure 44. OpenEMR prescriptions

[http://www.open-emr.org/wiki/images/1/1e/OpenEMR-Prescription\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/1/1e/OpenEMR-Prescription_4_1.jpg)

An administrator can define clinical decision rules, these are reminders for actions like cancer screening, different diabetes examines and so on.

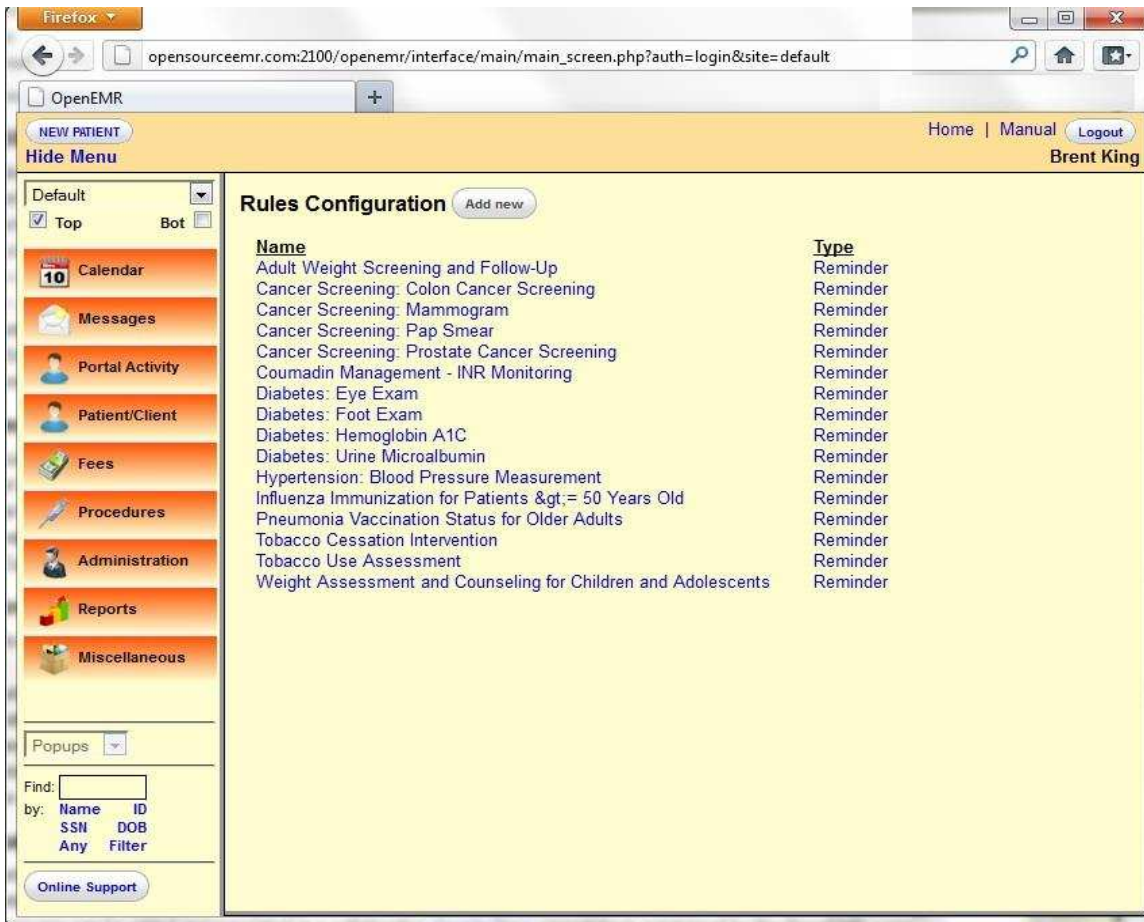


Figure 45. Configuring Rules  
[http://www.open-emr.org/wiki/images/4/4f/OpenEMR-CDR\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/4/4f/OpenEMR-CDR_4_1.jpg)

Another feature of OpenEMR are the reports, it can create reports for many purposes, as appointments, patient lists, prescriptions and drug dispensing, referrals, immunizations, clinical measure calculations, syndrome surveillance, pending procedure orders and ordered procedure statistics, paper chart tracking, sales, collections and insurance stuff.

**Report - Automated Measure Calculations (AMC)**

Begin Date:  End Date: 2011-10-06 00:59:46  
 Provider: -- All (Cumulative) --  
 Number labs (Non-electronic):

Title	Total Patients	Denominator	Numerator	Performance Percentage
Use CPOE for medication orders directly entered by any licensed healthcare professional who can enter orders into the medical record per state, local and professional guidelines. ( AMC:170.304(a) )	13	2	1	50%
Generate and transmit permissible prescriptions electronically. ( AMC:170.304(b) )	13	3	0	0%
Incorporate clinical lab-test results into certified EHR technology as structured data. ( AMC:170.302(h) )	13	0	0	0%
Maintain active medication allergy list. ( AMC:170.302(e) )	13	7	3	43%
Maintain active medication list. ( AMC:170.302(d) )	13	7	3	43%
The EP, eligible hospital or CAH who receives a patient from another setting of care or provider of care or believes an encounter is relevant should perform medication reconciliation. ( AMC:170.302(j) )	13	1	1	100%
Use certified EHR technology to identify patient-specific education resources and provide those resources to the patient if appropriate. ( AMC:170.302(m) )	13	7	1	14%
Maintain an up-to-date problem list of current and active diagnoses. ( AMC:170.302(c) )	13	7	4	57%
Provide patients with an electronic copy of their health information (including diagnostic test results, problem list, medication lists, medication allergies), upon request. ( AMC:170.304(f) )	13	3	0	0%
Provide clinical summaries for patients for each office visit. ( AMC:170.304(h) )	13	10	1	10%
Record demographics. ( AMC:170.304(c) )	13	7	1	14%
Record smoking status for patients 13 years old or older. ( AMC:170.302(g) )	13	7	2	29%
Record and chart changes in vital signs. ( AMC:170.302(f) )	13	7	4	57%
Send reminders to patients per patient preference for preventive/follow up care. ( AMC:170.304(d) )	13	3	0	0%
The EP, eligible hospital or CAH who transitions their patient to another setting of care or provider of care or refers their patient to another provider of care should provide summary of care record for each transition of care or referral. ( AMC:170.304(i) )	13	1	0	0%
Provide patients with timely electronic access to their health information (including lab results, problem list, medication lists, medication allergies) within four business days of the information being available to the EP. ( AMC:170.304(g) )	13	7	3	43%

Figure 46. Configure the automated measure calculations  
[http://www.open-emr.org/wiki/images/b/ba/OpenEMR-AMC\\_Report\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/b/ba/OpenEMR-AMC_Report_4_1.jpg)

## 6.2 Patient Account

As mentioned above, there is also a patient portal which has a slightly different login screen, and a different-looking simplified surface.

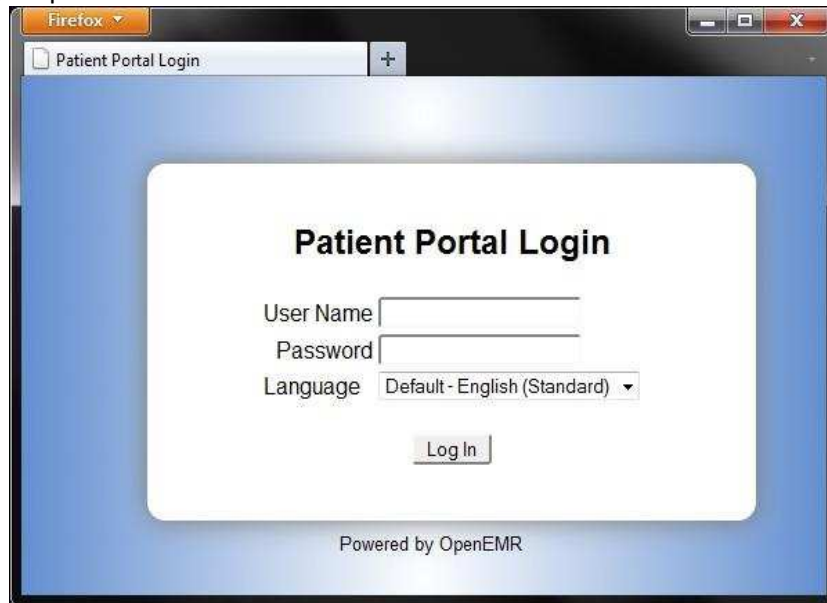


Figure 47. Patient Portal Login screen

[http://www.open-emr.org/wiki/images/6/65/OpenEMR-Patient-Portal-Login\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/6/65/OpenEMR-Patient-Portal-Login_4_1.jpg)



Figure 48. Patient Portal after logging in

[http://www.open-emr.org/wiki/images/e/e9/OpenEMR-Patient-Portal\\_4\\_1.jpg](http://www.open-emr.org/wiki/images/e/e9/OpenEMR-Patient-Portal_4_1.jpg)

Beside these features OpenEMR has the ability to encrypt patient documents and supports fine-grained per-user access controls. For the support there is an online documentation, a free support forum and IRC support channel and numerous of free and professional support options.

Web Links

Webpage: <http://www.open-emr.org/>

Demo: <http://demo.open-emr.org:2107/openemr/>

## 8. The Carrot

TheCarrot is a free online Platform that provides the user with a variety of possibilities for tracking his life, exercises, set goals, health, nutrition, overall fitness and medicine. The default format those events are depicted, is the calendar format, which with we are all somehow familiar. TheCarrot.com gives the User also the possibility to share his Health, exercise, medicine, and fitness, etc. information with care providers, community members and family. Of course this Information can also been kept private and only viewable from the user itself. This gives the opportunity to the User to have an overall view of his progress on his goals and create new goals or let the health provider set him future areas to improve in.

As TheCarrot.com is a more casual healthcare Platform it can be either used as a fitness tracker from individual Users. On the other side a more serious Use is not excluded as Doctors, Pharmacists, Nutritionists and Fitness trainers can demand a lot of details and information about the Users everyday life. This will help them to keep more track of the overall health situation the Patient is in and rearrange some goals, medicine dose, etc.

TheCarrot.com lets you track your health data, exercise progress, medicine doses in multiple and various ways. For example the user can share his information through text with his nutritionist, telling him what he ate and at what time of the day, can upload photos to the gallery, for his fitness trainer to keep track of his weight loss through the pictures and can send his doctor information about his health numbers by entering numerical data in pre made forms. TheCarrot.com gives you the possibility to track exercising time, distance and various other things as posting pictures to the private gallery through his cellphone App. The platform simplifies the task of tracking nutrition, medication data and fitness for both parties. The User who also is the patient and the Doctors, trainers, nutritionists who are the healthcare team.

TheCarrot.com is protecting privacy of its Users. Personal Data and Health records are being kept fully encrypted on the Server and will not be shared with third parties. VeriSign certified, TheCarrot.com uses a 128-bit SSL network encryption for Internet Security.

There is not a lot of Information about the Programming Language TheCarrot.com is implemented in, also which variety of Health Care Standards it fills, the minimum Requirements on the Web Server side and the internal Structure of the Platform. From the research we did, we actually found out, that it's free to use as an individual User, Healthcare Providers can build trackers for their Patients for low cost accounts. As the User can log in from the Web Browser, the Operating System used by the User is entirely irrelevant. Unfortunately at this moment, the only mobile operating System, the mobile App exists is iOS for Apple devices. Plans about porting the App into Android OS, mobile Windows OS and Blackberry OS are not known.



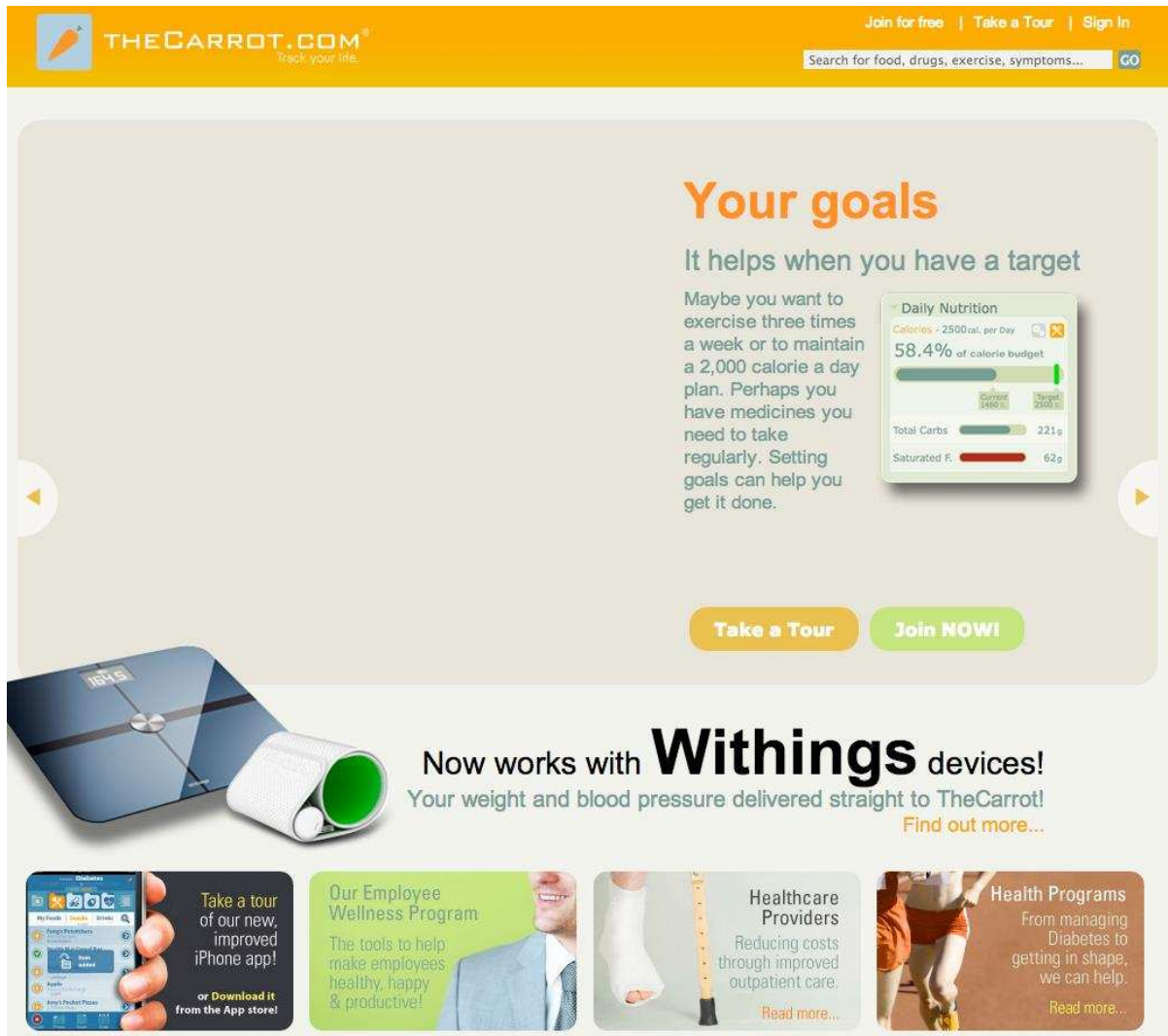


Figure 49. TheCarrot main page [http://thecarrot.com/]

The Login to the Platform is very easy. The User has just to open the exact link [http://thecarrot.com/] for site. On the Site there is a lot of Information. You can take a Tour through the possibilities the platform offers, get more information about the mobile App, Healthcare Providers Program, already available Programs for losing weight etc., a search bar and a Join for free Button.

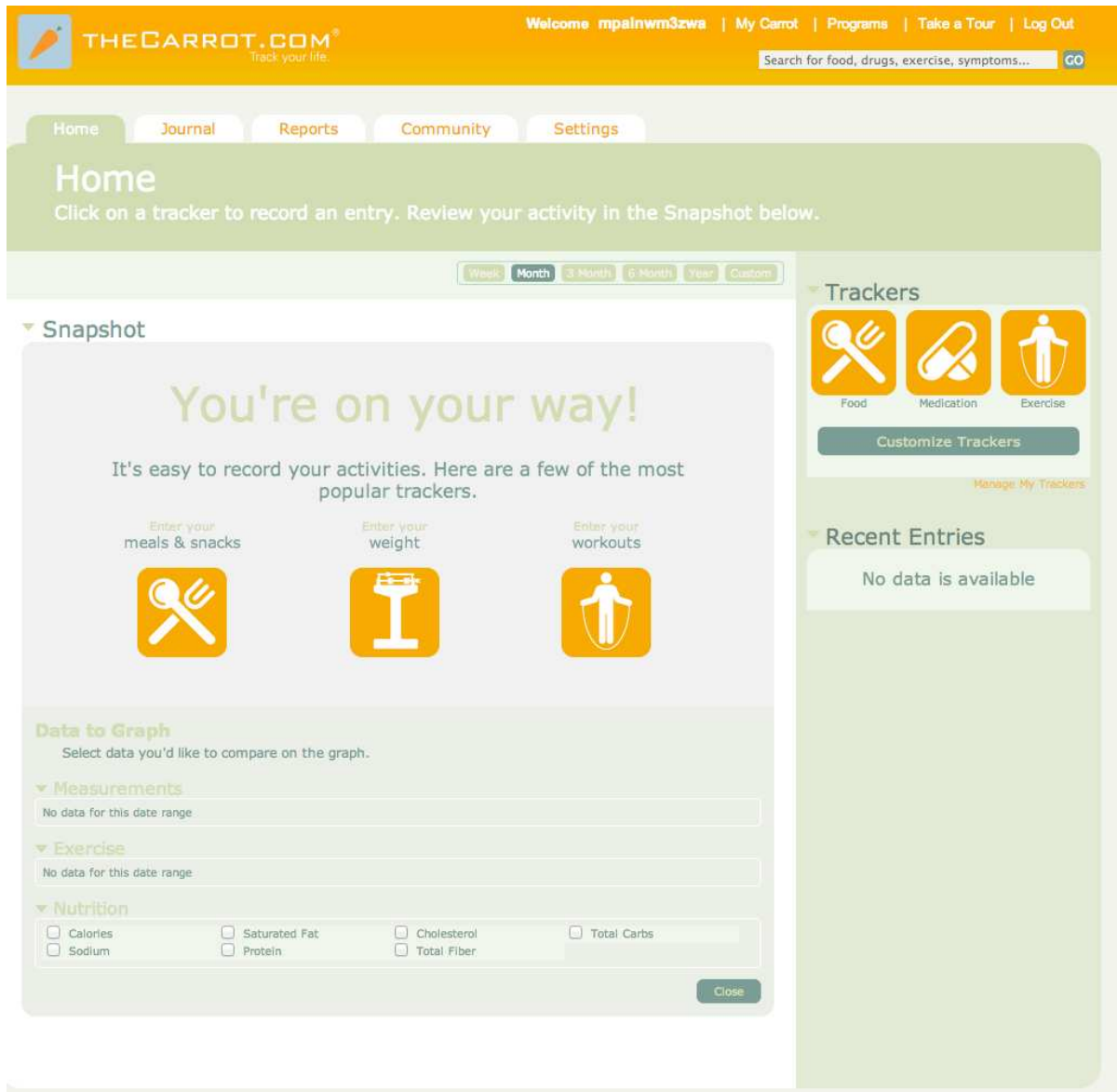


Figure 50. Home-screen after logging in

At the Default Home-screen the User gets a lot of Tabs to work with. Home which leads the User to the Home-Screen, Journal in which the User gets the Calendar view and he can insert his Meals, Reports in which he can take his feedback from the healthcare providers he is accustomed of. The Community Tab where he can Share his Photos and Information with TheCarrot.com Community and the Settings Tab where a lot of the viewed Information Format can be altered.

Quick navigation through the trackers is enabled as the User can click on Food, Medication or Exercise tracker, view the Recent Entries of his healthcare Team. Data can also be entered pretty fast and a Graph of the Progress is available if there is enough Information entered.



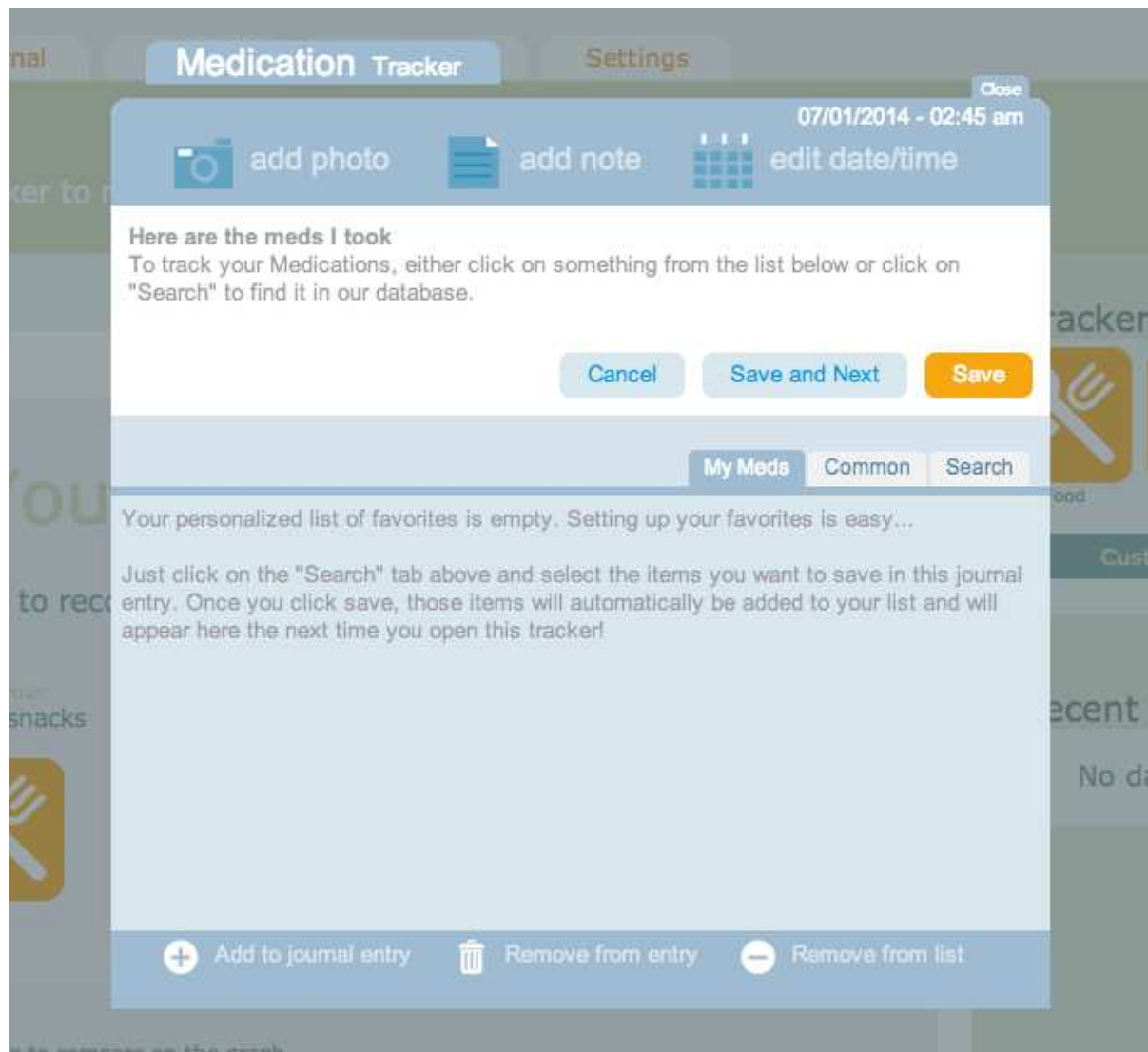


Figure 51. Medication tracker

Using the Medication Tracker the User gets a modal Window. Here he can keep track of the Medication he uses, the Date and add some Notes for the Doctors. My Meds Tab handles the most used Medication from the user. In the Common Tab the User can look for Medication he uses in a variety of widely and most common used Medication of the platform Users. In the Last tab a search bar is available for quick search results on Medication. Entering Medication and Doses on a weekly schedule will affect the Data Graph on the Welcome Page and also will be taken as Information from the Medical Team.

The screenshot shows the 'Journal' view in the Carrot system. At the top, there is a navigation bar with 'Home', 'Journal', 'Reports', 'Community', and 'Settings'. Below this is a search bar with the text 'Search for food, drugs, exercise, symptoms...' and a 'GO' button. The main content area is titled 'Journal' and displays a calendar view for Tuesday, Jul 1, 2014. The calendar is a grid with columns for days of the week and rows for dates. The main content area is a vertical timeline with time slots from 12 AM to 8 PM. Each time slot is labeled with a meal or snack name: Midnight Snack, Dawn Snack, Breakfast, Morning Snack, Lunch, Afternoon Snack, Dinner, and Evening Snack. To the right of the timeline is a sidebar with a 'Calendar' widget showing the month of July 2014, a 'Trackers' section with icons for Food, Medication, and Exercise, and a 'Recent Entries' section showing 'No data is available'.

Figure 52. Journal View in the carrot system

The Journal Tab gives the user the previous mentioned „familiar calendar view“- layout. The User now mainly enters his Information through this Layout so he can keep track of the Medication he uses, the Food he eats and the Nutrition he takes after every Meal. The projected Layout then gives the possibility for Entries of Meals, the amount of a food type and various Information, which leads to important Data such as calories, sodium, proteins, fat, total carbs, fiber, cholesterol, etc. taken by the patient.

In the Reports Section the User gets all his important Feedback from the Health Care Team. He can get Complete Reports for him to track his eating habits, the Calories he takes and various important Information. Hyperextension enables a report with more medical related Information to be reported to the Patient, as blood pressure, heart-rate etc. various Information that is being generated through the Information the User in inputting by tracking his exercise. At last there is the Diabetes Report which can be manipulated and tracks Information about the Users health condition and the illness.

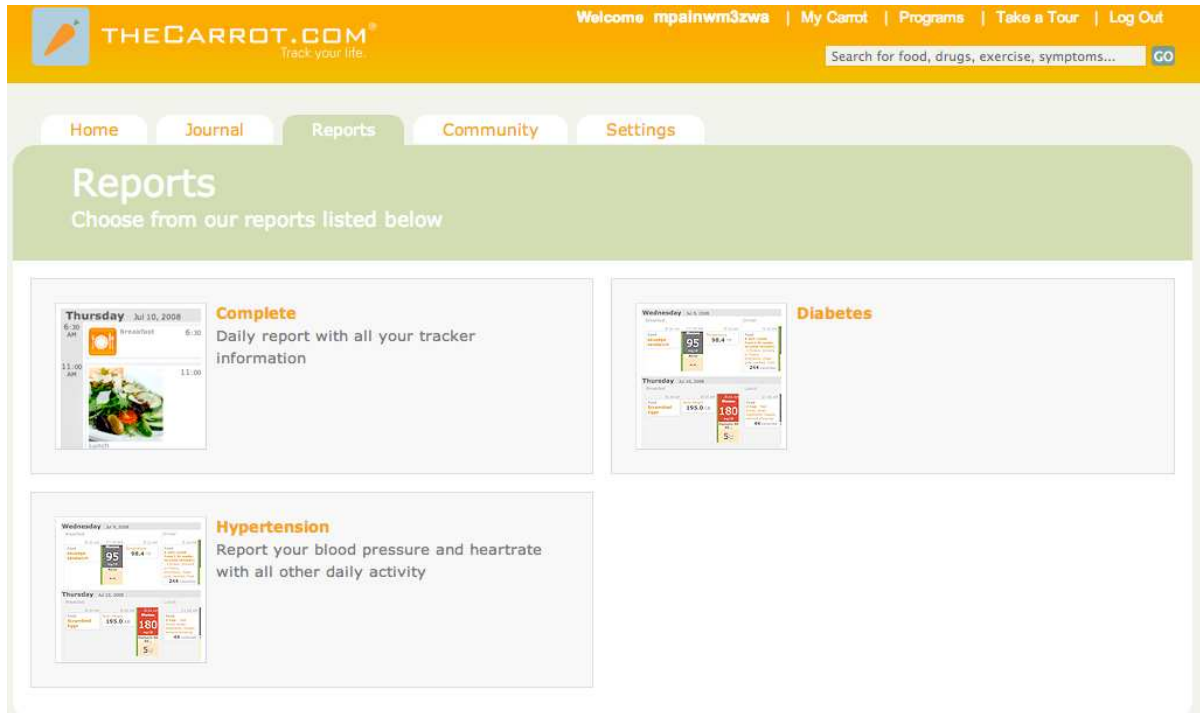


Figure 53. Reports provided by the carrot system

The Reports Section isn't limited to those three types of Reports. The more Trackers are being joined from the User and information is being inputted, more Reports will be available in this Tab. For example Flu, Food, Body, Vitals, Fitness etc. Trackers, will upload their own reports, as long the trackers are kept being fed with proper information.

In the Settings Tab we get a lot of Options to change and possibilities for modifications. Pre-made Trackers are available for to add and use. The most common Categories can be found in the left Column named „Tracker Categories“. In the Middle of the Screen All Trackers can be scrolled through. The two possible Options allow the User to either Try or Add the Tracker to his Settings. Interesting fact is that a new Tracker can be suggested TheCarrot.com Team and maybe add to the „All Trackers“ list. Actual available Trackers : Activity, Body Measurements, Energy Level, Exercise, Flu, Food, Job Satisfaction, Medication, Meditation, Mood, Notes, Pain, Sex, Sleep, Smoking, Steps, Symptoms, TV, Wake Ups, Blood Pressure, Heart Rate, Body Fat, Body Height, Body Temperature, Body Weight, Cholesterol, Fasting Glucose, HbA1c, Asthma, Diabetes, Hypertension, Migraine, Swine Flu, Menopause, Menstrual Cycle, Ovulation, Pregnancy, Smoking-Post Quit, Socializing, Bicycling, Running, Walking. There is a lot of diversity in the Pre-made Trackers. There are also Programs that can be joined to monitor the Users Heart Health, Diabetes, Weight management, Fitness and Smoking habit. Services to get information send directly to somebody's devices is also possible.

The screenshot shows the 'All Trackers' page on thecarrot.com. The page features a navigation bar at the top with 'Home', 'Journal', 'Reports', 'Community', and 'Settings'. Below this is a secondary navigation bar with 'Trackers', 'Programs', 'Services', 'Account', 'Preferences', and 'Favorites'. The main content area is titled 'All Trackers' and lists 11 different tracker categories, each with a brief description and 'Try' and 'Add' buttons. The categories are: Activity, Body Measurements, Energy Level, Exercise, Flu, Food, Job Satisfaction, Medication, Meditation, Mood, and Notes. On the left side, there is a 'Tracker Categories' sidebar with options like 'All Trackers', 'General', 'Vitals', 'Body', 'Lab', 'Conditions', 'Women's Health', 'Health Programs', and 'Fitness'. On the right side, there is a 'Calendar' for July 2014 and a 'Trackers' section with icons for Food, Medication, and Exercise, along with a 'Recent Entries' section that currently shows 'No data is available'.

Figure 54. Overview of all trackers which can be added

Web Links

Webpage: <http://thecarrot.com/>

## 9. Mirth Connect / DHIS2

In Addition to the already mentioned Health Care Systems there are a lot more available, many of them are open source and for the most part these systems are accessible via the internet browser and therefore on every common operating system. Even if they don't have an explicit interface for smartphones and tablets the web contents can be accessed from such devices.

There are also other kinds of applications like for example DHIS 2 which is not a tool for individual health care reports but for health management, analysis and health program monitoring. It has interfaces for desktops, laptops, tablets and smartphones.

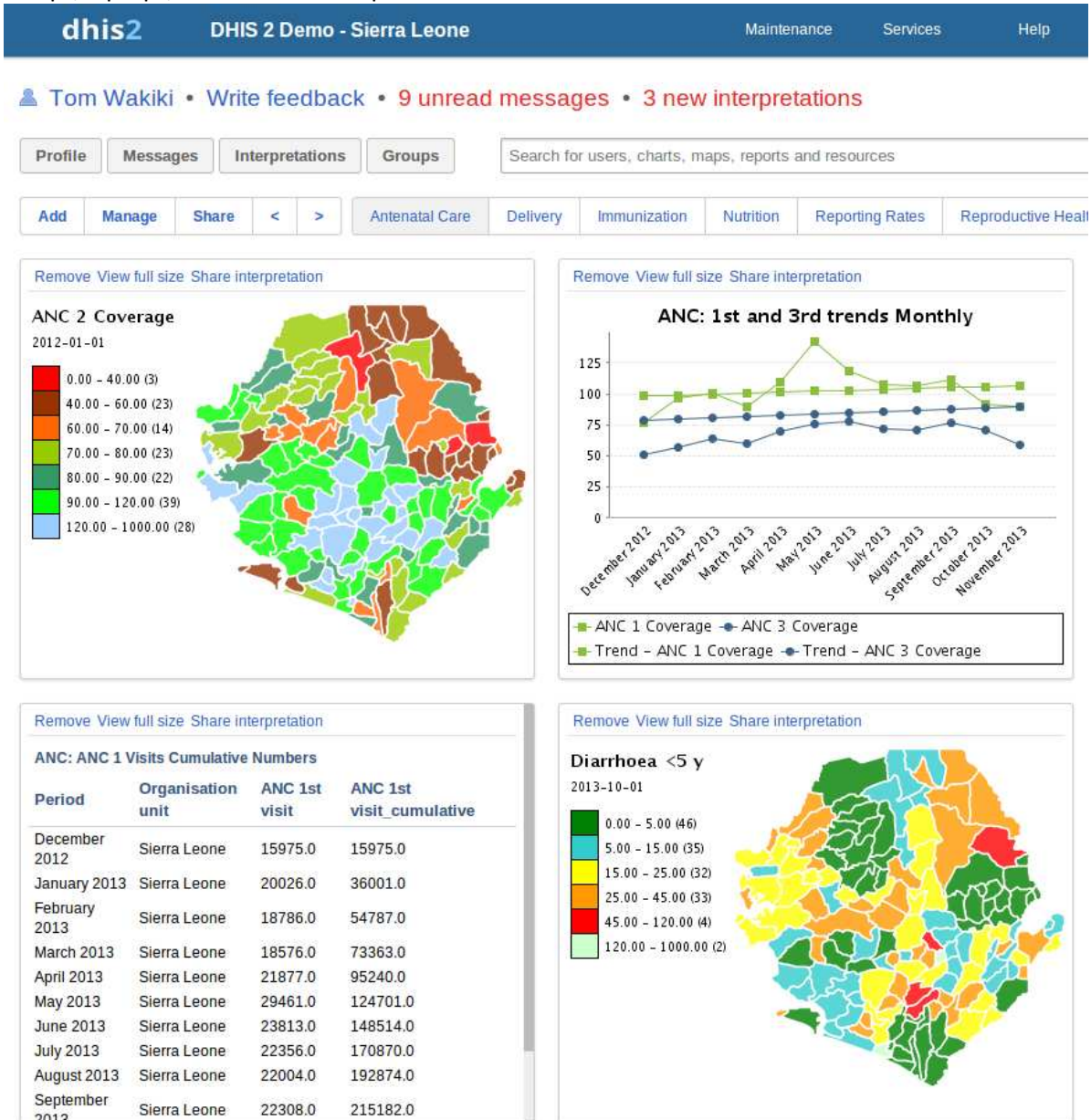


Figure 55. DHIS 2 Demo  
<https://www.dhis2.org/sites/all/themes/dhis/images/dashboard.png>



Mirth Connect is software that works as a router, filter and message transformer between different health care systems. So it can receive Data from different systems and send them to other systems and even change the format or store it in an internal database. For transportation it supports MLLP, TCP/IP, HTTP, Files, Database, S/FTP, Email, JMS, and Web Services, PDF/RTF documents and custom Java and JavaScript stuff. And beside these transport protocols it also supports several message standards. These are: HL7 v2.x, HL7 v3, XML, X12, EDI, DICOM and NCPDP.

As it is based on Java it is more or less platform independent, as long as there is a Java Runtime Environment available.

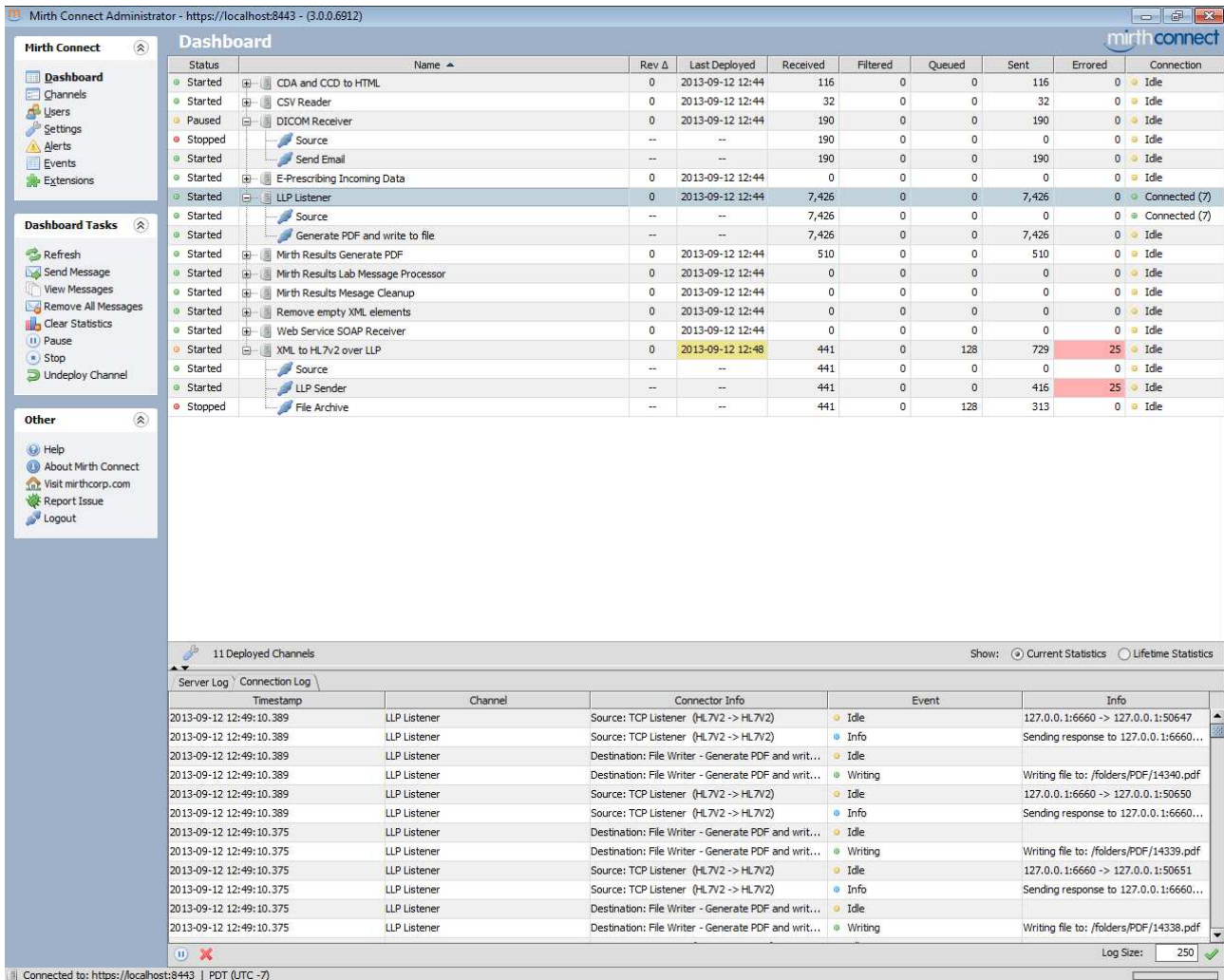


Figure 56. Mirth Connect Administrator System  
[http://www.mirthcorp.com/wp-content/gallery/mirth-connect/dashboard\\_0.png](http://www.mirthcorp.com/wp-content/gallery/mirth-connect/dashboard_0.png)

Web Links

Webpage: <http://www.mirthcorp.com/>

Webpage: <https://www.dhis2.org/>

## 10. Comparison

Name	Advantages	Disadvantages
<b>OpenMRS</b>	Open source Worldwide community Web based Platform independent Best design Easy to use	No patient accounts Only English
<b>Caisis</b>	Open source Web based Promotes standards Used worldwide (reliable) neat design good database search options	No patient accounts Primary developed for cancer Only English (extensible) Asp.Net, needs Microsoft Products
<b>Nosh</b>	Open source Web based Platform independent Internal message and calendar design Good bill support Multiple accounts (doctor, patient)	
<b>MS HealthVault</b>	Access family data Keep track of vitals history	Closed Source No control over data No doctor accounts
<b>OpenEMR</b>	Open source Web based Many languages Many features (voice, graphs) Multiple accounts Good bill support Automatic report generation	
<b>The Carrot</b>	Set health goals	Closed Source

Table 1. Comparison

OpenMRS is a strong, intuitive, web based, open source electronic health platform. It is supported by a worldwide community and entirely web based and based on Java which makes is platform independent. Another great aspect of OpenMRS is the way it feels and looks, it is very intuitive and easy to add new patients to the system. On the other hand OpenMRS is heavily based on visits, it does not support user or patient account, so updating any data requires to visit or at least contact a doctor. OpenMRS is only available in English but due to the fact of being open source also translated into other languages.

Caisis is also an open source, web based electronic health platform. It has been primary developed for cancer patients, being already used worldwide demonstrates the reliability of the system. It is easy to add new users to the system or to search for diseases or to set medications. It also offers a neat look and feel but is not as self-explaining as OpenMRS. Concerning language and patient accounts it is similar

to what we know from OpenMRS already, no patient account and only English but at least the language is extensible. Caisis is written in C# and therefore requires support for .NET and a Microsoft SQL Server, so the system itself may be free but one needs licenses for the Microsoft Products to host a Caisis system.

Nosh is another open source and platform independent system and despite feeling like using a desktop application entirely web based. One can add new accounts to the system, not only doctor account but furthermore patients or assistants which can e.g. raise an invoice. Nosh offers many features e.g. an internal message system with a calendar where patients can arrange their appointments online. In the end Nosh seems as a very solid system which is easy to use after time.

In comparison to the previous discussed system Microsoft HealthCare offers less required features for our research topic. It is not open source and does not even offer dedicated doctor accounts, instead each user can add another account as doctor. It offers a simple and neat look and has the ability to keep track of previous entered data. One can also store health and fitness info for other users and one's family. Being closed source one cannot keep track of the data or decide where and how they are stored. So we would definitely not recommend Microsoft HealthVault.

OpenEMR is written in php and therefore being a platform independent web based, open source platform. In comparison to Nosh, OpenMRS and Caisis it supports multiple languages and even more can be added to the system. As the name claims it can handle all the EMR data and supports graphical charting and even voice recognition. Administrators can create rules and reminders, e.g. several examinations needed for cancer or diabetes patients and furthermore he can create reports for all types of statistics. Patients have dedicated accounts which are quite simple to use compared to the doctor account, since they only need to access their own data. The only drawback might be the old style and the fact that it sometimes seems to be overloaded, otherwise OpenEMR is a great platform offering great features.

TheCarrot at last was the "best looking" Healthcare application we tested throughout this study. With an "intuitive" Appearance and a very helpful walkthrough in the beginning the user learns to use the platform in a playful way. The Carrot uses its own Database and we are not quite sure whether this might change when using the paid version. Also we don't know if there are more possibilities to interchange with other Platforms Information in the Health Level Seven Standard format, as it is nowhere mentioned. Patient's accounts are free to use with an easy sign up. To sign up as a doctor a license must be bought for commercial use, which we didn't do, so we are testing this Platform from the free user point of view. At the very End this Platform is in our opinion not suited for using in serious and big Organizations as it is not open source and there is no possibility to easily change the code and adapt it to the special uses of every user.

In the end we wanted to recommend a system that is open source and also features dedicated patient and doctor accounts. So the only two remaining systems are OpenEMR and Nosh. Both have nearly the same features whereas OpenEMR offers the ability for voice recognition, which is not that important since neither the doctor nor any assistant will use this feature during work time. On the other hand Nosh offers the same core features as well as an internal calendar and appointment system and a modern and neat design interface which is quite easy to use. In the end the user has to decide whether he wants Nosh or OpenEMR but we choose Nosh as best platform since it's good look and many features.



## 11. Conclusion

Going through this professional study we took a lot of things with us. In the Beginning most of our group members didn't know that Healthcare Platform existed in this way. We always thought of the Data that has being processed by various healthcare Providers as raw "chunks" of Data which consisted of this (the Patients' Health) Information.

After looking up the Definition of the Health Level Seven Norm we were astonished how much thought have been put behind all this. The healthcare branch of IT Industry had put a lot of effort and time to build those "interfaces". The simple fact that this standards were (and are being) fabricated in a clean software process, to provide safe and fast information exchange channels, was all new to us. We haven't thought that the IT business field had this much of an impact in this field. Also reading the history of the inventors of the Health Level Seven standards a lot of things left us speechless because of the very early thoughts to build something unique that would help to make everybody life easier.

Some Members of our study team didn't even know that Healthcare Platforms existed. On the other side the members knowing, or having heard about those software projects didn't know the degree of evolution they had achieved. Conducting the Study and various surveys, reading about this free Projects and even trying the most of them (for the sake of the study) learned us a lot of things. The most of us wondered how many People didn't know about Projects like this existed.

Having tested a lot of free Healthcare Platforms (most of them with available demo accounts) we came to the Conclusion that the open source Projects are to prefer compared to closed sourced Projects (which many times needed a license to unlock features and Options). We would not recommend to use any closed source system we tested during this study. The Benefits of open source projects are that there are a lot of application interfaces left open, giving the opportunity to an IT company to change and improve some passages of code. In this aspect having a finished, tested, safe and very easy to use application, which can be adjusted with a few modification to the users need, is a very powerful advantage. Also many of the close sourced Projects did not allow full functionalities to the user, unless he bought a license, which in our opinion is a downside of using those Projects in massive user organizations as hospitals and health insurances.

What are the benefits of Programs like this? This was the question we asked each other on the beginning of this study. Having spent a serious amount of time researching, searching, testing, comparing, evaluating and using (in some different modes) different healthcare platforms we are now asking ourselves the opposite question. How is it even possible to work without projects like this? Everything needed is there, implemented and accessible through a terminal. The internal organization and tools to support it, of a Healthcare Organization (hospital), the patients records, the upcoming schedules, Amount of medicine taken, possible consequences of the patients treatment, etc. All this Information accessible from everywhere (if somebody has the rights to access it) and interchangeable between different establishments.

After giving it a second thought, the members of this study team learned a lot of things. Standards that are imposing the Interfaces and form of data being processed and send, platforms that give somebody enormous possibilities to work with, internal organization tools and patient treatment sections. In the end we were really astonished how much the IT Branch of Industry has played an important role in the healthcare branch and had a great impact of forming it in some ways, as it is today.

## Table of Figures

All figures without any reference has been created by ourselves by visiting the corresponding webpage. Otherwise the reference is given below the figure and here in the table of figures.

Figure 1. Specific models and communication interfaces <a href="http://www.consortzioedith.it/public/immagineDocHisa.bmp">http://www.consortzioedith.it/public/immagineDocHisa.bmp</a> .....	8
Figure 2. Login screen for the OpenMRS Platform .....	11
Figure 3. Welcome Page, logged in the Inpatient Ward .....	12
Figure 4. Patient record overview.....	12
Figure 5. Private patient's record note .....	13
Figure 6. Overview of the last patient's visits .....	14
Figure 7. Editing a visit note.....	15
Figure 8. Another overview of the past visits .....	16
Figure 9. Active visits listed.....	17
Figure 10. Registering a new patient .....	17
Figure 11. Caisis Login Screen .....	19
Figure 12. Welcome Page in Caisis.....	20
Figure 13. Overview of the patient's data .....	21
Figure 14. Registering a new patient in Caisis .....	22
Figure 15. Overview of all patients .....	23
Figure 16. Login Screen for the Nosh Platform.....	25
Figure 17. Welcome Screen for a provider in NOSH.....	26
Figure 18. Message Overview in NOSH.....	26
Figure 19. Calendar and schedule option for appointments .....	27
Figure 20. Example appointment in the calendar.....	28
Figure 21. Scheduling an appointment.....	28
Figure 22. Demographics overview and edit option.....	29
Figure 23. Medications handling in NOSH .....	29
Figure 24. Financial section in NOSH .....	30
Figure 25. Office Tools to handle the inventory and import and exports of files in NOSH .....	31
Figure 26. An appointment in the view of an assistant .....	32
Figure 27. Welcome Page as patient (here: Child Boy).....	33
Figure 28. An appointment in the view of the patient .....	33
Figure 29. Listed issues .....	34
Figure 30. MS HealtVault after logging in .....	35
Figure 31. Editing a person's weight in MS HealthVault.....	35
Figure 32. Emergency profile in MS HealthVault.....	36
Figure 33. Editing Allergy information in MS HealthVault .....	36
Figure 34. List of several provided measurements.....	37
Figure 35. Health History in MS HealthVault .....	37
Figure 36. Look at the records history .....	37
Figure 37. The User's home page in MS HealthVault .....	38
Figure 38. Login Screen in OpenEMR.....	40

Figure 39. Schedule <a href="http://www.open-emr.org/wiki/images/thumb/4/40/OpenEMR-Calendar_4_1.jpg/800px-OpenEMR-Calendar_4_1.jpg">http://www.open-emr.org/wiki/images/thumb/4/40/OpenEMR-Calendar_4_1.jpg/800px-OpenEMR-Calendar_4_1.jpg</a> .....	41
Figure 40. Patient overview .....	42
Figure 41. Patient's demographic .....	42
Figure 42. Patient's vitals <a href="http://www.open-emr.org/wiki/images/thumb/4/47/OpenEMR-Vitals_4_1.jpg/613px-OpenEMR-Vitals_4_1.jpg">http://www.open-emr.org/wiki/images/thumb/4/47/OpenEMR-Vitals_4_1.jpg/613px-OpenEMR-Vitals_4_1.jpg</a> .....	43
Figure 43. Billing system <a href="http://www.open-emr.org/wiki/images/thumb/d/d4/OpenEMR-Billing_4_1.jpg/800px-OpenEMR-Billing_4_1.jpg">http://www.open-emr.org/wiki/images/thumb/d/d4/OpenEMR-Billing_4_1.jpg/800px-OpenEMR-Billing_4_1.jpg</a> .....	44
Figure 44. OpenEMR prescriptions <a href="http://www.open-emr.org/wiki/images/1/1e/OpenEMR-Prescription_4_1.jpg">http://www.open-emr.org/wiki/images/1/1e/OpenEMR-Prescription_4_1.jpg</a> .....	44
Figure 45. Configuring Rules <a href="http://www.open-emr.org/wiki/images/4/4f/OpenEMR-CDR_4_1.jpg">http://www.open-emr.org/wiki/images/4/4f/OpenEMR-CDR_4_1.jpg</a> ..	45
Figure 46. Configure the automated measure calculations <a href="http://www.open-emr.org/wiki/images/b/ba/OpenEMR-AMC_Report_4_1.jpg">http://www.open-emr.org/wiki/images/b/ba/OpenEMR-AMC_Report_4_1.jpg</a> .....	46
Figure 47. Patient Portal Login screen <a href="http://www.open-emr.org/wiki/images/6/65/OpenEMR-Patient-Portal-Login_4_1.jpg">http://www.open-emr.org/wiki/images/6/65/OpenEMR-Patient-Portal-Login_4_1.jpg</a> .....	47
Figure 48. Patient Portal after logging in <a href="http://www.open-emr.org/wiki/images/e/e9/OpenEMR-Patient-Portal_4_1.jpg">http://www.open-emr.org/wiki/images/e/e9/OpenEMR-Patient-Portal_4_1.jpg</a> .....	47
Figure 49. TheCarrot main page [ <a href="http://thecarrot.com/">http://thecarrot.com/</a> ] .....	50
Figure 50. Home-screen after logging in.....	51
Figure 51. Medication tracker.....	52
Figure 52. Journal View in the carrot system.....	53
Figure 53. Reports provided by the carrot system .....	54
Figure 54. Overview of all trackers which can be added .....	55
Figure 55. DHIS 2 Demo <a href="https://www.dhis2.org/sites/all/themes/dhis/images/dashboard.png">https://www.dhis2.org/sites/all/themes/dhis/images/dashboard.png</a> .....	56
Figure 56. Mirth Connect Administrator System <a href="http://www.mirthcorp.com/wp-content/gallery/mirth-connect/dashboard_0.png">http://www.mirthcorp.com/wp-content/gallery/mirth-connect/dashboard_0.png</a> .....	57

## **Declaration**

I hereby declare that the work presented in this thesis is entirely my own.

I did not use any other sources and references than the listed ones. I have marked all direct or indirect statements from other sources contained therein as quotations.

Neither this work nor significant parts of it were part of another examination procedure. I have not published this work in whole or in part before.

The electronic copy is consistent with all submitted copies.

Signature:

Stuttgart, 15.09.2014